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ABSTRACTS
MINUTES
BY-LAWS
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BUILDING THE MARKET FOR PEANUTS

by

Laurel C. Meade, Acting General Sales Manager,
Export Marketing Service, U. S. Department of Agriculture

As an Indiana farmer and seedsman, corn and soybeans were the most important crops to me. Peanuts were good to eat but rather far from a basic commodity in my view. The peanut program, from what I heard about it, probably was not too sound.

During the past nine months I have become acquainted with many of the fine people in this industry. I now feel I understand the importance of peanuts and the peanut program.

Peanuts, in the major producing areas of that commodity, are more important than corn and soybeans. There is no question they are more profitable for the farmer than other adapted commodities. They are the major source of farm income which underlies the economy of those communities.

As scientists, your pleasure and satisfaction come from discovery and accomplishment through research. The two-fold increase in yield and production of peanuts over the past fifteen years is evidence of your success and of the value of your work.

Production and marketing are more efficient now than in past years. Quality is better. Farm income is higher. Larger quantities are available to fill growing consumer demand for a cost related to a farm price down from 90 to 75 percent of parity; and to lower kernel costs coming out of the higher kernel content of the unshelled peanuts delivered by producers. In total these items reflect a cost reduction, relatively, of 20 to 25 percent for consumers.

I hope your contributions toward more efficient production and marketing of peanuts will be continued and enlarged in the future. Let us hope, also, that growth in demand can keep pace with that of production -- and not lag as it has for the past ten years.

It was suggested that I discuss: the supply-demand situation; the impact of the florunner variety; the pricing system or "differentials" and other subjects.

My emphasis will be mainly on the other subjects. Let me comment first on the other points.

First, the supply-demand situation - the peanut program is designed to maintain an adequate and stable supply for the domestic food market in this country. Price supports are related to the use and value of peanuts for food in this country. The law fixes a minimum acreage allotment and a minimum price support level. In large part because of your fine work, production on this minimum allotment has been moving up much faster than the food use of peanuts. As a consequence, there is a substantial surplus of peanuts which are sold for crushing and export at prices related to the world market value of peanuts crushing for oil and meal. This value is less than one-half of our support price.

In 1960-61, food use of peanuts in this country was 849 million pounds, shelled basis. In 1970-71 it was 1,155 million pounds - an increase of 36 percent. The average annual increase was about 3.1 percent.

At the same time CCC diversion for crushing and export rose from 165,000 tons to around 580,000 tons - an increase of 250 percent; and CCC program cost rose from $19 million to over $80 million - an increase of about 400 percent.

The peanut program maintains prices well above levels that would prevail without a program. It makes peanuts substantially more profitable than alternative crops and enterprises - at a substantial and rising cost to the U. S. Treasury.

The florunner variety has, as I have already indicated, contributed to more efficient production of peanuts. The farmer gets a larger return from the higher yield per acre. The consumer gets shelled peanuts for a somewhat lower price because of the higher kernel content of the farmer-stock peanuts. Thus far the variety seems to be meeting with reasonably good acceptance with manufacturers in this country and in foreign countries.

There is some uneasiness and uncertainty about the impact of the variety on the traditional larger kernel Virginia type and the Spanish types. It has displaced these types to a large extent in the Southeast. It may do so in other areas in the future. Obviously the higher yield adds to the surplus above domestic food requirements.

The pricing basis for peanuts (i.e., differentials) have been a source of controversy and conflict among shellers in the three producing areas for many years.

During most of the 1950's, prices received by farmers for the different types of peanuts were used as a basis for establishing dollar per ton support prices. These prices were then "broken down" and applied to the grade information to determine the loan value of each lot of peanuts delivered by the farmer.

With the chronic surplus it became evident that the historical method of pricing or establishing differentials resulted in the reading back and continuation of previously established support price relationships. There were no free market prices above support levels to indicate values. For this reason the differentials were shifted gradually to what is now uniform kernel pricing.

Essentially this means that uniform prices are applied to sound mature kernels, other kernels, and loose shelled kernels for all of the different types of peanuts. The only exception is the premium for the large Virginia kernel type and the related price for the Valencia type.

Theoretically this system cannot be defended as perfect or completely sound. It is obvious, however, that historical prices would not reflect market value relationships. It is essential, therefore, that some method or system be adopted and used. I am not a peanut expert and do not understand all the ins and outs of the differential arguments. I hope that the industry can satisfactorily resolve questions relating to the pricing method.

I do not intend that my comments about the peanut program be critical. There is need for a farm program. Farm income should be higher than it is. Nonetheless, along with growers and other members of this industry, I am concerned about the increasing disparity between production and food use of peanuts.

The balance of my comments will relate mainly to "other subjects".

Don Paarlberg, Director of Agricultural Economics in USDA, talked about farm policy at the recent Southeastern Shellers Convention. I brought copies of his talk. What he says about farm policy should be of interest to you. It strengthens my feeling that this indnstry should greatly increase its effort to expand the size of the market for peanuts. Production then should be geared to market demand - both domestic and export.

About two-thirds of the peanut crop is marketed for domestic food and related requirements. The remainder of the crop - the surplus - goes for crushing (here and abroad) and for food in foreign countries. The sales prices average less than half the support price.

I'm sure every producer and every other member of the peanut industry would like to see the domestic food market for peanuts enlarged by 25 percent this year - and by 100 percent in the next five years. I don't know anyone who thinks this really can be done.

Stepping-up the growth rate of domestic food use will not be easy. Nonetheless, research and promotion directed to that end should receive priority.

Efforts to build exports for food use need to be revived, organized and strengthened.

When peanuts are crushed here or in other countries they move into a huge, complex market. The oil from our entire crop of around 1.5 million tons would amount to little more than one percent of world production of fats and oils and less than five percent of world exports. This huge market will absorb all the peanuts we offer for crushing. The price or value of the peanuts in that market will be low. Supplies of fats and oils available from sources other than U. S. peanuts will determine the price level.

When U. S. peanuts are exported for food use they have a somewhat higher value than that for crushing. But in most of the world, except for Canada, peanuts are not consumed for food as they are in the U. S.! Total food use is small. The U. S. share of the world food market for peanuts, except for Canada, has been small. The value of U. S. peanuts in that market has been determined largely by the prevailing world prices for peanuts - less than half the U. S. support price.

The world other than the U. S. produces over 15 million tons of peanuts. Yet, if food use in other countries equalled that in the U. S. it would absorb most of the production - probably at a significantly higher value.

The potential for expansion of the food market for peanuts in other countries appears to be large. The expansion will involve changes in food habits - and this will be slow. Other countries will compete - and U. S. peanuts will capture only a part of the larger market.

The task will not be easy but I think this industry should unite in a strong effort to expand the food market for peanuts in other countries. The Department has indicated its willingness to support this effort.

The ways and means - the funds - to accomplish the job may be a smaller problem than the building of a team and development of a game plan.

Peanut growers in the six major producing states now have funds and programs - authorized by state laws - directed primarily toward market promotion and research. The total sum of money is not large relative to the job to be done. If used effectively, however, it should help to build a larger market.

The building of the export food market will depend in part upon the quantity of peanuts available to supply that market. For the next few years the quantity available above domestic food requirements probably will be adequate to fill the demand. If the export market grows and more are needed, farmers can produce them. I'm aware that it may be difficult to reach agreement on prices and program terms relating to such production. However, growers and other members of the industry in cooperation with Government should be able to find a way to cross this bridge when they come to it.

The entire peanut industry can benefit from expansion and growth of the food market for peanuts. The best market is here in the U. S. Every one interested in peanuts should support efforts to expand it. Some shellers, brokers or manufacturers may not be interested directly in the foreign market; but they should lend encouragement to others who work to develop it.

I am deeply interested in promotion and market development by the peanut industry. As a soybean grower, a long-time Director of the American Soybean Association and President of that organization I have supported and engaged actively in market promotion and development. I have a good idea of what the task is. In 1940, some 4,807,000 acres of soybeans were harvested in the U. S. The farm value was about $70 million. Exports were small.

Soybean oil was considered vastly inferior to cottonseed oil and undesirable as a salad oil. Now it is the major oil used in margarine and holds a larger share of the U. S. salad oil market than cottonseed oil.

In 1971 farmers harvested 42.4 million acres of soybeans having a farm value of almost $3.5 billion - 50 times the $70 million in 1940. A little over half of the U. S. soybean crop now is exported as beans, oil, and meal. Export value in 1971 was almost $2 billion.

The growth of the export market for soybeans, oil and meal is a direct result, in part, of industry - USDA market development activities. Trade teams and missions, overseas offices, technical assistance on processing, refining of oil, meal utilization indicate the nature and extent of the effort. Growers, processors and manufacturers have helped get the job done. The soybean people are continuing to work hard on market development.

This leads me to say, that first, there is urgent need for greater effort on market promotion and development on peanuts if the industry growth rate is to be increased; and, second, that industry wide participation in the development and in the execution of plans is needed if the effort is to succeed.

Let me say this another way. There is a major game to be played. A strong team is needed. A game plan is needed. Each member of the team must play his position willingly and well if the team is to win.

Growers constitute the largest segment of the peanut industry. They have some funds that now are used for promotion and development activities. They have not yet come together to form a team, to develop a game plan and to play the game of market promotion and development as a team. I hope they will do so and that they will be joined by shellers and manufacturers.

It is vital that manufacturers be on the team. They have knowledge of marketing that may be translated to commodity promotion. Such promotion cannot replace commercial brand name advertising and it should be planned to avoid any such conflict.

In both domestic and export markets manufacturers may be able to contribute to the effective execution of plans. They have trade contacts and relationships which they may be able to touch and activate advantageously without undue burden upon themselves.

In foreign markets they may have business interests which can profit from organized market development activities by the U. S. industry. They likely will be the key in the production and marketing of known and of new peanut products in foreign countries.

I have developed a strong friendly interest in this industry over the short span of nine months. I hope and believe its members can construct and effectively implement a sound plan for market promotion and development.

This can lead to progress for the industry, and to production for a growing market rather than to restriction and shrinkage of production.

Finally, members of this organization do not have direct responsibility for promoting and building consumption of peanuts. Yet, my deep respect and appreciation for your ingenuity and ability causes me to believe you can contribute much to that end. May I ask you to join the team?

PEANUT EXPORTS AND THEIR FUTURE

by

John Dehne

C & S International Ltd., Toronto, Ontario

We just completed the 1971 crop of 1.5 million tons, of which almost 500,000 tons were sold through Commodity Credit Corporation, and if normal weather conditions continue during the next few weeks, the 1972 crop will be even greater. It is not unreasonable to assume that within the next few years our peanut production will be near two million tons.

It is therefore no coincidence that your Program Chairman has invited exporters to speak to you during two successive annual meetings. The research and education carried out by your organization has to a large extent made it possible for the farmers to produce these crops.

Some segments of the peanut industry are concerned as to whether increased crop yields are actually needed, or whether these peanuts will have to be crushed into oil, thereby adding more stocks to the American vegetable oil market, which is already over supplied.

I can assure you, Gentlemen, that we in the export trade can use every peanut which your intense research helps to produce. After India and China, the United States is the world's third largest peanut producer, but you are already the world's largest exporter of edible peanuts. Out next goal is for the exports to equal domestic consumption, because a two million ton crop requires us to export 750,000 tons shelled peanuts in the form of edibles, crushing stock, or oil and meal.

Larger crops mean increased direct cost of the poanut program, and any discussions must take this fact into consideration. Exports will help to reduce this cost but the price differential between American peanuts and world markets is too great to close the gap. Export prices for edible peanuts have risen considerably over the last few years, but so has the support price.

The peanut support program was enacted by the Congress, and therefore represents the wishes of many Americans. Not being a citizen of this country, it is not for me to comment on the policy of your Government, but to conduct my business dealings within this policy.

Within that reference I want to take a few minutes to reply to the critics of the peanut support program. Many other agricultural commodities enjoy government support in one form or another, but we seldom hear the cost being questioned.

Take for example that other great oilseed crop, soyabeans, and the praise given to those who promoted export sales. The fact is that during the 1970/71 season the States exported about 870,000 tons of soyabean oil, but at least 75%, or about 650,000 tons, were given away under A.I.D. funds, or Public Law 480. The value for 650,000 tons soyabean oil is approximately 160 million dollars.

Take grains, cottonseed oil, tallow and lard, to mention a few commodities, but involving very large exports under similar programs. To be sure, the Department of Agriculture receives credits from other Government Departments for these exports, which in the mysterious ways of Government bookkeeping (American or others) make these give-away sales look like commercially sound transactions.

Have any of you heard questions being asked about the spiralling cost of the soyabea program?

I refuse to accept that our peanut program is the bad apple in Agriculture's very big basket. To the contrary, we in the peanut industry can be proud of the fact that every ton of peanuts, peanut oil or peanut meal is exported for cash. About 60 million dollars is my estimate of 1971 crop export revenues. It is true that export prices are lower than domestic edibles, but I want to reassure you all, especially our Washington friends, that the prices paid to C.C.C. reflect world markets.

There is another even more import aspect to the peanut program of which the critics must be made aware.

During the last 2 years we have seen a considerable expansion in the peanut shelling and crushing capacity. At this very moment more new plants are under construction and existing mills are increasing their capacity and up-grading their equipment.

The transport industry is adding fleets of trucks, while the railroads are using more box cars and hoppers to transport the farmerstock to the mills and ship the shelled peanuts to Canada and the ocean ports. The allied industries, and especially peanut equipment manufacturers, are enjoying a boom in sales and services.

This expansion is not primarily being undertaken for the domestic peanut market, which sees little prospect for sizeable increases in consumption and for which we already have an excess shelling capacity. It is also fair to say that the industry would not be expanding at its current rate if the increased crop production had to be diverted for crushing only.

The fact is, Gentlemen, that the foreign buyers cash payments will pay for this tremendous expansion in our industry in all peanut producing areas.

I suggest we stop talking about a peanut surplus with the implication of charity from Washington. If we compare the actual cost of C.C.C. of the peanut program with the overall benefit to the economy as a whole, I feel that all of us can still our critics and show that we have a viable and dynamic industry which benefits every community in which we operate.

From the 1971 crop the C.C.C. very successfully sold a record 481,000 tons farmerstock and almost 50,000 tons of shelled bagged peanuts for export. Despite this large supply we saw the peanut oil market ranging from 17 - 19¢, while soyaoil and cottonseed oil had marketing problems in the 12¢ range, a peanut meal market of $90.00 per ton, and export prices for edible peanuts at much higher levels than most of us exporters had anticipated in the beginning of the season.

The 1971 crop year was the first season for Florunners. This time last year foreign buyers did not even know what this peanut looked like, let alone how their consumers would accept it.

I have just returned from a European trip and can report to you that European roasters are enthusiastic about the Florunners. With the 1972 crop, the Florunners will be the No. 1 edible peanut in Europe, largely replacing African, Indian and Chinese origins. The same holds true for Canada. On the other hand Japan, because of import license specifications, is not expected to be a major buyer of Florunners. They prefer Virginias and Spanish.

It was also the first year for exports of shelled, fragmented peanuts in bulk, to European oil crushers. My customers had but one complaint, they could not file claims. We had the peanuts at the docks when the ships arrived to load and we shipped the quality we said we would supply. They will be back for larger quantities next year.

The third new venture was exports of farmerstock, which contribute nothing to our industry and were opposed by almost every member who has a stake in seeing a viable shelling and crushing industry.

Therefore, I was pleased to learn that oilmillers have indicated a strong perference for the shelled and fragmented peanuts, and thus at this time we do not anticipate a repetition, in volume at least, of this form of peanut exports.

Peanut oil exports have also increased, but slowed towards the end of the crop season when American prices exceeded other origins by almost two cents per pound. These high oil prices during a record crop production are the best evidence of a successful export season.

In my opinion, therefore, the 1971 crop was a satisfactory test run for the future.

Looking at the future and near two million ton crops, we have to think in terms of two separate markets.

A domestic market adjusted to the support price but with captive buyers who have a choice between American Spanish, American Runners and American Virginias, for an approximate total of one million tons farmerstock.

An export market with the potential to absorb another one million tons of farmerstoc provided each of us, in our respective field, give our best effort to produce the best quality peanuts at competitive prices.

Our three principle export markets, Canada, Japan and Europe, now import each year about 450,000 tons of edible peanuts, and the steady annual consnption increase will soon raise these imports to 500,000 tons.

To be more specific, Canada imports 55,000 tons edible peanuts. This market is soli American and we plan to keep it that way.

Japan issues annual import licenses for about 65,000 tons to supplement their domestic peanut production, which, due to rising land values, is declining, and will lead to increased imports of edible peanuts. Volume sales to Japan started three years ago with shipments of 8,000 tons shelled Virginias, and these purchases were repeated each season. The Japanese also buy each season about 12,000 tons of Virginia type from China.

From the 1970 and 1971 crop Japan started buying American Spanish against their annual imports of 44,000 tons Small Kernels. If our Spanish export prices were more competitive, Japan would purchase 20,000 tons or more of this variety.

The Japanese Health Anthority introduced an aflatoxin control program last year but the sampling and analysis method are still sufficiently flexible to permit imports from origins already benned by Canadian and European manufacturers.

Europe, including the United Kingdom, with imports over 330,000 tons shelled edible peanuts, offers the greatest potential for export expansion from our current shipments of around 50,000 tons.

While the States and Canada use over 50% of the shelled peanuts for peanut butter, Japanese and European consumption is almost entirely confined to salted nnts and confectionary. The Japanese are not traditional bread eaters, which is one of the major stumbling blocks in promoting peanut butter.

Great Britain produces only a very limited quantity of peanut butter, while the Dutch are strong consumers and have several local manufacturers, some of whom produce an excellent quality of peanut butter.

But the rest of Europe has not acquired the taste for this good food and I suggest that for any future peanut promotion programs it might be worthwhile to explore peanut butter production in Germany and the Scandinavian countries. If more Europeans can be sold on peanut butter we would see a dramatic increase in peanut exports.

To gain a larger share of these markets I cannot emphasize enough that the foreign manufacturer can buy worldwide and does not have to depend on shippers who look on exports as a place to unload their inferior production. Too many times we hear the comment that our peanuts are acceptable to the American manufacturer and consumer and therefore good enough for foreign buyers. This statement may be partially true when speaking of flavour and soundness of kernels, but certainly it is not true for grade and cleanliness because too many shipments reach overseas destinations only to be rejected by the manufacturers, as happened again during this current season.

Many other exporting countries take great care in shipping peanuts free from foreign material, and also take better care in sizing the peanuts to the international standards. A U.S. No. 1 grade certificate certifies the variety, crop year and minimum screen size, but not the grading requirements of overseas manufacturers.

Each season pressure is applied on C.C.C. to lower the export grade specifications in line with domestic grades, and to permit the export of splits, or as we understand, some mills even suggest unrestricted export of No. 2 peanuts.

We must give credit to our friends from the C.C.C. that they have resisted these pressures because nothing could be more harmful to peanut exports than to lower our existing minimum standards, which if anything should be tightened to prevent poor quality parcels from reaching the export markets. However, we can live with the program as it is today because the foreign manufacturers will not hesitate to ban shippers who do not meet the required standards.

We have two other problems on which we need your help. The first is loose skins, and as far as I know, this can be largely overcome if more care and supervision is applied during mechanical drying.

The other problem, of course, is aflatoxin.

The foreign buyer finds it difficult to understand a shipment being officially certified as negative when tolerances of 25 parts per billion are allowed. While our standards are based on a tolerance combining the 4 aflatoxins, the Europeans as well as the Japanese concern themselves only with aflatoxin B1 with a tolerance of only 5 parts per billion.

I am not qualified to argue the difference in approach between the 4 aflatoxins or only B1, I am merely pointing out to you what is needed to meet the government regulations of foreign countries. On the other hand, the work done on our existing aflatoxin regulations and the certification of each lot has been largely responsible for the increased acceptance of American peanuts on world markets.

However, that second million tons of farmerstock produces not only 400,000 tons of edible peanuts but also 350,000 tons of oilstock residue which must be exported as crushing stock or oil and meal.

As recent as 1968 Europe imported over one million tons of shelled peanuts for crushing. Unfortunately, high prices compared to other oilseeds have reduced peanut crushing to less than 500,000 tons, while imports of peanut oil are now only about 300,000 tons, compared with 450,000 tons imported by Britain and Western Europe during 1968.

It is essential that we capture this European market for our oilstock residue in order to maintain a stable and steady outlet for our total peanut production. Fortunately, the Florunner is also an excellent raw material for the production of oil and meal and if competitively priced, we have no problems competing with other origins.

I am sure none of us favour an artificial reduction in the peanut crop, which will happen if we cannot expand the sales outlets. I hope I have been able to convince you that the market already exists and speaking for our own group, I assure you that we will sell them American peanuts, peanut oil and meal, so that every crop is sold before we start a new season.

OBSERVATIONS OF A PRACTICAL PEANUT BREEDER

W. A. Carver, Agronomist, 1925-64
Florida Agricultural Experiment Station
Gainesville, Florida
Consultant, peanut breeding, Gold Kist Inc.
Atlanta, Georgia, 1964-

Statements listed below are based on working principles of the author. Some are self-evident, others may need experimental proof of their virtue or fault. These are marked as "*".

(1) Seed and Pod

Large seed size is generally associated with higher yield of peanuts per acre.

Seed that lose their skins easily (known as blanched or bald heads) are usually very smooth surfaced and have thin skins. These characters should be selected out and such lines discarded. Less blanching occurs on seed with slight surface grooves and thicker skins.*

When utility in processing will allow, a larger than usual runner-type seed should be bred for the southeast area.

Uniformity in pod and seed size and shape should be carefully selected.

Pod size and shape, also seed size and shape and color should conform to the peanut type usually handled by shellers in your area, and should be of type desired by peanut processors and the trade.

The pod should be cylindrical and strait, with slight waist between seeds, and tough hulled-resistant to breakage in rough handling. The pod's beak should be short and strong.

Small waist pods and long slender pods break easily in handling, allowing insects and disease to reach the seed, and also results in excess of loose shelled kernels. Pegs of long slender pods break off easily at junction with pod.

In runners, the ratio of seed width to seed length should conform to that of standard varieties. The so-called shoe peg shaped seed and roundish or marble shaped seed should be avoided.

The peg should be of good size, not deteriorate easily and should hold tightly to the pod and branch.

A slightly dirty (fuzzy) appearance of hull at digging is desirable. Dirty hull appears to be associated with high yield of peanuts per plant.*

White mold damaged seed results from disease of plant stems, spreading to peanut hulls, and next to seed - while still in the soil.

Breeding lines that have seed damage concealed under their skins must all be discarded on sight.

Split-skin is an undesirable character of seed, that occurs in hybrid lines. It appears to be recessive in inheritance and can be eliminated by selection plant rows that do not show split skins.

Split pod seen mostly in small-seeded lines is undesirable because seed are exposed to water and to disease in the soil, and to disease and insect damage in curing and storage. This appears to be an inherited character and can be eliminated by selecting plant rows that are free of it.

There is a pod defect in which the hull is of soft tissue, becomes water soaked before harvest, disintegrates, and becomes diseased along with its seed. The peg on these same plants shows the same defect. Peanut lines showing this defect must be discarded in spite of their other good characters.

The shelf-life of seed and seed products, or the time span between harvest and seed rancidity should be noted for all favorable lines that have high producing capacity. Long shelf-life shows an analysis, a lower iodine number and lower linoleic acid percentage.

Selection based on chemical analyses might improve the protein and vitamin content of the peanut kernel.

(2) Plant Growth and Fruiting Habit

A line of superior yielding capacity should produce a good field stand of vigorous fast growing plants and maintain a good stand of healthy plants up to harvest time.

The plant branching habit that produces the highest yield of peanuts is the so-called Virginia (or runner) type in which the side limbs bear vegetative and fruiting branches in pairs alternately, or in other words two nodes bear vegetative branches and two nodes bear fruiting branches along the side limbs. No flowers are borne on the terminal or center branch.

Selection for shorter internodes should be a profitable objective. An essential character for high yield per plant is a prolific pegging habit - in which fruiting points carry three or more pegs for several joints away from the central branch.

Advantages of prolific pegging are: (1) the crop of peanuts are set over a short period, (2) earliness in maturity of crop, (3) less loss of peanut pods in the soil at harvest - because the time lapse between first and last set pod is short, and (4) a high yield of peanuts.

The ideal plant habit is a spreading bunch or semirunner which holds branch ends above the soil.

The terminal or central branch of Virginia (or runner) type plants usually carry several shorter limbs above the crop-bearing ones. The top limbs make a good ground cover and retard loss of moisture from the soil.

Branches should be small in diameter and non-woody. Extra large woody limbs make a heavy plant which is usually associated with a low yield of peanuts.

However, strong plant limbs, and some nature of branching which would hold most peanut pods above the soil, when in the windrow, should improve seed quality.

The nonprolific plant or one that averages little over one peg per node produces relatively low yields of peanuts but large yields of hay. It does not respond in peanut yield to high fertility and good culture.

Lower yields per plant and usually per acre are produced by plants having the Spanish or Valencia branching habit - in which side branches send out fruiting branches largely - or few vegetative branches. Plants of the Spanish-Valencia branching habit bear flowers, pegs, and pods on their terminal branch.

(3) Crosses and Selection Methods

Crosses between productive unrelated varieties or lines having widely different characters have given best results.

When intercrossing hybrid strains for the purpose of combining the good characters of each, let the lines be unrelated - to the best of your knowledge. Unrelated parents have a better chance of producing vigor and high yield. Exceptions are known.

First generation plants from wide crosses can be detected by their plant characters. They are vigorous, wide spreading with long branch internodes, and make thin ground cover. If parents are somewhat similar, their hybrid plants will show some characters coming from each parent.

Some peanut strains have a very high potency in transmitting high yield to their descendants. Frequent use of any one such line as a parent should be avoided. Overuse could result in wide area plantings of one blood line and lead to area failure from a common disease.

Recessive characters, as dwarf and albino plants, show up in the second generation of wide crosses.

Variegated leaf plants, a form of maternal inheritance, can be eliminated by pulling up such plants before harvest.

White mold disease of plants is inherited to some degree. Selection can be made to reduce its incidence.

Resistance to seed disease damage, visible and concealed, is inherited and can be isolated by selection. Hybrids between Spanish and Virginia jumbo runner types make good material from which to select. Always select the highest yielding line having the least seed damage - when grown in the field in competition with a standard variety of high yield and high seed quality.

Only single plant selections are made in the second generation plant rows, bulk harvest of plant rows in later years - usually starting in the third generation, when plant and seed characters are fairly uniform, are desirable and production is high.

Bulk seed harvest from superior plant rows are grown in preliminary performance tests where they are compared to standard varieties in yield and other characters.

Many second generation plant rows can be judged by sight to be inferior in plant, pod, or seed characters. Such are discarded without further planting, an entire cross in the third or fourth generations.

The breeder should walk over his field weekly, carefully observing each line as it develops from seedling to mature plant, taking notes on variants from the average in important factors such as rate of seedling emergence, field stand of plants, rate of growth, plant branching habit, number of branches, length of internodes, length of branches, time of flowering, fruiting habit, number of pegs per node, tolerance to drought, and resistance to disease.

When making comparisons of different peanut materials in the field or in the seed room, it is well that the plant breeder observe and study the characters of each row or seed sample until he can carry a picture of them in his eye.

The usual heavy discarding of old lines calls for new crosses yearly and a constant supply of new hybrid materials.

The peanut breeder must have no mercy in discarding, but let his judgment be based on knowledge.

Charles Darwin wrote as follows: "Not one man in a thousand has accuracy of eye and judgment sufficient to become an eminent breeder. If gifted with these qualities and he studies his subject for years, and devotes his lifetime to it with indomitable perseverance, he will succeed, and may make great improvements; if he wants any of these qualities, he will assuredly fail". (See the Origin of Species by Charles Darwin, Chapter 1, subheading---Principles of Selection Anciently Followed, and Their Effects.)

POTENTIAL SOURCES OF RESISTANCE TO POD BREAKDOWN IN PEANUTS

by
P. H. van Schaik, K. H. Garren, and D. M. Porter
Southern Region, Agricultural Research Service, USDA
Holland, Virginia 23391

ABSTRACT

Over a period of 3 years, a number of cultivars and breeding lines of peanuts were screened for resistance to pod breakdown. Although considerable variation occurred from year to year, varietal rankings were quite consistent. Five cultivars, all having Spanish types in their pedigrees, exhibited low pod breakdown each year. They were 'Florunner', 'Early Runner', 'Florigiant', 'NC 2', and 'NC 17'. NC Acc 344, an advanced breeding line from the North Carolina Experiment Station program, also showed good resistance. Susceptible cultivars included 'Va. Bunch 46-2', 'Va. 56R', 'Va. 61R', 'Va. 72R', 'Va. Bunch 67', 'NC 5', and 'Ga. 119-20'.

Of 39 breeding lines and plant introductions tested for two years six ranked among the 15 with lowest pod breakdown each year.

These results suggest that genetic sources of resistance to both organisms causing pod breakdown in peanuts are available.

INTRODUCTION

Pod breakdown, a rotting of fruits on otherwise healthy-appearing peanut (Arachis hypogaea L.) plants is caused primarily by two organisms, Pythium myriotylum Drechs. (1) and Rhizoctonia solani Kuehn (3). It is an increasingly severe problem in peanut producing areas. In Virginia and North Carolina it is considered to be one of the most important factors limiting production.

Overall, long term peanut crop losses in the Virginia-Carolina area due to pod breakdown are estimated to be about 15 to 20 percent. Conditions have been observed where pod breakdown in individual fields was so severe that harvest of the crop was not considered worthwhile.

The rot symptoms caused by these two primary organisms usually cannot be distinguished visually. Identification of the specific causal organism requires making isolations from infected pods. The situation is further complicated by Sclerotium rolfsii Sacc., Fusarium spp. and other soil borne fungi though the pod-rot phase of some of these organisms almost always is preceded by above ground symptoms (2, 5). The Ca, Mg, and K cations from sulfates also influence the amount of pod breakdown (4). Other unpublished data indicate that various environmental factors and cultural practices such as temperature, humidity, rainfall, soil type, organic matter (both total content in the soil and type), and fertility status may affect the amount of pod breakdown occurring.

A varietal screening program was started at the Tidewater Research Station in Holland, Virginia in 1969 to determine if differences in resistance to pod breakdown exist in peanut germplasm.

Screening for resistance can be done under controlled conditions, such as a greenhouse, where several variables can be eliminated and a plant's resistance to a single organism can be determined, or it can be carried out under field conditions where all variables which effect the expression of disease symptoms are at work. For practical purposes field screening is considered to give more meaningful results as the interactions between the organisms and with various environmental factors are of considerable importance in the expression of the disease symptoms.

This paper reports on the results of field screening of a number of released and commonly grown peanut cultivars and breeding lines.

MATERIALS AND METHODS

In 1969 eleven peanut cultivars were planted in a randomized block experiment with 4 replications at the Tidewater Research Station in Holland, Virginia. Cultural practices were those used for production of good yields of high quality peanuts. No soil fungicides or nematicides were used. In advance of normal plot harvest four plants were dug at random in each plot. After washing, the fruits were pulled from the plants by hand and counted. The percent of each sample which showed pod breakdown symptoms was determined. Isolations were made from random samples of rotted pods to determine the most prevalent pathogen in the field in which the test was located.

In 1970 and 1971 the same procedures were followed but the tests were enlarged to include additional cultivars and breeding lines.

RESULTS AND DISCUSSION

Pod breakdown counts expressed in percent of total fruit produced are shown in Table 1. Pod breakdown was least severe in 1970. In 1969 the

Table 1. Percent fruit with pod breakdown symptoms of 20 peanut cultivars and breeding lines, Holland, Virginia.

Cultivar or Line	1969 %	1969 Rank/ 11	1970 %	1970 Rank/ 50	1971 %	1971 Rank/ 52	Ave.
Florunner	4.1	5	0.4	2	6.4	15	3.6
Early Runner	1.6	1	0.7	6	6.7	17	3.0
Florigiant	2.2	3	0.9	8	6.6	16	3.2
NC Acc. 344	1.8	2	1.8	13	6.3	13	3.3
NC 2	3.3	4	0.6	4	9.2	28	4.4
NC 5	11.1	10	3.2	23	22.3	51	12.2
NC 17	---	--	1.0	10	4.5	4	2.8
Va. 56R	6.8	6	3.7	26	24.2	52	11.6
Va. 61R	10.1	9	4.8	31	10.2	34	8.4
Va. 72R	---	--	---	--	11.7	41	11.7
Va. Bunch 46-2	7.3	7	5.5	36	10.7	37	7.8
Va. Bunch 67	9.3	8	2.7	20	10.8	38	7.6
Ga. 119-20	11.5	11	8.8	46	9.8	31	10.0
PI 295214	---	--	0.3	1	6.1	12	3.2
PI 341880	---	--	1.0	9	5.7	10	3.4
PI 341884	---	--	0.9	7	3.1	2	2.0
PI 341885	---	--	1.9	15	5.4	8	3.7
PI 343394	---	--	0.7	5	4.7	5	2.7
F 439-16-6	---	--	1.3	11	3.0	1	2.2
PI 343415	---	--	20.8	50	15.6	48	18.2
Average all entries	6.3		4.6		9.2		6.7
Range	1.6-11.5		0.3-20.8		3.0-24.2		

predominant organism causing pod breakdown was P. myriotylum while in 1970 and 1971 R. solani was isolated with greater frequency from rotted pods. The stem rot organism, S. rolfsii, greatly complicated the pod breakdown situation in 1971.

Though several organisms may contribute to the pod breakdown syndrome and though considerable seasonal variation occurred, varietal differences in pod breakdown were consistent from year to year (Table 1). The same five or six cultivars consistently exhibited the lowest percentage of pod breakdown. It is of interest to note that the resistant cultivars, 'Florunner', 'Early Runner', 'Florigiant', 'NC 2', and 'NC 17' all have Spanish types in their pedigrees. NC Acc 344, which also showed a high degree of resistance is a North Carolina Experiment Station breeding line derived from a cross of 'NC Bunch' and a runner type introduction from Argentina (PI 121067). Highly susceptible cultivars were 'NC 5', 'Va. 56R', 'Va. 72R', and 'Ga. 119-20'. Intermediate in resistance were 'Va. 61R', 'Va. Bunch 46-2', and 'Va. Bunch 67'. With the exception of 'NC 5', which has Improved Spanish in its pedigree, all of the highly susceptible cultivars and those rated intermediate in resistance are Virginia genotypes (A. hypogaea, subspecies hypogaea, variety hypogaea), derived as selections from Virginia genotypes or as progeny selections from crosses among Virginia genotypes.

Of 39 additional breeding lines and plant introductions in the 1970 and 1971 tests six lines ranked among the 15 with lowest pod breakdown in both years. Four of these (PI 295214, PI 341880, PI 341884, PI 341885) were among those reported (1) to be "moderately to highly resistant to the Pythium pod rot complex", one (PI 343394) was an apparent pod rot resistant selection from a cross made in Israel; and one (F 439-16-6) was a selection out of the same cross from which the Florunner cultivar was derived.

These data indicate that sources of resistance to pod rotting organisms are available.

Although these results appear to indicate a high degree of actual resistance to pod breakdown, only one of these tests (1971) produced pod breakdown as severe as is often encountered in farmers' fields with commonly grown cultivars such as 'Florigiant', 'NC 5', 'Va. 56R', and 'Va. 61R'. The data therefore must be interpreted as being indicative of relative resistance among the cultivars and breeding lines.

An increased severity of pod breakdown is necessary to obtain a true separation of susceptible and resistant types. Porter and Garren (unpublished data) have found that high rates of cow manure applied to the soil just before planting gave marked increases in peanut pod breakdown severity. This practice will be applied to future pod breakdown resistance studies. The common parental lines of the resistant cultivars, 'Small White Spanish' and 'Ga. 207' will also be included to study the degree and nature of the resistance as well as the mode of inheritance.

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CHEMICALS IN THE WINDROW FOR CONTROLLING AFLATOXINS IN PEANUTS[1/]

by
D. K. Bell and Ben Doupnik, Jr.[2/]

PAPER

The efficacy of chemicals for controlling Aspergillus flavus Link and aflatoxin contamination of peanut kernels on windrowed plants in the field was examined for the second consecutive year. Cultivar Starr (Spanish type) peanuts were grown according to local recommended cultural practices. Plants were dug and inverted in the windrow 135 days after planting. Then, samples of pods were collected and assayed for background contamination with A. flavus on high salt-malt agar and for aflatoxins B_1, B_2, G_1, and G_2 by TLC and the aqueous acetone method similar to the methods previously described (1). Before plating, kernels were soaked 3 minutes in a 0.53% (w/v) solution of sodium hypochlorite. A. flavus was isolated from an average of 15.1% of freshly dug kernels, and total aflatoxins averaged 8 ppb in these samples. After sampling pods, approximately 6.4 mm of water was applied to the plot area by overhead irrigation. After irrigation, aqueous solutions or suspensions of 27 chemicals (Table 1) were applied to pods in each of four replicates/treatment. Then, the plants were covered with Tri-Pli(T) white, opaque moisture barrier, which was sealed around the edges with moist soil. After 24 hours, the Tri-Pli was removed, pods were inoculated with a dense aqueous spore suspension of an aflatoxin-producing strain of A. flavus (NRRL 2999), and the Tri-Pli was replaced and sealed with moist soil. Both inoculated and noninoculated windrows treated with water only were maintained as controls. After incubating 6 days, samples were collected and kernels from each replicate were assayed for A. flavus and aflatoxins as described for digging samples.

Twenty treatments decreased and seven increased aflatoxins as compared to the controls (Table 1). Less than 20 ppb total aflatoxins were recovered from thirteen treatments and none was found in four. In several treatments, total aflatoxins were not positively correlated with degree of A. flavus infestation. Alconox(T) treated pods had 53% of the kernels infested with the fungus and 4.2 ppb aflatoxins, and tin chloride treated ones had 48.8% infested kernels with 24.2 ppb aflatoxins. With Zinc Omadine(T), 8-hydroxyquinoline sulfate, Borax(T), boric acid, propionic acid, 1% potassium azide, and malachite green treatments, aflatoxin recovery exceeded the extent of fungal infestation. This could be due to stimulation of aflatoxin accumulation and/or experimental error.

Results of this test and a similar one conducted in 1970 indicated that aflatoxin contamination of windrowed peanuts can be substantially reduced by chemical means. Manzate(T), Benlate(T), Botran(T), and secondary butylamine treated pods had no detectable aflatoxins. A. flavus, however was recovered from kernels of these treatments. Apparently, aflatoxin accumulation was prevented or nonaflatoxin-producing strains of A. flavus were extant in the kernels.

The moisture barrier might have created conditions around the peanut pods that would be the near-equivalent of a fumigation chamber and thereby possibly have given some of the applied chemicals a degree of effectiveness in suppressing aflatoxin development that could not be anticipated under natural conditions in a field windrow. Additional tests will be needed to resolve this question.

Vines and pods treated with potassium azide and propionic acid were discolored dark brown to black and had a pungent, offensive odor. Kernels from these treatments were normal colored and had only a slight off odor.

1/ Contribution of the University of Georgia College of Agriculture Experiment Stations, Coastal Plain Station, Tifton, Georgia 31794. Work supported in part by the Agricultural Research Service, U. S. Department of Agriculture through Grant No. 12-14-100-9900(34), and administered by the Plant Science Research Division, Beltsville, Maryland 20705.

Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the U. S. Department of Agriculture, and does not imply its approval to the exclusion of other products that may also be suitable.

This is a report on the current status of research involving use of certain chemicals that require registration under the Federal Insecticide, Fungicide, and Rodenticide Act. It does not contain recommendations for the use of such chemicals, nor does it imply that the uses discussed have been registered. All uses of these chemicals must be registered by the appropriate State and Federal agencies before they can be recommended.

2/ Plant Pathologists.

Table 1. Chemicals applied to peanut pods in the windrow and Aspergillus flavus and aflatoxins recovered from kernels of treated pods.

Chemical	Concentration/ liter of water	Kernels yielding Aspergillus flavus, % [a]	Total aflatoxins, ppb [b]
Manzate 80D(T) (maneb)	12 g	7.0	0
Benlate 50W(T) (benomyl)	5 g	2.5	0
Botran 75W(T) (DCNA)	4 g	9.8	0
Secondary butylamine 100	50 ml	12.3	0
Bordeaux 8-8-100	23 g	12.8	4.0
Alconox(T)	50 g	53.0	4.2
Saccharin 100	40 g	22.5	5.5
Dithane M45(T) (mancozeb)	12 g	5.5	8.8
Copper sulfate 100	50 g	12.3	9.2
Sulfanilamide 100	50 g	0	12.3
Crystal violet 100	200 mg	2.0	14.2
Potassium azide 100	20 g	0.3	15.0
Nutonex Sulphur 94W(T)	50 g	7.3	18.2
Difolatan 4F(T) (captafol)	20 ml	6.0	22.8
Tin chloride 100	50 g	48.8	24.2
Brilliant green 100	200 mg	3.8	25.0
Centian violet 100	200 mg	4.5	29.2
Mertect 60W(T) (TBZ)	5 g	2.5	32.6
Borax 100	10 g	2.8	44.2
Boric acid 100	20 g	0.8	45.9
Borax 100	20 g	1.8	60.0
Malachite green 100	200 mg	3.5	62.6
8-hydroxyquinoline sulfate 100	30 g	1.0	66.7
Zinc Omadine 48EC	7 ml	12.0	67.6
Potassium azide 100	10 g	0.8	77.6
Boric acid 100	10 g	8.5	79.2
Propionic acid 100	50 ml	4.0	90.0
Noninoculated control	0	12.8	54.2
Inoculated control	0	24.3	57.7
Background contamination	0	15.1	8.0

[a] Mean of four 100-kernel replicates.

[b] Mean of four 25-g kernel samples.

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PROTEINS FROM PEANUT CULTIVARS (ARACHIS HYPOGAEA) GROWN IN DIFFERENT AREAS. V. BIOCHEMICAL OBSERVATIONS ON ELECTROPHORETIC PATTERNS OF PROTEINS AND ENZYMES

by
Robert L. Ory and John P. Cherry[1]
Southern Marketing and Nutrition Research Division
Agricultural Research Service, USDA
P. O. Box 19687
New Orleans, Louisiana 70179

ABSTRACT & PAPER

ABSTRACT

This paper summarizes the characterization of total proteins and selected enzymes (peroxidase, catalase, leucine aminopeptidase, esterase, acid phosphatase, alcohol dehydrogenase and INT-oxidase) of peanuts by polyacrylamide and starch gel electrophoretic techniques. Approximately 400 seeds from cultivars of six Spanish and nine Virginia (three Runner and six Virginia Market types) botanical types grown in one to four different areas (Virginia, Georgia, Oklahoma, Texas) were individually examined and compared.

Intravarietal protein polymorphism shown by gel patterns was similar for all of the cultivars making it difficult to define specific differences by electrophoretic analyses. However, quantitative and qualitative variations did distinguish between the same cultivars grown in different areas; e.g., Oklahoma-grown peanuts had less large molecular weight and more small molecular weight proteins. These electrophoretic protein patterns differed from those of cultivars grown elsewhere.

PAPER

INTRODUCTION

Gel electrophoretic analysis of seed proteins and enzymes has been an important technique for obtaining information relating cultivars or species of plants. Such comparisons of seed proteins have been obtained for a large number of species: cotton (4,5,6,7), wheat (12,31), potatoes (14,15,22,34), beans (17) and soybeans (17,20,21,24). A year ago, we presented the first part of an extensive comparison by polyacrylamide disc gel electrophoresis of total proteins from nine different peanut cultivars including Spanish, Runner and Virginia Types grown in one to four different areas: Georgia, Virginia, Texas and Oklahoma (8). Differences in specific proteins such as the major storage globulins, arachin and conarachin, were further identified by immunoelectrophoretic techniques (23). The goal of these investigations was to establish the electrophoretic patterns of healthy peanuts from commercial cultivars which could serve as "standard patterns" to which proteins from damaged, processed or mold-infected seeds might be compared for induced changes. These studies also allowed us to determine the genetic relationships among peanut cultivars by a biochemical technique (8,9,10).

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1 National Research Council Postdoctoral Research Associate. Present address: Department of Biochemistry and Biophysics, Texas A&M University, College Station, Texas 77840

Peroxidase showed the most intra- and intervarietal isozyme variations for both developing and mature seeds grown in different areas; only five major bands of activity were consistently observed in all cultivars. Esterase, acid phosphatase and leucine aminopeptidase also showed isozyme polymorphism, but to a lesser extent than for peroxidase. No detectable variations were observed for catalase, alcohol dehydrogenase and INT-oxidase. These results indicate that although electrophoretic variations in banding patterns within and between cultivars exist, there is sufficient consistency to support the theory that these peanuts are highly inbred with similar genetic backgrounds.

Although peroxidase is most frequently employed in plant or seed studies as a biological indicator of externally induced changes, the large amount of isozyme polymorphism found in these peanuts could make it difficult to interpret the true origin of induced changes in experimentally treated peanuts. The six other enzymes examined produced much less electrophoretic variability and were selected to serve as alternate biochemical indicators of externally induced changes in peanut proteins. Since enzymes are proteins with a specific biochemical function in the seeds, it is possible to employ these proteins as biochemical indicators of changes in plants due to external factors. For example, peroxidase isozymes have been frequently employed as indicators of disease resistance and/or susceptibility, or of plant injury (1,3,13,18,26-30,32), and as a quality control indicator in corn processing (16). Other enzymes have been employed in plant studies but to a lesser extent, e.g., acid phosphatase, esterase, catalase, leucine aminopeptidase, alcohol dehydrogenase and most recently, INT-oxidase (iodophenyl-nitrophenyl-tetrazolium violet oxidase) (2,19,25,30). We have recently examined and characterized by both polyacrylamide and starch gel electrophoresis these same enzymes in peanuts to obtain "standard patterns" for comparison with respect to seed development, maturity and germination, genetic and environment relationships (9,10).

The purpose of this paper is to review briefly the types of electrophoretic patterns obtained for total proteins and seven selected enzymes in fifteen peanut cultivars, to emphasize the major variations in proteins of peanuts grown in different areas, their genetic relationships, and to discuss these "standard" isozyme patterns as potential biochemical indicators of externally caused changes in electrophoretic patterns such as Aspergillus contamination, as will be described in the adjoining paper by Cherry et al., (11).

Materials and Methods

The peanuts of different cultivars grown in four areas of the United States were provided by W. K. Bailey (Virginia-grown), J. I. Davidson (Georgia), R. O. Hammons (Georgia), A. L. Harrison (Texas) and J. S. Kirby (Oklahoma). Seeds of each cultivar were extracted individually for protein content and enzyme analyses as described by Cherry et al., (8). Each seed was either decoiled by acetone extraction prior to protein solubilization or directly macerated in buffer with a mortar and pestle for enzyme analyses. The polyacrylamide disc gel electrophoretic technique used was a combination of the methods of Steward et al., (28) and Cherry et al., (4). Starch gel electrophoresis was performed as described by Brewbaker et al., (2).

For catalase, leucine aminopeptidase, acid phosphatase and alcohol dehydrogenase, freshly prepared supernatants were examined by starch gel electrophoresis and histochemically stained by the technique of Scandalios (25). INT-oxidase

activity was identified on the same gels as the alcohol dehydrogenase, but as clear areas, while the latter enzyme appeared as dark blue bands on a pale blue background (20). For the esterase and peroxidase analyses, the extracts were first clarified by adding solid ammonium sulfate to 40% saturation and allowed to stand with occasional shaking for 30 min. The samples were centri- at 39,000 g for 10 min and the clear supernatants dialyzed overnight to remove excess salt. The dialyzed samples were then subjected to polyacrylamide gel electrophoresis and the gels examined for enzyme activities.

The authors thank Jack J. Bergquist for his skillful photographing of the hundreds of electrophoretic gels required in these investigations.

RESULTS AND DISCUSSION

Gel Electrophoretic Patterns of Proteins.

Figure 1 briefly reviews the results obtained on disc gel electrophoretic patterns of the total proteins from cultivars of Spanish, Runner, and Virginia-type peanuts grown in the four areas (Georgia, Oklahoma, Texas, and Virginia). However, Spanish-type peanuts grown only in Texas and Oklahoma were available for these studies.

The consistency of the protein variations within and between these different cultivars made it somewhat difficult to clearly distinguish between them simply on the basis of their electrophoretic protein profile. However, minor qualitative and quantitative variations in the protein patterns partially distinguished some types grown in one geographic area compared to the same type grown in a different area (Figure 1). The most obvious of these are shown in the upper half of the gels of Spanish type peanuts grown in Oklahoma compared to the same corresponding bands of peanuts grown in the other three areas. Oklahoma-grown peanuts showed a larger number of minor protein bands in the lower half of the gels compared to those grown in the other areas. Some of these minor bands were not even evident in the patterns of cultivars grown in the three other areas. In addition, region 0 to 4.0 cm in gels of Oklahoma-grown peanuts contained a greater number of minor bands not clearly visible in the patterns of peanuts from the other areas. Whether this is due to a dissociation of some of the larger storage proteins of Oklahoma-grown peanuts into smaller subunits or whether these are different types or groups of proteins cannot be discerned by disc gel electrophoresis alone. In an earlier report (23) immuno-electrophoretic analysis of the proteins in the region 1.0 to 2.5 cm showed that these bands consisted primarily of the high molecular weight storage globulins, arachin and conarachin. As will be described later, catalase and peroxidase activities are also located in this region. Thus, these two enzymes may account for some of the observable minor bands in region 0 to 4.0 cm of Oklahoma-grown peanuts. The proteins in the lower half of the gels consist mostly of enzymes and other low molecular weight proteins.

These gel electrophoretic protein patterns, therefore, indicate that we have a technique which can be utilized to show that peanuts from one region may vary from those of the same cultivar grown in another region. They also show that Oklahoma-grown peanuts do not contain as much large molecular weight storage proteins as do peanuts grown in the other three states, but contain more of the low molecular weight proteins and/or enzymes. Since we know very little about the growing conditions and environment in the areas from which the seeds used in these studies had been grown, a precise explanation for the observed differences is difficult. Irrigation (or excess rainfall) can cause increases in the amount of protein normally present in mature peanuts (33). Our results indicate that environment may play an important role in the difference observed. In Oklahoma, the temperature declines towards the end of the

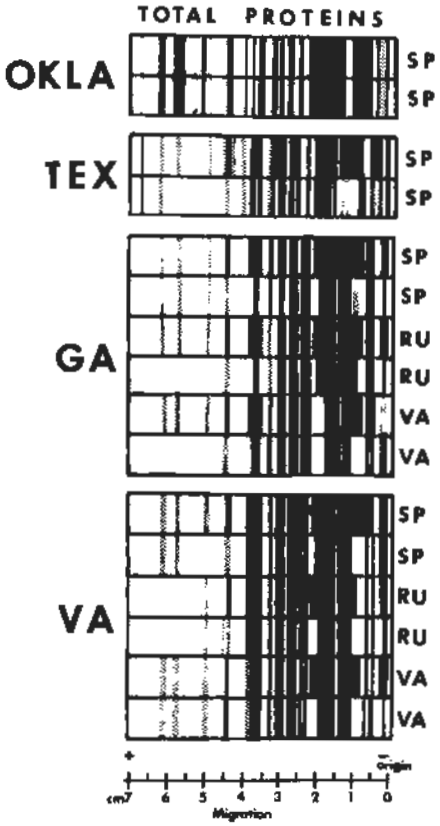

Figure 1. Diagrams of disc gel electrophoretic patterns of total proteins of Spanish, Runner, and Virginia peanuts grown in Georgia, Oklahoma, Texas and Virginia. Abbreviations on right: SP, Spanish; RU, Runner; VA, Virginia Types. Electrophoresis of proteins was from right to left (origin to 7 cm).

end of the growing season and these cooler temperatures could conceivably affect the specific mechanisms regulating gene expression, as discussed in our first paper (8).

Electrophoretic Patterns of Enzymes

Since enzymes are physiologically important proteins in the development, metabolism, and germination of seeds, we also examined seven enzymes which might be potentially useful as indicators of externally induced changes in peanut proteins, since they would also be present in the extracts although in much smaller quantities. Using chromogenic substrates specific for each enzyme, even small traces of activity can be readily detected.

Peroxidase is probably the enzyme most widely used as a biochemical indicator of disease, cellular injury, trauma, damage, infection, etc., in plants and seeds (1,3,13,16, 18,26-30,32). A diagramatic sketch of peroxidase isozyme patterns for mature seeds of these different cultivars from the four areas is shown in Figure 2. Over 380 seeds were extracted individually and their peroxidase zymograms compared, producing 15 different patterns. Figure 2 shows only those patterns appearing in the highest frequencies; gels 1 to 3 are Virginia-type peanuts and gels 4 to 5 are Spanish and Runner types. Gel 1 was present in the highest frequency, 24.7%; with others decreasing in order, respectively: 20.3%, 18.5%, 9.1%, and 5.7%. Bands 1 and 2 of Figure 2 both contained one major band at the origin, one at 0.7 cm and three bands at 3.0 to 4.0 cm. The presence or absence of a minor band at 1.0 cm was typical of most of these zymograms. Other variations from these five major patterns were all minor in either quality or in the intensity of certain bands already present.

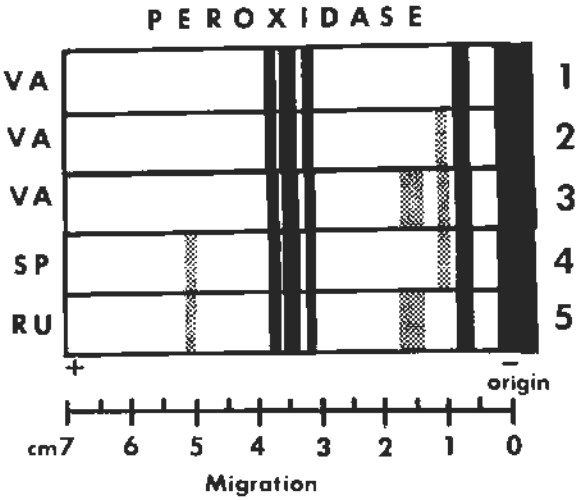

Figure 2. Photographs of major disc gel electrophoretic patterns of peroxidase isozymes in mature peanuts from different areas. Gels 1-3, Virginia-type peanuts; gels 4-5, Spanish and Runner types. These 5 patterns comprize 78% of the 15 different ones observed for all varieties analyzed as described in text.

However, if peroxidase activities of very immature, premature, or germinating seeds were examined and compared by gel electrophoresis, as many as twenty-three different patterns were found (9). Much intravarietal isozyme polymorphism was also observed in seeds of a single cultivar grown in one area. These differences in mature seeds, plus the added variations found in developing or germinating seeds made it rather difficult to establish a "standard" peroxidase isozyme pattern for healthy peanuts to which diseased or damaged peanuts might be compared. The interpretation of such results based solely on electrophoretic patterns can often be affected by a lack of knowledge of the precise stage of maturity of the seeds being analyzed. This problem is generally averted for samples obtained from large lots of peanuts by carefully selecting only seeds of uniform size and quality and examining as many individual seeds as possible in order to develop the best possible analysis of intra- and intervarietal protein polymorphism.

Because of the many variations found in peroxidase patterns, six other enzymes were examined either by starch gel or by disc gel electrophoretic techniques to serve as alternate biochemical indicators of changes in these peanut proteins, if needed. Of these enzymes, esterase activity (Figure 3) showed only four different patterns with gel patterns (a) appearing in 21% of the seeds

Figure 3. Photograph of major disc gel electrophoretic patterns of esterase isozymes in mature peanuts from different areas. Gel patterns (a) and (b) comprized 93% of the 4 observed for all varieties, regardless of areas where grown.

examined and pattern (b) in 72%. Like peroxidase, however, esterase activity in the developing and germinating peanut seeds produced 13 different isozyme patterns (10).

Acid phosphatase and leucine aminopeptidase (LAP) also showed some differences in isozyme patterns. Figure 4 shows an actual photograph of a starch gel electrophoresis pattern of acid phosphatase activity in various peanut cultivars. Two patterns observed in highest frequency of the six different patterns were found in 87% of the peanuts examined. One pattern comprised only 9% of the total while the other occurred in 78% of the seeds examined. Although variations were noted in the isozymes of both esterase and acid phosphatase, the high frequencies of the esterase pattern in gels a (Figure 3) and the major acid phosphatase pattern (78% frequency) suggests that these two enzymes may be useful as biochemical indicators of seed maturity, disease, injury, or other types of externally caused damage.

LAP, examined by starch gel electrophoresis, seemed to show only two basic patterns differing only by the presence of a minor band at 1.0 cm in 46% of the seeds examined (Figure 5) which was absent in all of the other gels. Only one peanut of the 384 examined lacked the band at 3.8 cm.

This is illustrated in Figure 5, which shows five major bands that were consistently present in all of the peanut cultivars examined. These results suggested that LAP might also he a potentially useful enzyme as an indicator of induced changes in peanut proteins.

The most consistent patterns, however, were shown by the enzymes catalase, alcohol dehydrogenase, and INT-oxidase. As seen in the starch gel patterns of catalases in Figure 6, two major bands are present in all of the peanut cultivars, regardless of the areas where they were grown. Alcohol

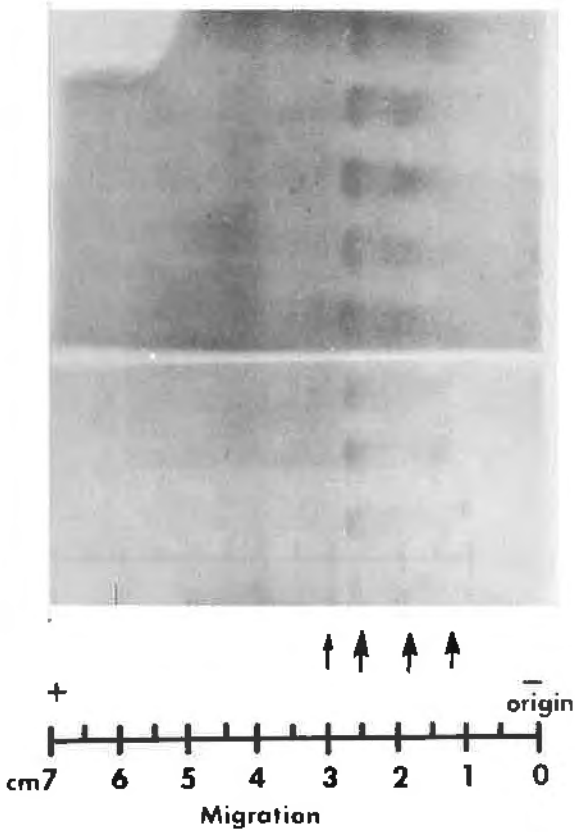

Figure 4. Photograph of typical starch gel electrophoretic isozyme patterns of acid phosphatase activity in mature peanuts from different areas. Two patterns appeared in 87% of the seeds examined.

dehydrogenase and INT-oxidase activity also show just two isozymes, though in smaller quantities than those of the catalases. These three enzymes showed no qualitative and little or no quantitative variations in their patterns for all of the cultivars examined from the different growing areas and, in addition, these same two isozyme bands were present in developing and germinating seeds. This consistent simplicity in the zymograms of catalase, alcohol dehydrogenase, and INT-oxidase suggested these three enzymes as potentially promising indicators of induced changes in peanut proteins; any alteration from this "standard pattern" could be readily detected.

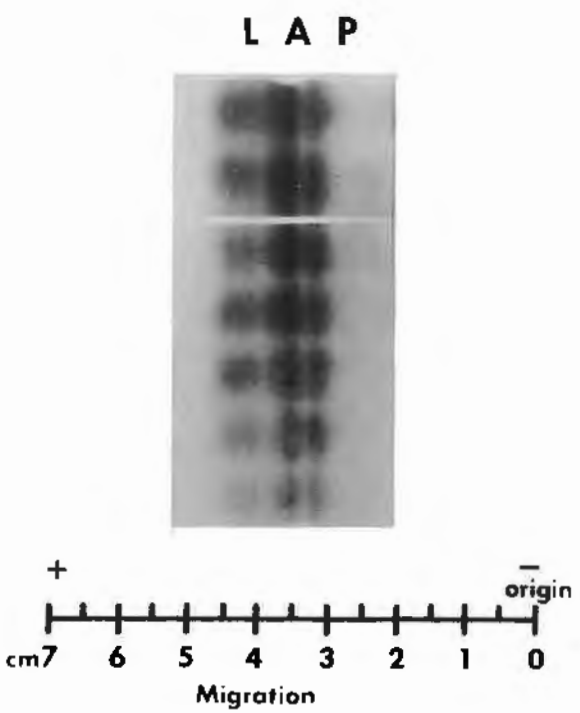

Figure 5. Photograph of typical starch gel electrophoretic isozyme patterns of leucine aminopeptidase activity in mature peanut seeds from different areas. Two patterns only appeared in all of the seeds examined (46% and 54% respectively).

In summary, these studies on healthy cultivars of Spanish, Virginia, and Runner peanuts grown in four areas (Virginia, Georgia, Texas, and Oklahoma) suggest:

1. The large number of isozyme patterns for peroxidase activity would probably make any induced changes in these patterns difficult to interpret.

2. Although isozyme patterns for esterase and acid phosphatase activities in developing and germinating peanuts showed numerous differences, most of these variations were not found in mature seeds. In fact, for esterases two isozyme patterns occurred in 93% of the seeds examined and for acid phosphatase activity, two patterns appeared in about 87% of the seeds. This indicates a potential usefulness for these enzymes as biochemical indicators of changes in peanut protein patterns. In addition, they might be more important as indicators of seed maturity.

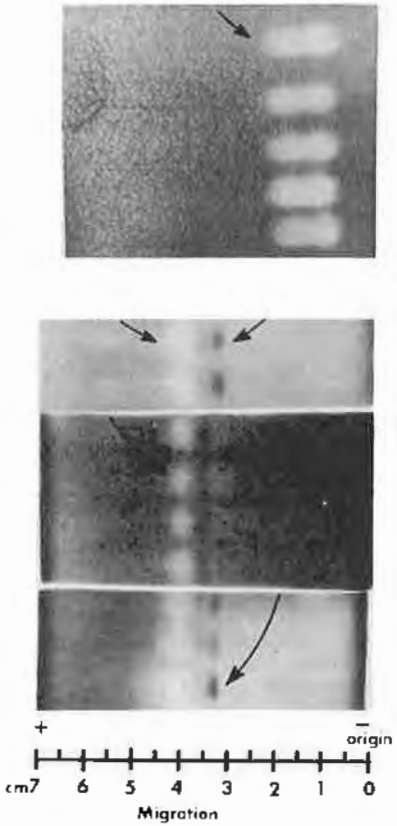

Figure 6. Photographs of starch gel electrophoretic patterns of catalase, alcohol dehydrogenase, and INT-oxidase isozymes in peanuts from different areas. Abbreviations: CAT, catalase; ADH, alcohol dehydrogenase; INT, INT-oxidase. Catalase activity pattern in all seeds; as described in Materials and Methods, ADH appears as dark blue bands and INT as clear bands on the same gels; both show same patterns in all seeds.

3. The most promising enzymes for studies such as those proposed here appear to be LAP, catalase, alcohol dehydrogenase, and INT-oxidase. While LAP did show some quantitative differences in developing and germinating seeds, the mature peanuts showed only two basic patterns. The other three enzymes showed only one pattern of two bands each for all cultivars examined, regardless of the areas where grown. This suggests that these isozyme patterns under normal growing conditions remain constant and are not influenced by peanut cultivar differences or by environmental conditions in the different growing areas. Therefore, any changes in these "standard patterns" found upon examination of mold-infected or damaged peanuts could be interpreted as changes caused by some type of external factors. Such changes induced by Aspergillus contamination will be described in the following paper by Cherry, et al., (11).

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PROTEINS FROM PEANUT CULTIVARS (*ARACHIS HYPOGAEA*) GROWN IN DIFFERENT AREAS. VI. CHANGES INDUCED IN GEL ELECTROPHORETIC PATTERNS BY *ASPERGILLUS* CONTAMINATION

by

John P. Cherry[1/], Robert L. Ory, and Ruth Y. Mayne

Southern Regional Research Laboratory

Southern Marketing and Nutrition Research Division

ARS, USDA, P. O. Box 19687, New Orleans, Louisiana 70179

ABSTRACT AND PAPER

ABSTRACT

Gel electrophoretic studies were employed to develop "standard" gel patterns of total proteins and enzymes from crude extracts of individual seeds of a commercial peanut cultivar (*Arachis hypogaea* L. subsp. *hypogaea* var. *hypogaea*; Virginia market type; Virginia 56R) for use in comparative biochemical investigations. Changes in these "standard" patterns due to growth of a weakly pathogenic or saprophytic organism, *Aspergillus parasiticus*, on the peanuts were easily detected. Within two to three days after inoculation of peanuts with the fungus, large molecular weight proteins in the upper half of the gels rapidly decreased. At the same time, many new, small molecular weight proteins appeared in the lower half of the gels. After five days of fungal development (sporulation), most of the small molecular weight proteins were difficult to detect in the electrophoretic patterns. Simultaneously with these changes in the total protein patterns, new and more complex zymograms were observed for several enzymes compared to their "standard" patterns. Examination of these same enzymes in the fungal tissue collected from the external surfaces of peanuts, or grown separately in Czapek's solution, indicated that most of the new isoenzymes in contaminated seed extracts were derived from the invading mold. The implications of these changes from the "standard" protein and enzyme patterns of peanuts and their relation to the development of *A. parasiticus* on these seeds are discussed.

INTRODUCTION

Closely coinciding with the development of certain species of the genus *Aspergillus* in seed or forage foodstuffs is the production of a group of mycotoxins known collectively as aflatoxins (9). There have been numerous investigations on the biochemical and physiological effects of aflatoxins on animal systems, but significantly fewer studies of the effects of the fungi or the toxins on plants. It would seem that more attempts would be made to elucidate the biochemical changes induced in peanuts by *Aspergillus* species so that genetic or agronomic techniques could be developed to alter the growing conditions or possibly to create a resistant peanut cultivar.

1/ Postdoctoral Research Associate of the National Research Council. Present address: Dept. Biochemistry and Biophysics, Texas A&M University, College Station, Texas 77840

Increased ribonucleic acid, protein and dry weight changes in plant tissues have been correlated with either disease resistance or susceptibility and symptom response to fungal infection (5). Polyacrylamide and starch gel electrophoretic techniques have been widely used to investigate qualitative and quantitative alterations in proteins, enzymes, and metabolites of host-pathogen interactions, relating these changes to biochemical and genetic mechanisms (1, 7, 10-12, 14, 16-19).

These electrophoresis techniques are extremely useful although some controversy has arisen concerning interpretations of the data. For example, the alterations in the gel patterns might be due to: (1) artifacts of the extraction procedures, (2) responses by the plant to infection, (3) differences in the ontogenic stage of the plant or pathogen tissue under investigation, (4) environmental conditions present during the hostpathogen interaction, and/or (5) induction of biochemical or genetic changes in the plant by the pathogen, or vice versa.

Gel electrophoretic patterns of the total proteins and seven enzymes (esterase, peroxidase, catalase, leucine aminopeptidase, acid phosphatase, INT-oxidase and alcohol dehydrogenase) in normal mature Virginia 56R peanuts have been presented in a previous paper (15), along with the gel patterns from various other cultivars grown in different locations. Other papers of this series included examinations of the proteins and enzymes in immature, mature and germinating peanuts (3, 4, 6). Intravarietal genetic polymorphism and variations due to different environments in the areas where these cultivars were grown were also evaluated. The patterns for catalase, leucine aminopeptidase, alcohol dehydrogenase and INT-oxidase isozymes developed early in the peanut, remained constant through maturity and at least 24 hours germination, and showed no intra- and intervarietal variability regardless of the environmental conditions in the areas where grown. Conversely, total proteins, esterase, acid phosphatase and peroxidase patterns in early developing and germinating peanuts could be distinguished from predormant and mature seeds and showed much variation within and between cultivars and between the areas where grown (3,4,6,15).

These extensive characterizations of proteins and enzymes from different cultivars of healthy seeds "standardized" the techniques (i.e., preparation of seed extracts, electrophoretic techniques, etc.) to be used and provided patterns which could be used for comparison to those of individual seeds contaminated with A. parasiticus.

The purpose of this report is to describe the use of polyacrylamide and starch gel electrophoresis for detecting changes from "standard" patterns of total proteins and seven enzymes from healthy individual seeds of a peanut cultivar, Virginia 56R, after contamination by Aspergillus parasiticus.

Materials and Methods

Testae-free seeds of Arachis hypogaea L. subsp. hypogaea var. hypogaea (Virginia market type: Virginia 56R) were incubated for two, three and five days in the presence of A. parasiticus Speare (NRRL A-16, 462). This strain produces high amounts of aflatoxins B_1 and G_1 and some B_2 and G_2. For each experiment, the mold was grown at 30 C for 7 days on potato dextrose agar

plates from which a suspension containing 4.5 to 7.6 x 10^6 spores per ml was made in sterile 0.05% Tween-20. Individual peanuts, although not surface sterilized, were handled aseptically and immersed completely for a few seconds in the suspension of spores. The inoculated peanuts were then placed in a moist chanber in an incubator at 30 C for the required incubation period. Control seeds were similarly treated, omitting the spores in the Tween-20 solution. Some of the contaminated seeds were analyzed for aflatoxins, confirming that the toxins had indeed been produced.

The proteins and seven enzymes (peroxidase, esterase, catalase, leucine aminopeptidase, acid phosphatase, INT-oxidase and alcohol dehydrogenase) from individual contaminated seeds (with and without removal of visible mycelial growth from the seed surface) and the control seeds were extracted, separated by polyacrylamide or starch gel electrophoresis and stained by the techniques described by Ory and Cherry (15). Mycelial and spore tissue of A. parasiticus gently removed from the surface of the peanuts or from a sporing culture of the fungus grown in Czapek's solution (mineral salts plus sucrose) at 30°C were also examined. The entire fungal tissue was ground in buffer, centrifuged and the clear supernatant analyzed for protein and enzyme patterns by the same gel electrophoretic techniques.

Results and Discussion

The gross morphologic development of A. parasiticus on Virginia 56R peanuts is shown in Figure 1. In most cases the entire seed was uniformly covered with a white fuzzy mycelial growth within two days after inoculation. At three and five days after inoculation, mycelial and spore development throughout the peanut was very profuse; especially in the embryo region (see cross section of a peanut after five days). In an earlier study by electron microscopy, Lee et al. (13), showed that the hyphae of A. flavus could penetrate deeply into peanuts on which it was growing.

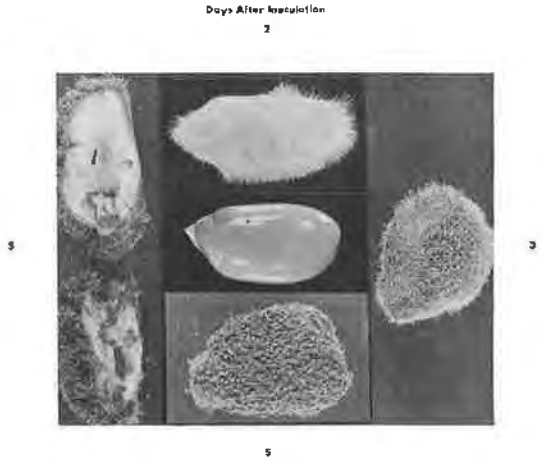

Fig. 1. Virginia 56R peanuts contaminated with A. parasiticus for two, three and five days. Included is a cross section of a peanut contaminated for five days. Untreated control is in the center.

Changes in the total protein patterns resulting from the contamination were analyzed by disc gel electrophoresis and are illustrated in Figure 2.

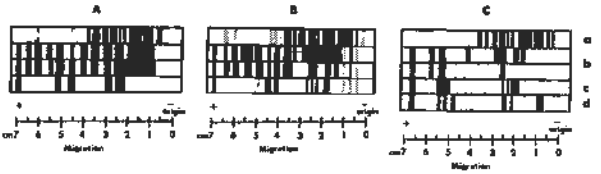

Fig. 2. Representative polyacrylamide gel electrophoretic patterns of total proteins from extracts of individual Virginia 56R peanuts and A. parasiticus at two (A), three (B) and five (C) days after inoculation. Description of gels:
a. Uninoculated whole seed.
b. Inoculated whole seed with (first) or without (second) fungal mycelial tissue on the surface of the seed; the two gels represent the qualitative and quantitative variations between inoculated seeds.
c. Fungus growth removed from the surface of the seed.
d. Culture-grown fungus.

Within two to three days after inoculation of peanuts with A. parasiticus, the major bands (dark staining), or large molecular weight proteins, in region 0.5 to 2.0 cm of the electrophoretic gels decreased rapidly or became diffuse compared to those of untreated seeds during this same period of contamination (Figure 2A, B; compare both gels of b to a, respectively). Simultaneously, many new and smaller molecular weight proteins appeared in the lower half of the gels (regions 3.0 to 7.0 cm, gels b). Continued qualitativ e and quantitative changes in region 0.5 to 3.0 cm occurred during the advanced steges of fungal development at five days (Figure 2C; compare gels of b to a). Also, most of the small molecular weight proteins in region 3.0 to 7.0 cm were becoming difficult to detect (Figure 2C; compare gels of b to a). Examination of the protein patterns in fungal tissue collected from the external surfaces of peanuts at days two, three and five (Figure 2A, B and C, gels c; respectively), or grown on Czapek's solution (Figure 2C; gel d), clearly identified the bands in contaminated seed extracts belonging to or having similar mobilities to the mold proteins. Bagley et al., (2) followed the changes in protein bodies of germinating peanuts caused by proteolytic degradation of arachin stored within. These changes required two weeks to reach the same stage of proteolysis observed in two to five days after Aspergillus contamination. This rapid and complete destruction of the proteins in only two to five days indicates that the proteolytic system(s) of A. parasiticus must be more potent than that in the germinating peanut.

The isozyme patterns of esterase, peroxidase, catalase, leucine aminopeptidase, acid phosphatase, alcohol dehydrogenase and INT-oxidase of peanut extracts after contamination by A. parasiticus for two, three and five days showed major qualitative and quantitative changes when compared to the zymograms of uninoculated seeds.

Two days after inoculation of the peanuts, the esterase zymograms showed increased activity in region 4.0 and 4.6 cm and new isozymes appeared in region 6.0 to 7.0 cm (Figure 3D; compare gels b and c to a at two, three and five days; zymograms of A, B and C, respectively). These changes were similar for peanut extracts prepared with (gels b) or without (gels c) observable fungal tissue on the seed surfaces. All of the isozyme changes, as well as several other bands in zymograms of seed extracts, could be closely correlated with similar regions of esterase activity in the isozyme patterns of fungal tissue (compare gels d and e to b and c during these same periods). The greatest changes noted in peroxidase activities after fungal contamination were quantitative (Figure 3E; compare region 0.5 to 2.0 cm of gels b and c to a; A, B and C, respectively). Also, new isozymes appeared in region 4.5 and 6.6 cm. As shown for esterase, these peroxidase changes for contaminated peanuts could be correlated with isozymes observed in tissue extracts of the fungus (compare gels d and e to b and c).

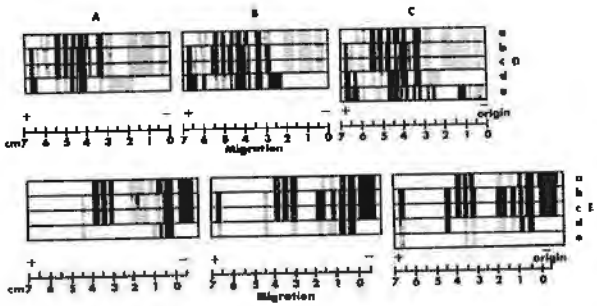

Fig. 3. Representative polyacrylamide gel electrophoretic isozyme patterns of esterase (D) and peroxidase (E) from extracts of individual peanuts and A. parasiticus at two (A), three (B) and five (C) days after inoculation. Description of gels:
a. Uninoculated whole seed.
b. Inoculated whole seed plus visible fungal growth.
c. Inoculated whole seed after removal of visible fungal growth.
d. Fungus growth removed from the surface of the seed.
e. Culture-grown fungus.

During this same period, five new catalase isozymes (regions 4.2, 3.2, 2.0, 0.7 and 0.5 cm) gradually appeared in all of the zymograms of inoculated peanut extracts (Figure 4D; compare gels b and c to a; A, B, and C, respectively). Some quantitative differences were observed two and three days after inoculation (regions 2.0 and 3.0 cm) in zymograms of seed extracts prepared with (gels b) and without (gels c) visible fungal growth on the surfaces of the peanuts (Figure 4D; A, B. respectively).

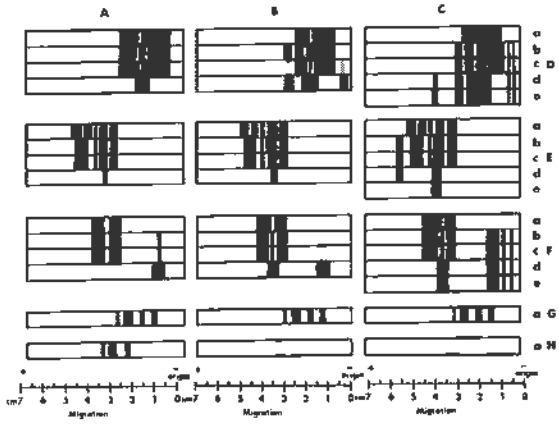

Fig. 4. Representative starch gel electrophoretic isozyme patterns of catalase (D), leucine aminopeptidase (E), INT-oxidase (F), acid phosphatase (G) and alcohol dehydrogenase (H) from extracts of individual peanuts and A. parasiticus at two (A), three (B) and five (C) days after inoculation. Description of gels:

a. Uninoculated whole seed.
b. Inoculated whole seed plus visible fungal growth.
c. Inoculated whole seed after removal of visible fungal growth.
d. Fungus growth removed from the surface of the seed.
e. Culture-grown fungus.

In the zymograms of inoculated seeds, two leucine aminopeptidase isozymes were observed in region 4.0 to 5.0 cm (Figure 4E, gels a); whereas, contaminated peanuts contained one large band in this same area (Figure 4E; compare gels b and c to a; A, B and C, respectively). This band was not observed in extracts of fungal tissue (Figure 4E; gels d and e). A band in region 3.3 cm appeared in the isozyme patterns of all seed and fungal tissue extracts (Figure 4E; compare gels a to d). Five days after inoculation, one new isozyme (region 5.5 cm) gradually appeared in the preparations of both fungal and contaminated seed extracts (Figure 4E; compare gels b, c and d to a). As observed with leucine aminopeptidase, four new isozymes of INT-oxidase (region 3.5, 1.4, 0.8 and 0.5 cm), gradually appeared in zymograms of both fungal and inoculated peanut extracts (Figure 4F; compare b, c, d and e to a; A, B and C, respectively). Acid phosphatase and alcohol dehydrogenase activity could not be clearly distinguished in fungal or contaminated peanut extracts (Figure 4G and H, respectively); alcohol dehydrogenase activity decreased in the control seed extracts.

Many of the esterase bands in mycelial tissue from the surfaces of peanuts were weaker than those from extracts of mold grown on Czapek's solution (Figure 3D; compare gels d and e at five days, C). No differences in the isozyme patterns of catalase and INT-oxidase were noted between these two extracts (Figure 4D and F, respectively; compare gels d and e in C). However, qualitative and quantitative differences in the peroxidase and leucine aminopeptidase isozymes were observed in fungal tissue from the surfaces of peanuts compared to that of mold grown on Czapek's solution (Figures 3E and 4E; compare gels d and e in C).

These variations in isozyme patterns of fungal tissue collected from the two sources (i.e., peanut or Czapek's solution) may be elaborated by the mold during development under different conditions, or may be due to differences in the extraction of these isozymes by our procedures.

Because these experimental conditions are extreme, having an excessive number of spores in the inoculum used, they are not typical of conditions normally observed in contamination during commercial storage. However, these results do indicate that changes induced in proteins and enzymes by the presence of A. parasiticus on peanuts occur rapidly and uniformly and should be readily detectable by gel electrophoretic techniques.

It is clearly evident from this preliminary study that significant changes in proteins and enzymes are induced in peanuts by contamination with A. parasiticus. The basis for these changes and their full significance will depend largely upon the acquisition of more detailed knowledge of their subcellular distribution and the precise nature of the host-interaction. At this point, we know that the invading saprophyte rapidly converts the seed storage materials into nutrients needed for its own development, because the gels show: (1) a rapid breakdown of the large molecular weight peanut globulins to their subunit structures, and (2) qualitative and quantitative changes in isozymes involving hydrolysis of ester linkages (esterases, acid phosphatases), hormonal interaction and oxidation of organic substrates with hydrogen peroxide (peroxidases), decomposition of toxic hydrogen peroxide (catalases), proteolytic activity (leucine aminopeptidases), and oxidation of alcohols and other organic compounds (alcohol dehydrogenases, INT-oxidases). In addition, it seems that most of the peanut isozymes (except alcohol dehydrogenase and acid phosphatase) remain active during this invasion by A. parasiticus and may conceivably be used by the organism to function in its behalf. Thus, in order to stop such an interaction and possibly create resistance in peanuts, it may be necessary to try and alter conditions in the seed in such a way that one or more of these new isozymes of A. parasiticus cannot function properly. This may be possible only through controlled genetic breeding studies.

In conclusion, Farber (8) sums up the necessity for basic biochemical research on host-pathogen interactions which can lead to ways of removing these environmental hazards from man: "Although the complete story has yet to be told about the cellular reaction pattern of any environmental hazard, the data reviewed today are sufficiently encouraging to warrant the prediction that the expanded study in depth of the molecular pathology of selected environmental agents may lead to a new and exciting insight into the interplay between man and his environment, and may well lead to new and better ways to insure the maintenance of health and the success of man in his continual struggle with the hazards in his environment."

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THE DAMAGE AND CONTROL OF THE LESSER CORNSTALK BORER, *Elasmopalpus lignosellus* (Zeller), ON PEANUTS[1]

by
John C. French – Extension Entomologist
University of Georgia – Tifton, Georgia
and
L. W. Morgan – Research Entomologist
Coastal Plains Experiment Station
University of Georgia – Tifton, Georgia

ABSTRACT & PAPER

ABSTRACT

The lesser cornstalk borer, *Elasmopalpus lignosellus* (Zeller), is a sporadic damaging pest of peanuts in Georgia. Observations over a three year period revealed seven different types of damage caused by this insect to the peanut plant. The most important economic damage was due to peg and pod feeding. Two control tests conducted in 1968 and 1969 showed that the insect could be controlled and yields significantly increased using granular parathion and Diazinon.

PAPER

The adult of the lesser cornstalk borer, *Elasmopalpus lignosellus* (Zeller), is a small moth of the family Phycitidae, sub-family Phycitinae. It is distributed throughout the Western Hemisphere, from Southern United States to Argentina and Chile (Luginbill and Ainslie, 1917). The lesser cornstalk borer attacks 62 host plants representing 14 families (Stone, 1968). During the last eight years the authors have observed the insect damaging corn, grain sorghum, millet, small grains, bean, peas, soybeans, and peanuts in Southern Georgia. The damage has ranged from slight to complete destruction of entire plantings. The larva is a semi-subterranean feeder, usually attacking a seedling plant at, or just below the soil surface, boring into the stem and feeding upward and downward from the entrance hole. The result is a severe stunting or death of the young plant. The peanut plant is usually attacked after it is past the seedling stage and death is the exception rather than the rule. It is generally agreed that the lesser cornstalk borer is, at times, a serious pest of peanuts in the Southeastern Peanut Belt. Damaging populations have been sporadic, and have normally been associated with sandy soils, during periods of hot, dry weather. Chemical control investigations, carried out annually since 1949 have consistently shown no increase in peanut yield (Leuck and Morgan, 1969).

In assisting county agents with peanut insect problems across the Georgia Peanut Belt, a constant vigil was maintained for lesser cornstalk borer infested peanuts. Observations were made in approximately 140 fields in 1968, 110 fields in 1969 and 90 fields in 1970. When borer infestations were found, observations and pictures were made to show the types of damage caused by the borer, and in some cases efforts were made to estimate populations. Entire plants were dissected periodically to observe the internal injury.

Of the 140 fields of peanuts checked for insect problems in 1968, 68 were found to be infested to some extent by the lesser cornstalk borer. Only in 16 of these was the infestation such that heavy damage was obvious, and in only 6 was there an active, heavy larval population at the time the field was inspected. In every instance, hot, dry weather conditions were associated with the damaging infestations.

[1] From Ph.D. dissertation submitted to Department of Entomology and Economic Zoology, Clemson University, Clemson, South Carolina.

In 1969, 25 of the 110 fields inspected were infested by the lesser cornstalk borer. Only 8 of the fields had moderate to heavy infestations. Seven of the heavily infested fields were located in the Western part of Miller County and the Eastern part of Seminole County, an area which had an extended dry period.

Ninety peanut fields were inspected for insect damage in 1970 and none was found to have what was considered to be a damaging infestation of the lesser cornstalk borer. This was a year of above normal rainfall, and a record average State yield of peanuts of 2220 lb. per acre was produced.

Observations during these three summers have revealed the following types of damage to the peanut plant by the lesser cornstalk borer:

1. Leaf-feeding especially on leaves that are in contact with the surface of the soil.

2. Feeding on the epidermis of branches and at times feeding into the cortex and pith of branches, hypocotyl and epicotyl without tunneling.

3. Tunneling inside of branches and occasionally the hypocotyl and epicotyl.

4. Peg feeding as the pegs extend to the surface of the soil from the branch nodes.

5. Pod feeding beneath the soil surface.

Silken tubes, or webbing, covered with soil particles and excrement are usually associated with the lesser cornstalk borer. The damage to pegs and pods was considered to be of greatest economic significance.

Three control tests were conducted on naturally occurring populations of lesser cornstalk borers. Each test was arranged in a randomized complete block design. Treatments included 2 lbs. of actual parathion, 2 lbs. of actual Diazinon, both applied in a band over the row as granules, and an untreated check. Granules were applied using a gravity flow granule applicator equipped with a granule spreader raised about one foot above the plants. This equipment gave a band of granules about 16-18 inches wide on the surface of the soil, centered on each row.

A significant yield increase was obtained in two of the tests. Table 1 presents an average of the two tests in which a significant yield increase was obtained. Yield differences in the third test were not significant.

At the time this test was begun, the plants in the field had already been badly damaged by borers and a tremendous number of moths was present. Only a few larvae were found. Following treatment, the field was never again under moisture stress and apparently a damaging population of borers did not develop.

Table 1. Average per acre peanut yield, sound mature kernels and percent damaged pods following treatment with two granular insecticides to control the lesser cornstalk borer in Georgia in 1968 and 1969.

Treatments	Formulations	Lb. A.I. Per Acre	% Dam. Pods	% SMK	Per Acre Yield (lb.)
Parathion	10% G	2.0	16.2	65.5	2307
Diazinon	14% G	2.0	22.7	65.0	2083
Check	---	---	32.4	63.5	1586

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CONTROL OF THE GRANULATE CUTWORM, FELTIA SUBTERRANEA (F.), A FOLIAGE FEEDING PEST OF PEANUTS

by
L. W. Morgan
Entomology & Fisheries Department
University of Georgia College of Agriculture
Coastal Plain Experiment Station, Tifton, Georgia
J. C. French
Extension Entomologist, Cooperative Extension Service,
University of Georgia College of Agriculture
Coastal Plain Experiment Station, Tifton, Georgia

ABSTRACT AND PAPER

ABSTRACT

The granulate cutworm Feltia subterranea (F.) is one of the major pests of peanut foliage in Georgia. Methods and materials used in studying control measures will be discussed. The insecticides used were formulated as baits, sprays, dusts and granules. A review of the literature has been made in this study. Trichlorfon in bait formulation is the primary material recommended for use on peanuts against this insect at this time.

PAPER

INTRODUCTION

The granulate cutworm Feltia subterranea (F.), in the larval stages, damages peanuts in Georgia by feeding on the foliage, usually at night. Recommendations for control of this insect infesting peanuts in Georgia have been made since 1955, McGill et. al. (1955).

The female of this species oviposits on the leaves of peanuts near the periphery of the plant. The eggs are deposited singly or in small groups on the leaf surfaces. Shortly after hatching, the larvae go to the soil surface beneath the plants, where they feed on vegetative matter, usually the leaves which have been shed by the plant or those which are in contact with the soil. At sometime during the period between mid-June and mid-July, the cutworm larvae crawl up the plants at night, and when infestations are heavy damage is severe. For additional observations on the biology of this insect in relation to peanuts, see Morgan and French (1971).

The range of the granulate cutworm has been discussed by Riley (1885) and Crumb (1929), and its importance as a pest of cultivated crops was noted at least 120 years ago (Guénée and Boisduval (1852)).

The life history of this insect has been described in detail by several entomologists, notably French (1882) and Crumb (1929).

PROCEDURE

Individual experiments were arranged in randomized complete blocks, replicated 3 times in 1966 and 4 times in 1967, 1968, and 1969. Plots were 4 rows x 40 feet long (approx. 1/100 acre). All these tests were superimposed on existing populations of cutworms in farmer-owned fields, and yields were not obtainable.

All spray materials were applied with a knapsack sprayer, using a 3x nozzle and 40 psi, at a rate of 3 gal/acre finished formulation. A hand-operated duster

was used for applying the toxaphene-DDT dust. Baits and granules were weighed for each individual row, placed in small paper bags, and applied by hand. This method was used for speed of application and to confine application error to the 1 row involved. All insecticides were applied in the afternoon, and counts were made 24 hr later by measuring a randomly selected 10-ft length of the plot, and counting live and dead larvae found from row center to row center in the middle alley of the plot.

DISCUSSION

Investigations have been conducted since 1966 at Tifton, Georgia in order to determine the feasibility of chemical control of this insect in peanut fields. These studies have included formulations applied as baits, sprays and granules.

Although in these experiments several insecticides have given at least 90% control of the granulate cutworm infestations in peanut fields, Trichlorfon is the only chemical, in bait formulation, currently being recommended. The recent introduction of pesticides in sprayable form for peanut foliage disease control has stimulated an interest in insecticide spray formulations which may be used in combination with the disease-controlling chemicals.

Experimental procedures used and results obtained in these studies are discussed in detail by Morgan and French (1971).

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CHEMICAL CONTROL OF SOUTHERN CORN ROOTWORMS ON PEANUTS IN TIDEWATER VIRGINIA

J. C. Smith
Associate Professor of Entomology
Tidewater Research and Continuing Education Center
Virginia Polytechnic Institute and State University, Holland, Va. 23391

ABSTRACT

Labeled and candidate insecticides were field tested from 1968 through 1971. Small plots (12 ft. X 20 ft.) were utilized and standard agronomic practices for the production of large-seeded, Virginia-type peanuts were followed except for the insecticide variable. In 1968, selected sites with histories of rootworm infestations illustrated that carbofuran @ 3.0 lb AI/acre applied as an 8-in. band at planting was statistically equal in effectiveness with split-combination (planting + pegging) treatments of disulfoton + diazinon, phorate + diazinon, or split applications of carbofuran. The preplant application of carbofuran, however, was inferior to the split-combination treatments of phorate + Dyfonate or disulfoton + Dyfonate. Yields from plots treated with split applications of carbofuran and split-combinations of phorate + Dyfonate or disulfoton + Dyfonate averaged 630 pounds/acre above the untreated controls. In other tests, injury as high as 48% resulted in yield decreases of 1074 lb/acre. Parathion treatments in some tests had significantly more injury than untreated controls and effects on yield were proportional. Aldrin failed to control the cyclodiene-resistant rootworms although it had not been used in the area for 10 years.

In 1969 carbofuran as a split treatment, and pegging treatments of carbofuran, Mocap, and diazinon reduced rootworm injury by 61%. Plots treated with carbofuran, Dyfonate, Bux, Mocap and phorate had yields significantly higher than yields from plots treated with split applications (early & delayed pegging) of parathion.

Low infestation in 1970 resulted in many instances where yields from untreated controls were superior to treated plots. However, at selected sites with histories of rootworm problems, the effective materials significantly reduced injury.

In 1971, standard chemicals continued to be effective, and new material, SN316, gave promising results at low rates of treatment.

INTRODUCTION

From about 1948 to 1958, the southern corn rootworm, Diabrotica undecimpunctata howardi Barber, was effectively controlled in Virginia with the insecticides, aldrin, dieldrin, and heptachlor. These materials were extremely effective when applied as dusts, sprays, granules, or in fertilizer mixtures. Because of their efficacy and broad useage, the southern corn rootworm had been relegated from a major problem to a nuisance pest status. However, in 1958, in the Cypress Chapel area of Nansemond County, Virginia, applications of aldrin and heptachlor failed to give control on about 200 acres of peanuts. The apparent sudden resistance was coupled with resurgent populations of the pest, and numerous instances of complete crop failure due to rootworm were reported. Populations of the cyclodiene-resistant rootworms spread quickly, and the entire peanut belt of Virginia was affected by 1961.

Boush et al. (1963) and Boush and Alexander (1964) reported results of screening new insecticides in Virginia. Their investigations led to the establishment of acceptable control measures employing diazinon granular insecticide applied as an early, pegging-time, band treatment over the row. Subsequently, phorate, Dasanit® (O,O-diethyl O-p-(methylsulfinyl) phenyl phosphorothioate), Dyfonate® (S-(p-chlorophenyl) O-ethyl ethanephosphonodithioate), and parathion have been

registered, labeled and recommended for use in control of rootworms in Virginia (Roberts and Smith 1972). Parathion formulations later proved to have insufficient residual effectiveness and recommendations were withdrawn.

Evaluations of field trials from 1965 through 1967 with selected insecticides were reported by Smith (1971). Several candidate insecticides including Landrin® (4:1 mixture of 3, 4, 5 and 2, 3, 5 trimethylphenyl methyl carbamate), Bux® (4:1 mixture of m-(1-methylbutyl) phenyl methylcarbamate and m-(1-ethylpropyl) - phenyl methylcarbamate) and carbofuran (Furadan) appeared particularly promising for rootworm control.

This paper reports continued field trials with candidate insecticides with various application procedures employed from 1968 through 1971.

METHODS AND MATERIALS

Candidate soil insecticides were applied in 1968-1970 with a Gandy® Mod. 901-2 granular applicator precalibrated to deliver the desired quantity of each insecticide. In 1971, in-furrow treatments were applied with the Gandy applicator, but pegging-time applications were made with Rzee Flow® granular applicators mounted on a garden-type tractor. In-furrow applications were incorporated with a garden-type rotary tiller prior to planting, subsequently their placement was equivalent to an 8-inch band treatment at planting. Pegging-time treatments were applied as 14-inch bands over the center of the row, and these treatments were incorporated by a shallow cultivation unless vine growth was excessive and pegging was at an advanced stage. Insecticides used in these studies were: aldicarb, aldrin, carbofuran, diazinon, disulfoton, methomyl, parathion, phorate, Bux® (m-(ethylpropyl) phenyl methyl carbamate mixture (1-4) with m-(methylbutyl) phenyl methylcarbamate), Dyfonate® (O-ethyl S-phenyl ethylphosphonodithioate), Fisons NC 6897 (2,2, dimethyl -1-3-benzodioxol-4-yl-N-methyl carbamate), Landrin® (3,4,5-trimethylphenyl methylcarbamate, 75%; 2, 3, 5-trimethylphenyl methylcarbamate, 18%), Mocap® (O-ethyl S,S-dipropyl phosphorodithioate), and Baygon® (2,3,O-isopropoxyphenyl metholocarbamate). Except where further noted in the text, no control measures were directed to tobacco thrips, Frankliniella fusca (Hinds), or potato leafhopper, Empoasca fabae (Harris). Other standard recommended practices for the culture of Virginia-type peanuts were followed.

Except for 1 test located at Holland in 1968, the soil types were classified as Bertie fine sandy loam and loamy fine sand (Aquic Hapludaults; fine loamy, mixed, thermic). These sites were somewhat poorly drained and had a history of rootworm infestations.

Cultivars grown included Va. 56R, Va. 61R, Florigiant, and Va. Bunch 46-2. Plot size of 12 ft width (4-36 in rows) and 20 ft length and 5 ft alleys between blocks was standard in all tests. Randomized complete block design with 4 or 5 replicates was used.

Chemical efficacy was determined by hand digging 2 plants from each of the 2 center rows of each plot. The fruit from the 4 plants formed a composite sample which was separated into mature and immature fruit based on pod texture and seed coat color, then these categories were further separated into sound and damaged fruit. Damaged fruit were defined as those showing larval feeding damage irrespective of the degree of damage. Percent damaged fruit was calculated from these observations. Percentages were transformed using Arc Sin transformation and analyzed by the Duncan's Multiple Range test. Evaluations on efficacy were conducted between the second and third week in September each year.

Yields were determined by digging plots with a commercial digger and stacking vines by plots for field curing. Peanuts were later harvested by plots with a stationary picker, weighed and samples were taken for determination of grade factors.

RESULTS AND DISCUSSION

Thrips and Rootworm Test

Carbofuran (@ 3.0 lb AI/acre) as a planting time application was statistically equal in rootworm control with split applications of phorate or disulfoton for control of thrips and rootworms (Table 1). The single planting application of carbofuran was somewhat less effective than applications of phorate or disulfoton for thrips followed by applications of diazinon at pegging for rootworms, although they were in the same statistical grouping. The combination treatments including phorate or disulfoton at planting followed by Dyfonate at pegging were the most effective. All treatments which included diazinon or Dyfonate at pegging were significantly superior to the untreated controls. There were no statistical differences in yield, although split applications of carbofuran and the combination treatments with Dyfonate had yields that averaged 630 pounds higher than untreated controls. All treatments except the combination of disulfoton at planting plus diazinon at pegging had a higher (not significant the 5% level of probability) percent SMK than the untreated controls.

Rootworm Control Tests

A summary of test results in which only southern corn rootworms were controlled is presented in Table 2 (Efficacy) and Table 3 (Grade and Yield effects). Many chemicals tested during the period 1968-1971 are not listed. Only those materials which were included in more than one test or during more than one year are discussed. Further, only data from tests with statistically significant (5% level of probability) differences are presented.

Carbofuran @ 1.0, 2.0, and 3.0 lb AI/acre, Mocap @ 2.0, Dyfonate @ 2.0, diazinon @ 2.5 and phorate @ 2.0 lb AI/acre have been consistently effective in rootworm control during several years at several sites with histories of rootworm problems. The percentage of injured pods presented in Table 2 reflects damage to both immature and mature pods and is not fully representative of the satisfactory results which a commercial grower would receive. Many of the immature pods would not have been marketable irrespective of injury. The relatively high percentage of injury likewise does not reflect the degree of injury, and many pods classified as injured contained perfectly sound seeds.

Rootworm control by parathion has proven generally unsatisfactory in Virginia. High infestations and lack of residual effectiveness are believed responsible for the failure of this chemical, since laboratory studies have revealed no resistance to this insecticide.

It was thought that perhaps rootworms might have regained a degree of susceptibility to aldrin since that insecticide had not been used for better than ten years. Data from several tests demonstrated that the above was not the case, and the degree of damage in aldrin-treated plots was equal to or worse than in untreated plots.

Few promising candidate insecticides are presently being developed as soil insecticides for southern corn rootworm control. The high cost of development together with the extreme difficulty of gaining EPA registration for pesticidal chemicals seems to be generally discouraging most proprietary companies. One promising exception to the above has been Noram's SN316. This chemical showed promising results in 1971 tests at two sites and appeared to have the advantage of being more effective at low than high rates of application.

Efficacy data do not always reflect the true value of a rootworm insecticide. Ultimately, the yields and grades which result from treatments must justify their application. With few exceptions, carbofuran, Mocap, Dyfonate, diazinon, Dasanit (no data shown) and phorate have significantly improved grades and yield (Table 3). Upon occassion, carbofuran has increased yield above that which might be expected from rootworm control. We have a paper (in press) which indicates this yield increase is probably due to additional nematicidal effect.

The lack or rootworm control by parathion and aldrin was also expressed in

reduced yields and lower SMK. In 50% of the tests yields from parathion and aldrin-treated plots were lower than in untreated controls. This phenomenon is somewhat difficult to explain, but often occurs. It is likely a result of lack of efficacy against the target species, but the chemical results in the elemination of antagonists (competitors or predators).

In summary, presently labeled and recommended insecticides continue to be effective in rootworm control. Several insecticides representing another class of chemicals have had extensive field testing and appear promising should resistance occur to the presently-used materials.

Table 1. Grade, yield, and % injury of peanut fruits treated with granular insecticides at planting and pegging, Holland, 1968.

Treatment	% Injured Pods[1/]	% SMK[1/]	Yield/acre lb.
	Holland Test - 1968		
Carbofuran 10G @3.0*	15.9abc	60.3 bcd	2958
Disulfoton 10G @1.0+2.0	25.1ab	63.8 d	2795
Phorate 10G @1.0+2.0	14.2abcd	61.8 bcd	2650
Disulfoton 10G + Diazinon 14G @1.0+2.5	5.4 cde	56.5ab	2650
Phorate 10G + Diazinon 14G @1.0+2.5	9.4 cde	61.8 bcd	2777
Carbofuran 10G @0.5+2.0	9.4 cde	61.0 bcd	3122
Phorate 10G+Dyfonate 10G @1.0+2.0	4.1 de	61.0 bcd	3086
Disulfoton 10G + Dyfonate 10G @1.0+2.0	2.2 e	59.8 bcd	3140
Untreated	29.6a	57.0abc	2487

* Application at planting-time only.

1/ Means not followed by the same letters are significantly different at the 5% level of probability.

Table 2. Southern corn rootworm injury to peanut fruits treated with granular insecticides at pegging-time. Several Virginia locations, 1968-1971.

Treatment - formulation and rate		% Injured Pods - Year and Location of Test[1/]						
		1968 Holland	1968 Chucka-tuck	1968 Cypress Chapel	1969 Holland	1969 Chucka-tuck	1970 Cypress Chapel	1971 Holland
Carbofuran 10G	@1.0	2.6a						3.8a-d
Carbofuran 10G	@2.0	5.5abc	13.9abc	12.1a	16.3bc	3.3a	1.0a	3.0abc
Carbofuran 10G	@3.0	4.4ab			5.4a			
Mocap 10G	@2.0	8.6abc	18.8abc	14.4a	11.1ab	3.1a	3.1ab	
Dyfonate 10G	@2.0	7.6abc	14.6abc	16.4ab		4.3a	1.6a	
Dyfonate 15G	@1.5	7.5abc	33.8bc					
Diazinon 14G	@2.5	7.2abc	4.2a	11.6a	9.6a	6.0ab	5.7abc	3.5a-d
Phorate 10G	@2.0	11.5abcd	14.7abc	18.1ab		5.2a	5.6ab	
Parathion 10G	@2.5	50.4g	16.2abc	29.1b		12.7c	9.8bcd	
Landrin 10G	@2.0		8.8ab	57.8c				
Aldrin 10G	@2.0		31.5bc			18.0c		
Untreated Control		27.6def	39.3c	47.9c	20.8c	17.2c	19.7d	10.8d

1/ Means not followed by the same letters are significantly different at the 5% level of probability.

Table 3. Grade factors and yield of peanuts treated with granular insecticides for southern corn rootworm control. Several Virginia Locations, 1968-1971.

Chemical-formulation & rate			Year and Test Location									
			1968 Holland		1968 Chuckatuck		1968 Cypress Chapel		1969 Chuckatuck		1971 Holland	
			SMK[1/]	Yield	SMK	Yield	SMK	Yield	SMK	Yield	SMK	Yield
Carbofuran	10G	@1.0	66.4a	3731a							62.8	3567
Carbofuran	10G	@2.0	65.6abc	3739a	60.2ab	2977ab	57.8a	2991a	67.3a	2977ab	64.3	3267
Carbofuran	10G	@3.0	67.6a	3630ab								
Mocap	10G	@2.0	64.2b	3612ab	55.6abcd	2795abc	56.3a	2875a	65.7abc	2777abcd		
Dyfonate	10G	@2.0	64.2bc	3630ab	59.8abc	3067ab	53.5ab	2744ab	65.0abcd	2595cde		
Dyfonate	15G	@1.5	63.2bcd	3703a	60.2ab	3013ab						
Diazinon	14G	@2.5	63.0bcd	3812a	60.8a	3176a	55.7ab	2744ab	64.8abcd	2686bcde	64.3	3539
Phorate	10G	@2.0	59.6efg	3067cde	54.8bcd	2759abc	51.2b	2614abc	66.8ab	3031a		
Parathion	10G	@2.5	54.2ij	2305f	58.6abc	2977ab	45.0c	2309bcd	65.9abc	2523de		
Landrin	10G	@2.0			59.8abc	2922ab	45.8c	2207cd				
Aldrin	10G	@2.0			58.4abc	2413c			62.2d	2650cde		
Untreated control			57.0ghi	2813de	45.8e	2341c	42.0c	1917d	63.7bcd	2704abcde	62.5	3231

1/ Means not followed by the same letters are significantly different at the 5% level of probability.

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Effect of Leafspot Control on the Arginine Maturity Index of Peanuts

Clyde T. Young, Sam R. Cecil, and Donald H. Smith
University of Georgia, Georgia Station,
Experiment, Georgia 30212

INTRODUCTION

Effective control of peanut leafspot diseases is necessary for maximum productivity of peanuts. At present, leafspot control is obtained with selected fungicidal sprays and dusts (Jackson and Bell, 1969). Control of leafspot appears to delay maturity, while a lack of control tends to hasten it. Therefore, the optimum harvest date for a given variety is often influenced by the degree of leafspot disease control. With the increasing interest in the production of high quality peanuts, it is becoming important for peanut growers to harvest peanuts at the proper time in order to obtain maximum yield and quality. An improved method for measuring the maturity of peanuts has been sought for some time.

Holley and Young (1963) reported that the amount of carotenoid pigments was associated with the level of peanut maturity. Because of interference by components unrelated to maturity, no quantitative interpretations were developed. Emery *et al.* (1966) used a pigmentation method to determine the maturity level of farmers stock peanuts and found it to be relatively effective. Later Perry (1971) discontinued the attempted adaptation of this method at the farm level because of the lack of predictability of the year to year differences and their effect on changes in maturity values.

Newell (1967) and Mason *et al.* (1969) reported a large decrease in arginine content of Spanish peanuts with advancing maturity. Young and Mason (1972) conducted an investigation to evaluate the usefulness of arginine content as a measure of maturity of peanuts and found it to be reliable under field conditions. The method has been adapted to automated analytical equipment (Young 1972).

The purpose of this investigation was to determine the effect of various foliar fungicides used for control of Cercospora leafspot on peanut maturity as measured by free arginine content.

EXPERIMENTAL

Agronomic Practices

Argentine peanuts, a Spanish type, were planted at Plains, Georgia using a seeding rate of 120 pounds per acre on 40 ft beds with 4 close-rows per bed. The beds were arranged in randomized blocks with 4 replicates per treatment within each test. Herbicides and insecticides were applied as needed for satisfactory control. The peanuts were harvested at 118 days after planting (Table 1) or as specified in Table 2. In another test at Tifton, Georgia, Florunner peanuts were planted according to a split plot--randomized blocks with 5 treatments (see Table 3), 6 replications and 3 harvest dates for each treatment. The peanuts were harvested at ten-day intervals at 112, 122 and 132 days after planting.

Sample Preparation

The unshelled samples were placed at 0°F to prevent insect infestation. Upon removal, they were washed in a weak Calgon solution to remove dirt, then

rinsed in tap water, dried overnight at 80°F to remove excess water and shelled with a Federal State Inspection Service Sheller. Shelling, grading, sound mature kernels (SMK), processing, taste panel and other chemical data were obtained. Samples were collected for chemical analyses and free arginine was determined immediately.

Determination of Arginine Maturity Index (AMI)

Arginine was measured by using an automation (Young, 1972) of the Sakaguchi reaction as reported by Young and Mason (1972). The method consisted of grinding 20 gm of SMK peanuts (based on screen size as stated by the Federal-State Inspection Service grading instructions) in 200 ml of trichloroacetic acid solution for 30 seconds, then filtering, and analyzing the filtrate for free arginine. The optical density of the filtrate was determined with a Spectronic 20 colorimeter, at a wavelength of 520 nm with the OD X 100 being designated as the arginine maturity index (AMI).

RESULTS AND DISCUSSION

Table 1 shows the arginine maturity index (AMI) values for peanuts from the 1971 peanut leafspot fungicide tests, in which the fungicides were applied using the meteorological schedule as recommended by Jensen and Boyle (1966), or using 14 or 21 day intervals. The AMI data for each test has been arranged from lowest (more mature) to highest (least mature) within the two groupings of these data. Table 2 shows the AMI of peanuts obtained from the digging dates test at Plains also using Argentine peanuts. The results of the digging dates test at Tifton are shown in Table 3.

With the maturity index, as measured by free arginine content (AMI), values below 30 were indicative of mature kernels, while values above 35 represented immature kernels. Present data also indicate that there is relatively little variability in this maturity measurement among most peanut varieties. However, some varieties, notably those of the Runner type, have a tendency to mature unevenly, resulting in somewhat higher arginine maturity index values.

It has been observed that proper drying at temperatures not exceeding 95°F, and proper control of temperature and moisture at relatively low levels in storage tend to result in moderate reduction in arginine values. Thus, properly cured and stored peanuts harvested at variable maturity or slightly immature may exhibit arginine values comparable with those of a more uniformly mature lot which has been improperly handled. Investigations of the influence of such variations on storage and product stability, as well as definite association of various levels of arginine with cured peanut quality, are being continued.

The initial examination of the data in Table 1 indicated unmeasured variability associated with experimental design. This was thought to be the result of the 14 and 21 day tests being on land planted to peanuts the previous year. Since the peanuts in the meteorological test were grown on land not in peanuts the previous year and the leafspot was less severe in the meteorological test, the data were divided and treated statistically.

The mean value for AMI in the meteorological study was 37.25 with a pooled standard deviation of ± 5.32 for rep locations, while the 14-day and 21-day applications section averaged 34.92, with a replication deviation of ± 6.04. In each of these tests, most of the rep variation was caused by a single treatment. This is indicative of results that might be expected at the farm level. In a related experiment, differences such as these were often associated with other diseases such as pod rot and white mold. A more careful observation of these factors appears necessary in future tests. In the meteorological test, the values for Benlate were significantly higher than those for Kylar and Copper

Table 1. Arginine maturity index (AMI) of Argentine peanuts (SMK) from meteorological, 14 day and 21 day leafspot control tests at Plains, Georgia, 1971

Treatment	AMI	Standard Deviation
Meteorological[1]:		
Kylar[2]	30.0a	2.95
Cu-S + Kylar	35.0ab	1.83
Cu-S dust	36.5abc	2.89
Fungi-Sperse S-Z	36.8abc	2.88
Control	39.0bc	2.31
Bravo 75W	39.3bc	2.37
Benlate 50W	44.3c	12.58
mean	37.25	5.32
14 day and 21 day[3]:		
Benlate 50W + Kylar	30.5a	0.58
Bravo 75W + Kylar	30.8a	0.50
Control*	32.0a	1.83
Control	33.0a	1.42
Benlate 50W + Oil	39.8ab	0.96
BAS-3201-F*	43.5b	14.55
mean	34.92	6.04

[1]Timing of fungicide applications based on temperature and relative humidity conditions (Jensen and Boyle, 1966).
[2]Kylar, a growth regulator, was applied only twice, alone or to fungicide test peanuts as shown.
[3]Fungicides applied at intervals of 14 days (with *) or 21 days.

sulfur dust. The mean for Kylar (30.0) was significantly lower than both Bravo (39.3) and Benlate (44.3). A smaller but significant and similar observation was observed on preliminary studies from 1970 samples.

In the 14 and 21 day application interval tests, the lower values associated with Kylar applications on the Benlate and Bravo plots are notable, but further tests are needed to determine the validity of these observations.

Based on present experience, all AMI values above 35 indicate that the peanuts were definitely immature, while those from 30 to 35 were of questionable maturity. In a similar preliminary test performed in 1970, a mean AMI value of 27.7 was obtained with peanuts harvested at 125 days. This would indicate that the 1971 test may have been harvested at least a week sooner. However, further reference to Table 2 shows that 127-day Argentine averaged 41.0, 138-day 38.8, and 148-day samples 37.0.

The high AMI values observed throughout the 1971 Plains digging dates test (Table 2) were attributed to the poor drainage of the experimental plots and high rainfall during the latter part of the growing season. Peanut yields for 1971 were generally about one-half of those obtained in 1970 from the same test in the same field. This indicated that the mature pods were lost either before or

Table 2. Arginine maturity index (AMI) of Argentine peanuts (SMK) from digging dates test at Plains, Georgia, 1971

Treatment*	Harvest (days after planting)					Standard Deviation
	118	127	138	148	mean	
Control	38.0a	40.8ab	39.8bc	38.0bc	39.12ab	1.91
Cu-S 10-90 Dust	41.3b	41.0ab	37.0a	37.3abc	39.12ab	1.57
Bravo 75W	41.3b	40.5ab	37.3ab	35.5a	38.62a	1.57
Polyram 80W	38.0a	39.5a	39.3abc	37.0abc	38.44a	1.22
Fungi-Sperse, S-Z	39.3ab	41.5ab	41.0c	38.3c	40.00c	1.43
Benlate 50W	40.8b	42.8b	38.3ab	36.3ab	39.50bc	1.19
mean	39.75c	41.00d	38.75b	37.04a	39.14	
Standard deviation(±)	1.48	1.78	1.59	1.09	1.50	

*Fungicides were applied on a 14 day schedule.

during harvest. AMI means of 41.0 and 37.0 were obtained at 127 and 148 days respectively compared to 1970 means of 25.5 and 24.9 at 125 and 146 days.

In addition to the higher AMI values for the 1971 Argentine resulting from adverse growing conditions, taste panel members frequently noted bitter or other off-flavors in salted peanuts made from them, suggesting that kernels of this quality should be withheld from commercial edible stocks. Under the present crop program, they could be diverted to "surplus" without loss to the farmer.

The data for Florunner peanuts in Table 3 exhibited a somewhat different

Table 3. Arginine Maturity Index (AMI) of Florunner peanuts (SMK) from tri-state digging dates test at Tifton, Georgia, 1971

Treatment**	Harvest (days after planting)				Standard Deviation
	H1 (112)	H2 (122)	H3 (132)	mean	
Benlate 50W	29.3b	25.3a*	36.3a	30.33a	4.00
Control	24.0a*	30.8ab	47.0b	33.94b	5.68
Bravo 75W	24.7a	25.3a*	42.3b	30.78a	3.19
Kocide 101-65W	22.0a*	30.8ab	43.5b	32.11ab	2.56
Cu-S + Sevindust	24.7a*	32.7b	53.8c	37.06c	4.29
mean	24.93a	29.00b	44.60c	32.84	
Standard deviation(±)	3.22	5.10	3.70	4.09	

*Harvest for a given treatment returning the highest dollar value per acre.
**Fungicides were applied on a 14 day schedule.

pattern in that mean AMI value increased from 27.0 for the first two harvests to 44.6 for the third harvest. With the exception of Benlate and Bravo treatments,

the increase was progressive from first to third harvests. Means for the control, Kocide and Cu-S treatments were 23.6 at 112 days, 31.4 at 122 days and 48.1 at 132 days. The sharp decreases in third-harvest yields was clear proof that more mature pods were lost on late harvest, and suggested the possibility of some reversal of maturation processes towards germination reactions.

In addition to the above varietal and seasonal variation in the maturity index, certain treatment differences were also observed. Argentine peanuts grown with Kylar, a growth regulator, with or without leafspot control agents, had consistently lower AMI values than other treatments in the same tests. Four of the five Kylar-treated samples examined (Table 1) averaged 31.6 in comparison with 38.2 for other treatments and controls in the same tests. Thus it would appear that Kylar applications tend to influence earlier maturation.

In the applications schedule tests with Argentine peanuts, such as those shown in Table 1, AMI values of treatments with Fungi-Sperse were consistently lower and those with Cu-S slightly lower than the untreated controls, while values from Bravo treatments were somewhat higher and those from Benlate markedly higher. In the Argentine harvest dates tests, AMI values for Fungi-Sperse treatments averaged higher, Cu-S, Bravo and Benlate treatments averaged higher than controls for the early harvests and decreased to lower values for the later harvests.

The general increase in Florunner AMI values for the second and/or third harvest is shown in Table 3. Values for the Benlate treatment increased less, Bravo somewhat less, and Kocide about the same as untreated controls. Cu-S values and increases were consistently higher.

Data in Table 3 indicated that the maximum quality as measured by the AMI values may also be related to maximum yields, as five of the six lowest values were for treatments having highest economic returns.

In general, the data indicate that leafspot control with chemicals such as Benlate and Bravo may delay maturity in Runner type peanuts, so that they may be harvested later than peanuts that are unsprayed or treated with Kocide or Copper sulfur dust. Harvest practices may need to be varied depending upon the leafspot control method and/or chemical applied.

SUMMARY

Peanuts treated with various fungicides to control Cercospora leafspot have been observed to affect the maturity as determined by a newly-established arginine maturity index (AMI). The maturity index is based on a quantitation of the free arginine values of peanuts, with the lowest values indicating the more mature peanuts. Data indicated that the maximum quality as measured by the AMI values may also be related to maximum yields, since samples with the lowest values represented treatments having highest economic returns. Harvesting recommendations apparently need to be varied depending upon the variety, leafspot control method, and/or the chemical applied.

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PEANUT DISEASE CONTROL IN MALAWI, CENTRAL AFRICA

by
R.W.Gibbons and P.C.Mercer
Plant Breeder and Plant Pathologist, Grain Legume Productivity Unit,
Agricultural Research Council of Malawi, Lilongwe, Malawi.

ABSTRACT & PAPER

ABSTRACT

Two peanut diseases are discussed. The first, rosette virus, has been known in Africa since 1907 but the second, probably caused by the fungus Fusarium oxysporum, has only recently been noticed in Malawi.

Resistance to rosette has only been demonstrated in a group of relatively unproductive cultivars from the Ivory Coast, Upper Volta regions of West Africa. These cultivars have been used in a breeding programme to transmit resistance to the commercial susceptible Malawi cultivars. Resistance is governed by two recessive genes. At present the newly developed resistant hybrids are in nationwide yield trials and their commercial acceptance and yielding capacity are discussed.

A new pod-rot disease of peanuts in Malawi is described, and the roles of F.oxysporum and other pathogens as causal agents are discussed. The incidence of the pod-rot is correlated with the occurrence of paler than normal testas. Possible methods of controlling the pod-rot are being investigated.

PAPER

Introduction

Malawi is a small landlocked country of Central Africa, approximately two thirds the size of Georgia. Peanuts rank about third in value of agricultural exports after tobacco and tea. Last year some 40,000 short tons of shelled peanuts were purchased by the Agricultural Development and Marketing Corporation. The peanut crop is produced by farmers on small acreages and the majority of operations, from planting to shelling the harvested crop, are done by hand. The export crop is sold almost entirely for confectionery purposes on the European market where there is a good demand for the very large kernels of the Chalimbana cultivar. A Spanish type (Malimba) is also produced in the hotter, lower altitude areas and Mani Pintar, a cultivar for internal oil expressing use, is grown on the Salima Lakeshore.

The Grain Legume Productivity Unit of the Agricultural Research Council of Malawi is responsible for all peanut research in Malawi. Three main disease problems are being investigated. The virus disease known as 'rosette' is the subject of a breeding programme; leafspots caused by Cercospora spp. are being investigated by treatment with fungicidal compounds and research on a pod breakdown disease is just starting. The first and last diseases are discussed in this paper.

PEANUT ROSETTE VIRUS.

Rosette was first reported in Tanzania by Zimmermann (1907) and later in South Africa by Storey and Bottomley (1928). The disease is widespread in Africa south of the Sahara (Adams and Gibbons - unpublished data). The virus is transmitted in a persistant manner

by the aphid, Aphis craccivora Koch. It is not seedborne unlike peanut mottle virus (Kuhn, 1965) or peanut stunt virus (Troutman et al., 1967) which occur in the U.S.A. Cultural control is possible by close spacing and early planting and has been demonstrated by several workers (Storey and Bottomley, 1928; Tourte and Fauche, 1954). Many farmers, however, do not follow these recommendations and the release of resistant varieties would be the simplest method of control.

Resistance to the virus has only been found in a group of cultivars from the Ivory Coast, Upper Volta areas of West Africa. These cultivars belong to the Castle Cary cultivar cluster of Arachis hypogaea ssp. hypogaea (the Virginia group) according to the classification of Gibbons et al (1972). No resistance has been found in the early maturing sequentially branched cultivars belonging to A.hypogaea ssp. fastigiata. Although strains of the virus undoubtedly exist the resistance of the West African material has been confirmed in West Africa by Sauger et al (1954), in Malawi by Nutman et al (1964) and in South Africa by Klesser (1965). Nutman et al (1964) clearly demonstrated that these cultivars from West Africa were highly resistant although not immune to rosette. Berchoux (1960) found that resistance was controlled by two independant recessive genes.

Breeding for rosette resistance

Breeding for resistance started in West Africa some fifteen years ago and considerable progress has been made with oil seed cultivars (Dhery and Gillier, 1971). In Malawi where the emphasis is on confectionery peanuts breeding started in late 1964 using the West African resistant material which is low yielding and only suitable for oil expressing.

Crosses were made in the greenhouse and F_1 plants, which are susceptible to the virus, were grown under vector free conditions. F_2 plants were field grown at wide spacings and were inoculated with the virus by placing infective aphids on the plants as well as exposing them to maximum natural infection. At harvest symptomless plants were selected and progeny rowed the next season. Confirmation of resistance was obtained by further exposure to the virus both in the field and in the greenhouse.

Yield testing of resistant hybrids

By 1969 preliminary yield trials were conducted. The first group of progeny rows showing uniformity had Makulu Red, a red seeded derivative of Mani Pintar, as the susceptible parent. Mani Pintar is probably the highest yielding cultivar in the higher altitude areas of Malawi as well as in other African countries such as Ghana (Norman, 1961) and Zambia (Smartt, 1966). It is purely an oil seed type and has a characteristic red and white variegated testa. Makulu Red is similar in all respects to Mani Pintar except it has a pure red testa. In the cross Makulu Red x 48-34 (resistant cultivar with a dark tan testa) the F_1 seed coat colour was pink and the F_2 segregated in the ratio 1 brown : 2 pink : 1 red indicating incomplete dominance (Gibbons in litt.) whereas many previous reports on testa colour inheritance have shown red to be dominant to tan. Within the resistant hybrids selection pressure was for tan coloured kernels with a good shape which could be used for confectionery purposes and in particular the making of peanut butter. In the Salima Lakeshore area where Mani Pintar is grown the Early Runner cultivar has been released in the past as a confectionery nut. Results of yield trials are shown in Tables 1 and 2. In these trials rosette was not a limiting factor because planting was early and the spacing was correct. In 1971/72 however many farms

Table 1: Salima Lakeshore Trials - Chitala Research Station

Unshelled yields (kg/ha.).

Cultivar	1969/70	1970/71	1971/72	3 year mean
Mani Pintar	1555	3177	2844	2525
RG1*	1498	2642	2244	2128
RG11*	-	2472	1832	-
Early Runner	-	-	1737	-
S.e.	±98	±170	±283	-

Table 2: Salima Lakeshore Trials - District Sites.

Unshelled yields (kg/ha.) 1971-72

Cultivar	Kalambe	Mwimba	Unit 2	Benga	Pemba	Sites Combined.
Mani Pintar	3277	3809	3785	3899	3989	3752
RG1*	3235	3098	3205	2882	2009	2686
RG11*	2960	3337	3080	2470	2195	2808
MB6616	2775	3510	2237	2763	2619	2781
Fla.416	2697	1967	2404	2607	1818	2299
Malimba	2027	2667	2470	1728	1991	2177
Early Runner	1854	2302	2368	2440	1758	2144
S.e.	±252	±217	±173	±246	±204	±37

* Rosette resistant hybrid

Table 3: Chitedze Yield Trials 1970-1972

Unshelled yields (kg/ha.)

HYBRID	1970/71	1971/72
PR59B*	2855 (1)	2081 (3)
PR60B*	2787 (2)	-
PR64B*	2720 (3)	1856 (4)
PR65B*	2662 (4)	1536 (6)
Chalimbana	2430 (5)	1793 (5)
PR30B*	2233 (6)	-
PR61B*	2141 (7)	-
B222/RR/6/1/B1/1*	-	2578 (1)
B222/RR/1/1/B1/1*	-	2215 (2)
S.e.	±217	N/A

Table 4: Southern Region Trials 1971/72

Unshelled yields (kg/ha.)

CULTIVAR	MAKOKA	THUCHILA
Mani Pintar	2870	3237
NC5	2601	-
RG1*	2530	2805
RG22*	2046	-
Sigaro Pink	2043	-
PR59B*	1964	2687
PR46B*	1780	-
Chalimbana	1429	2462
PR64B*	1143	2580
PR20B*	-	3333
Shulamith	-	3394
PR60B*	-	3077
Fla.416	-	2805
PR65B*	-	2789
S.e.	±215	±138

*Rosette Resistant Hybrid.

N/A not yet analysed

adjacent to the trials had quite severe attacks of rosette. Mani Pintar seems particularly prone to early attacks of rosette and yields can be seriously affected. In the 1967 season Mani Pintar only yielded 660 kg/ha. due to a severe rosette attack.

The most promising of the resistant hybrids for the Salima area is RG1 which has a good shape, a tan coloured testa, a similar oil content to Mani Pintar but a higher oleic / linoleic acid ratio. It does not yield as well as Mani Pintar but it consistently outyielded Early Runner in the 1971/72 trials (Tables 1 and 2). It would therefore be suitable as a confectionery nut in this area and steps are being taken to start multiplication in the 1972/73 season.

Hybrids with Chalimbana as the susceptible parent are also promising, as can be seen from results shown in Tables 3 and 4, but further testing before release is required.

Future work and discussion

The most promising of the new resistant hybrids are being back crossed to susceptible cultivars to try and get increased yields and better quality. So far successful crosses have been made between eight hybrids and the following susceptible cultivars:-

Chalimbana - For large kernel size and yield (confectionery trade).

Shulamith - For large kernel size and shape (confectionery trade).

Mani Pintar - For yield (oil trade).

Malimba - For earliness and a Spanish type nut (confectionery trade).

It should be emphasised that all the yield trials reported here were conducted under optimum conditions as far as prevention of rosette is concerned. The trials are direct comparisons of the resistant hybrids against susceptible cultivars under rosette free conditions and the yield of the latter would be much less if rosette had been prevalent as it often is under local farming practices.

POD ROT (BREAKDOWN) OF PEANUTS.

Characteristics and occurrence

In certain years in Malawi it has been noticed that the peanut crop, notably the Chalimbana cultivar, contained a high proportion of kernels which were much paler than normal, or had a yellow-brown cast (Fig.1). They were also c. 10-15% lighter in weight than normal kernels. When split open the kernels usually appeared quite normal, but the testa colour spoiled the appearance of the crop. No previous work had been done on the phenomenon apart from estimating the oil content of the paler nuts (Anon, 1962).

It was subsequently noticed that in the years when there was a high incidence of "pale-testa" kernels there was also a high incidence of pod-rots. The pod-rots were characterised by the breakdown of the corky outer layers of the pod. In the more severe rots this layer was missing at harvest and the underlying venation was also frequently detached (Figs. 2 and 3). Very often the pods were stained with deep purple patches (Fig. 4) and kernels from these pods invariably had pale-testas. It was also observed that these pod-rots and pale-testa kernels occurred mostly in years in which the wet season was longer than average. In years with very long wet seasons (e.g. 1971/72) kernels too were frequently attacked (Fig.5) and even in less wet years the kernels often had a fine weft of mycelium over the testa. Certain cultivars, notably early and middle maturing ones, appeared to be more affected than late maturing ones.

It was further noticed that when plants were sprayed with fungicides to control Cercospora arachidicola leafspot the pods of these plants were healthier and there was a lower incidence of pale-testa (e.g. in one trial in 1971/72 plants sprayed with the fungicide BASF 67054 had 2.5% pod-rots and 34.6% pale-testa kernels, while control plants had 73% and 86.2% respectively).

Isolation of pod-flora

Pods with rots were surface sterilised with 1% sodium hypochlorite solution for 10 minutes and then incubated in moist chambers at c. 27°C for several days. The fungi which were isolated are shown below but only Fusarium oxysporum was consistantly isolated.

Aspergillus flavus	Rhizopus stolonifer
A. niger	Sclerotium rolfsii
A. wentii ?	S. bataticola
Fusarium oxysporum	Trichoderma viride
Penicillium spp.	Trichothecium roseum

Inoculation of pods with F.oxysporum

F.oxysporum isolated from pods was shake-cultured and washed. A macerate was then poured over surface-sterilised healthy pods and incubated for several days. The pods were quickly covered with a fluffy white mycelium (Fig.6) and became blotched with a similar purple stain to that encountered in the field. If inoculated pods were subsequently dried and shelled the kernels were found to have a pale colour. F.oxysporum was re-isolated from the inoculated pods.

It is thus tempting to suggest that F.oxysporum is the causal agent of the pod-rots, Koch's postulates having been fulfilled. However, it was subsequently found that keeping non-inoculated pods in a moist chamber for about 10 days was sufficient to cause a fading of the testa colour. Furthermore, although all pod-rots contain pale-testa kernels the converse is not true, i.e. pale-testa kernels are also found in pods attacked by termites and sometimes in apparently undamaged pods. Fig.7 of data from a sulphur-dust leafspot control trial (1971/72), is a graph of arcsin √% rotted and termite damaged pods against arcsin √% pale-testa nuts. It can be seen that there is a reasonable correlation between the two variates, both being much higher in the control than in the treated plants. The graph cuts the 'y' axis at c. 25 suggesting that this proportion of pale-testa kernels could have occurred even if apparently healthy pods had been sampled.

Aflatoxin

It was feared that the paler kernels might have higher aflatoxin levels than normal. However, the Agricultural Development and Marketing Corporation (ADMARC) tested pale and normal kernels and found no significant difference in aflatoxin levels.

Conclusions

It is thus postulated that this is a maturity problem, i.e. if the pods are left in the ground after optimum lifting time they begin to die, may become detached from the plant and become attacked by fungi, notably F.oxysporum, and by other factors such as termites. It is probable that the pods therefore become more porous, either by attack or by drying out, and that the testa-colour is leached out by soil

water. This would obvlously be less likely to occur in a drier year. Later maturing varieties would also tend to be less affected as the season is becoming drier towards their maturity.

Fungicides acting on C.arachidicola probably do not act on the pod-fungi directly, but by maintaining the plant in a green and healthy condition they delay the maturity of the pods until drier conditions prevail.

It is not clear if F.oxysporum is responsible for the initiation of the pod-breakdown or if it comes in afterwards. All attempts to rot healthy pods still attached to the plant have failed, but older or detached pods are easily infected. F.oxysporum is not just a saprophyte however, as it is quite capable of invading kernels both naturally (Fig.5) and artificially (Fig.8).

Fusarium spp. have usually been noted by other workers on pod-flora (Gilman, 1969; Jackson, 1968; Frank, 1968; Kranz and Pucci, 1963), but only Kranz and Pucci (1963), working in Libya, suggest that Fusarium spp. are solely responsible for pod-breakdown. Frank (1968) associates Fusarium spp. with Pythium spp. in pod-breakdown in Israel, stating that Pythium spp. precede Fusarium spp. Garren (1966) however states that in the pod-breakdown he was investigating in the U.S.A. Fusarium spp. preceded Pythium spp. In the present case Pythium spp. have not yet been isolated and F.oxysporum is quite capable of invading mature pods and kernels without assistance.

Prevention

Prevention is effected by making sure that pods are harvested as soon as mature, especially in a wet season. This is easier to do if the plants have been sprayed against C.arachidicola leafspot.

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Figure captions.

1. Normal kernels right. Pale-testa kernels left.
2. Part of damaged pod showing removal of corky outer layer (↑)
3. Badly rotted pod showing detached venation (↑)
4. Pod showing deep purple stain (↑)
5. Pod with infected kernels.
6. Pods artificially inoculated with *F.oxysporum* showing fluffy white mycelium.
7. Graph of relationship between rotted and termite-damaged pods and pale-testa nuts.
8. Kernels artificially inoculated with *F.oxysporum*.

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

Figure 6

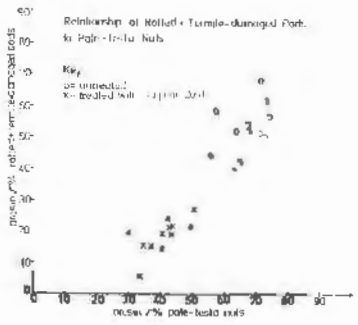

Figure 7

Figure 8

THE CYLINDROCLADIUM BLACK ROT OF PEANUT IN VIRGINIA AND NORTH CAROLINA

by

K. H. Garren [1/], M. K. Beute [2/], D. M. Porter [1/]

Cooperative Investigations of the Southern Region, Agricultural Research Service, U. S. Dept. of Agriculture, The Research Division, Virginia Polytechnic Institute and State University, and North Carolina State University.
1/ Agr. Res. Serv., Holland, Va. 2/ N. C. State Univ., Raleigh.

ABSTRACT

As far as we can tell, the Cylindrocladium black rot of peanut was first found in the Virginia-North Carolina area in one field almost on the State line in Nansemond County, Virginia in 1970. In 1971 it was found in several fields in the Williamston, N. C. area, and in two fields in Virginia. Reports from Georgia and South Carolina where it has been known for several years indicate that the black rot of peanut is increasingly more important as a peanut disease in that area. We have established that this peanut disease was found in Japan in 1970 and was regarded as a major disease of peanuts in Japan in 1971.

A severe outbreak of Cylindrocladium black rot in a peanut field in Nansemond County, Va. near the Tidewater Research Station in 1971 gave opportunity to check on the effect of this disease on yield. Unquestionably this disease is a threat to peanut production. When 50% of the plants were visibly infected, though not necessarily dead, there was a twofold increase in yield over the yield from areas in which 100% of the plants were visibly infected. With only 15% visibly infected there was almost a threefold increase in yield, and with no plants visibly infected there was almost a fourfold increase in yield. There was no evidence that the pathogen is seed transmitted. Because black rot is a potential threat to peanut production, peanuts have been replanted in the aforementioned field in 1972. We hope to study epiphytology of the disease in 1972.

INTRODUCTION

In the United States Cylindrocladium black rot was first recognized as a disease of peanuts in Georgia in 1965 (2). Apparently the discovery of the disease in Georgia was the first record of this peanut disease anywhere in the world. There was further study of it in Georgia (1, 4), and it was found in South Carolina about 1968 (F. H. Smith, personal communication). Cylindrocladium black rot was found on peanuts in one field in Virginia in 1970 (3). This field was less than 100 yards from the boundary between Virginia and North Carolina. In October 1971 one of us (Garren) found it in peanut fields near Chiba, Japan. A plant pathologist, T. Misonou, stated that the black rot disease was first found in Japan in 1970; that it was undoubtedly the disease described from Georgia, U.S.A. by Bell & Sobers (2); and that he considered it a major threat to peanut production in Japan. Probably black rot was present on peanuts in North Carolina in 1970 for it was found in 3 counties in North Carolina in 1971. At a conference on peanut problems in Oklahoma and Texas in November 1971 we found no one who suspected that peanut black rot was present in these states.

We have, then, a special set of circumstances, to wit: i. A "new(?)" disease of peanuts was found in Georgia in 1965. ii. Three years later it was found in South Carolina. iii. Two years later it was found in Virginia and North Carolina. iv. At the same time it was first found in

Virginia and North Carolina it was first found in Japan. v. In one year it increased in range in Virginia and North Carolina as well as in Japan. These circumstances lead to the following suppositions: (i). Cylindrocladium black rot of peanuts is definitely a new disease. (ii). There has been a change in the genus of soil borne fungi "Cylindrocladium" in Southeastern United States and Japan (and possibly elsewhere). (Either there have been mutations in Cylindrocladium or repeated use of certain fields for peanuts has build up in these fields dense populations of a Cylindrocladium sp. which hithertofore had existed only as rare and widely scattered fungal clones.) At any rate our conversations with plant pathologists who work with nurseries and woody ornamentals and our study of plant pathological literature of recent years show that not only has the relation between peanuts and the fungal genus Cylindrocladium recently changed from innocuous to harmful but also there has been a concurrent similar change in the relation between this fungal genus and many woody plants.

We hope the new peanut disease Cylindrocladium black rot will recede into the background just as did another new disease of a few years ago, namely peanut stunt. However, we are doing our best to be prepared in the event our hopes come to naught.

SYMPTOMS

Jackson & Bell (4) in their 1969 bulletin on peanut diseases gave an excellent, concise description of symptoms of peanut black rot. Their description is modified in light of symptoms observed in Virginia and added to a bit for use here.

The first obvious symptoms in the field were yellowing and wilting of the leaves on the main stem, followed by yellowing and wilting and some death of leaves on secondary branches. The main stem often dies while lateral branches remain alive or even apparently unaffected. Hypocotyls and tap roots die and turn black, but the dying sometimes stops at the groundline. This is because adventitious roots sometimes develop on diseased plants near the groundline. Frequently, however, the entire root system of a diseased plant is destroyed, leaving a blackened and fragmented tap root which looses its bark and branch roots when the plant is pulled from the soil. Dark brown, slightly sunken lesions occur on pegs and pods. The lesions on pods may remain discrete or the entire pod may become dark brown or rot. Reddish-orange perithecia of the sexual stage of the causal fungus are occasionally visible just above the groundline on badly diseased stems. These structures are frequently mistaken for small sclerotia of either Sclerotium rolfsii Sacc. or some other sclerotium producing fungus. However, when seen in the field these reddish-orange structures are an unmistakable sign of the pathogen.

THE CAUSAL FUNGUS

Bell & Sobers (2) performed the prescribed routine of greenhouse inoculations with laboratory-grown cultures of a fungus isolated from diseased peanut plants. This routine is necessary to prove that the fungus isolated can cause the disease. Furthermore their studies established the scientific names of Cylindrocladium crotalariae (Loos) Bell and Sobers and Calonectria crotalariae (Loos) Bell and Sobers for the asexual and sexual stages, respectively, of the causal fungus. Since the asexual stage is the stage in which the fungus grows and spreads and the sexual stage is associated with dormancy and overwintering, the asexual stage name was used in naming the disease.

When the disease was found in Virginia and North Carolina we repeated the routine for establishing the Cylindrocladium sp. as the causal fungus.

We found most isolates of the fungus lost their ability to cause the disease rapidly when kept in culture. However, in a few rare instances we had isolates which were pathogenic only after being kept in culture for a few weeks. Much remains to be learned about the pathogenicity of C. crotolariae.

INCREASE IN THE DISEASE FROM 1970 TO 1971

As far as we can tell, the Cylindrocladium black rot of peanut was first found in sufficient quantity to warrant investigation and identification in the Virginia-North Carolina area in one field in Nansemond County, Va. in 1970. In 1971 this disease was found in several fields in both states. We identified the fungus as causing disease in North Carolina in Halifax County (localized in one field, 100% of 10 acres), Bladen County (65% or 5 acres in a 30 acre field) and in Martin County (25% of 8 acres). In Virginia in 1971 black rot symptoms were observed at two locations, one in Nansemond and one in Southampton County.

The field in Nansemond County, Va. in 1970 was, as reported (3), planted to two cultivars--a local cultivar 'Holland Station Bunch' and 'Florigiant'. The 1970 observations suggested that the disease was less severe on 'Florigiant' than on 'Holland Station Bunch'. The field in Nansemond County in 1971 was planted entirely to 'Florigiant'. As best we could tell, disease development was as severe in 1971 as in 1970, thus there is no evidence that 'Florigiant' is less susceptible to C. crotolariae than is 'Holland Station Bunch' or any selection from it.

IS THE BLACK ROT FUNGUS SEED-TRANSMITTED?

The field in Nansemond County, Va. in which black rot was found in 1971 was about 6 airline miles from the field in which it was found in 1970. No development of black rot could be found in the area between the two fields. The Extension Service had alerted county agents after black rot was found in 1970 and a county agent reported the disease in the Southampton County field in 1971. Several other suspicous fields were checked carefully and all found to be negative for black rot.

In our studies on peanut microflora (cited in 3), made in connection with the aflatoxin problem, we have found Cylindrocladium spp. to be virtually non-existant in the seed-borne microflora of peanuts grown in Virginia. We checked seed from the 1970 field and could find no Cylindrocladium spp. in them. The seed for the field in which black rot was found in Nansemond County, Va. in 1971 came from the warehouse in which the planting seed saved from the field in which the disease was found in 1970 had been stored. The owner of the 1971 infested field also owned the warehouse, but he was positive that the seed he planted in the 1971 infested field came from a field that was free of root diseases in 1970. Nevertheless, cured seed from the 1971 infested field were checked thoroughly and no Cylindrocladium spp. was found in them; not even in seed hand-harvested from rows in which 100% of the plants had dead tops.

C. crotolariae could be isolated from freshly dug fruits and from seed from freshly dug fruit from infested fields in 1970 and 1971. However, after these fruits were handled as peanuts are handled on the farm there were no Cylindrocladium spp. in the fruit or seed microflora. We cannot say this fungus is not seed borne until we eliminate the possibility of there being a selective culture medium that will show that C. crotolariae is sometimes viable in cured peanut seeds. It is possible that C. crotolariae cannot be detected on standard media because of other faster growing fungi.

ARE THERE PARTICULAR ENVIRONMENTAL OR WEATHER CONDITIONS ASSOCIATED WITH BLACK ROT DEVELOPMENT?

Here again we can best call on the greater experience of our Georgia colleagues. Dr. Durham Bell (in personal correspondence) reports that in Georgia black rot has been observed only in heavy clay soil having low water percolation rates (relative to light sandy soils), fairly high organic matter content (3.5-4.5% w/w), and pH greater than 5.8. However only a few pH readings have been made in Georgia. The two infested fields found in Nansemond County, Va. could not be described as having heavy clay soils, though there seemed somewhat more clay in the surface of these fields than in most peanut fields of the county.

Bell states further, "The sequence of events runs something like this: If there is extensive rainfall in May, plants become infected and disease progresses during June, but no aboveground symptoms show; soils begin to dry out creating water stress early in July, and aboveground symptoms begin to show in late July; in early August plants are severely wilted, dying, or dead. If May is relatively dry and June unusually wet, the whole process shifts forward 2-3 weeks." We have not yet had enough experience with black rot to develop a sequence such as this for Virginia, North Carolina.

DAMAGE POTENTIAL OF BLACK ROT

The aforementioned field of Florigiant peanuts in Nansemond County, Virginia was found, in early August of 1971, to have scattered spots of severe infection. These spots were marked off and at normal harvest time (ca. October 10) 12 plots were hand-harvested in the corner of the field in which there was most evident black rot. Yields of these plots determined after stack curing in the field, were converted to pounds per acre and are given in Table 1. A visual estimation was made of the

Table 1. Cylindrocladium black rot of peanut and peanut yields.

Estimated percentages of plants infected, percentages of plants dead, and harvested yields for 12 plots in Nansemond County, Va. 1971

Plot	Code Inf./dead	Yield Lb/A
1	100/60	1021
2	100/60	1021
3	100/96	742
4	100/96	1160
5	100/100	934
6	15/5	3587
7	15/5	4113
8	100/75	1162
9	25/10	3530
10	50/20	3049
11	100/95	1116
12	0/0	4752

percentage of plants infected and percentage of plants dead in each plot.

All plots were in the same general area of the field. For example, the plot with no infection was only five rows from a plot which had 100% infection and 60% dead plants. Table 2 groups the plots into 5 groups on

Table 2. Cylindrocladium black rot of peanut and peanut yields.

Average yield and percentage increase of yield over 100% infection for 5 infection groups in Nansemond County, Va., 1971.

Plants Visibly Infected %	Yield Lb/Acre	Yield Increase over 100% infection %
100	1022	---
50	3049	198
25	3530	245
15	3850	276
0	4752	365

the basis of estimated percentages of plants infected with Cylindrocladium and converts yield to percentage increase over that of the 100% infected plots.

In view of these results we conclude Cylindrocladium black rot of peanut can greatly depress yield of peanuts in Virginia and North Carolina, therefore it is a potential threat to peanut production in these states. As a consequence we have 'Florigiant' peanuts in each of the Virginia fields which had black rot in 1970 and 1971. On June 30 there were no diseased plants evident in either field. On July 11 numerous plants in both fields had typical black rot symptoms and C. crotolariae was easily isolated from these plants. We plan to make a fairly detailed study of the epiphytology of black rot in these fields.

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DEVELOPMENT AND EVALUATION OF PEANUT SALVAGING AND CLEANING EQUIPMENT--A PROGRESS REPORT 1/

George B. Duke 2/

Introduction

Peanut digging losses consist of those peanuts that shed from the plants before digging and those that are separated from the plants by the digger. Digging early is one way to minimize field losses from natural shedding, but lower yield and quality may result. In recent studies 3/ in Virginia, losses from early digging ranged between 3 and 10%; at normal digging date, 10 to 20%; and at late digging, 15 to 30%. Of the total losses, approximately 20% are visible on the soil surface and 80% are below the soil surface. The 80%, not visible, are distributed from immediately below the soil surface to depths of 4 to 5 inches. Limited revisions made on the conventional type peanut digger have not significantly reduced losses nor will this equipment save peanuts detached from the vines. If field losses are to be reduced, equipment to salvage these peanuts must be provided or varieties must be developed that shed less before and during the digging operation.

Methods Used to Recover Peanut Losses

As a result of studies designed to determine the magnitude of losses associated with digging, a salvaging device was constructed. This unit, shown in Figures 1 and 2, lifted and sifted a 6-foot wide by 4- to 5-inch deep strip of soil. Operating at a speed of 15 to 20 feet per minute, the salvager recovered about 98% of the peanuts left in the soil by the conventional digger. Use of the conventional digger and the experimental salvager required two separate operations over the field.

1/ For presentation at the American Peanut Research and Education Association Meeting, July 16-19, 1972, Albany, Ga.

2/ Agricultural Engineer, Harvesting and Farm Processing Research Br., AERD, ARS, USDA and Associate Professor, Department of Agricultural Engineering, Virginia Polytechnic Institute and State University, Tidewater Research Station, Holland, Va.

3/ Effects of Digging Time on Peanut Recovery Yield, Salvaged Yield and Quality --A Progress Report by George B. Duke.

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2. Messrs. H. L. Smith and W. E. Walls, Virginia Department of Agriculture, Richmond, Va. for making germination studies.

3. Commercial companies for loan of a peanut digger, for pricing farmer's stock grade peanuts, and for CLER flavor evaluations.

4. Messrs. C. E. Holaday and J. Pearson, National Peanut Research Laboratory, Dawson, Ga. for mold, aflatoxin, rancidity, and fat acidity determinations.

Figure 1. Front view of 6-foot wide peanut salvager.

Figure 2. Rear view of peanut salvager.

In searching for a more efficient method to reduce losses and recover shed peanuts, a machine was designed to combine digging and salvaging in one operation. The experimental two-row peanut digger-salvager uprooted the plants, conveyed them upward and rearward with peanuts attached and discharged the plants from the upper end of the conveyor onto a vine rack. Vibrating action of the vine rack dislodged the soil from the peanut plants and moved the vines rearward into a windrow. Soil and detached peanuts were also simultaneously collected by the conveyor and were elevated with the peanut plants. The soil and detached peanuts were discharged from the upper end of the conveyor and dropped into the soil sifting hopper to separate the soil from the peanuts. After a plot had been sifted, the collected material in the hopper contained good quality peanuts and foreign material which were separated and removed from the hopper by hand.

The conveyor speed of the 1970 digger-salvager exceeded the equipment ground speed by about 3.3 to 1. With the conveyor speed operating faster than ground speed, more peanuts were separated from the plants than were separated with a conventional type digger. A high percentage of these detached peanuts were not lost as they were collected by the salvaging components. The peanut plants were pulled apart and deposited in a windrow in intermittent bunches. The salvager collected detached peanuts and soil from a 28-inch width band from each row. The total recovery yield (vine and salvaged yield combined) from this equipment is expected to be a little less than the total vine and salvaged yield obtained with a commercial digger followed by a 6-foot wide experimental salvager, but considerably more than the vine yield from a commercial digger.

In 1971 the digger-salvager was altered to reduce the conveyor-ground speed to a ratio of 2.8 to 1, when the ground speed was 60 feet per minute. A faster rate of sifting the soil from the peanuts was achieved by installing a screen made from 3/4-inch mesh hardware cloth 2 inches above a 5/8-inch mesh hardware cloth in the hopper to divide the soil mass. Handling and field cleaning components incorporated in 1971 were:

1. Horizontal, cross-mounted open mesh type conveyor, 6 inches wide x 7 feet long, installed at the discharge end of the soil sifting hopper to collect and convey the peanuts to one side of the machine.

2. Vacuum type fan to lift light trash from peanuts in the 6-inch wide conveyor.

3. Inclined, side-mounted open mesh type conveyor, 6 inches wide x 9 feet long, to convey peanuts upward to the vibrating soil and clod screen and bagging attachment.

4. Vibrating screen made from 1/2-inch mesh hardware cloth to break up soft clods and separate additional fine soil particles.

5. Bagging attachment for collecting the salvaged peanuts.

Both materials handling conveyors were constructed of Sani-grid belting consisting of parallel metal rods of number 9 gauge wire with 3/8-inch space between the wires. The 3/4-inch mesh hardware cloth, materials handling conveyor, cleaning fan, vibrating screen and bagging attachment installed on the 1971 model added to the overall efficiency of the digger-salvager. Photographs of the 1971 model are shown in Figures 3 and 4.

The principal factor that restricts the capacity of the present machine is the rate that the peanuts are separated from the soil mass. The use of hardware cloth has limited capacity for screening soil, and capacity is further restricted due to fine root hairs and peanut leaflets lodging on the cross wires of the hardware cloth. Under damp soil conditions, root hair accumulation is greater than under drier soil conditions. Under very wet soil conditions, soil particles tend to cling to the root hairs and ultimately choke the screen. Under some soil conditions excessive quantities of clods were collected and exceeded the quantity of peanuts salvaged. All salvaged samples in 1971 contained a very high percentage of foreign material and the peanuts were recleaned before drying.

Some of the salvaged peanuts in 1971 were covered with a thin layer of soil due to the wet soil conditions. Their appearance was unattractive and believed to be unacceptable unless the adhering soil was removed before marketing.

Figure 3. Front view of 1971 combination peanut digger-salvager. View of cleaning fan, inclined conveyor and bagging attachment as installed on the left side of the machine.

Figure 4. Rear view of the peanut digger-salvager.

Field Testing Procedure

In 1970, field plots were dug to determine the quantity and quality of the peanuts attached to the vines and those detached from the vines by two digging methods. The tests were dug with (1) a conventional type peanut digger followed by a 6-foot wide salvager to collect the losses and (2) the two-row unit which combines digging and salvaging into one operation. Three varieties of peanuts, Va. 61R, Florigiant and NC-17, were dug with each machine. Each variety was dug at 3-day intervals during the normal harvesting period with eight digging dates involved, commencing Sept. 29 and ending Oct. 20. Each plot consisted of two rows, 36 inches apart, 14.52 feet long (.002 acre) and treatments were randomized with three replications.

In 1971 plans were to repeat the same experiment described above. Over 11 inches of rainfall during the normal digging period severely disrupted the planned harvesting program. Only one test was dug before the arrival of Hurricane Ginger on September 30 and the accompanying rains. Digging and salvaging dates in 1971 were Sept. 29, Oct. 14 and 17, and the last test was dug on Nov. 2 which is normally about 2 weeks beyond the last digging dates in Virginia.

Four types of peanut samples were collected to determine plot yields and quality: (1) vine yield from the conventional digger, (2) salvaged yield from the conventional digger, (3) vine yield from the two-row digger-salvager, and (4) salvaged yield from the digger-salvager. Peanuts on the vines after digging were picked off by hand. Salvaged samples were hand cleaned to remove foreign material. All samples were artificially cured and dried to equilibrium moisture before weighing and grading.

Harvested Peanut Yield and Grade

Yield data results from the 1970 test are shown in Table 1. Average conventional digger losses from each of the varieties, Va. 61R, Florigiant and NC-17, were 798, 608 and 633 lb/a, respectively. Peanuts harvested with the two-row digger-salvager (vine plus salvaged yield combined) increased the per acre recovery yield over the vine yield from the conventional digger by about 500 lb/a with each of the three peanut varieties.

Yield data results from the 1971 tests are shown in Table 2. Average conventional digger losses from each of the three varieties for the three first digging dates were 1459, 1091 and 897 lb/a, respectively, for Va. 61R, Florigiant and NC-17. Peanuts harvested with the two-row digger-salvager (vine plus salvaged yield combined) increased the per acre recovery yield over the vine yield from the conventional digger by about 900 to 1400 lb/a.

Peanuts dug unusually late, Nov. 2, after the rains subsided gave very low vine yields. Conventional digger vine yield from the three varieties ranged between 790 and 1395 lb/a and losses ranged between 3223 and 3364 lb/a. Yield from the digger-salvager, vine plus salvaged yield, combined, increased recovery yield by 3003 lb/a over the vine yield from the conventional digger.

Quality of the peanuts from the vine and salvaged samples collected in 1970 and 1971 is shown in Tables 3, 4 and 5. The commercial grade, price per pound, and germination of the salvaged peanuts were about equal to the vine sample. CLER flavor ratings of the salvaged samples were not appreciably different from the vine samples. None of the peanut samples contained aflatoxin.

Mr. C. E. Holaday of the National Peanut Research Laboratory, Dawson, Ga. analyzed the samples for the presence of molds, aflatoxin, rancidity and fat acidity. His remarks after analyzing the 1971 samples were: "Except for discoloration and appearance of the skins, the salvaged peanuts seem to have excellent quality--as good as the ones picked from the vines."

Equipment to Reclean Salvaged Peanuts

Salvaged peanut samples contain, in addition to the good quality peanuts, an excessive quantity of foreign material. Under cloddy soil conditions the quantity of clods may greatly exceed the quantity of detached peanuts. If the soil is not dry, an excessive quantity of fine soil particles is also collected. Salvaged peanut samples collected with presently available equipment and under the above adverse conditions contained several times more foreign material

than good quality farmer's stock peanuts. Other forms of foreign material consist of peanut leaflets, segments of the plant branch, deteriorated peanuts and corn cobs from previously grown crops plus hand tools and various types of implement parts lost or left in the field. These salvaged peanut samples require recleaning before drying.

In 1971 a recleaner was designed and constructed to separate foreign material from salvaged peanuts. The equipment is shown in Figure 5 and consists of the following components:

1. Corrugated soil and clod screen.
2. Horizontal conveyor equipped with open mesh type belting.
3. Vacuum and pressure fans and bagging attachment.

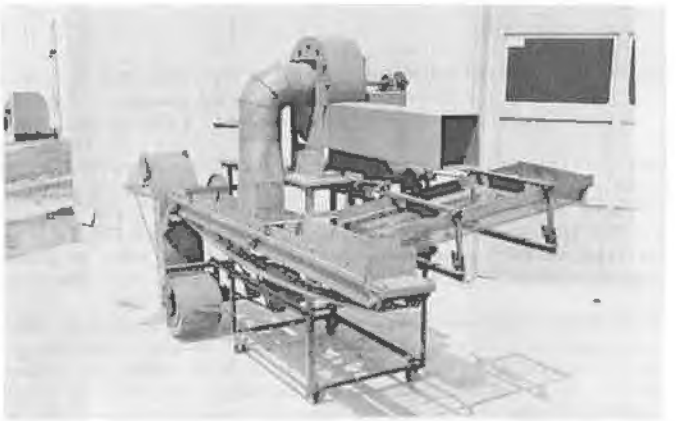

Figure 5. Equipment for recleaning salvaged peanut samples.

Vibrating action of the screen separates fine soil particles and disintegrates soft clods. The vacuum fan lifts out light weight foreign material. Remaining material is dropped into a pressure type air stream to separate the peanuts from the clods.

Results from recleaning a field sample of salvaged material are shown in Figure 6. The collected field sample contained considerably more foreign material than peanuts. The photograph shows each fraction after it was separated from the composite--A, soil clods; B, good quality peanuts; C, peanut leaves, hulls and other forms of light weight material; and D, fine soil particles. Separation of several types of foreign material from the good quality peanuts was effectively accomplished with the above described low capacity, laboratory model recleaner.

Summary

Peanut losses are associated with digging. Conventional peanut diggers are not designed to save any of the detached peanuts which consist of those that shed before digging or become separated from the plants during the normal

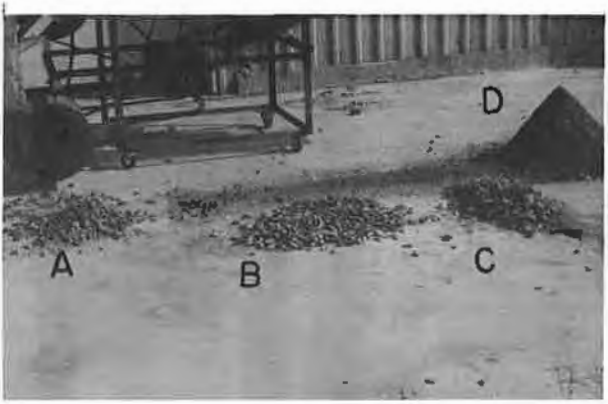

Figure 6. Foreign material separated into fractional parts from recleaning a field sample of salvaged peanuts. From left to right, soil clods, recleaned peanuts, leaves, and fine soil particles.

digging, lifting and windrowing operation. Overall average losses from a conventional peanut digger from three varieties of peanuts and eight digging dates in 1970 were 679 lb/a. Losses from three digging dates and three varieties of peanuts dug in 1971 were 1149 lb/a. Unusually high rainfall during normal digging time in 1971 prevented the digging of the test as planned, and the wet soil may have contributed to the increased losses from the conventional digger.

Experimental equipment was designed and constructed to dig and salvage peanuts in one operation. Peanuts attached to the vines after digging may be left in a windrow and combined at a later date. Soil is lifted and sifted to recover the detached peanuts and the salvaged material is collected in a bag. The digger-salvager was designed for plot use, has low field operating capacity, and operates at a ground speed of only 40 to 60 feet per minute. The sifting screen partially chokes with fine root hairs under normal soil moisture conditions and completely chokes when operated in wet soil. Salvaged peanut samples collected under moderately high soil moisture conditions contained several times more loose soil, clods and other types of foreign material than peanuts.

Peanuts salvaged under wet soil conditions were completely coated with soil particles, were unattractive, and were believed to be unacceptable in that condition for the edible trade.

Peanuts harvested with this equipment increased recovery yield about 500 lb/a in 1970 and about 1000 lb/a in 1971 over the vine yield from a conventional digger.

Peanut salvaging equipment is expected to have a high initial, operating and maintenance cost and low field operating capacity. The cost to cure and dry high moisture salvaged peanuts will exceed the cost of drying semi-cured windrow harvested peanuts.

A laboratory model, low capacity recleaner was constructed and tested for recleaning salvaged peanuts. This equipment is effective for separating foreign material from salvaged peanut samples.

Hand cleaned samples of salvaged peanuts were graded to determine their quality. The commercial grade, price per pound, germination, rancidity, and fat acidity of the salvaged peanuts were not appreciably different from the vine samples. None of the salvaged samples, including some collected in 1971 one month after the close of the normal digging time, nor any of the shrivelled or decayed kernels contained aflatoxin. CLER score ratings showed no appreciable differences between the vine and the salvaged samples.

Table 1. Peanut yield (lb/a). Holland, Va. 1970

Digging Date	Conventional Digger			Digger-Salvager		
	Vine Yield	Salvage Yield	Total	Vine Yield	Salvage Yield	Total
			Va. 61R Variety			
9/29	4073	552	4625	3270	581	3851
10/2	3652	518	4170	3114	532	3646
10/5	3165	692	3857	2717	804	3521
10/8	3916	464	4380	3178	854	4032
10/11	3367	830	4197	3081	806	3887
10/14	3172	1204	4376	3031	1144	4175
10/17	2869	1044	3913	3012	1399	4411
10/20	3166	1081	4247	2711	1437	4148
Avg	3422	798	4220	3014	945	3959
			Florigiant Variety			
9/29	4509	312	4821	4085	821	4907
10/2	4583	384	4967	4255	662	4917
10/5	4642	570	5212	3930	673	4603
10/8	4512	633	5145	4039	925	4964
10/11	4500	823	5323	4134	906	5040
10/14	4795	670	5465	3887	1257	5144
10/17	4240	592	4832	4418	1162	5581
10/20	4412	887	5299	4279	1056	5335
Avg	4524	608	5132	4128	932	5060
			NC-17 Variety			
9/29	4456	175	4631	4608	150	4758
10/2	4399	182	4581	4278	254	4532
10/5	4506	339	4845	4509	183	4692
10/8	4266	290	4556	4493	398	4891
10/11	4359	673	5032	3912	881	4793
10/14	4247	486	4733	3726	913	4639
10/17	3572	1271	4843	3390	918	4317
10/20	3169	1653	4822	3745	944	4689
Avg	4121	633	4754	4083	580	4663

Table 2. Peanut yield (lb/a). Holland, Va. 1971

Digging Date	Conventional Digger			Digger-Salvager		
	Vine Yield	Salvage Yield	Total	Vine Yield	Salvage Yield	Total
			Va. 61R Variety			
9/29	4203	708	4911	4163	656	4819
10/14	3631	1574	5205	2653	1972	4625
10/17	2587	2097	4684	3477	2014	5491
Avg	3473	1459	4933	3431	1547	4978
11/2 1/	1150	3223	4373	1189	2936	4125
			Florigiant Variety			
9/29	3934	781	4715	3960	894	4854
10/14	4355	1325	5680	3530	1747	5277
10/17	4012	1169	5181	3179	1998	5177
Avg	4100	1091	5192	3556	1546	5102
11/2 1/	790	3364	4154	725	3317	4042
			NC-17 Variety			
9/29	4448	607	5055	4580	442	5022
10/14	4328	817	5145	4702	999	5701
10/17	4041	1269	5310	4557	943	5500
Avg	4272	897	5170	4613	794	5407
11/2 1/	1395	3303	4698	1067	3110	4177

1/ Unusually late digging date.

Table 3. Summary*, peanut grade and value per pound.

Sample	% Fancy		% ELK		% SMK		% Damage		Price/lb	
	1970	1971	1970	1971	1970	1971	1970	1971	1970	1971
Va. 61R										
Vine	69	76	27	28	67	71	0.6	0	13.5	14.6
Salvage	81	73	34	26	70	70	1	0.6	13.9	14.2
Florigiant										
Vine	83	86	46	46	72	73	0.3	0	14.7	15.5
Salvage	88	86	42	34	70	70	2.3	1.3	13.8	14.5
NC-17										
Vine	68	71	58	57	75	74	0.3	0	15.4	16.2
Salvage	85	87	60	63	74	75	1.1	0	15.3	16.0

Table 4. Summary*, germination percentages.

Variety	1970		1971	
	Vine Sample	Salvage Sample	Vine Sample	Salvage Sample
Va. 61R	92.3	92.8	96.0	97.0
Florigiant	92.6	91.7	97.0	97.2
NC-17	90.1	90.3	97.6	98.8
Avg	91.6	91.6	96.8	97.6

Table 5. Summary*, CLER score rating.

Variety	1970		1971	
	Vine Sample	Salvage Sample	Vine Sample	Salvage Sample
Va. 61R	50.5	49.2	50.3	49.0
Florigiant	39.7	38.0	47.3	42.3
NC-17	46.3	44.6	26.3	58.6
Avg	45.5	43.9	41.3	49.9

* Average of 8 digging dates in 1970 and 3 digging dates in 1971.

CURING PEANUTS WITH PERIODIC HIGH TEMPERATURES

by
John M. Troeger and James L. Butler
Agricultural Engineers, ARS, USDA, University of Georgia
College of Agriculture Experiment Stations
Coastal Plain Experiment Station, Tifton, Georgia
Jack L. Pearson
Research Horticulturist, MQRD, ARS, USDA
Dawson, Georgia

ABSTRACT & PAPER

ABSTRACT

The paper reports the results of three years experiments to evaluate the effect of periodic high temperature (120°F) on the drying rate, flavor and milling quality of green harvested peanuts. Results indicate that cycling the temperature to simulate windrow drying conditions will increase the drying rate without necessarily degrading flavor. Percentage of split kernels was higher than with standard drying conditions.

In a related experiment, peanuts dried continuously at 120°F to 20% moisture, then dried with standard conditions (95°F maximum) had a superior flavor when compared with peanuts dried to 20% moisture with standard conditions and finished with high temperature.

The results indicate that limited application of high temperature during drying of green peanuts will not necessarily degrade their flavor quality. This procedure can be used as a successful alternative to windrow drying which is subject to uncontrolled weather conditions.

Peanut harvest normally begins by removing the plant from the soil and allowing it to dry in the windrow for several days. The partially dried peanut is removed from the vine and subjected to further drying with forced, heated air until the moisture content is reduced to a safe level for storage. The initial windrow drying reduces the moisture content from 40-60% (wet basis) down to 15-20% under favorable weather conditions. Exceptional drying conditions may reduce the moisture level below 10% but rainy, foggy weather may prevent drying below 25%. Prolongation of the time for drying makes the peanut more vulnerable to attack by insects and mold growth. In addition, it promotes excessive loss during combining because of deterioration of the pods' attachment to the vines.

Immediate harvest after digging followed by prompt drying can minimize the losses attributable to poor drying weather. Addition of heat to the drying air will increase its drying potential and thereby reduce the drying time. Excessive heat during drying, however, can result in a poor flavor of the final product (1)*. Experience has indicated that limiting the air temperature to a maximum of 95°F will prevent the poor flavor caused by high temperature.

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*Numbers in parentheses refer to appended references.

Recent research by the Agricultural Engineering Research Division at Tifton, Georgia in cooperation with the Market Quality Research Division at Dawson, Georgia and the Georgia Coastal Plains Experiment Station has indicated that green-harvested peanuts, dried with forced heated air limited to 95°F, had a flavor which was inferior to peanuts dried in the windrow under good weather conditions (Fig. 1). The taste panelists characterized the peanuts as having a lack of flavor or "bland" flavor rather than a bad flavor. Concurrent research showed that the temperature of peanuts in the windrow may reach 120°F or higher for three hours or more per day under good weather conditions (2).

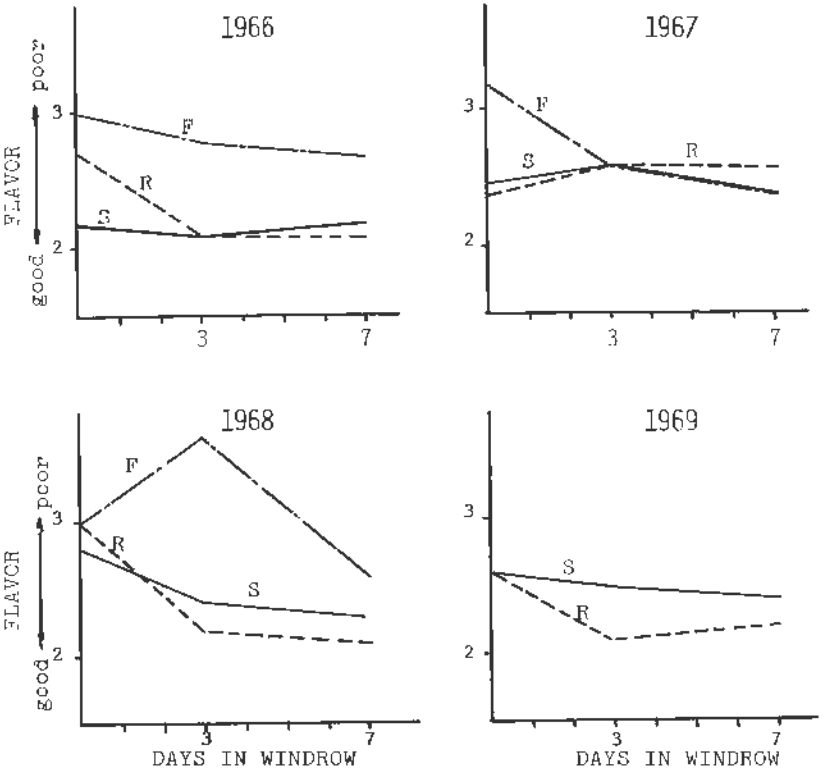

Figure 1. Flavor evaluation for windrow dried peanuts. (S=Starr Spanish, R=Early Runner, F=Florigiant)

Objective

The objective of these experiments was to investigate the hypothesis that a limited exposure to high temperature may decrease the drying time without damaging flavor quality.

Equipment and Procedure

Drying plenums were equipped with time clocks for programmed temperature control. The high temperature was thermostatically controlled at 120°F. The low temperature was the standard recommended conditions for drying peanuts

(heat added when the relative humidity exceeded 65% but with a maximum temperature of 95°F). The drying air was heated with electric heaters.

The peanuts were dried in boxes with one square foot floor area and one foot depth. Air flow rate through the peanuts was 50 cfm, monitored by a hot-wire anemometer. Wet and dry-bulb temperatures of the drying air were recorded at half hour intervals. Each box was initially filled with 30 pounds of green peanuts, and the weight loss was determined by periodic weighing. Treatments were replicated three times. Moisture contents were determined after oven drying at 180°F for 48 hours. Federal-State grading procedures were used in evaluating milling quality.

Flavor quality was evaluated at the National Peanut Research Lab., Dawson by ten-member panels of selected and experienced tasters. Samples of butter made from roasted, blanched peanuts (with no additives) were rated on a five-point hedonic scale as "excellent" to "very poor". (The lower the score, the better the flavor.) Sampling, processing and presentation were standardized to minimize error, and tasting was done in individual masking-lighted booths to minimize extraneous influences upon flavor response. (Cler score evaluations were made at Tifton.)

Discussion of Results

Peanut quality can be measured by several criteria, depending upon the end use. For the edible trade, flavor is the primary criterion. Flavor was best evaluated subjectively by taste panels and the results quantified. Sampling procedure is critical if significant results are to be achieved.

Milling quality is evaluated by the percentage of split kernels in a graded sample. Excessive split kernels usually indicates that high temperatures were used in drying. Thus it may be used as a secondary indicator of flavor. The split kernel percentage is also used in determining the price paid to the producer. Split kernel percentage greater than 4% results in a lower price.

Molds and aflatoxin contamination will degrade the peanut quality. Prompt drying will usually minimize this deterrent to good quality.

Cycled high temperature

By periodically cycling the drying air temperature, the time required to dry the peanuts was reduced by 40-60% below the time required using the normal drying procedure (Table 1). Similar reductions in drying time were noted in all years.

Flavor evaluation of peanuts dried with cycled temperatures (Table 2) generally indicated no significant difference or a preference for the cycled temperature treatment. For the 1969 Spanish harvest the taste panel showed a slight preference for the cycled temperature treatment. The 1969 Runner harvest and both 1970 harvests showed no significant difference in flavor between the cycled treatments and the standard treatment. In 1971 the harvests were evaluated for flavor using the Cler method (3). These tests showed a slight preference for the standard treatment. Correlation with the taste panel evaluations used in previous years is not available at this time.

The percentage of split kernels (Table 3) increased significantly when high temperature was applied during the drying period. In several instances, the split kernel percentage was above the 4% level used in determining the price paid to the producer.

These results indicate that drying time can be reduced without significantly affecting peanut flavor by periodic use of higher temperatures during drying. Milling quality, however, will be reduced with this procedure.

Table 1. Time (Hours) to Reach 10% Moisture Content

Treatment	1969		1970		1971	
	Starr Spanish	Early Runner	Starr Spanish	Florunner	Florunner	Florigiant
Standard drying[1/]	77	70	142	80	90	56
Ambient air, no heat added	183	69	242	128	--	--
Continuous 120°F to completion	23	28	---	---	--	--
High - Low[2/]	61 (15)[4/]	84 (18)[4/]	---	---	--	--
Low - High[3/]	50 (9)[4/]	43 (17)[4/]	---	---	--	--
Cycled Treatments						
% High Temp. / Hours Per Cycle						
12.5 / 24	65	--	80	46	--	--
25 / 12	49	--	--	--	54	33
31.3 / 8	31	35	63	33	49	24
31.3 / 4.75	--	41	--	--	52	29
31.3 / 3	--	40	61	46	57	25
31.3 / 2	--	--	--	--	48	26

[1/] Standard drying - heat added when relative humidity exceeds 65%, maximum 95°F.

[2/] High - Low - Continuous high heat at 120°F to 20% moisture, then standard drying.

[3/] Low - High - Standard drying to 20% moisture, then continuous high heat.

[4/] Time in parenthesis indicates hours at high temperature.

Table 2. Flavor Evaluation*

Treatment	1969		1970		1971	
	Starr Spanish	Early Runner	Starr Spanish	Florunner	Florunner	Florigiant
Standard drying[1/]	2.6[4/]	2.6	2.4	2.3	70[5/]	55
3 days in windrow	2.5	2.1	---	---	--	--
Ambient air, no heat added	2.7	2.4	2.2	2.6	--	--
Continuous 120°F to completion	4.0	4.7	---	---	--	--
High - Low[2/]	2.6	2.9	---	---	--	--
Low - High[3/]	2.6	3.8	---	---	--	--
Cycled Treatments						
% High Temp. / Hours Per Cycle						
12.5 / 24	2.0	---	2.3	2.6	--	--
25 / 12	2.3	---	---	---	65	49
31.3 / 8	2.3	3.0	2.2	2.2	63	51
31.3 / 4.75	---	2.7	---	---	61	53
31.3 / 3	---	2.4	2.4	3.0	63	51
31.3 / 2	---	---	---	---	61	47

*Note - Comparisons should be made only within a given year and variety. Comparison across varieties and years are not valid.

1/ Standard drying - heat added when the relative handling exceeds 65%, maximum 95°F.

2/ High - Low - Continuous 120°F to 20% moisture, then standard drying.

3/ Low - High - Standard drying to 20% moisture, then continuous 120°F.

4/ Flavor panel evaluation - scale ranges from 1 (excellent flavor) to 5 (very poor flavor).

5/ 1971 peanuts evaluated by Cler score (3). Scale for Cler evaluation ranges from 0 (badly off flavor) to 100 (good peanut flavor).

Table 3. Percentage of Sound Split Kernels

Treatment	1969 Starr Spanish	1969 Early Runner	1970 Starr Spanish	1970 Florunner	1971* Florunner
Standard drying[1/]	0.8	0.3	1.5	1.0	2.5
3 days in windrow	0.3	0.4	3.8	1.9	---
Ambient air, no heat added	0.8	0.5	0.7	1.7	---
Continuous 120°F to completion	1.9	3.7	---	---	---
High-Low[2/]	0.8	1.7	---	---	---
Low-High[3/]	2.1	2.2	---	---	---
Cycled Treatments					
% High Temp. / Hrs. Per Cycle					
12.5 / 24	2.2	---	2.2	1.3	---
25.0 / 12	1.8	---	---	---	3.9
31.3 / 8	2.6	5.9	2.9	2.7	3.4
31.3 / 4.75	---	1.4	---	---	4.8
31.3 / 3	---	1.7	1.9	1.5	4.6
31.3 / 2	---	---	---	---	4.6

1/Standard drying - heat added when relative humidity exceeds 65%, max. 95°F.
2/High-Low - Continuous 120°F to 20% moisture, then standard drying.
3/Low-High - Standard drying to 20% moisture, then continuous 120°F.
* Florigiant samples were not graded.

Partial drying with high temperature

Instead of programming a change in drying-air temperature with time, the programming may be based on moisture level of the peanut. This approach hypothesizes that the interaction between temperature and moisture level is important in flavor development. One experiment applied high temperature (120°F) air at moisture levels above 20% (high-low), the other applied high temperature air below 20% (low-high).

The results indicate that high temperature applied near the end of the drying process will reduce the drying time more than application during the early stage of drying (Table 1).

In the flavor evaluation of the 1969 Spanish harvest, 15 hours of high temperature treatment at high moisture (high-low) was judged to have a similar flavor to 9 hours of high temperature applied at low moisture (low-high) (Table 2). Both were similar to the flavor of the standard treatment. In the 1969 Runner harvest, 18 hours of high temperature treatment at high moisture (high-low) was judged to be significantly better than 17 hours of high temperature at low moisture (low-high). These results suggest that the peanut is better able to withstand high temperature flavor damage when its moisture is high. Further data are needed to substantiate this inference.

Milling quality, as indicated by the percentage of split kernels, was better with the high-low treatment (Table 3). Both treatments had higher percentages than the standard treatment but were below the 4% level used by the buyer.

Summary

Drying in the windrow will produce peanuts with an acceptable flavor quality except under prolonged rainy weather. Delayed drying encourages mold growth, and aflatoxin contamination, and contributes to increased harvesting losses. An alternative solution involves harvesting immediately after digging and prompt drying under controlled conditions. Complete, continuous drying with temperatures above 95°F will likely damage flavor quality. Programmed drying with high temperature (120°F) applied periodically, decreased the drying time by 40-60% and maintained or improved flavor quality. Split kernel percentage increased slightly.

Tests indicated that the peanut is less likely to sustain flavor damage if the high temperature is applied at high moisture rather than low moisture. Further data are needed to substantiate this inference.

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THE EFFECT OF DRYING RATES ON SEPARATION OF COTYLEDONS OF BALD KERNELS

by
John D. Woodward, Mechanical Engineer
and Reed S. Hutchison, Agricultural Engineer
National Peanut Research Laboratory
Transportation and Facilities Research Division
Agricultural Research Service
U. S. Department of Agriculture
Dawson, Georgia

ABSTRACT

Green peanut kernels with their skin removed (bald kernels) were dried at four humidities. Relative displacement between cotyledons of the bald kernels was shown to be a function of relative humidity (RH). For Virginia- and Runner-type, the average amount of separation between the cotyledons at the end opposite the germ was about 0.055-inch at 12 and 40 percent RH, but declined sharply to about 0.040- and 0.015-inch at 60 and 80 percent RH, respectively. The values of lateral movement declined steadily with increased relative humidities, averaging about 0.029-, 0.015-, 0.008-, and 0.002-inch at 12, 40, 60, and 80 percent RH, respectively. For Spanish-type peanuts, the magnitude of the values was considerably less for each type of movement, but the same trend was followed.

INTRODUCTION

Drying tests conducted at normal or low temperatures have shown that splitting of kernels is a function of drying rate (1, 2), i.e., if other things are equal, higher drying rates cause more splitting. This is illustrated in figure 1 with data from Beasley and Dickens. However, the exact mechanism

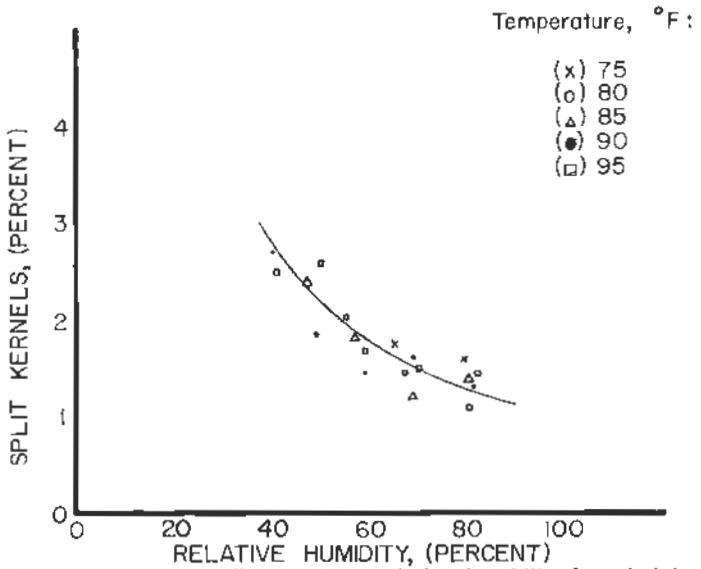

Figure 1.--Percent split kernel vs. relative humidity for Virginia peanuts dried at 75° to 95°F. Data taken from "Engineering Research in Peanut Curing." Tech. Bul. No. 155.

that causes splitting and/or skin slippage has not been revealed. Some of the theories which have been projected are shrinkage or expansion of the skin, "steaming off" of the skin, and stresses due to moisture or temperature gradients. An understanding of the mechanism of splitting could lead to a general improvement of milling quality from alteration of the peanut properties by breeding, or use of a more suitable and more precise drying process.

Previous studies at the National Peanut Research Laboratory (NPRL) (3) involving drying rates of kernels and components revealed a splitting apart of the cotyledons of bald kernels under some conditions while remaining attached at the germ. The tests described herein were planned to determine if the amount of splitting is a function of drying rate.

MATERIALS AND METHODS

The tests were performed on freshly dug Starr Spanish, Florunner, and Florigiant peanuts. After combining, the peanuts were hand shelled within a high humidity environmental chamber to prevent drying. Skins were removed from the kernels, and the bald kernels were divided into four groups. Each group was placed in a single layer in one of four environmental chambers at 75° F., having relative humidities of 12, 40, 60, and 80 percent, respectively. Air was circulated at a velocity of about 25 feet per minute. The peanuts were allowed to dry to about 12 percent moisture content in three tests, and completely to equilibrium in two tests.

Dislocation was observed both away from (opposing displacement) and parallel to (parallel displacement) the plane between two cotyledons (figures 2 and 3).

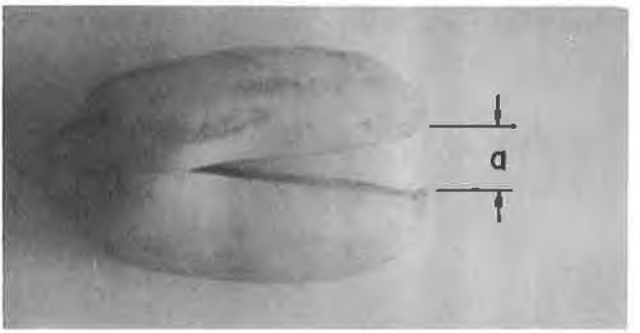

Figure 2.--Opposing displacement of cotyledons, a.

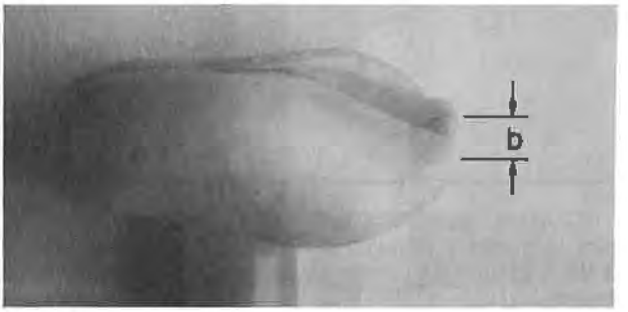

Figure 3.--Parallel displacement of cotyledons, b.

Measurement of the relative displacement of the cotyledons of each bald kernel was measured at the end opposite the germ using micrometer calipers, thickness gages, and/or ocular micrometer (figure 4).

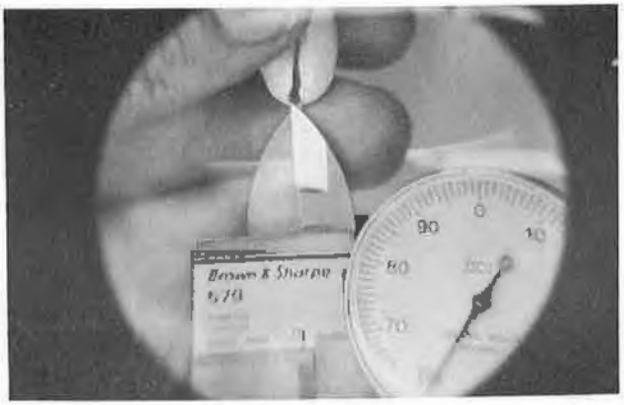

Figure 4.--Caliper method of determining displacement.

Photographs of typical groups of kernels are shown in figures 5 and 6.

Figure 5.-- Typical group of Florunner peanuts.

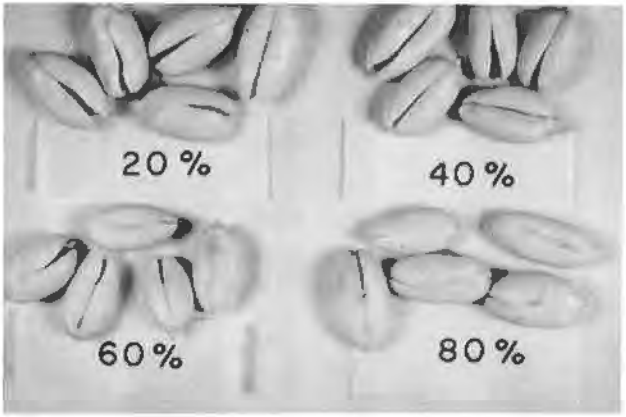

Figure 6.-- Typical group of Florigiant Virginia peanuts.

The average valnes for opposing displacement are plotted versus drying humidity in figure 7. The trend of the average values was the same for

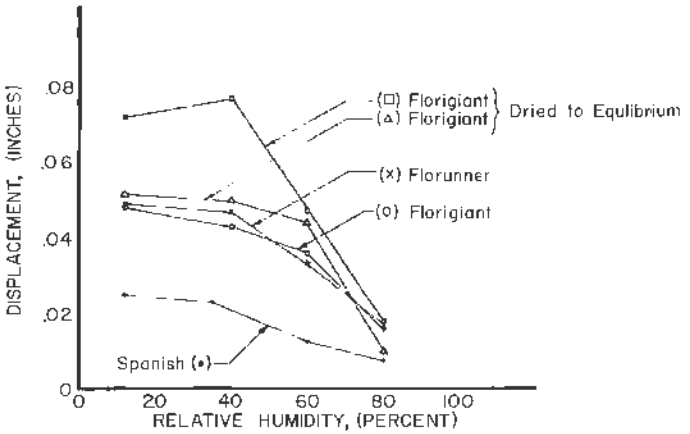

Figure 7.--Opposing displacement of cotyledons versus relative humidity of drying air.

each test. The values were about equal at the two lower values of relative humidity but decreased sharply to 60 and 80 percent relative humidity.

The average values for parallel-type displacement are plotted in figure 8.

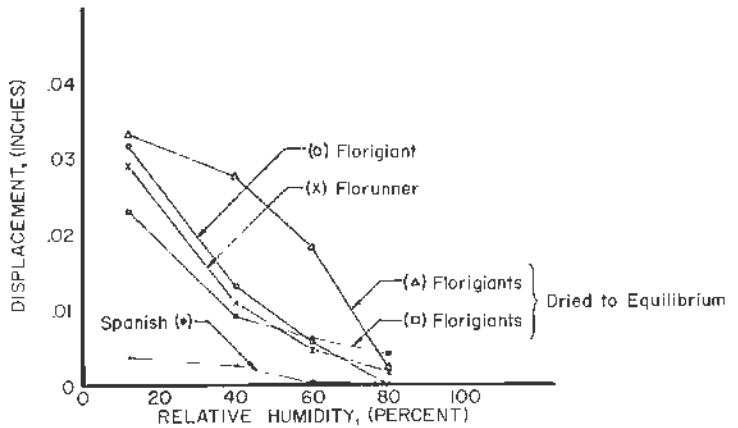

Figure 8.--Parallel displacement of cotyledons versus relative humidity of drying air.

For each test, the values showed a continuous decline for increasing relative humidity.

For opposite-type displacement, there was no statistically significant difference between values at 12 and 40 percent relative humidity for any of the tests. Between any other humidity levels, there was significant difference for all or most values.

For parallel displacement, significant difference was found between values of 12 percent and each other humidity level. Other values generally were not significantly different. Measurement of parallel displacement was subject to more error because of the difficulty in defining the original position of the cotyledons. However, the trends of the parallel displacement versus humidity seemed well established.

Figures 9 and 10 show the percentage of kernels having displacement greater

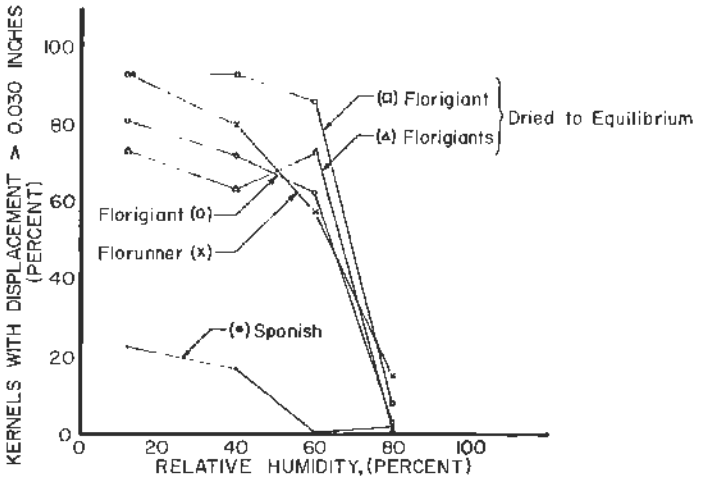

Figure 9.--Percent of kernels with opposing displacement greater than 0.030 inch.

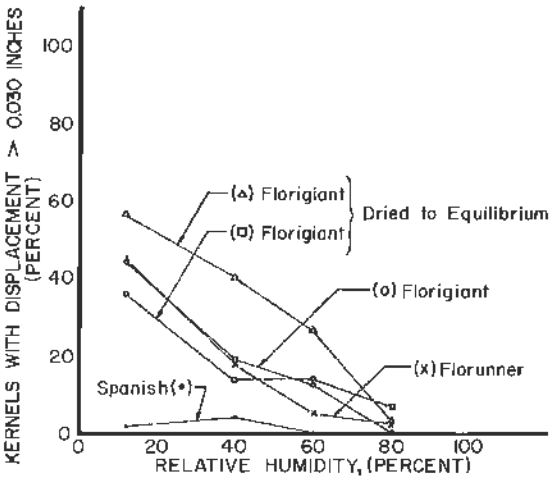

Figure 10.--Percent of kernels with parallel displacement greater than 0.030 inch.

than 0.030-inch. The trends established are similar to those of the average values.

Displacement values were always lower for the Spanish peanuts than for Virginia or Florunner. This difference was expected since Spanish kernels are considerably shorter. However, on an angular basis (displacement divided by length of kernel), the values for Spanish peanuts were still lower than Florunner or Florigiant. Some effect may have resulted from the drying range. The initial moisture content of the Spanish peanuts was somewhat lower, 45 percent dry basis, than that of the Florunner and Florigiant which was 57 and 64 percent, respectively.

Displacement values apparently were not dependent on final moisture content. The peanuts dried to equilibrium showed no consistent difference from those dried to 12 percent moisture content.

DISCUSSION

Relative displacement between cotyledons of bald kernels has been established as a function of the relative humidity of the drying air. The relationship between the displacement and relative humidity is similar to that of splitting versus relative humidity of the drying air. The theory follows that the forces causing displacement create stress in the skins of whole kernels, causing, or at least enhancing, splitting (during subsequent shelling and handling) of peanuts dried at lower relative humidities. The values presented here would indicate a sharp rise in splitting for drying air humidities lower than 80 percent; however, they represent humidity of the air directly surrounding the kernel. Kernels inside hulls (farmers' stock) probably have a higher surrounding humidity than that of the drying air since the hulls act as a moisture buffer. The curves presented here probably should be shifted to represent farmers' stock peanuts.

Based on the curves of opposing displacement, splitting probably would reach a point of no increase for further increase in drying rate. This has generally not been the case in most drying research. Thus, the forces causing parallel displacement may be predominant in causing splitting, since these values are higher with drying air at lower relative humidities. However, a combination of the two forces may determine the milling quality.

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(1) Beasley, Eustace O., Dickens, James W.; 1963. Engineering research in peanut curing. Tech. Bul. 155, 38 pp.

(2) Woodward, J. D., Hutchison, R. S., Davidson, J. I., Jr.; 1969. Drying farmers' stock peanuts at 40° and 60° F. ASAE Paper 69-345, 4 pp.

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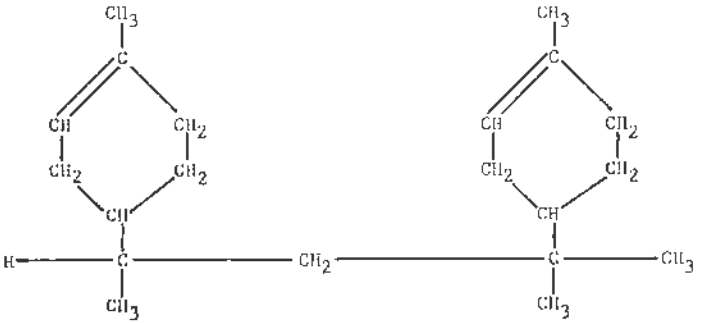
EVALUATION OF DI-L-P-MENTHENE FOR POTENTIAL USE ON FARMERS' STOCK PEANUTS

by
James I. Davidson, Jr. and Freddie P. McIntosh,
Mechanical Engineer and Agricultural Engineer, respectively
National Peanut Research Laboratory
Transportation and Facilities Research Division
Agricultural Research Service
U. S. Department of Agriculture
Dawson, Georgia
and
Leonard M. Redlinger, Investigations Leader
Coastal Plain Experiment Station
Market Quality Research Division
Agricultural Research Service
U. S. Department of Agriculture
Tifton, Georgia

INTRODUCTION

This report covers a cooperative study by the Transportation and Facilities Research Division and the Market Quality Research Division of ARS to evaluate the potential uses of di-l-p-Menthene in the commercial storage and shelling of farmers' stock peanuts.

Di-l-p-Menthene is a Lewis acid catalyzed polmyer of β pinene - one of the major constituents of pine oil. It has two sub-units in the polmyer for a molecular weight of 274. Its chemical structure is represented by the following:



Di-l-p-Menthene is relatively non-toxic to mammals, has been cleared by the Food and Drug Administration for use in cosmetics and chewing gum, and has a tolerance exempt status in agriculture. One of its primary uses is to control pesticide residues. Some physical and chemical properties of this material are listed in table 1.

Various substances have been used to extend and control the residues of pesticides. It was reported that di-l-p-Menthene has such properties and, in addition, possesses qualities of retarding moisture loss. It is readily soluble in water and when applied to a material and allowed to dry, a thin film is formed on the surface. This thin film retards the transfer of moisture between the material and its surroundings. Plants are dipped in a solution of di-l-p-Menthene and water to retard wilting and are sprayed with similar solutions to retard transpiration. In some cases, its use reduces the number of irrigations required to produce a crop.

Since the film-forming properties of this material had been successfully utilized on other agricultural products, it appeared that such a film on farmers' stock peanuts might form a significant barrier to moisture, bacteria, and molds as well as being useful in maintaining residues of malathion or other insecticides. A thin film on the surface of the peanut hull could affect the shelling rates of commercial shellers and improve sheller performance. Application of the di-l-p-Menthene could be easily implemented into current storage programs by mixing this material with the insecticide and spraying the peanuts in the usual manner.

The objectives of this preliminary study were to determine the potential of the di-l-p-Menthene for:

Table 1.--Characteristic chemical and physical properties of di-l-p-Menthene 1/

Property	Value or characteristic
State at room temperature	- liquid
Acid number	- approximately zero
Average specific gravity	- 0.95
Iodine number	- approximately 98
Solubility	- unpolymerized, this material is soluble in all aliphates and aromatic solvents, ketones (except acetone), higher molecular weight alcohols and chlorinated solvents. After polymerization, solubility is generally decreased in all solvents.
Vapor pressure at room temperature	- extremely low
Vapor pressure at 200° F.	- 2 mm Hg
Vapor pressure at 300° F.	- 15 mm Hg.
Flash point	- 330° F.
Refractive index	- 1.5098

1/ Chemical and physical property data were supplied by the distributor, Miller Chemical and Fertilizer Corporation, WHVR Road, Box 311, Hanover, Pennsylvania 17331. Listing of the distributor does not imply that the Government recommends use or non-use of this product. The distributor furnished the di-l-p-Menthene and consulted with the authors in planning this research. Cooperation of Mr. Charlie Svec and Miller Chemical and Fertilizer Corporation is greatly appreciated.

a. Reducing moisture loss of farmers' stock peanuts during storage.

b. Conditioning peanut pods for shelling.

c. Minimizing mold and bacterial infestation of farmers' stock peanuts.

d. Increasing the length of residual toxicity of malathion and thereby minimizing insect infestation of farmers' stock peanuts.

This study is part of an overall program conducted by ARS to improve methods, techniques, and equipment for storing and shelling farmers' stock peanuts. It was conducted at Dawson and Tifton, Georgia, from June to October 1971.

MATERIALS AND METHODS

A 1,175-pound lot of Spanish-type peanuts (1968 crop year) was removed from refrigerated storage and divided into five samples as follows:

Sample no. 1 - Untreated control (375 pounds)
Sample no. 2 - Water-treated control (200 pounds)
Sample no. 3 - Malathion-treated (200 pounds)
Sample no. 4 - Di-l-p-Menthene-treated (200 pounds)
Sample no. 5 - Di-l-p-Menthene plus malathion-treated (200 pounds)

The samples received the treatments as shown in figure 1.

The 375-pound untreated control lot was divided into a 275-pound sample and a 100-pound sample. The 275-pound untreated sample was used to determine the properties of the peanuts prior to storage, and the 100-pound untreated sample was used to determine the peanut properties after storage. Two hundred and fifty pounds of the 275-pound sample were divided into five subsamples of 50 pounds each for shelling tests to determine the initial milling quality of the lot. The remaining 25 pounds were divided into 5-pound samples for immediate determinations of official grades and germinations. One hundred kernels from each official grade sample were subjected to mold assays to determine mold contamination. The 100-pound sample was placed in ambient storage for 3 months and then shelled to determine milling quality, grade, and germination after storage.

All of the treated samples were sprayed at a rate of 32 ml of solution per pound of peanuts. Previous experiments with water showed that this rate would thoroughly wet the surface of all peanut pods. The malathion spray was prepared by mixing 8.75 ml of premium grade, 57 percent EC malathion per gallon of water. The di-1-p-Menthene solution was prepared by adding 392 ml to a gallon of water. The malathion plus di-1-p-Menthene solution consisted of 8.75 ml of premium grade, 57 percent EC malathion, and 392 ml of the di-1-p-Menthene per gallon of water.

Uniform coverage by the spray solutions was achieved by spraying the peanuts with a flat spray nozzle as they discharged from a bucket elevator. The bucket elevator was fully loaded to maintain a constant rate of flow. After the peanuts passed through the sprayer, they tumbled down an inclined belt and mixed with the runoff solution. This procedure insured that the solution was applied to the entire surface area of the peanut pods.

Immediately after spraying, each sample was aerated for 2 hours so that the di-1-p-Menthene would "set," forming a film around the pods. Each sample was weighed immediately before and after it was sprayed, and again at the end of the aeration period.

Following aeration, each sample was thoroughly mixed and divided into subsamples as indicated in figure 1. One hundred pounds of each sample were placed in burlap bags and held in a storage room at ambient conditions. Each bag of peanuts was weighed weekly, and the temperature and humidity of the storage building was recorded every 2 hours. After 3 months (90 days), the samples were subjected to official grade, hull and kernel moisture determinations, shelling and germination tests. A 1/4-size commercial-type sheller was used for all shelling studies.

Five 5-pound subsamples were taken from each of the four 200-pound samples for mold studies. Each 5-pound subsample was divided into 1-pound portions, placed in mesh bags, and stored in a chamber controlled at 80 ± 10 percent relative humidity. Temperature was not controlled, but it was in a range favorable for mold growth at all times (80° to 105° F.). After 8, 19, 26, 35, and 42 days' storage, five 1-pound portions of each treatment (water, malathion, di-1-p-Menthene, and malathion plus di-1-p-Menthene) were taken from the humid environment. One hundred kernels from each 1-pound portion were surface sterilized by soaking in a 2 percent solution of sodium hypochlorite for 2 minutes. The sterilized kernels were then transferred to petri dishes containing an agar solution 2/. After 5 days, the number of mold-infected kernels was counted. The mold infestations were divided into three categories: (1) Aspergillus flavus, (2) other Aspergillus and Penicillium species, and (3) Mycelia-type fungi. Bacteria-infected kernels were also counted.

2/ The cooperation and assistance of Mr. Jerry Kirksey, Pathologist, MQRD, ARS, USDA, and Dr. Richard Cole, Microbiologist, MQRD, ARS, USDA, who assisted with the mold evaluations are greatly appreciated.

The 75-pound lots of peanuts, selected for exposure to an insect environment, were divided into five 15-pound subsamples for each treatment. The peanuts were placed in cardboard boxes 12 x 12 x 12 inches and stored under simulated warehouse conditions with exposure to a high population of stored-product insects. In addition to the natural insect population present during storage, 500 Indian-meal and 800 almond moth eggs were sprinkled over the surface of each box of peanuts. At the end of 1, 2, and 3 months of storage, insect evaluations were made of all samples.

Each 15-pound peanut sample was divided with a farmers' stock peanut divider to a representative 1,000-gram sample. The peanuts were sifted over a 1/4-inch screen with a mechanical sifter operated for 1 minute. The numbers of live and dead insects were recorded.

Insect emergence records were obtained from peanuts held in an environmental room maintained at 27 $\pm$ 1° C and 65 $\pm$ 2 percent RH for a 42-day period. At the end of this period, the peanuts were sifted and the number of insects recorded.

Insect kernel damage was recorded from a representative 100-pod sample from each replication and treatment.

Malathion residues were analyzed from 1-quart samples of peanuts taken immediately after treatment and at the end of 1, 2, and 3 months of storage.

DATA AND RESULTS

General

The peanuts treated with solutions of di-1-p-Menthene gained less weight (absorbed less moisture) during the spraying operation than the peanuts treated with other solutions (table 2). It appeared that the di-1-p-Menthene solutions

Table 2.--Weight and moisture gain of peanuts when sprayed with different solutions

Type of solution	Weight gain	Moisture gain	
		Hulls	Kernels
	Percent	Points (wet basis)	Points (wet basis)
Water	3.3	9.5	1.2
Malathion and water	3.7	10.3	0.7
Malathion, water and di-1-p-Menthene	2.7	8.7	0.9
Di-1-p-Menthene	2.5	6.7	0.8

formed a smooth sticky film on the exterior surface of the pod. This film shielded the hull resulting in a relatively low hull moisture content. Immediately after spraying, the film remained tacky. However, no problems were experienced in the normal handling of these peanuts. Aeration set the film and caused the peanuts to appear bright and polished.

After the first week in storage, the film did not significantly reduce the loss of kernel moisture (figure 2). Kernel moisture content of all peanuts

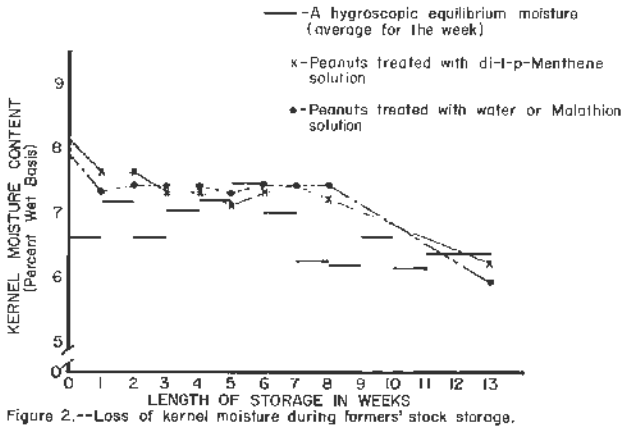


Figure 2.--Loss of kernel moisture during farmers' stock storage.

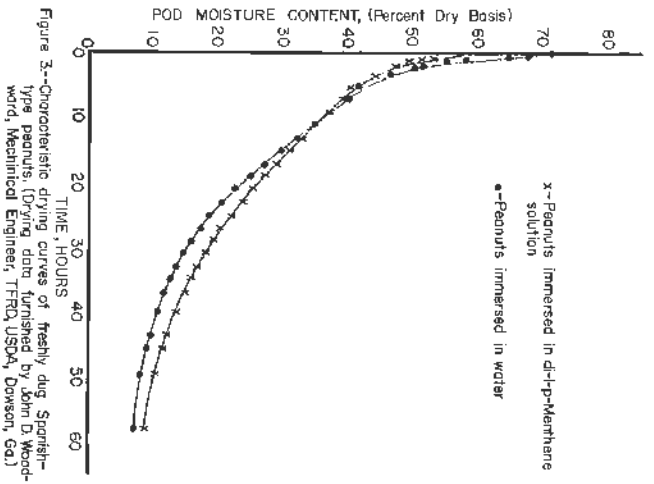


Figure 3.--Characteristic drying curves of freshly dug Spanish-type peanuts. (Drying data furnished by John D. Woodward, Mechanical Engineer, TFRD, USDA, Dawson, Ga.)

approached hygroscopic equilibrium for the particular storage environments.

Although the di-1-p-Menthene treatments were not effective for maintaining kernel moisture contents of farmers' stock peanuts for long periods of storage, the treatments appeared to be effective for short-term (1 week) storage. To further evaluate the effects of the film on short-term storage, two samples of freshly dug ("green") peanuts were immersed simultaneously, one in a 10 percent di-1-p-Menthene solution and one in water. The samples were then subjected to normal drying conditions and their drying rates compared (figure 3). The film

effectively reduced the drying rate of the peanuts and indicated some potential for using di-1-p-Menthene to reduce sporadic changes in kernel moisture during storage.

Shelling, grades, and germination

Both storage and spray treatments lowered milling quality (table 3).

Table 3.--Effect of treatments on shelling and germination properties of Spanish peanuts after 3 months' storage

Spray treatment	Sound mature kernel outturn	Split kernel outturn	Oil stock outturn	Skin slippage (bald kernel outturn)	Kernel moisture (wet basis)	Shelling efficiency of first stage sheller	Shelling rate of first stage sheller	Grade damage	Germination
	Percent	Percent	Percent	Percent	Percent	Percent	Pounds per hour	Percent	Percent
Controls[1/]	64.6	11.3	1.5	12.1	7.3	91.6	689	1.2	79.0
Controls[2/]	66.3	12.4	1.4	12.7	6.2	92.5	684	4.0	70.3
Water	65.9	12.5	1.3	15.2	6.3	89.9	754	3.0	71.8
Malathion	65.9	13.0	1.4	14.0	6.4	91.6	660	2.5	71.4
Di-1-p-Menthene	64.8	13.0	1.3	18.1	6.3	94.1	763	2.5	73.2
Di-1-p-Menthene plus malathion	65.2	13.5	1.4	17.9	6.4	93.9	820	3.0	74.4

1/ Peanuts were not sprayed, but shelled at the beginning of the experiment.

2/ Peanuts were not sprayed, but shelled after 3 months' storage.

Storing the untreated peanuts for 3 months increased the split kernel outturn and skin slippage by 1.1 and 0.6 percentage points, respectively. Treating the peanuts resulted in a 0.6 and 3.6 percentage points higher split kernel outturn and skin slippage, respectively, than that obtained for the untreated peanuts. Peanut samples treated with di-l-p-Menthene solutions had the poorest milling quality, but the highest shelling rates and shelling efficiencies. Undoubtedly, the high values of skin slippage for the treated peanuts resulted from rewetting the peanuts. Aerating the peanuts immediately after treatment may have minimized skin slippage for the water and malathion treatments.

Differences in grade were attributed to insect activity and not to treatments. Most of the grade damage above 1.2 percent resulted from worm cuts.

Germination decreased slightly during storage, bnt did not appear to be affected by the spray treatments. Peanuts treated with the di-l-p-Menthene had slightly higher germination percentages than those obtained from peanuts of other treatments.

Mold Study

Mold contamination data indicated that inoculum capable of growing species of Aspergillus, Penicillium, and Mycelia-type fungi and bacteria was present in the control samples (table 4). Only a small percentage of kernels from these

Table 4.--Mold contamination of peanut kernels prior to storage

Sample number	Type of contamination			
	Aspergillus flavus	Other Aspergillus and Penicillium	Mycelia-type fungi	Bacteria
	Percent	Percent	Percent	Percent
1	1	0	36	11
2	1	1	42	8
3	3	0	37	10
4	3	0	33	14
5	1	0	31	16
Range	1 - 3	0 - 1	31 - 42	8 - 16
Average	1.8	0.2	35.8	11.8

samples had A. flavus or other Aspergillus and Penicillium inoculum present (average of 1.8 and 0.2 percent, respectively). However, a large percentage of the control kernels tested contained inoculum for the Mycelia-type fungi and bacteria (35.8 and 11.8 percent, respectively).

If the di-l-p-Menthene film is a barrier to mold, then the number of infested kernels should not change appreciably during storage. Data from each of the four treatments after 8, 19, 26, 35, and 42 days of storage are presented in figures 4 through 8. Spraying the peanuts with solutions containing the di-I-p-Menthene did not prevent invasion of the kernels by any of the contaminants studied. There was no indication that this spray treatment inhibited or affected infestation by A. flavus or mold fungi (figures 4 and 5). For purposes

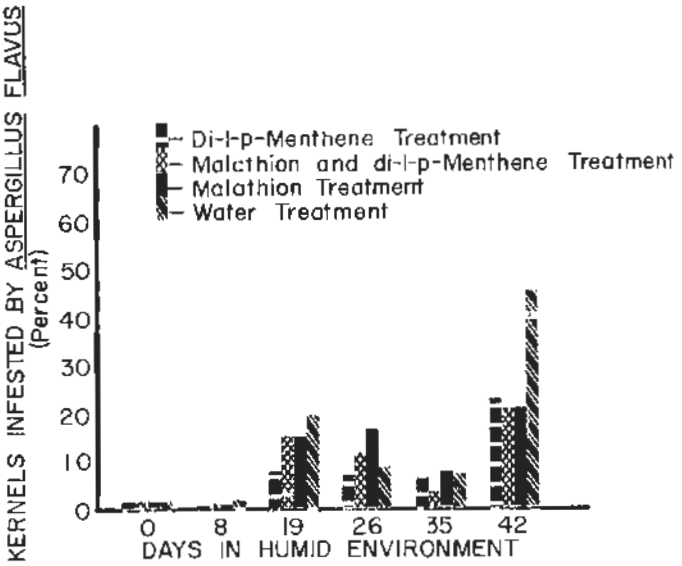


Figure 4.--Effect of di-l-p-Menthene treatments on invasions of peanut kernels by Aspergillus flavus.

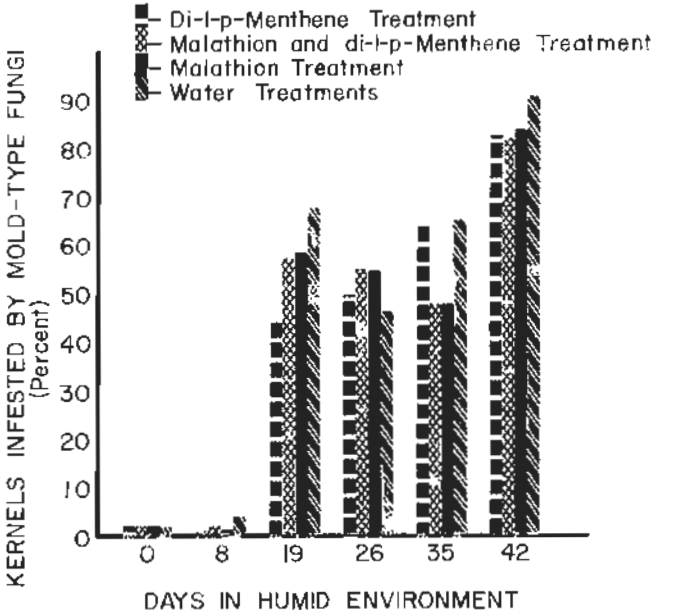


Figure 5.--Effect of di-l-p-Menthene treatments on invasion of peanut kernel by mold-type fungi.

of this presentation, the mold fungi include all Aspergillus and Penicillium species. At best, the only effect of di-l-p-Menthene on mold growth was to reduce infestation by the Mycelia-type fungi and bacteria for about 8 days (figures 6 and 7). It should be noted, however, that the film formed by the

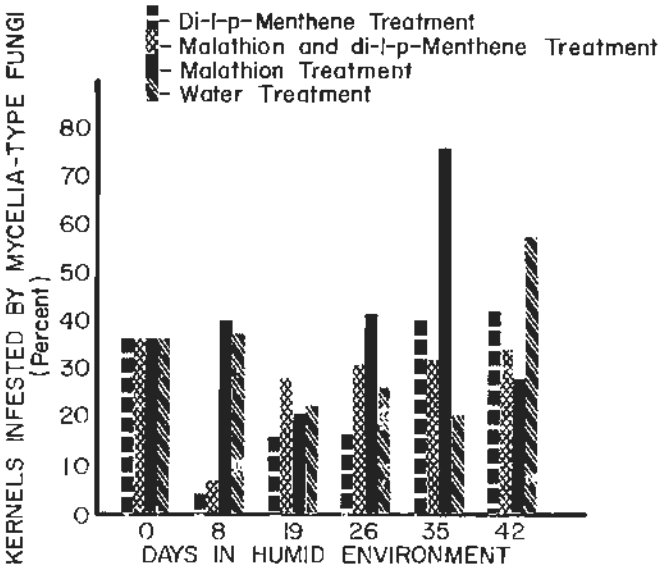


Figure 6.--Effect of di-l-p-Menthene treatments on invasion of peanut kernels by Mycelia-type fungi.

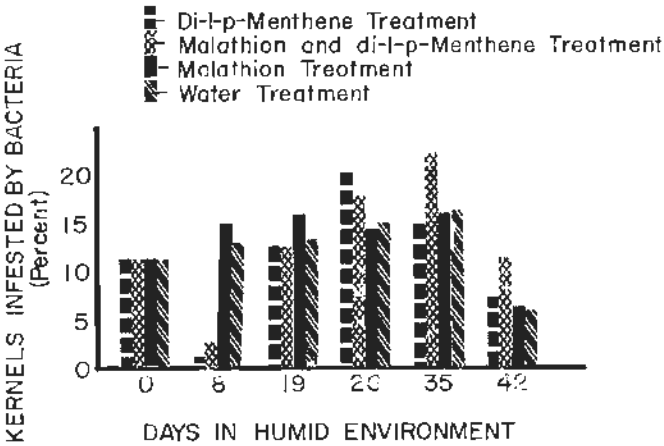


Figure 7.--Effect of di-l-p-Menthene treatments on invasion of peanut kernels by bacteria.

di-l-p-Menthene did not promote mold growths. This is an important result if di-l-p-Menthene is used commercially.

Insect study

The average number of insects and damage recorded from each treatment is shown in table 5. The high insect counts recorded at one month after treatment is a

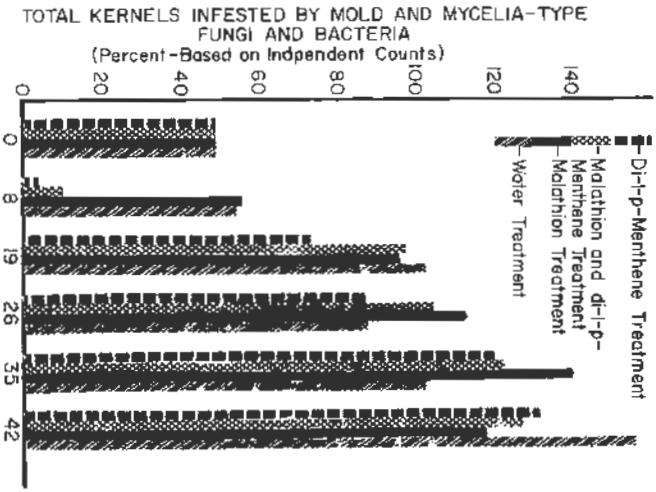


Figure 8.--Effect of di-l-p-Menthene treatment on invasion of peanut kernels by various types of fungi and bacteria.

Table 5.--Number of insects and percentage of damage recorded from farmers' stock peanuts following various treatments and lengths of storage -- Tifton, Georgia, June - September, 1971 1/

Treatment and sampling date	Insects per 1,000 grams			Percentage data from 100-pod counts	
	Alive	Dead	Emerged	Cracked pods	Kernels damaged
	Number	Number	Number	Percent	Percent
Untreated controls					
1 month	200.8	64.4	56.0	29.2	12.7
2 months	62.4	44.0	204.0	34.4	14.1
3 months	118.4	48.4	577.6	28.8	15.4
di-l-p Menthene					
1 month	208.0	65.2	79.6	25.6	12.1
2 months	80.4	84.8	156.8	25.0	14.8
3 months	96.0	59.2	504.0	27.6	14.1
Malathion					
1 month	130.8	80.4	34.8	30.6	11.7
2 months	52.0	113.6	74.0	31.0	11.9
3 months	62.4	101.6	239.6	27.6	12.5
Malathion + di-l-p-Menthene					
1 month	208.0	74.8	70.8	23.8	10.3
2 months	75.6	79.6	156.8	22.2	11.8
3 months	45.6	64.0	177.2	27.0	12.4

1/ Average of 5 replications

direct result of the moth eggs introduced at the beginning of storage. The number of insects recovered from the peanuts on later sampling dates was at a lower level. The applied treatments offered little or no protection from insect attack. Peanuts treated with malathion alone and the combination of malathion plus di-l-p-Menthene had fewer live and emerged insects than the other treatments. Very little difference was noted between the two malathion treatments. The greatest numbers of insects and damage were recorded from the untreated controls and the di-l-p-Menthene-treated peanuts.

Residues

The average malathion residues are shown in table 6. All of the residues were

Table 6.- Malathion residues recovered from farmers' stock peanuts after various storage periods—Tifton, Georgia, June - September, 1971

Treatment	Residues, months after treatment			
	0	1	2	5
	ppm	ppm	ppm	ppm
Malathion	12.6	4.3	3.8	2.5
Malathion + di-l-p-Menthene	18.4	4.5	6.4	4.6

unusually low. A malathion deposit of approximately 52 ppm, the standard recommendation for farmers' stock peanuts, was desired for this study. However, with the method of application used (wetting the entire peanut pod), it was difficult to determine the amount of malathion that would be retained on the hull. Residue analyses made of the samples 1 day after treatment showed a deposit of 12.6 ppm for the malathion alone and 18.4 ppm for the combination. Even though the intended deposit was low, it can be seen that very little difference occurred in the degradation of malathion from the peanuts treated with malathion alone or in combination with di-l-p-Menthene. During the first month of storage, average residues decreased from 65 to 75 percent. The decrease was gradual during the remainder of the storage period. The low malathion residues accounted for the poor insect control obtained.

CONCLUSION

Treatment of farmers' stock peanuts with di-l-p-Menthene at the conditions specified did not significantly affect grade, germination, or resistance to invasion by mold, bacteria, and insects.

Di-l-p-Menthene solutions formed a thin film on the outside of the peanut pods, giving them a bright and shiny appearance. This film appeared to shed water solutions sprayed on the pods but was effective for only short periods in reducing moisture loss by the peanuts. The film increased the shelling rate and efficiency of a commercial-type sheller, but the milling quality of the treated peanuts was generally lower.

Spraying the peanuts with an application rate of 32 ml per pound essentially rewet the peanuts and resulted in an increase in both kernel moisture and skin slippage. Because an increase in kernel moisture makes the peanuts more susceptible to aflatoxin, rewetting is prohibited by the Peanut Administrative Committee. For these reasons, a lower application rate would have to be used in a commercial operation. Although lower rates of spray application may fail to form a complete film on the pod, they would minimize the bad effects of the spray on peanut quality. More research may be warranted to determine the potential use of di-l-p-Menthene at lower application rates.

This preliminary study indicates that some potential uses of di-l-p-Menthene on farmers' stock peanuts include:

a. Pre-shelling treatment to condition hull for higher shelling rates, greater shelling efficiencies, and less wear on sheller grates and cylinders.

b. Treating surfaces of peanuts in warehouses to reduce the effects of condensation and moisture variations.

c. Treating salted inshell nuts to improve their appeal to consumers.

CERTAIN PHYSICAL AND MECHANICAL PROPERTIES OF VA. 61R PEANUTS

by
J. L. Steele, F. S. Wright and P. H. van Schaik
Agricultural Engineers and Agronomist
Agricultural Research Service, USDA, Southern Region
Holland, Virginia 23391

Summary

Certain physical and mechanical properties of individual Va. 61R peanuts were determined. The mechanical properties determined were: (a) peanut-peg strength, (b) peg tensile strength, and (c) shell strength at the basal and apical ends of the peanut. The physical properties determined were: moisture content, dry weight, wet weight, peg length, peg diameter, pod length and pod profiles.

Relationships between the above properties and age from pegging were examined. Variability between peanuts and the associated strength measurements prevented the development of relationships with a high degree of certainty. The most consistent relationships were: (a) dry weight increase with age, (b) moisture content decrease with age, (c) peg diameter product change with age, (d) dry weight density decrease with moisture content, (e) a decrease in the ratio of the peanut-peg separation force to dry weight with age, (f) a decrease in the ratio of the peg separation force to dry weight with age, and (g) an increase in apical and basal shell puncture force with dry weight.

Introduction

Knowledge of the physical and mechanical properties of the peanut can contribute in many areas to the production of quality peanuts. The definition, measurement and tabulation of these properties and their change during fruit development, harvesting and curing are needed for variety evaluation, machine design and drying and curing recommendations. The purpose of this study was to define and quantify certain properties of the peanut which relate to growth, maturation, harvest and mechanical damage.

Certain physical and mechanical properties of Va. 61R peanuts were studied in 1969 and 1971 (1). 1/ The objectives were: (a) develop procedures and instrumentation for the measurement of certain physical and mechanical properties of individual peanuts, (b) relate the peanut-peg strength, peg tensile strength and shell strength to moisture content and other physical properties of the peanut. These studies were conducted by the Agricultural Research Service, USDA, Southern Region at the Tidewater Research and Continuing Education Center, Holland, Virginia.

Instrumentation

Peanut-peg, peg and shell strength were characterized by measurement of the force required during slow loading to separate the peanut and peg, separate (break) the peg and puncture the shell. The force measurements were made using a crosshead and drive assembly, a strain-gage load cell and a dynograph. The crosshead was equipped with four load cells to permit simultaneous

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1/ Numbers in parentheses refer to references.

observations on four peanuts. The crosshead speed was 12.7 mm/min for all force measurements.

For measurement of the peanut-peg separation force, each peanut was pinned and clamped as illustrated in Figure 1. The pin was inserted directly behind the peanut-peg attachment and in line with the normal peg projection. The clamp was installed approximately 25 mm from the pin. For the peg separation force measurement, a second clamp was added as shown in Figure 1. The peanut-peg and peg separation forces were defined as the maximum force observed during loading.

For the basal and apical shell puncture force measurement, a load cell was equipped with a blunt 1.83-mm diameter punch and each peanut was punched perpendicular to the suture at the basal and apical ends as illustrated in Figure 1. The force required to puncture the shell was also defined as the maximum observed force.

Peg diameters, pod length and pod profiles were determined with a light sensing device. A phototube, a light source, a constant speed drive unit and a dynograph were used for these measurements. Each peanut peg was placed in the light beam to determine the peg diameter (approximately 3mm from the clamp) in two directions before the peg separation force was measured. Each peanut was moved through the light beam for the profile measurements. Profiles perpendicular and parallel to the suture were recorded on chart paper.

Each peanut was weighed on an analytical balance and placed in an oven at 180°F for 3 days for moisture content and dry weight determinations.

Test Procedure

In 1969 the effect of moisture content on the peanut-peg and peg separation forces was investigated. Peanuts of various moisture contents were obtained by hand harvesting after 0, 1, 2, 3, 4, 7, 9 and 11 days of field exposure. Thirty-two visibly sound peanuts and pegs were selected from an inverted windrow of peanuts dug on 10/13/69. Force measurements and moisture content determinations were made on each peanut as previously described.

In 1971 peanuts of a known age were defined by selection. Forty-eight peanuts were selected and tagged on four specific dates when the peg was about to enter the soil surface. Eight peanuts were dug from each age group at regular intervals, placed in a sealed container and evaluated within 4 hours. The following measurements were completed on each peanut: peg length, peg length beneath soil surface, peanut-peg separation force, peg diameters, peg separation force, wet weight, pod profiles, basal and apical shell puncture forces and dry weight after 3 days in an oven at 180°F.

Results and Discussion

The average moisture content of the peanuts harvested in 1969 from an inverted windrow is presented in Figure 2. The variability between individual peanuts is indicated by the moisture content range. The average peanut-peg separation force with days in the windrow is shown in Figure 3. The variability in these data is indicated by the range and standard deviation of the separation force for the fruits observed each day. The same information is presented in Figure 4 for the peg separation force. As indicated, the

separation forces are not significantly related to moisture content. From other examinations of these data, the separation forces are not related to either dry weight or wet weight of the peanut fruit.

In 1969 no significant change in shell puncture force was observed with days in the windrow. Further examination of the data suggested a slight decrease in shell puncture force occurred with an increase in moisture content.

The magnitude of the variability between individual peanuts and the associated force measurements was unexpected. To further illustrate this variability, the data for two peanuts are presented in Table 1. The moisture content and dry weight of these peanuts were essentially the same; however, the peanut-peg separation force differed by a factor of two. Peanuts at other moisture contents and dry weights exhibited similar variations. This variability suggested factors other than moisture content and dry weight influence the separation and puncture forces.

In 1971 other physical factors of the individual peanut fruits were observed. In Table 2 an arbitrary peanut age was defined with respect to the tag date and harvest date. Peanuts failed to develop on many of the pegs tagged on 8/6 and 8/13; therefore, a limited number were observed for these two dates. The average physical and mechanical properties of the peanuts evaluated within each age group are presented in Tables 3A and 3B.

In Figure 5, the average peanut dry weight with age is shown for each tag date. Within a tag date, an increase in dry weight with age is apparent. Some differences between tag dates existed; however, a single trend line was drawn. These data are in general agreement with those reported by Schenk (5).

In Figure 6, the average moisture content with age is shown for each tag date. Within a tag date, a decrease in moisture content with age is apparent. A single trend line was suggested even though some differences appeared between tag dates.

In Figure 7, the average peg diameter product (an index of peg cross-sectional area) with age is presented for each tag date. A significant difference between tag dates is apparent. A maximum peg cross-sectional area was suggested at 60-70 days of age.

No apparent patterns were suggested by the data for peg or pod length with age or dry weight.

Six diameters were selected from the profile data to compute pod volume. Typical pod profiles were drawn for Figure 8. Maximum diameters in the basal and apical sections of the pod were better defined in the profile perpendicular to the suture. These two maximum diameters and a third minimum diameter were selected from this profile. Three additional diameters parallel to a plane through the suture were determined at corresponding points along the pod as illustrated in Figure 8. These diameters and length were used to compute pod volume by Simpson's rule. In Figure 9, the most consistent relationship between pod volume and other physical factors was presented. In this figure, dry weight density decreased linearly with an increase in moisture content. Since all peanuts were examined immediately after digging, this trend represented the change in dry weight density during growth and development. This linear relationship, as shown in Figure 9, also implied that the peanut wet weight density remained constant during growth and development.

The peanut-peg separation force (F_1) was not significantly related to any one of the following factors: wet weight, dry weight, moisture content or age. However, the ratio of F_1 to dry weight with age was fairly consistent as shown in Figure 10. An average peanut-peg separation force of 1.3 kg was in general agreement with those reported by Bauman and Norden (2) for other varieties.

The peg separation force (F_2) was not significantly related to any one of the following factors: wet weight, dry weight, moisture content, peg diameter product or age. However, the average ratio of F_2 to dry weight with age exhibited a pattern similar to (F_1/DM) as shown in Figure 11. The average peg separation force was 2.6 kg.

Shell puncture forces (F_3 and F_4) were related to both dry weight and age. Upper limits for F_3 and F_4 were approached at about 70 days of age with the maximum value observed at 96 days. A linear relationship between shell puncture force and dry weight was suggested as shown in Figure 12 and 13. Shell puncture force was equally related to dry weight density.

The variation in the force measurements was reduced slightly by the selection of peanuts the same age from pegging. Many of the properties evaluated were related to age and other were inter-related through age. The apparent difference between tag dates was attributed to different growing conditions and tagging late in the season. A single tag date, more harvest dates and controlled growing conditions were suggested for continued study and confirmation of these results.

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Table 1. Separation forces for two peanuts of equal moisture content and dry weight.

Moisture Content % w.b.	Dry Weight gms	Separation Force F_1 (Peanut-Peg) kg	Separation Force F_2 (Peg) kg
38.3	2.158	1.21	1.81
38.3	2.301	0.57	1.32

Table 2. Age in days and number of peanuts evaluated with respect to the harvest and tag dates.

Harvest Date	Tag Date 7/23	7/30	8/6	8/13
9/15	54(8)	47(8)	40(4)	33(4)
9/29	68(8)	61(8)	54(4)	47(4)
10/13	82(8)	75(8)	68*	61*
10/27	96(8)	89(8)	82*	75*

* These groups were not harvested.

Table 3A. Average physical and mechanical properties.

Harvest Date	Age (days)	Moisture Content % w.b.	Dry Matter gm	Force F_1 kg	F_2 kg	F_3 kg	F_4 kg
9/15	54	61.3	1.382	1.39	2.27	2.37	2.50
"	47	69.0	1.336	1.74	2.74	2.26	1.93
"	40	86.1	0.530	1.17	3.11	1.51	1.11
"	33	87.8	0.397	1.41	3.87	1.66	0.71
9/29	68	53.3	1.570	1.28	2.21	3.33	3.37
"	61	60.1	1.407	1.21	2.61	2.64	2.56
"	54	84.7	0.510	1.14	2.09	1.46	1.16
"	47	83.4	0.630	0.65	2.06	1.17	1.03
10/13	82	51.8	1.775	1.22	2.00	3.36	2.89
"	75	52.9	1.661	1.61	2.87	3.27	3.06
10/27	96	48.5	2.222	1.13	2.45	4.28	3.28
"	89	53.2	1.837	1.29	2.83	2.69	2.94

Table 3B. Average physical and mechanical properties.

Harvest Date	Peg Length A mm	Peg Length B mm	Peg Diameter D_3 mm	Peg Diameter D_4 mm	Pod Dimension Length mm	Perp. to Suture B mm	Perp. to Suture M mm	Perp. to Suture A mm	Par. to Suture A mm	Par. to Suture M mm	Par. to Suture B mm
9/15	53	24	1.81	1.91	31	14.6	12.9	14.9	13.6	14.9	14.2
"	61	32	1.92	2.02	34	15.7	13.1	15.3	14.0	14.7	15.5
"	81	32	2.16	2.17	30	15.0	13.9	15.2	14.6	14.9	15.0
"	109	30	2.20	2.24	31	14.3	12.9	13.3	12.9	13.6	14.1
9/29	49	32	2.14	2.13	29	14.0	12.7	13.6	13.2	13.7	13.5
"	48	31	2.14	2.17	30	14.2	12.7	14.4	13.7	14.7	14.8
"	76	27	2.33	2.28	29	14.1	12.3	13.1	12.6	13.1	14.6
"	84	30	2.45	2.19	32	14.3	13.1	15.1	14.1	14.9	14.6
10/13	48	31	1.93	1.87	33	14.2	11.7	13.8	12.8	13.7	13.9
"	47	24	2.10	2.11	30	14.4	12.7	14.4	13.5	13.7	13.6
10/27	56	35	1.79	1.87	32	15.7	14.0	15.1	14.8	16.4	15.4
"	54	34	1.89	2.02	31	15.9	14.3	15.1	15.1	16.1	16.3

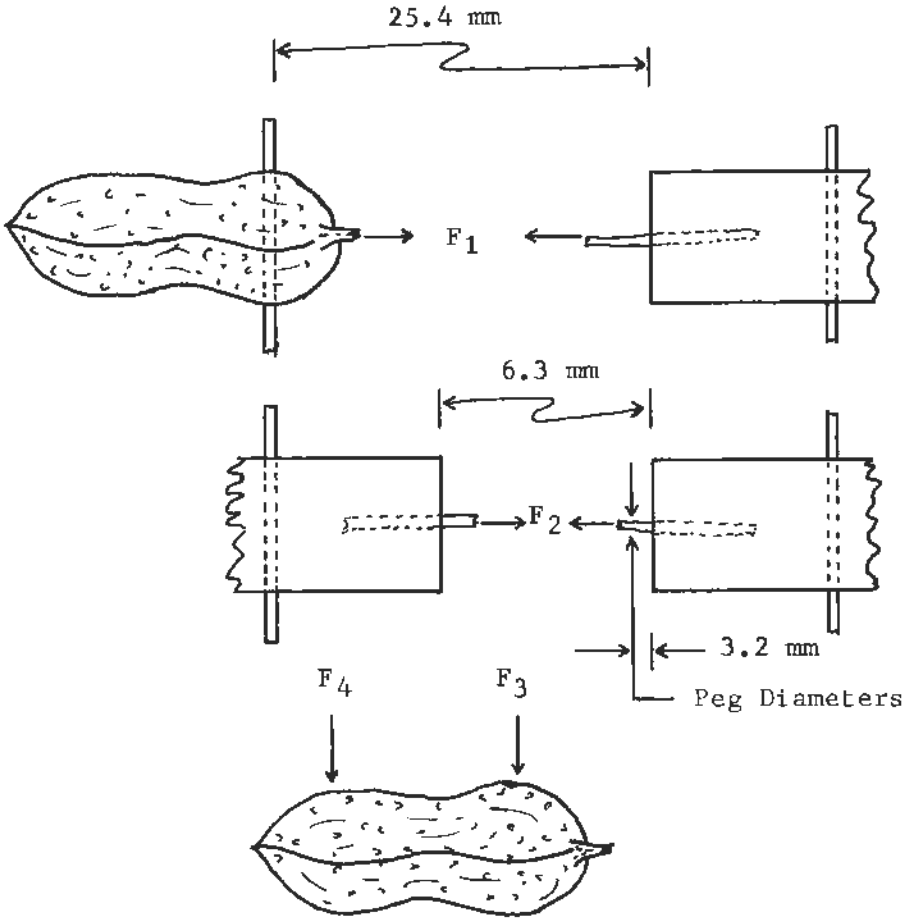


Figure 1. Illustration of certain physical and mechanical property determinations.

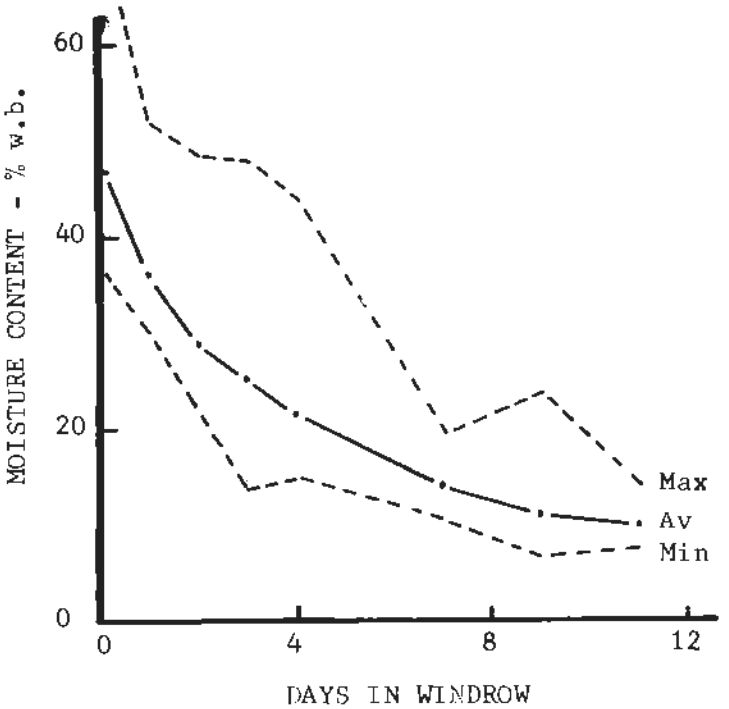


Figure 2. Peanut moisture content with days in the windrow.

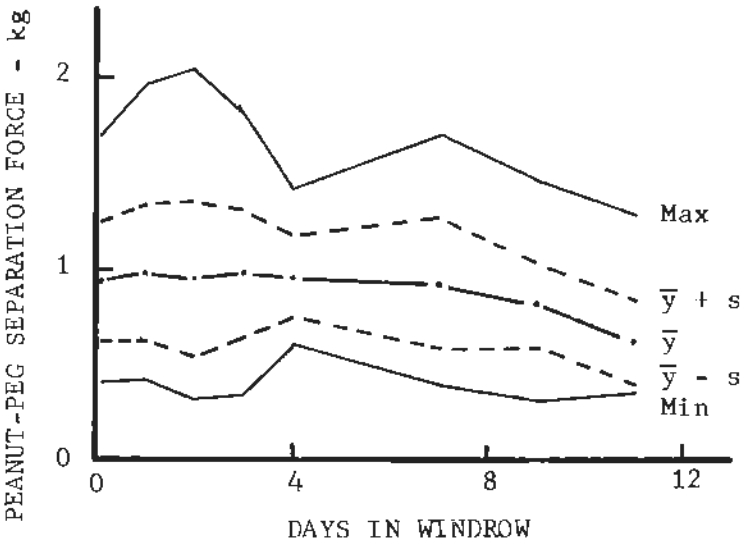


Figure 3. Peanut-peg separation force with days in the windrow.

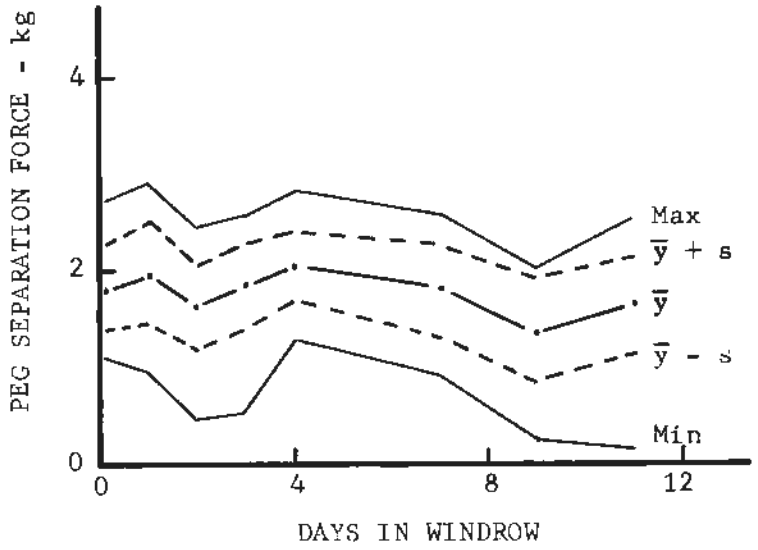


Figure 4. Peg separation force with days in the windrow.

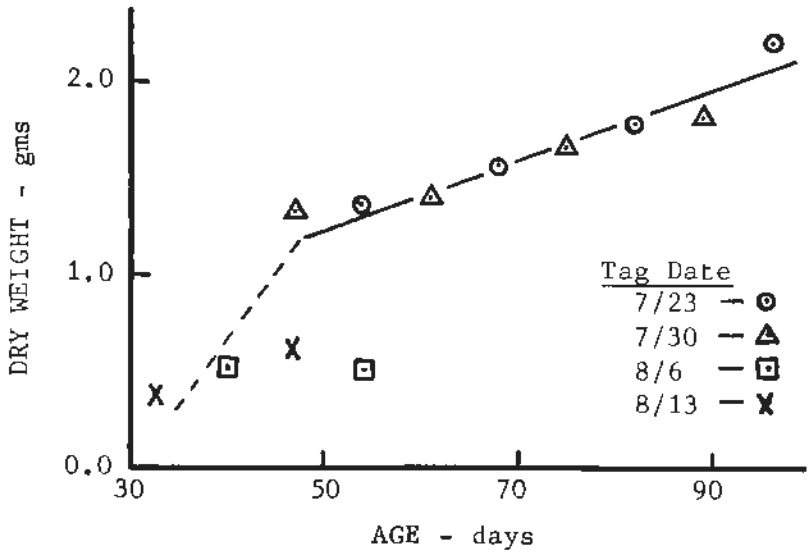


Figure 5. Average peanut dry weight with age.

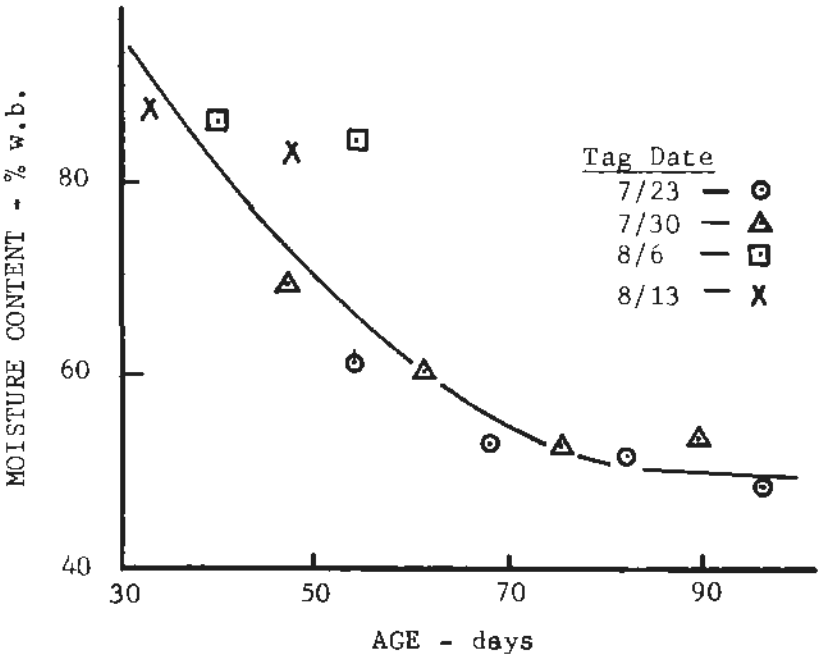


Figure 6. Average peanut moisture content with age.

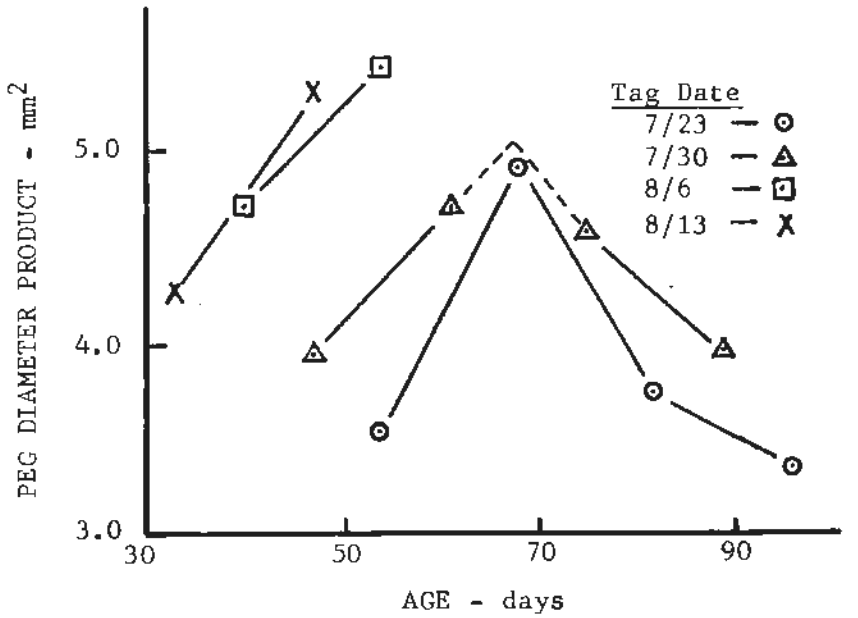


Figure 7. Average peg diameter product with age.

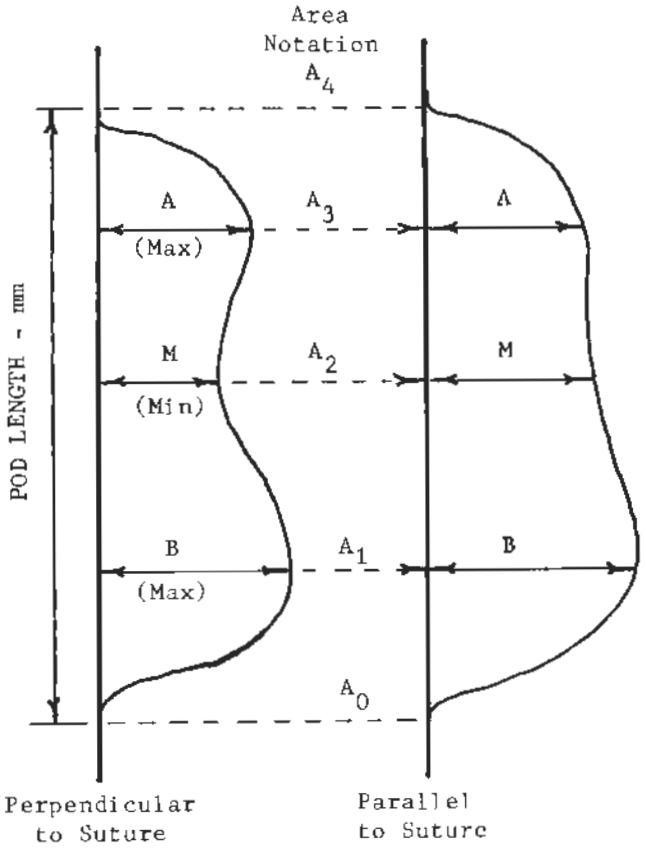


Figure 8. Typical pod profiles and selected data points for volume calculations.

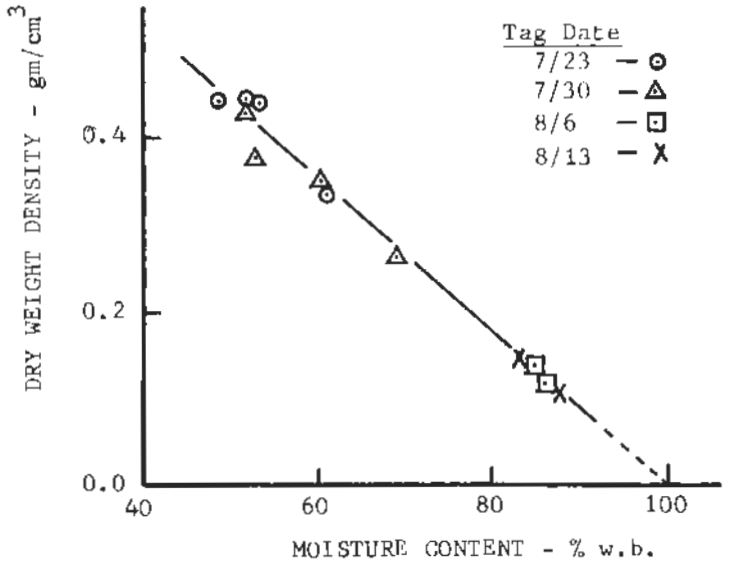


Figure 9. Dry weight density with moisture content during fruit development.

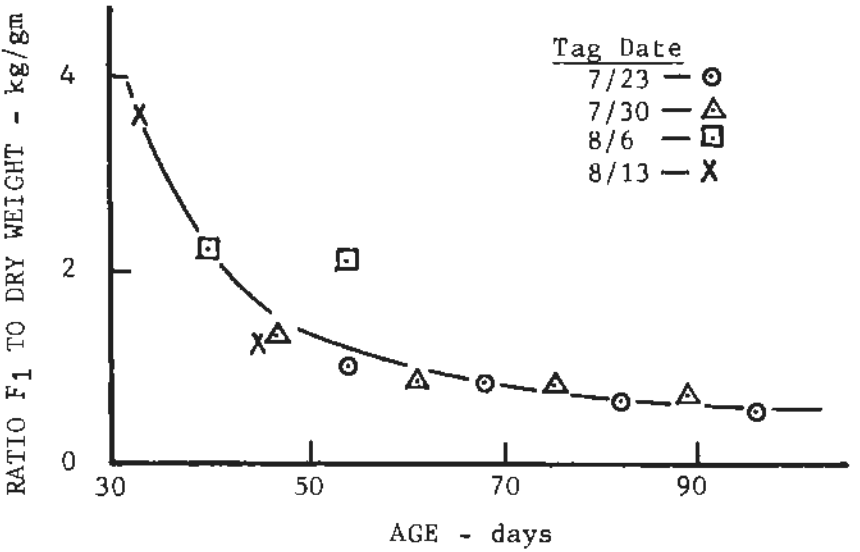


Figure 10. Average ratio of peanut-peg separation force to dry weight with age.

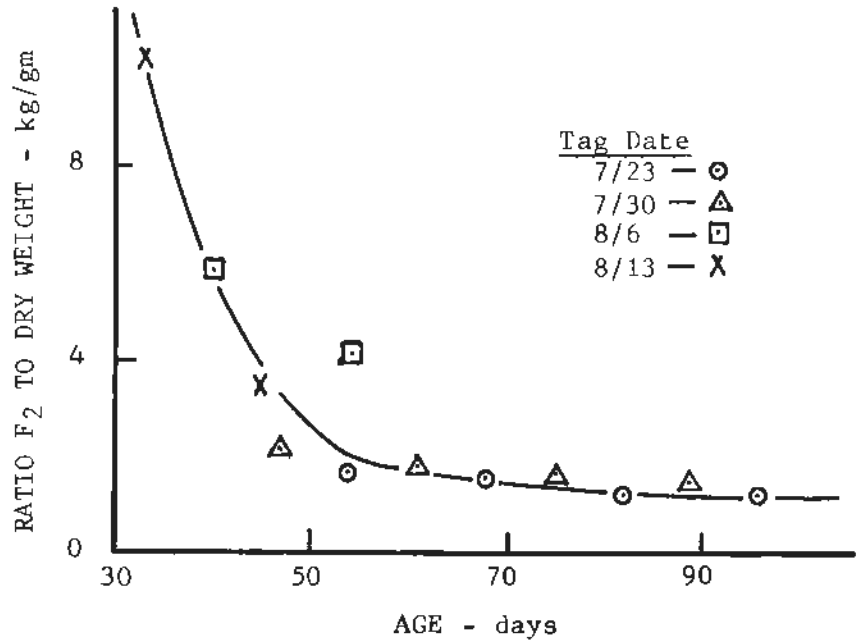


Figure 11. Average ratio of peg separation force to dry weight with age.

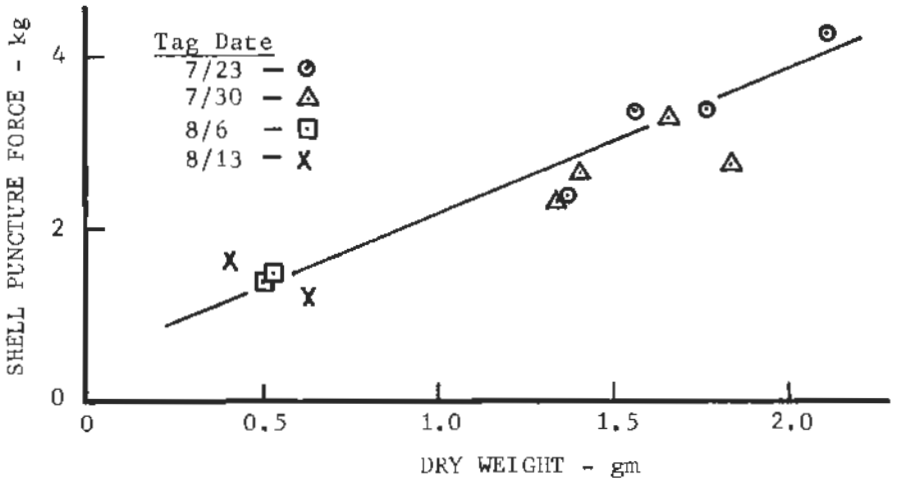


Figure 12. Average basal shell puncture force with peanut dry weight.

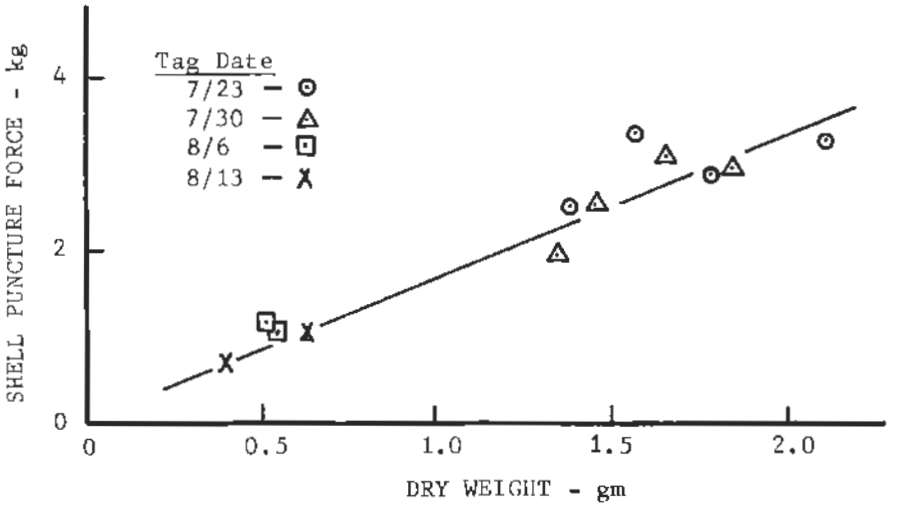


Figure 13. Average apical shell puncture force with peanut dry weight.

A PLOW-PLANT SYSTEM

James L. Shepherd, Head
Agricultural Engineering Department
University of Georgia Coastal Plain Experiment Station
Tifton, Georgia 31794

PAPER

Peanuts continue to give excellent yield response to mechanization research and development effort. The writer has culminated twenty-six fruitful years in this area with the development of a new-concept one-trip system of land turning, treating and planting. Results after two years studies with this system indicate very significant potential in benefits for the grower through adoption of the principles involved.

The following advantages are gained by this new approach to peanut planting: 1) Minimized requirements in labor and machines by combining all operations in: turning soil with mouldboard plow bottoms with concave discs for deep burial of organic residue; subsoiling behind tractor furrow-wheel; granulating and conditioning soil for maximum moisture preservation; applying all necessary chemical pesticides, liquid and/or granular, and by injection and/or incorporation; and planting in rows in numbers and patterns compatible with plow swaths. 2) Maximized yield potential through precise integrated application of the several necessary optimum treatments including: selective placement of seed, plant food and other control ingredients; uniform retention of good seedbed environment, with virtual elimination of problems of soil compaction from implement travel; and unprecedented yield potential from added soil surface area by a great reduction in necessary tractor wheel traffic.

Configurations of the 1971 and 1972 experimental prototype machines differed only in minor details. The first, employed a standard 4-bottom one-way mouldboard plow, planting two rows of 32-inch spacing; while the last tested unit employs a specially prepared 2-bottom plow with a 38-inch swath for one or more planters in providing optional row spacing patterns. Currently, peanuts which were successfully planted with the new system include all three basic types in modified 2-row and close 4-row, or twin, patterns. Also, cotton, corn, and soybeans were planted with comparable ease.

Merits of the several exclusive individual design features of the new system have previously been established in the Package Plan of mechanized peanut production. Assembly of these features into the composite once-over functional unit involves only two basically new elements; one, the modified mouldboard plow bottoms, each of which plows an unconventional 19-inch soil swath; and the concave disc coulters, consisting of a two-disc cantilever-mount companion unit for each plow bottom. The current availability of 18-inch mouldboard plow bottoms enhances the potential for further development of plow-plant systems in harmony with popular conventional production row patterns. Development of the double-disc coulter units is quite feasible, as existing single-disc units are of sufficient bearing strength to withstand the added disc load in soft soil. Double disc units require the same critical setting and adjustments, but are functionally superior to single-disc units for plow swaths above 16 inches.

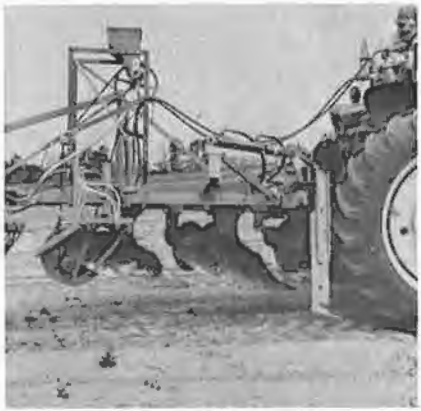
The integral-mount subsoiling chisel is hydraulically moved into position to break soil to a depth of 6 to 7 inches directly behind the furrow wheel of the

towing tractor. This places the advantageous chisel furrows directly beneath crop rows.

Soil granulation and conditioning is performed by torsion spring tines, which carry back-mounted tubes for injection of herbicides for control of nutsedge, etc. The tine action, with soil smoothing plate, also incorporates surface sprayed chemicals. Each plow bottom has a companion side-mount assembly of spring tines, and spraying, injecting and smoothing provisions.

Standard wheel drive planters are mounted for optional or single row patterns. The tool bar positions the planting, followed by preemergence herbicide spraying, directly upon the freshly prepared seedbed. The seedbed may have also received selectively placed granular systemic material from an applicator which is belt driven from the hub of the plow furrow wheel.

The complete technique of harvesting undisturbed plow-plant peanuts is considered feasible; and, barring unforeseen difficulty, new highs in peanut yield attainments are anticipated. This particularly applies to varieties which will not require implement traffic beyond wide-swath delivery of chemicals during the production period.



The Complete Plow-plant system. Left, shows exclusive features: the enlarged and modified mouldboard plow bottoms; the double concave disc coulters; the subsoiling chisel; torsion spring tine soil conditioning and injector units; the granular applicator, etc. Right, shows view of the entire system planting peanuts in "twin-twelve" row patterns; leaving only control of water requirements, diseases and insects to follow prior to harvest.

EFFECT OF CALCIUM SOURCES AND A FUNGICIDE ON PEANUT PRODUCTION [1/]

by

F. R. Cox [2/]

ABSTRACT

The response of peanuts to foliar applications of Magi-Cal, with and without fungicide, and to a complexed Ca material with a fungicide was studied at various rates of landplaster. Field experiments were conducted on four soils that differed in their soil Ca level (dilute acid extract). Yield and grade were measured and value determined. There was no response to the complexed Ca source but three types of responses due to Magi-Cal application were noted. The first was apparent only when no landplaster was applied, and it seemed that calcium from Magi-Cal and landplaster affected pod development similarly. The second type, which occurred at two locations, was a response to Magi-Cal only when no fungicide was used. The incidence of leafspot seemed to be decreased by this treatment also. The third type of response to Magi-Cal was independent of landplaster or fungicide treatment; it occurred on the site with the lowest soil calcium (380 lb/acre). Since applications of landplaster and fungicide are routine in this area, only the third type of response may be economically important. Also such responses may be encountered only at low soil calcium levels.

INTRODUCTION

The calcium supply in some North Carolina soils, even when adequately limed, is often insufficient for optimum economic peanut production. This condition primarily affects pod development. With inadequate Ca in the fruiting zone, pods either do not form or the kernel does not form inside the pod, making what is termed a "pop." Burkhart and Collins (1941) first showed this effect by isolating the fruiting from the rooting zone. At moderate soil calcium levels, kernels may sometimes form; but they are usually smaller. The final result is lower yield, fewer sound mature kernels (SMK), and fewer extra large kernels (ELK), and reduced value of the crop.

Since additional calcium is needed for fruit formation, the standard method to provide it has been to apply landplaster at early bloom, just prior to pegging. Recently, however, it has been postulated that certain calcium sources could be applied to the foliage to provide this calcium. From previous experiments, this did not seem likely. A greenhouse study conducted by the author also indicated that calcium applied to the foliage would not supply an adequate amount for pod development. Some observations in the field, however, have indicated a possible beneficial effect from calcium applied to the foliage. Such comparisons were often made between the yield with foliar-applied calcium and that with landplaster applied. Often there was little difference, but it was unknown if the landplaster had caused a yield increase or not because no check plots were included. Bracho et al. (1971) conducted field and greenhouse studies comparing foliar- and soil-applied calcium sources and included a valid check treatment. They found no response to landplaster or the foliar-applied calcium sources. The soils they used contained approximately 600 pounds of exchangeable Ca per acre. This is near the critical level indicated in the data presented by Colwell and Brady (1945), which may explain the lack of response.

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[2/] Associate Professor of Soil Science, North Carolina State University at Raleigh, North Carolina 27607.

The purpose of these studies was to determine if there is a beneficial effect of foliar-applied calcium on peanuts grown under several soil conditions and, if so, to determine how the effect may be modified by the landplaster or fungicide treatments commonly used.

METHODS

Four sites for field experiments in 1971 were selected so there would be a range in the soil calcium level. The level of soil calcium was used as the identifying number of each location. The soils were well drained and had a loamy sand texture in the surface horizon. Soil test data, varieties used and degree of leafspot infection are given in Table 1.

Table 1. Soil test analyses, dates of treatment application and digging, and the varieties used at the four locations.

Description	Location			
Experiment No.	380	610	720	880
Soil analyses[1/]				
Ca (lb/acre)	380	610	720	880
Mg (lb/acre)	24	24	84	53
K (lb/acre)	72	92	92	75
P (lb/acre)	72	108	103	120
O.M (%)	0.5	0.6	0.7	0.6
pH	5.6	5.9	6.0	5.9
Date of treatment				
Landplaster	6/29	6/29	6/28	6/29
Spray	7/1	7/1	7/7	7/1
	7/14	7/14	7/23	7/14
	7/28	7/28	7/30	7/27
	8/10	8/10	8/11	8/11
	8/23	8/23	8/24	8/24
	9/16	9/16	——	9/20
Date of digging	10/12	10/12	9/24	10/15
Variety	NC-2	NC-5	Flrgnt.	Flrgnt.
Incidence of leafspot on checks[2/]	Severe	Moderate	Slight	Severe

[1/] Conducted by the Soil Testing Division, N.C. Dept. Agr.

[2/] Ranking of susceptibility of varieties to leafspot: NC-2 = Least, NC-5 = middle, and Florigiant = most susceptible.

Five foliar spray treatments were imposed upon each of four landplaster rates (0, 200, 400, and 800 lb/acre) in a factorial arrangement. These included a check, calcium sulfate (Magi-Cal) 3/, fungicide (Fungi-Sperse), Magi-Cal plus Fungi-Sperse, and a complexed calcium material (SASE-Ca) plus Fungi-Sperse. The specifications of the materials used are given in Table 2.

Table 2. Description and total amount of calcium sources and fungicide applied to peanuts.

Material	Description	Total Applied (lb/acre)
Landplaster 1/	94% $CaSO_4$	0, 200, 400, 800
Magi-Cal 2/	8 lb $CaSO_4$/gal	48
Fungi-Sperse 2/	6 lb S and 0.5 lb basic $CuSO_4$/gal	39
Magi-Cal plus 2/ Fungi-Sperse	4.05 lb $CaSO_4$, 3 lb S, and 0.285 lb basic $CuSO_4$/gal	48 + 39
SASE-Ca 3/	1 lb Ca/gal, (equivalent to 3.4 lb $CaSO_4$/gal)	(14)

1/ U.S. Gypsum Company

2/ Standard Spray and Chemical Company

3/ Buckman Laboratories (sodium silicic ester sequestered)

Magi-Cal and Fungi-Sperse were applied at each date (5 or 6 times) listed in Table 1 at the rate of 1 gal of commercial material/acre for single materials and 2 gal/acre on the combination. The complexed calcium (SASE-Ca) was applied at 2 gal/acre on the first date and 1 gal./acre on the second and third dates. This treatment also received Fungi-Sperse on all spray dates. The materials were diluted with water and 20 gallons of solution per acre was applied with a knapsack sprayer having a single nozzle. Low pressure (15 psi) was used to minimize drift. Two passes were made on each row to give complete coverage.

Each experiment was composed of three replications, and individual plots were 2 rows (6 ft.) wide and 50 ft. long.

Growing conditions, temperature and rainfall, were generally favorable during the season up until harvest time. Heavy rains from Hurricane Ginger fell on September 30 and October 1. Location 720 was dug and combined prior to these rains so there were few peanuts lost in harvesting. At Location 380, the crop was dug after the hurricane and stacked, which also tended to minimize losses. However, above average rainfall continued throughout October which impeded harvesting and caused significant losses at Locations 610 and 880. It is assumed that these losses were proportional to the yields obtained. However, if peg strength is affected by treatment the results will be somewhat biased. After harvesting and curing, the peanuts from each plot were weighed and sampled for grading. Value per acre was computed from the yield, SMK and ELK. The effect of the treatments on each of the factors was then analyzed statistically.

3/ The use of trade names in this publication does not imply endorsement by the North Carolina Agricultural Experiment Station of the products named, nor criticism of similar ones not mentioned.

RESULTS

Yield and Value

Yield responses (Table 3) to increasing landplaster rate were noted at two of the four sites. At Location 610, a large response occurred with the application of 200 pounds of landplaster per acre, and no further yield increase was indicated as higher rates were applied. There was also an interaction between this effect and that due to Magi-Cal. When no landplaster was applied the application of Magi-Cal increased the yield 740 lb/acre, whereas with 200-800 lb. landplaster this difference was only 50 lb/acre.

Table 3. Main effects of calcium sources and a fungicide on peanut yield at four locations.

Material	Rate (lb/acre)	Location 380	610	720	880
		(lb/acre)			
Landplaster	0	3045	1988*	5077	2864
	200	3233	3259	4946	2977
	400	3095	3279	5225	2843
	800	3288	3115	5261	2938
	LSD (.05)	ns	238	238	ns
Fungi-Sperse (F)	0	2418	2642	4982*	1594*
	39	3814	3046	5213	3793
	LSD (.05)	272	188	188	190
Magi-Cal	0	2905	2733	5075	2536
	48	3327	2955	5119	2851
	LSD (.05)	272	188	ns	190
Magi-Cal + F	48 + 39	4004	3197	5132	3724
SASK-Ca + F	14 + 39	3363	3176	5248	3754
	LSD (.05)	385	ns	ns	ns

*There was an interaction between this response and that due to Magi-Cal. The effect was greatest when other factor was not applied.

The effect of landplaster rate noted at Location 720 was erratic and generally small. The yield from the 200 lb/acre treatment was less than that from the 400 or 800 lb/acre treatment.

Application of the fungicide increased the yield at all locations, with the effect being greater when no Magi-Cal was applied at Locations 720 and 880 (Table 4). At the latter site a similar response to Magi-Cal was noted with respect to the fungicide, and as mentioned before, at Location 610 Magi-Cal treatment increased the yield only when no landplaster was applied. At one location (380) the application of Magi-Cal increased the yield, and the nature of this increase was not significantly influenced by any other treatment effect. Also at this site the yield from the Magi-Cal treatment was greater than that due to

the SASE-Ca.

The value of the crop was computed from the grade and yield data and analyzed for treatment effects. Significant responses for treatments as they affected crop value were almost identical to those presented for yield so will not be itemized.

Table 4. Interaction of foliar-applied $CaSO_4$ and a fungicide on peanut yields at two locations.

Treatment		Location			
		720		880	
Magi-Cal (lb/acre)		0	48	0	48
		(lb/acre)			
Fungi-Sperse (lb/acre)	0	4858	5107	1209	1979
	39	5294	5132	3863	3724
LSD (.05)		266		269	

Percent Sound Mature Kernels

Percentage SMK was affected only by the fungicide treatment at Location 880 (880 lb. dilute acid extractable Ca/acre), as shown in Table 5. However percent SMK increased only with increasing landplaster rate at Locations 380 and 720. A similar but more striking response to landplaster was found at Location 610, as well as increases in % SMK due to the application of Fungi-Sperse and Magi-Cal.

An interaction occurred between the landplaster and Magi-Cal rate effects at location 610. There was a response to Magi-Cal only when no landplaster was applied. With no $CaSO_4$ the SMK was 39.6% whereas it was 48.9% when the 48 lb. rate of Magi-Cal per acre was applied. When 200 lb $CaSO_4$ as landplaster or 248 lb. as landplaster plus Magi-Cal was applied the SMK was 69.4 and 69.3%, respectively.

One other difference in % SMK due to treatments was found at Location 610. The % SMK was greater when the crop was treated with Magi-Cal rather than the SASE-Ca. Both treatments also received the fungicide.

Percent Extra Large Kernels

Treatment effects were also shown on % ELK (Table 6). While increasing the landplaster rate had no effect on % ELK at Locations 380 and 720, the percentage was increased considerably at Location 610 with the first 200 lb/acre increment of landplaster and tended to decrease at Location 880 when 400 or 800 pounds were applied.

Applying the fungicide increased the % ELK at all locations except 720, with the effect at Location 880 being greater when no Magi-Cal was applied. The Magi-Cal treatment did not affect the percentage ELK. In one case (380) the Magi-Cal treatment gave a higher % ELK than the SASE-Ca treatment.

Table 5. Main effects of calcium sources and a fungicide on percentage of sound mature kernels at four locations.

Material	Rate (lb/acre)	Location 380	610	720	880
		SMK (%)			
Landplaster	0	74.4	44.2*	71.2	72.2
	200	77.0	69.3	71.9	72.6
	400	76.1	70.5	72.2	71.7
	800	77.8	72.1	71.8	72.5
	LSD (.05)	1.9	3.1	0.5	ns
Fungi-Sperse (F)	0	76.4	63.0	71.7	70.8
	39	76.3	65.6	71.8	73.3
	LSD (.05)	ns	2.4	ns	1.3
Magi-Cal	0	76.3	62.8	71.5	71.6
	48	76.5	65.8	72.0	72.5
	LSD (.05)	ns	2.4	ns	ns
Magi-Cal + F	48 + 39	76.2	66.7	72.2	73.3
SASE-Ca + F	14 + 39	76.1	63.1	71.8	73.2
	LSD (.05)	ns	3.5	ns	ns

* There was an interaction between this response and that due to Magi-Cal. The effect was greatest when other factor was not applied.

DISCUSSION

In these studies primary consideration was given to determining if foliar-applied calcium materials would increase the value of the crop and, if so, the nature of the response. Responses were obtained due to the Magi-Cal treatment, but the nature of this response differed with location. At the site with the lowest soil calcium level the Magi-Cal application resulted in a 400 lb/acre increase in yield regardless of landplaster or fungicide treatment. Thus, the nature of the response at this location cannot be related to either of these factors.

At Location 610 the role of Magi-Cal in increasing the yield and grade seems to be simply that of supplying a small amount of $CaSO_4$. The sharp response in yield and SMK due to $CaSO_4$ applied as landplaster indicates that pod development was enhanced by additional calcium. The response due to Magi-Cal appeared to have a similar effect on yield and SMK and the point from the Magi-Cal treatment fits well into the $CaSO_4$ response curve (Figure 1). This indicates that much of the $CaSO_4$ from Magi-Cal must have reached the fruiting zone in order to be effective in this manner.

Table 6. Main effects of calcium sources and a fungicide on percentage of extra large kernels at four locations.

Material	Rate (lb/acre)	Location			
		380	610	720	880
		ELK(%)			
Landplaster	0	38.8	21.2	40.4	37.7
	200	42.9	37.1	42.1	38.9
	400	40.5	37.3	41.8	34.6
	800	41.5	37.4	40.5	35.8
	LSD (.05)	ns	2.6	ns	2.4
Fungi-Sperse (F)	0	38.0	32.1	40.7	30.1*
	39	44.2	34.8	41.6	41.2
	LSD (.05)	3.0	2.1	ns	1.9
Magi-Cal	0	40.5	32.6	41.3	35.2
	48	41.7	34.3	41.1	36.2
	LSD (.05)	ns	ns	ns	ns
Magi-Cal + F	48 + 39	45.3	35.0	41.1	40.4
SASE-Ca + F	14 + 39	40.4	32.7	41.4	40.9
	LSD (.05)	4.3	ns	ns	ns

* There was an interaction between this response and that due to Magi-Cal. The effect was greatest when other factor was not applied.

Response to Magi-Cal at Locations 720 and 880 occurred only when no fungicide was used. Visual observations during the growing season also indicated that the Magi-Cal treatment decreased the incidence of leafspot. To be effective in this manner the treatment could be either fungicidal or fungistatic, or both. When leafspot was severe as at location 880, however, Magi-Cal was much less effective in increasing yields than was Fungi-Sperse. Whereas the application of Magi-Cal increased the yield 770 lb/acre, the application of Fungi-Sperse increased it 2650 lb/acre.

In these experiments when the usual landplaster and fungicide treatments were imposed, Magi-Cal application increased the yield at only one location. This site, with the lowest soil calcium level (380 lb/acre) exhibited no response to landplaster, which is quite unusual as far as this author is concerned. It has been inferred (Colwell and Brady, 1945) that climatic factors may affect the response due to landplaster. Seasonal conditions may also affect foliar calcium concentrations. Thus, both soil and climatic factors may be involved in determining when foliar-applied calcium will give a yield response.

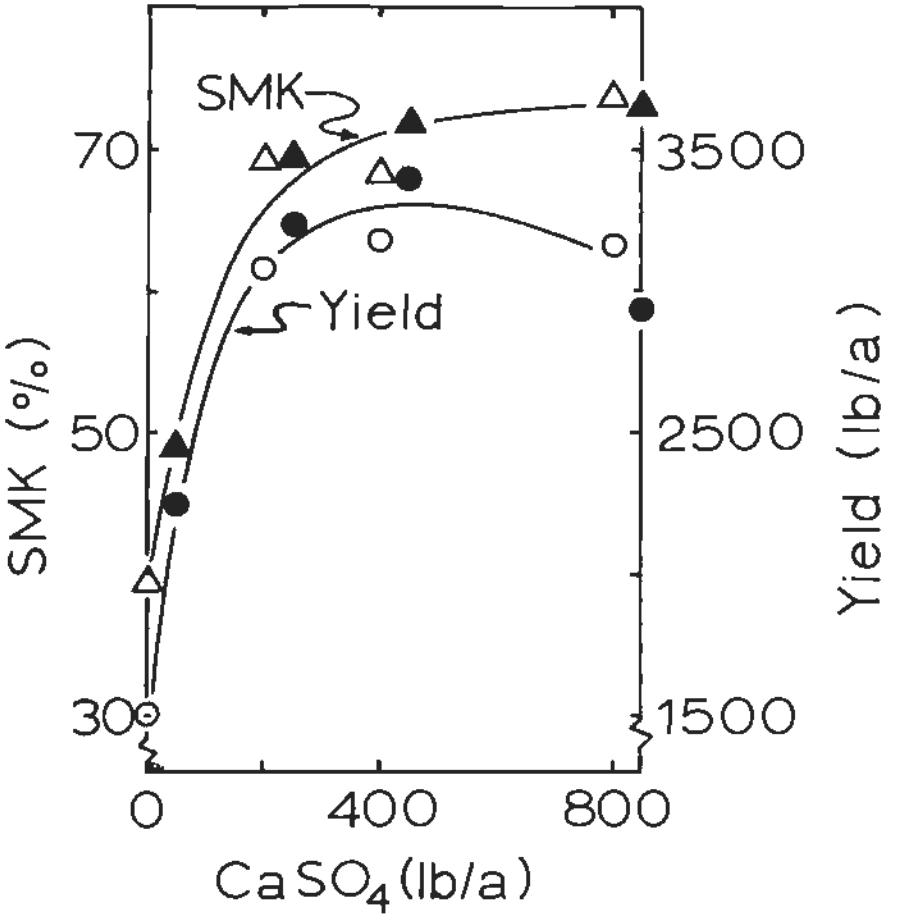

Figure 1. Effect of rate of $CaSO_4$ applied as landplaster with (solid points) and without (open points) Magi-Cal on the percentage SMK and yield of peanuts produced at Location 610.

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COMPARATIVE NUTRIENT COMPOSITION OF LATERAL VERSUS CENTRAL BRANCH LEAVES OF 10 VIRGINIA VARIETY PEANUT LINES AND CULTIVARS

D. L. Hallock, D. C. Martens and P. H. van Schaik
Associate Professors of Agronomy
Agronomy Department, Virginia Polytechnic Institute & State University
Holland and Blacksburg, Virginia 24061
and Agronomist
Agricultural Research Service, U. S. Department of Agriculture
Tidewater Research and Continuing Education Center
Holland, Virginia 23391

ABSTRACT

Eight large-seeded and two small-seeded Virginia variety peanut (Arachis hypogaea L.) cultivars or lines were field grown in highly fertilized Woodstown loamy fine sand at Holland, Virginia during 1970 and 1971. Leaves of the upper central stems and also of the principal lateral branches were sampled at three stages of development and divided into blade and petiole portions. These leaf segments were analyzed for contents of eight nutrients to determine relative uptake among cultivars.

Highest average (all segments) contents of P, K, Zn and Cu were found in the July 13 samples, Mg in the August 10, and Ca and Mn in the September 14 samples. The July and August samples contained equivalent B. The blade portion of upper central stem leaves was highest in contents of Ca, B, and Mn and the petiole portion was highest in K and Mg when average values for all cultivars and optimum (highest content) sampling dates are considered. The principal lateral blades were highest in average P content. Zinc and Cu contents were similar in all portions for optimum sampling dates.

'Florunner' was highest in contents of Mg and B; 'Early Runner' was highest in Mn and Zn; and 'Va. 61R', 'Va. 72R', 'NC Acc. 15714', and 'F-392-1' were highest in contents of P, K, Ca, and Cu, respectively.

The relatively high Mg content of Florunner main stem petioles, and also the Mn contents of the main stem leaf blades and to a lesser extent the lateral branch blades of Early Runner, NC Acc. 15714, Va. 72R, and 61R, were especially noteworthy. The Mg and Mn requirements of these cultivars may warrant special attention.

INTRODUCTION

Many recently released peanut (Arachis hypogae L.) cultivars have demonstrated superior yield capability. It seems reasonable to postulate that part of this increased yield potential may be related to improved nutrient uptake and utilization efficiency. Also, these higher yielding cultivars and new lines being developed may possess higher nutrient uptake potentials than older lower yielding cultivars. Identification of these attributes could have genetic as well as nutrition significance.

Recently, Nicholaides and Cox (10) noted that nutrient levels which produced plant tops having 0.38% P at 7 weeks, and 1.20% Ca and 0.60% Mg at 9 weeks promoted more rapid development of 'NC 2' than when lower contents of P and Mg or higher contents of Ca occurred. Hallock, et al. (4,5), Martens, et al. (7), Cox, et al. (2), and Rich (12) have investigated macro-and micronutrient distribution within plants of several cultivars and lines of three market types of peanuts. Some of the research (4,5,7) involved production of peanuts on highly fertilized soil. No definite relationship between the yield levels of cultivars or lines and nutrient content of the portions analyzed was apparent in these studies.

It may be necessary to sample plants during several growth stages among cultivars and lines to discern nutrient uptake differentials. Burkhart and Page

(1) sampled the foliage of a large seeded Virginia bunch cultivar at the vegetative, early fruiting and mature stages. They found that average K, Ca, and Mg contents were highest in the top petioles, middle or lower blades and lower petioles, respectively. Phosphorus contents were similar in the various plant tissues analyzed.

This paper presents the average contents of eight nutrients found at three stages of growth in specific leaf parts of 10 peanut cultivars or lines grown in heavily fertilized soil. Complementary investigations are being conducted with the same cultivars and lines in continuously cropped containers filled with unfertilized soil. The investigations reviewed herein are part of a project to discern differences in nutrient uptake potentials and requirements among eight Virginia and two runner market type peanut cultivars and lines showing superior yield capability.

EXPERIMENTAL PROCEDURE

This study was conducted at the Tidewater Research Station, Holland, Va. in 1970 and 1971. Peanuts were grown on a Woodstown loamy fine sand, which is classified as Aquic Hapludults (fine loamy, siliceous mesic), one of the principal soils on which peanuts are grown in the Coastal Plain of Virginia. Phosphorus, K, B, Mn, Zn, and Cu at rates of 133, 500, 5, 15, 5, and 5 lb/a, respectively were broadcast and plowed under prior to planting. Other land preparation procedures followed Virginia recommendations. Corn preceded peanuts in the rotation each year.

Thiram treated seeds of the cultivars and lines (shown in Table 3) were machine planted on May 13 and 24, 1970 and 1971 respectively, in rows 3-feet apart and to give 5-inch plant spacings within the rows. Virginia recommendations were followed for use of various pesticides as described previously (5). No gypsum or Cu-S fungicides were applied. Growth and development of the plants appeared normal.

Each plot represented a different peanut cultivar or line. The plots were 12 feet wide (4 rows) and 15 feet long, and were arranged in a randomized complete block design replicated four times. Foliar samples were taken at full flowering, early fruit development and near maturity growth stages. The principle lower lateral branches and the upper main stem branch were sampled from 10 or more plants per plot. After thorough washing in distilled and deionized water, the leaves of these branches were removed and separated into blades and petioles. The samples were dried at 70C and finely ground in a blendor and/or small mill, both stainless steel, and then stored in soft glass or plastic bottles. The foliage was sampled at full flowering, early fruit development, and near maturation stages of peanut development.

Dry (70C) 1-g subsamples of leaf tissue were ashed at 450C for 2.5 hours and the nutrient constituents of the ash dissolved in 100 ml of 0.3N HNO_3. Contents of K, Ca, and Mg in solution were determined by flame spectrophotometry and P contents by the ammonium vanadate procedure (6). Another 1-g subsample of dry leaf tissue was ashed at 450C for 2 hours in preparation for Mn, Zn, and Cu determinations. The ash was shaken for 1 hour with 15 ml of 6N HCl and filtered. The filtrate was dried and the resulting precipitate dissolved in 15 ml of 0.5N HCl. Contents of Mn, Zn, and Cu in the acidic solution were determined by atomic absorption spectrophotometry. Total B in the dry tissue was determined by a curcumim procedure (9).

Soil samples, obtained from the plow layer when the peanuts were harvested in 1970 and in July 1971, were analyzed for pH, and contents of organic matter and available P, K, Ca, and Mg by rapid soil-testing procedures (11). Contents of Cu, Mn, and Zn were extracted by shaking 5 g of soil with 50 ml of 0.1N HCl for 1 hour. A 25-ml aliquot of the acidic solution was dried on a steam plate, and the resulting precipitate was dissolved in 15 ml of 0.5N HCl and filtered. Nutrient concentrations were determined by an atomic absorption technique. Hot water soluble B extracted by refluxing 10 g of soil for 10 min. with 20 ml of deionized water was determined by a curcumim procedure (9).

Statistical methodology utilized were analyses of variance and Duncan's Multiple Range Test (3). Nutrient content means labeled by all unlike letters are

significantly different at the 5% level, however, many differ at the 1% level of probability.

Yields of the cultivars and lines considered in this paper were obtained in 1970, only. The relative yield capabilities of these lines and cultivars under Virginia conditions were projected from these 1970 data, other unpublished data*, and data published by Mozingo (8). The projections are as follows (in decreasing order): 'Florunner', 'Florigiant', 'NC Acc. 15714', 'Virginia 72R', 'Early Runner', 'NC 5', 'NC 17', 'F392-1', 'Virginia 61R', and 'NC Acc. 366'. The first four will be called superior yield potential (SYP) cultivars in this paper. Relative differences in yield potential among the latter 3 or 4 cultivars and lines are probably small.

RESULTS

The nutrient content data presented in this paper are averages of two year's results. The data for individual years are not discussed since the variability between each year is principally one of nutrient content. Differences in relative nutrient concentration among the leaf segments and/or among the sampling dates during the two years were similar.

Weather - Soil Analyses

The monthly total precipitation and mean air temperatures which occurred during the 1970 and 1971 growth periods and the 39-year means for Holland, Va., are given in Table 1. Rainfall was appreciably subnormal during the early and late parts of the 1970 growing season, but was normal during the period of fruit initiation and early development. Early vine growth was slightly below normal possibly due to low precipitation during June. Rainfall distribution during the 1971 growing season was generally excellent, although June and July were slightly deficient. Air temperatures during both years were approximately normal. Generally, excellent vine and fruit development occurred.

Table 1. Monthly total precipitation and mean temperatures* and 39-year means of each for Holland, Va., 1970 and 1971.

Month	Precipitation			Temperature		
	1970	1971	39-yr. Mean	1970	1971	39-yr. Mean
	in.	in.	in.	°F	°F	°F
May	2.61	4.86	3.54	68	64	66
June	1.58	2.55	4.58	74	75	74
July	6.24	4.10	6.23	77	77	77
August	4.94	9.12	6.36	76	75	76
September	1.72	4.67	4.15	74	72	71

*/ Average of means of daily maximum and minimum temperature.

Macro and micro nutrient levels in the plow layer following cropping in 1970 and in July 1971 are given in Table 2. Nutrient levels in the soil generally were quite high and no visnal deficiency symptoms occurred in the crops.

Table 2. Soil Analyses of Plow Layer of Woodstown Loamy Fine Sand, Holland, Va., 1970 and 1971.

Chemical Property	Value	
	1970	1971
pH	5.7	5.5
Organic matter content, %	2.3	2.1
Available P, lb./a	105	110
Available K, lb./a	245	275
Available Ca, lb./a	1035	940
Available Mg, lb./a	120	145
0.1N HCl-extr. Cu, ppm	0.9	1.6
0.1N HCl-ext. Mn, ppm	5.4	6.0
0.1N HCl-ext. Zn, ppm	1.3	1.6
Hot water soluble B, ppm	0.5	0.3

*/ P. H. van Schaik. Recent cultivar and line yield trials, Holland, Va.

P Contents

The average (1970-71) P contents of the petioles and blades of principal lateral branch and upper main stem peanut leaves are given in Table 3. Phosphorus contents varied from 0.31% to 0.09% depending on time of sampling and the portion of leaf sampled. The P content of peanut foliage generally decreases considerably with maturation, as is evident in these data. The blades were considerably higher in P than the petioles. Also, the principal lateral branch segments were higher in P content than the respective main stem leaf segments. A greater relative decrease in P content with maturity occurred in the principal lateral branch than in the upper main stem segments (ca 1/2 vs 1/3).

The average variability in P contents of leaf petioles and blades among varieties was consistent, although small. The apparent superior yield potential (SYP) cultivars were generally intermediate in P content, although the average P content of Va. 72R leaf portions was higher than most. NC 17 averaged lowest in percent P overall variables.

K Contents

Potassium contents (Table 4) of the leaf segments varied from over 6% to 1.2%. The petioles were considerably higher in percent K than the blades. Furthermore, the upper main stem petioles were higher in percent K than the lateral branch petioles when sampled in July but the reverse occurred in later samplings. The contents of all segments except that in the lateral branch petioles decreased with maturity. However, the relative decrease in K content of the lateral branch blades with maturity was considerably less than occurred in the upper main stem petioles.

The overall mean K content of the leaf segments varied from 3.88% to 3.44% among cultivars. One of the SYP cultivars, Va. 72R, was highest in % K, whereas the others were intermediate. NC 17, Va. 61R, and NC 5 cultivars also averaged relatively high in percent K. Early Runner, NC Acc. 366 and F392-1 were generally lowest in K content.

There were differences in percent K of petioles at various samplings among cultivars. Va. 72R and Florigiant lateral branch petioles were higher in percent K than the upper main stem petioles in the July sampling, whereas the opposite was true for other cultivars and lines. There was considerable variability among cultivars and lines in K contents of leaf segments for the various dates of sampling. However, the K content of Va. 72R was highest or nearly so in leaf segments and for sampling dates when the K contents generally averaged higher over all cultivars. The K content of the blade portion was highest in NC 17 for all three samplings.

Ca Contents

Calcium content (Table 5) varied from 2.9 in certain blades of nearly mature plants to 1.1% in petioles of heavily flowering plants. In contrast to P and K contents of leaf tissue, percent Ca increased as the plants matured.

In the July sampling, percent Ca in the blade portion generally was higher than in the petioles and the upper main stem leaf segments were higher in percent Ca than for respective lateral branch segments. However, as the plants matured, percent Ca in petioles on the upper main stem generally became higher than that in the blades of principal lateral branches. This change in site of Ca concentration took place between the July and August samplings.

The variation in overall mean Ca content was only from 1.93% (NC Acc. 15714) to 1.69% (Florigiant). Greatest Ca content variability among cultivar and lines (0.67%) occurred in the blades of upper main stem leaves sampled in September; least variability was in the lateral branch petioles sampled in July. Among the SYP cultivars and lines, NC Acc. 15714 and Va. 72R generally were highest or nearly so in % Ca in the various leaf segments and dates of sampling, whereas Florigiant was frequently lowest and Florunner was intermediate.

Table 3. Average Phosphorus Content (%) of Certain Peanut Leaf Segments, Holland, Va., 1970-71.

Date of Sampling	NC 17	NC ACC. 15714	Va. 72R	Flo-Runner	Florigiant	NC ACC. 366	Va. 61R	F 392-1	Early Runner	NC 5	Mean all Cultivars
					PETIOLES OF PRINCIPAL LATERAL BRANCH LEAVES						
Jul 13	0.18	0.20	0.22	0.22	0.21	0.22	0.22	0.20	0.21	0.22	0.21c_1*
Aug 10	0.14	0.12	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.12	0.14c_2
Sep 14	0.09	0.12	0.12	0.11	0.11	0.12	0.13	0.11	0.11	0.10	0.11b_3
Ave	0.14	0.15	0.16	0.16	0.15	0.16	0.16	0.14	0.16	0.15	0.15c_4
					PETIOLES OF UPPER MAIN STEM LEAVES						
Jul 13	0.16	0.21	0.20	0.18	0.18	0.20	0.20	0.18	0.18	0.18	0.19d_1
Aug 10	0.10	0.12	0.12	0.12	0.12	0.12	0.12	0.10	0.12	0.11	0.11d_2
Sep 14	0.09	0.11	0.10	0.11	0.12	0.12	0.10	0.10	0.12	0.10	0.11b_3
Ave	0.12	0.14	0.14	0.14	0.14	0.14	0.14	0.12	0.14	0.13	0.14d_4
					BLADES OF PRINCIPAL LATERAL BRANCH LEAVES						
Jul 13	0.28	0.22	0.28	0.28	0.28	0.30	0.31	0.26	0.24	0.28	0.28a_1
Aug 10	0.22	0.22	0.24	0.20	0.22	0.24	0.23	0.22	0.21	0.24	0.22a_2
Sep 14	0.17	0.18	0.20	0.18	0.18	0.18	0.19	0.19	0.18	0.19	0.19a_3
Ave	0.22	0.20	0.24	0.22	0.23	0.24	0.24	0.24	0.21	0.24	0.23a_4
					BLADES OF UPPER MAIN STEM LEAVES						
Jul 13	0.26	0.26	0.27	0.24	0.25	0.28	0.26	0.24	0.24	0.27	0.26b_1
Aug 10	0.20	0.20	0.21	0.20	0.20	0.20	0.20	0.19	0.19	0.20	0.20b_2
Sep 14	0.18	0.19	0.20	0.18	0.20	0.18	0.18	0.18	0.18	0.18	0.19a_3
Ave	0.21	0.22	0.22	0.20	0.22	0.22	0.22	0.21	0.20	0.22	0.21b_4
					MEANS - OVERALL						
Jul 13	0.22	0.22	0.24	0.22	0.23	0.24	0.24	0.22	0.22	0.24	0.23a_5
Aug 10	0.16	0.16	0.17	0.16	0.16	0.17	0.18	0.16	0.16	0.17	0.17b_5
Sep 14	0.13	0.14	0.16	0.14	0.16	0.15	0.15	0.14	0.14	0.14	0.15c_5
Ave	0.172C	0.180BC	0.191A	0.181BC	0.184AB	0.191A	0.192A	0.178BC	0.180BC	0.183AB	0.18

*/ Means are significantly different when labeled by all unlike letters. Compare means followed by small letters with similar subscripts.

Table 4. Average Potassium Content (%) of Certain Peanut Leaf Segments, Holland, Va., 1970-71.

Date of Sampling	NC 17	NC ACC. 15714	Va. 72R	Flo-Runner	Flori-giant	NC Acc. 366	Va. 61R	F 392-1	Early Runner	NC 5	Mean all Cultivars
PETIOLES OF PRINCIPAL LATERAL BRANCH LEAVES											
Jul 13	4.94	4.94	6.01	5.00	5.90	4.47	5.28	4.68	4.34	4.96	5.06b_1*
Aug 10	5.02	5.09	5.61	5.15	5.18	4.60	5.52	5.19	4.98	5.54	5.18a_2
Sep 14	5.19	5.12	5.70	5.52	5.14	4.61	5.82	5.06	5.00	5.32	5.24a_3
Ave	5.06a	5.05a	5.77a	5.22a	5.40a	4.56a	5.54a	4.98a	4.77a	5.27a	5.16a_4
PETIOLES OF UPPER MAIN STEM LEAVES											
Jul 13	5.78	5.69	5.66	5.42	5.58	5.44	5.38	5.68	5.26	5.96	5.58a_1
Aug 10	4.62	4.97	5.50	4.69	5.38	4.68	5.06	4.61	5.19	5.24	4.99a_2
Sep 14	3.33	3.37	3.90	2.96	3.58	3.52	3.74	3.14	3.26	3.67	3.45b_3
Ave	4.51b	4.68b	5.02b	4.36b	4.84b	4.55a	4.72b	4.47b	4.59a	4.96b	4.67b_4
BLADES OF PRINCIPAL LATERAL BRANCH LEAVES											
Jul 13	3.21	2.80	2.88	2.84	2.86	2.88	2.80	2.88	2.88	2.74	2.88c_1
Aug 10	2.66	2.31	2.40	2.52	2.28	2.43	2.52	2.29	2.48	2.38	2.43b_2
Sep 14	2.56	2.15	2.52	2.30	2.10	2.44	2.50	2.07	2.35	2.52	2.35c_3
Ave	2.81c	2.42c	2.60c	2.55c	2.42c	2.58b	2.61c	2.41c	2.57b	2.55c	2.55c_4
BLADES OF UPPER MAIN STEM LEAVES											
Jul 13	3.16	2.78	2.74	2.60	2.64	2.68	2.76	2.66	2.58	2.73	2.73d_1
Aug 10	2.42	1.86	2.00	2.04	2.01	2.05	2.03	1.80	1.84	2.02	2.01c_2
Sep 14	1.82	1.61	1.67	1.42	1.44	1.78	1.50	1.20	1.46	1.58	1.55d_3
Ave	2.47d	2.80d	2.14d	2.01d	2.03d	2.17c	2.10d	1.89d	1.96c	2.11d	2.10d_4
MEANS - OVERALL											
Jul 13	4.27A	4.05A	4.32A	3.96A	4.24A	3.87A	4.06A	3.98A	3.76A	4.10A	4.06a_5
Aug 10	3.68B	3.56B	3.88B	3.60B	3.71B	3.44B	3.78B	3.47B	3.62A	3.80B	3.65b_5
Sep 14	3.23C	3.06C	3.45C	3.05C	3.07C	3.09C	3.39C	2.87C	3.02B	3.28C	3.15c_5
Ave	3.74AB	3.56CD	3.88A	3.54CD	3.67BC	3.47D	3.74AB	3.44D	3.47D	3.72AB	3.62

*/ Means are significantly different when followed by all unlike letters. Compare means followed by small letters with similer subscripts and without subscripts within varieties, only.

Table 5. Average Calcium Content (%) of Certain Peanut Leaf Segments, Holland, Va., 1970-71.

Date of Sampling	NC 17	NC ACC. 15714	Va. 72R	Flo-Runner	Flori-giant	NC ACC. 366	Va. 61R	F 392-1	Early Runner	NC 5	Mean all Cultivars
					PETIOLES OF PRINCIPAL LATERAL BRANCH LEAVES						
Jul 13	1.10	1.18	1.22	1.10	1.10	1.15	1.10	1.11	1.22	1.26	$1.15d_1$*
Aug 10	1.24	1.50	1.28	1.24	1.18	1.43	1.46	1.25	1.36	1.52	$1.35d_2$
Sep 14	1.69	1.80	1.65	1.64	1.50	1.60	1.48	1.74	1.64	1.54	$1.63d_3$
Ave	1.34d	1.49c	1.38d	1.33d	1.26c	1.40c	1.35c	1.36c	1.41c	1.44c	$1.38d_4$
					PETIOLES OF UPPER MAIN STEM LEAVES						
Jul 13	1.24	1.38	1.52	1.44	1.18	1.45	1.29	1.39	1.46	1.30	$1.38c_1$
Aug 10	1.60	1.96	1.94	1.74	1.64	1.79	1.94	1.85	1.84	1.87	$1.82b_2$
Sep 14	2.14	2.32	2.40	2.40	2.37	2.42	2.43	2.32	2.42	2.42	$2.30b_3$
Ave	1.69c	1.89b	1.95b	1.86b	1.73b	1.91a	1.89b	1.85b	1.91b	1.87b	$1.85b_4$
					BLADES OF PRINCIPAL LATERAL BRANCH LEAVES						
Jul 13	1.42	1.58	1.46	1.56	1.38	1.48	1.44	1.36	1.74	1.64	$1.51b_1$
Aug 10	1.76	1.86	1.72	1.70	1.62	1.62	1.77	1.78	1.70	1.72	$1.72c_2$
Sep 14	2.27	2.42	1.94	1.92	2.01	1.90	2.13	2.20	2.06	2.33	$2.12c_3$
Ave	1.82b	1.95b	1.71c	1.73c	1.67b	1.66b	1.78b	1.78b	1.83b	1.90b	$1.78c_4$
					BLADES OF UPPER MAIN STEM LEAVES						
Jul 13	1.78	2.02	1.88	1.82	1.52	1.84	1.77	1.60	1.88	1.78	$1.79a_1$
Aug 10	2.10	2.42	2.36	2.33	2.12	2.04	2.48	2.36	2.41	2.32	$2.29a_2$
Sep 14	2.74	2.71	2.88	2.72	2.62	2.23	2.83	2.54	2.90	2.78	$2.70a_3$
Ave	2.21a	2.38a	2.37a	2.29a	2.09a	2.03a	2.36a	2.17a	2.39a	2.29a	$2.26a_4$
					MEANS - OVERALL						
Jul 13	1.40C	1.54C	1.52C	1.48C	1.30C	1.49C	1.40C	1.37C	1.58C	1.50C	$1.46c_5$
Aug 10	1.67B	1.94B	1.83B	1.75B	1.64B	1.72B	1.91B	1.81B	1.83B	1.86B	$1.80b_5$
Sep 14	2.21A	2.31A	2.22A	2.17A	2.12A	2.03A	2.22A	2.20A	2.25A	2.27A	$2.20a_5$
Ave	1.76E	1.93A	1.86BC	1.80CDE	1.69F	1.75EF	1.84BCD	1.79DE	1.89AB	1.88AB	1.82

*/ Means are significantly different when followed by all unlike letters. Compare means followed by small letters with similar subscripts and without subscripts within varieties, only.

Mg Contents

Average Mg contents varied rather widely among variables measured (Table 6). Most of this variation (1.8% to 0.5%) occurred in the petioles of the upper main stem. Overall, percent Mg was highest in the upper main stem petioles, lowest in the principal lateral branch petioles, and intermediate in the blade portions. Also overall, percent Mg in the leaf segments was highest in the August and lowest in the July sampling, although that in three of the leaf portions tended to be lower in the last than in the first sampling. However, rather little difference in percent Mg occurred among sampling date means except in the upper main stem petioles in which the Mg contents increased markedly with maturity. It is noteworthy that Mg seems to be especially concentrated only in the petioles of certain leaves and not in the petioles of other leaves or blades of the same leaves.

Variability in Mg content among cultivars and lines was less than 0.3% except in the petioles of the upper main stem leaves in which the variability was as much as 1.0%. The main stem petiole samples obtained near maturity from Florunner contained 1.8% Mg. Early Runner was second highest with 1.4% Mg in similar samples. NC Acc. 366 generally was lowest in Mg content. Among the SYP group, NC Acc. 15714 and Florigiant (as well as Florunner) leaf segments frequently were relatively high in Mg content, whereas the Va. 72R segments generally were below average.

B Contents

Average B contents found in the leaf portions are given in Table 7. The range in B contents was from 82 to 22 ppm. The leaf blade portions were higher in B content than the petiole portions which were similar for both branches. Also, the main stem blades were higher than the lateral branch blades in B content. The effect of stage of growth on B content variations was small although the September samples averaged lower in B content than the other samplings.

Variability in B content among cultivars and lines was relatively low. Greatest variability among cultivars and lines in B content was in the September leaf blade samples, particularly the upper main stem blades. Overall, Florunner, NC Acc. 15714 and Va. 72R, all in the SYP group, were highest in B content. The other SYP cultivar, Florigiant, was somewhat lower in B content. Va. 61R averaged lowest in B content although such differences were not significant.

Mn Contents

The Mn content of the various leaf segments are given in Table 8. Average manganese contents ranged from 111 to 19 ppm. The leaf portions, particularly the blades of mature plants, generally were highest in Mn. Highest Mn contents were found in the upper main stem blades sampled in September and lowest contents in the principal lateral branch petioles. Generally, Mn contents in the principal lateral branch petioles did not increase appreciably as the plants matured. Also, Mn contents in petioles and blades of the upper main stem and principal lateral branches, respectively, increased only slightly, although consistently, with maturity.

There was no significant difference in average Mn contents among the cultivars and lines. However, among cultivars and lines, the range in Mn levels in blade tissues was appreciable, particularly in the late sampling. Overall, Mn contents of the Early Runner and NC Acc. 366 segments were highest and lowest, respectively. Average Mn contents of NC Acc. 15714 and Va. 72R of the SYP group were nearly as high as Early Runner, but average Mn contents of Florunner were nearly lowest. Manganese contents in Florigiant leaf segments were intermediate.

Zn Contents

The Zn contents found in the blades and petioles are given in Table 9. Zinc contents varied from 60 to 18 ppm in the segments. Mature plant leaves generally were lower in Zn than younger plants. No difference in Zn content of the petioles and blades was noted in the July samples. However in later samplings, the Zn content of the upper main stem blades was highest and that in the principal lateral branch petioles, lowest. Principal lateral branch blade and upper main stem

Table 6. Average Magnesium Content (%) of Certain Peanut Leaf Segments, Holland, Va., 1970-71.

Date of Sampling	NC 17	NC ACC. 15714	Va. 72R	Flo-Runner	Florigiant	NC ACC. 366	Va. 61R	F 392-1	Early Runner	NC 5	Mean all Cultivars
PETIOLES OF PRINCIPAL LATERAL BRANCH LEAVES											
Jul 13	0.56	0.63	0.62	0.75	0.64	0.59	0.58	0.60	0.63	0.68	0.63d_1*
Aug 10	0.67	0.78	0.71	0.77	0.76	0.72	0.82	0.74	0.73	0.80	0.74b_2
Sep 14	0.66	0.74	0.53	0.67	0.54	0.56	0.53	0.60	0.52	0.54	0.59d_3
Ave	0.63b	0.72b	0.62b	0.74c	0.65c	0.61b	0.63c	0.64c	0.63c	0.66c	0.65c_4
PETIOLES OF UPPER MAIN STEM LEAVES											
Jul 13	0.72	0.88	0.85	1.08	0.71	0.76	0.84	0.82	0.86	0.68	0.82a_1
Aug 10	0.86	1.06	1.02	1.27	0.92	0.82	0.91	0.97	1.02	0.88	0.98a_2
Sep 14	1.18	1.19	1.02	1.82	1.17	0.82	1.05	1.20	1.40	0.90	1.18a_3
Ave	0.92a	1.04a	0.97a	1.38a	0.94a	0.80a	0.93a	1.02a	1.09a	0.82a	0.93a_4
BLADES OF PRINCIPAL LATERAL BRANCH LEAVES											
Jul 13	0.71	0.74	0.67	0.87	0.80	0.65	0.70	0.82	0.78	0.69	0.74c_1
Aug 10	0.71	0.77	0.74	0.82	0.89	0.65	0.78	0.86	0.75	0.74	0.77b_2
Sep 14	0.58	0.66	0.64	0.72	0.78	0.52	0.66	0.80	0.63	0.74	0.67b_3
Ave	0.67b	0.72b	0.68b	0.80bc	0.82b	0.61b	0.71b	0.82b	0.72b	0.72b	0.73b_4
BLADES OF UPPER MAIN STEM LEAVES											
Jul 13	0.75	0.92	0.72	0.90	0.80	0.72	0.72	0.80	0.79	0.70	0.78b_1
Aug 10	0.70	0.75	0.72	0.92	0.80	0.62	0.75	0.81	0.80	0.66	0.75b_2
Sep 14	0.63	0.62	0.62	0.74	0.74	0.51	0.60	0.71	0.64	0.52	0.63c_3
Ave	0.70b	0.77b	0.69b	0.85b	0.78b	0.62b	0.69bc	0.77b	0.75b	0.63c	0.72b_4
MEANS - OVERALL											
Jul 13	0.69	0.79	0.71B	0.89B	0.74B	0.68A	0.71B	0.76B	0.76	0.68	0.74c_5
Aug 10	0.74	0.86	0.80A	0.94AB	0.84A	0.70A	0.80A	0.86A	0.82	0.76A	0.81a_5
Sep 14	0.76	0.80	0.70B	0.99A	0.81A	0.61B	0.71B	0.83A	0.80	0.67B	0.77b_5
Ave	0.73CD	0.81B	0.74CD	0.94A	0.80B	0.66E	0.74CD	0.81B	0.79BC	0.71D	0.77

*/ Means are significantly different when labeled with all unlike letters. Compare means followed by small letters with similar subscripts and without subscripts within varieties, only.

Table 7. Average Boron Content (ppm) of Certain Peanut Leaf Segments, Holland, Va., 1970-71.

Date of Sampling	NC 17	NC ACC. 15714	Va. 72R	Flo-Runner	Florigiant	NC ACC. 366	Va. 61R	F 392-1	Early Runner	NC 5	Mean all Cultivars
					PETIOLES OF PRINCIPAL LATERAL BRANCH LEAVES						
Jul 13	28	33	30	28	30	32	28	29	27	29	29c_1*
Aug 10	27	29	27	34	26	32	28	28	25	26	28c_2
Sep 14	27	28	24	29	28	29	26	26	30	28	27c_3
Ave	27	30	27	30	28	31	27	28	27	28	28c_4
					PETIOLES OF UPPER MAIN STEM LEAVES						
Jul 13	29	28	33	29	27	32	26	29	33	27	29c_1
Aug 10	25	28	27	28	28	28	27	24	28	26	27c_2
Sep 14	25	26	22	25	26	28	23	23	25	26	25c_3
Ave	26	27	27	27	27	29	25	25	29	26	27c_4
					BLADES OF PRINCIPAL LATERAL BRANCH LEAVES						
Jul 13	60	53	56	54	54	52	52	57	49	55	53b_1
Aug 10	57	59	64	52	46	46	55	52	50	58	53b_2
Sep 14	50	52	55	51	43	37	46	45	44	48	46b_3
Ave	56	55	58	52	48	45	51	51	48	54	51b_4
					BLADES OF UPPER MAIN STEM LEAVES						
Jul 13	65	59	63	65	56	58	49	72	57	50	59a_1
Aug 10	61	66	66	69	58	58	51	60	67	59	63a_2
Sep 14	61	54	57	82	54	52	48	57	72	52	59a_3
Ave	62	60	62	72	57	56	49	63	65	54	60a_4
					MEANS - OVERALL						
Jul 13	46	43	46	44	42	44	39	47	42	40	42a_5
Aug 10	42	46	46	46	40	41	40	41	42	42	43a_5
Sep 14	42	40	40	47	38	36	38	38	43	38	39b_5
Ave	43	43	44	46	40	40	39	42	42	40	41

*/ Means are significantly different when labeled with all unlike letters. Compare means followed by small letters with similar subscripts.

Table 8. Average Manganese Content (ppm) of Certain Peanut Leaf Segments, Holland, Va., 1970-71.

Date of Sampling	NC 17	NC ACC. 15714	Va. 72R	Flo-Runner	Flori-giant	NC ACC. 366	Va. 61R	F 392-1	Early Runner	NC 5	Mean all Cultivars
PETIOLES OF PRINCIPAL LATERAL BRANCH LEAVES											
Jul 13	20	27	27	22	22	22	23	20	28	22	$23b_1$*
Aug 10	24	25	28	23	21	23	25	21	29	23	$24d_2$
Sep 14	24	30	36	19	22	22	25	22	35	24	$26d_3$
Ave	23b	27c	30c	21c	22d	22c	24d	21d	31d	23d	$24d_4$
PETIOLES OF UPPER MAIN STEM LEAVES											
Jul 13	21	30	28	23	21	26	25	23	32	22	$25b_1$
Aug 10	23	33	35	28	33	25	33	27	37	28	$30b_2$
Sep 14	29	36	42	34	33	34	35	31	54	34	$36c_3$
Ave	24b	33c	35c	28c	29c	28b	31c	27c	41c	28c	$30c_4$
BLADES OF PRINCIPAL LATERAL BRANCH LEAVES											
Jul 13	42	59	54	42	41	36	47	44	61	43	$47a_1$
Aug 10	50	62	66	43	46	47	53	49	62	44	$52b_2$
Sep 14	52	72	79	42	52	42	55	50	70	46	$56b_3$
Ave	48a	64b	67b	42b	46b	42a	52b	48b	64b	44b	$52b_4$
BLADES OF UPPER MAIN STEM LEAVES											
Jul 13	46	63	59	46	43	41	58	45	67	43	$51a_1$
Aug 10	57	80	82	60	59	49	76	62	89	54	$67a_2$
Sep 14	63	90	96	67	75	59	90	67	111	77	$80a_3$
Ave	55a	78a	79a	58a	59a	50a	75a	58a	88a	58a	$66a_4$
MEANS - OVERALL											
Jul 13	32	45	42	33	32	31	38	33	47	33	$36b_5$
Aug 10	38	50	53	38	40	36	47	40	54	38	$43ab_5$
Sep 14	42	57	63	40	45	38	52	42	68	46	$50a_5$
Ave	37CD	51AB	53AB	37CD	39C	35D	46B	38C	56A	39C	43

*/ Means are significantly different when labeled by all unlike letters. Compare means followed by small letters with similar subscripts.

Table 9. Average Zinc Content (ppm) of Certain Peanut Leaf Segments, Holland, Va., 1970-71.

Date of Sampling	NC 17	NC Acc. 15714	Va. 72R	Flo-Runner	Florigiant	NC Acc. 366	Va. 61R	F 392-1	Early Runner	NC 5	Mean all Cultivars
PETIOLES OF PRINCIPAL LATERAL BRANCH LEAVES											
Jul 13	42	54	38	41	45	38	51	43	50	39	44
Aug 10	26	28	28	27	28	27	30	28	34	25	28d1*
Sep 14	21	21	23	18	24	23	25	22	27	20	22c2
Ave	30	34	29	29	32	29	35	31	37	28	31c3
PETIOLES OF UPPER MAIN STEM LEAVES											
Jul 13	44	51	47	44	44	43	51	41	51	37	46
Aug 10	24	31	31	30	34	33	30	32	38	30	31c1
Sep 14	26	30	28	30	29	33	26	29	36	29	29b2
Ave	31	37	36	35	36	36	36	34	42	32	36b3
BLADES OF PRINCIPAL LATERAL BRANCH LEAVES											
Jul 13	41	60	41	37	48	39	49	41	43	43	43
Aug 10	34	37	37	32	32	35	38	32	49	32	35b1
Sep 14	27	33	30	21	28	26	31	26	34	26	28b2
Ave	34	43	36	30	36	33	40	33	42	34	36b3
BLADES OF UPPER MAIN STEM LEAVES											
Jul 13	45	49	44	38	46	42	48	44	37	37	44
Aug 10	36	46	41	37	40	38	44	44	38	38	40a1
Sep 14	37	42	40	35	42	39	52	41	36	36	40a2
Ave	40	46	42	32	43	40	47	42	37	37	41a3
MEANS - OVERALL											
Jul 13	43	53	43	40	46	41	50	42	45	39	44a4
Aug 10	30	36	34	31	33	33	35	34	41	31	34b4
Sep 14	28	32	31	26	31	30	31	29	37	27	30c4
Ave	33	40	36	31	37	35	39	35	41	33	36

*/ Means are significantly different when labeled with all unlike letters. Compare means followed by small letters with similar subscripts.

petioles were similar in Zn content in the September samples.

The overall Zn content means were quite similar among cultivars and lines. However, average Zn content of Early Runner samples was highest, followed closely by NC Acc. 15714 and that in Florunner lowest. Average Zn contents of the Va. 72R and Florigiant tissues were intermediate.

Cu Contents

The Cu contents of the leaf segments are recorded in Table 10. Average Cu contents ranged from 16 to less than 5 ppm. Generally, Cu contents decreased in both petioles and blades as the plants matured. Overall, average Cu content of the blade portion of principal lateral branch leaves was highest whereas, the petiole portion was lowest. The blade and petiole portions of upper main stem leaves were intermediate in Cu. The blades were higher in Cu than the petioles in both cases. The Cu content differences among the leaf portions occurred mainly in the latter two samplings. Cultivar and line variability in Cu contents was insignificant. Among all cultivars and lines, Florunner and Florigiant of the SYP cultivar group averaged second highest and lowest, respectively, in Cu content. The other 2 SYP cultivars were intermediate.

DISCUSSION

One or more of the SYP cultivars was highest or equivalent, statistically in overall average content of each of the eight plant nutrients assayed in this investigation. NC Acc. 15714 was highest in Ca and higher than most in Mn, B and Zn contents; Va. 72R was highest in K, and higher than most in P, B, and Mn; Florunner was highest in Mg and B, and higher than most in Cu; and Florigiant was intermediate or lower than most cultivars in nutrient contents. In fact, Florigiant was lowest in overall average contents of Ca and Cu, and lower than most in B. Also, Florunner was lowest in Zn and lower than most in P, K, Ca, and Mn. The other two SYP cultivars were intermediate or not lower than most in contents of any nutrients.

Hence, only Florunner of the SYP group was highest in at least two nutrients. Among the other cultivars and lines, only Early Runner was highest in two nutrients (Mn and Zn). Early Runner was next highest to the SYP group in projected yield potential. Thus, the SYP group and Early Runner were highest in the eight nutrients investigated. Va. 61R and F392-1 were each highest in one nutrient (P and Cu, respectively). On the other hand, the SYP group was lowest in three of the eight nutrients. Florigiant accounted for two.

The data obtained in this study show that the projected high yielding cultivars and lines did not contain highest contents of all nutrients in any leaf segments. Nevertheless, these high yielding cultivars did include more of the cultivars which were highest in contents of one or more nutrients.

Some cases of especially high Mg and Mn contents occurred in certain cultivars. This was noted in the September sampling, particularly. The Mg content of Florunner main stem petioles, and the Mn contents of the main stem leaf blades and to a lesser extent the lateral branch blades of Early Runner, NC Acc. 15714, Va. 72R, and Va. 61R were relatively high. It seems that the Mg and Mn nutrition requirements of these cultivars may warrant special attention.

An important question in these considerations is the extent to which generalization or averaging across segments or dates of sampling can be done without confusion or alteration of apparent relationships. In this investigation, there was greater variation in Ca contents especially, but also in K and Mg contents than for other nutrients among cultivars and lines that was related to sampling differences. Somewhat more of the variability among cultivars was related to the leaf segment variable than to sampling dates. However, where appreciable content variations occurred, the relationship between general averages and specific variable means was reasonably good.

Nevertheless, a certain amount of sampling specificity seems warranted to identify significant differences in nutrient uptake potentials. For the optimum

Table 10. Average Copper Content (ppm) of Certain Peanut Leaf Segments, Holland, Va., 1970-71.

Date of Sampling	NC 17	NC ACC. 15714	Va. 72R	Flo-Runner	Flori-giant	NC ACC. 366	Va. 61R	F 392-1	Early Runner	NC 5	Mean all Cultivars
					PETIOLES OF PRINCIPAL LATERAL BRANCH LEAVES						
Jul 13	12.9	10.1	10.9	12.4	11.6	9.8	11.0	11.5	12.4	12.6	11.2
Aug 10	7.8	6.5	6.7	6.5	6.6	5.4	6.0	6.1	7.0	7.0	6.5
Sep 14	5.4	6.9	5.6	5.4	4.8	6.0	4.9	5.2	5.6	6.3	5.7
Ave	8.7	7.8	7.7	8.1	7.7	7.1	7.3	7.6	8.3	8.6	7.8d_1*
					PETIOLES OF UPPER MAIN STEM LEAVES						
Jul 13	10.8	11.4	12.8	13.8	12.2	9.1	13.8	10.8	11.6	12.9	11.8
Aug 10	7.1	9.2	8.5	8.5	7.0	7.9	7.9	7.9	10.2	7.9	8.2
Sep 14	7.2	7.0	7.6	6.8	7.3	8.6	7.0	6.8	6.8	6.2	7.1
Ave	8.4	9.2	9.6	9.7	8.8	8.5	9.6	8.5	9.5	9.0	9.0c_1
					BLADES OF PRINCIPAL LATERAL BRANCH LEAVES						
Jul 13	15.4	11.9	11.9	10.8	12.5	13.0	13.8	12.1	11.4	13.5	12.7
Aug 10	10.2	9.8	9.6	10.7	9.6	11.4	10.2	9.4	9.4	8.9	9.7
Sep 14	8.8	8.2	8.2	8.5	7.8	8.0	8.2	9.0	9.4	8.4	8.6
Ave	11.5	10.0	9.9	10.0	10.0	10.8	10.7	10.2	10.1	10.3	10.3a_1
					BLADES OF UPPER MAIN STEM LEAVES						
Jul 13	11.4	12.2	10.5	12.9	11.8	11.6	10.9	16.2	11.1	11.2	11.6
Aug 10	7.4	8.4	7.8	8.8	7.3	8.7	7.2	12.7	8.4	8.7	8.7
Sep 14	8.8	8.0	9.0	8.6	8.6	9.1	8.0	7.7	8.8	8.9	8.6
Ave	9.2	9.5	9.1	10.1	9.2	9.8	8.7	12.2	9.4	9.6	9.6b_1
					MEANS - OVERALL						
Jul 13	12.6	11.4	11.5	12.4	11.9	10.9	12.4	12.7	11.6	12.6	12.0a_2
Aug 10	8.2	8.4	8.1	8.6	7.8	8.3	7.8	9.0	8.8	8.1	8.4b_2
Sep 14	7.5	7.5	7.6	7.4	7.0	8.0	7.1	7.4	7.8	7.4	7.4c_2
Ave	9.4	9.1	9.1	9.5	8.9	9.1	9.1	9.6	9.3	9.4	9.3

*/ Means are significantly different when labeled with all unlike letters. Compare means followed by small letters with similar subscripts and without subscripts within varieties, only.

(highest content) date of sampling in each case, nutrient contents based on the highest level varied among leaf segments as follows: P decreased 30%; Ca decreased 40%; K, Mg and B decreased 50%, Mn decreased nearly 70%, but Zn and Cu contents did not vary appreciably. Similarly, date of sampling variations influenced nutrient contents as follows; P, Ca, Mg, Mn, and Cu decreased about 30 to 35%, whereas K, Zn and B contents varied little. Thus, variability among contents of these eight nutrients will be increased more by sampling only one leaf segment than by one sampling date.

Results of this investigation indicate that highest contents of all eight nutrients except P (nearly as high, however) can be identified by sampling only the upper main stem leaves. However, the blade and petiole portions must be sampled separately both during the active flowering period and again near maturity. The late sampling date is necessary for identification of highest Ca, Mg, and Mn contents. Earlier samplings are best for highest P, K, B, Zn, and Cu contents.

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SCREENING PEANUT GERM PLASM FOR RESISTANCE TO VERTICILLIUM WILT

Baz M. Khan, Graduate Student, Department of Agronomy
D. F. Wadsworth, Associate Professor, Department of Botany and Plant Pathology
and J. S. Kirby, Assistant Professor, Department of Agronomy
Oklahoma State University, Stillwater, Oklahoma 74074

ABSTRACT & PAPER

ABSTRACT

Verticillium wilt of peanuts was identified in Oklahoma in 1970. The disease appeared in irrigated fields in late summer and caused loss in yield of 63%. It has the potential of becoming a serious disease in this area. The fungus persists for long periods in the soil and has a very wide host range. Therefore, wilt is difficult or impractical to control with fungicides or crop rotation. A possible control may be the development of resistant varieties. Search for resistance to Verticillium wilt in peanuts is the first step in a breeding program.

Eight commercial Spanish peanut varieties and 81 plant introductions were screened initially in a naturally-infested field. Twenty-four entries which showed less than 40% disease prevalence in the field were selected and further evaluated in a greenhouse as well as a growth chamber by artificial inoculation at an inoculum level of 4.5×10^6 spores/ml. Disease severity in both environments was rated three times after inoculation at time intervals of 20 days. A rating scale of 1 to 13 was used, where 1 indicated healthy plants and 13 indicated completely defoliated, dead plants.

On the basis of the mean disease severity index, entries were divided into tolerant, intermediate and susceptible groups. The Argentine Spanish peanut variety and 9 of the introductions were placed in the tolerant group; however, the line Georgia Bunch 182-28 previously reported to be highly resistant, ranked in the intermediate group.

PAPER

Verticillium wilt of peanuts (*Arachis hypogaea* L.) has been reported from Asia, Australia, and the United States of America (1, 2, 3). In Oklahoma, Verticillium wilt of peanuts was identified in late summer of 1970, where it caused loss in yield of 63% (6). Since this fungus has an extremely wide host (5) range and can persist for long periods of time in soil (7), it has the potential of becoming a serious disease in this area.

Verticillium wilt occurred in irrigated fields, particularly in low areas. Wilt symptoms began to appear in late August and were characterized by stunting, leaf yellowing, withering, defoliation and brown discoloration of the vascular tissues. Severely infected plants were dead by harvest time. The disease occurred irregularly over large areas. Therefore, spot treatment of infested soil with chemicals might be difficult and uncertain, while treatment of entire fields would be expensive. As a result, control of Verticillium wilt by means of resistance would be desirable.

Two species of *Verticillium* (*Verticillium albo-atrum* and *V. dahliae*) have been recognized as causal organisms of wilt but cogent opinions support both the separation or the synonomy of the two species. Therefore, in this study only the genus name of the pathogen was considered.

MATERIALS AND METHODS

Preliminary screening of 89 peanut accessions was made in a naturally infested farmer's field near the Caddo Peanut Research Station, Ft. Cobb, Oklahoma in 1971.

A randomized block design was used and replicated 4 times. The soil type was a fine sandy-loam in which peanuts, sorghum and cotton were in rotation.

The disease prevalence data for percentage of Verticillium infected plants were recorded 90 days after planting. Entries which showed less than 40% disease incidence were selected for further evaluation under greenhouse and growth chamber environments.

Procedures were the same for both greenhouse and growth chamber plantings. Flats were filled with vermiculite, and replicated 4 times in a completely randomized design. Inoculations were made by dipping roots of 10-day old seedlings in a spore suspension with an inoculum density of 4.5×10^6 spores/ml, adjusted by means of a hemacytometer. The disease severity of individual plants, both in greenhouse and growth chamber was rated three times after inoculation: first rating after 20 days, second rating after 40 days and final rating 60 days after inoculation. An arbitrary rating scale of 1 to 13 was used, in which 1 indicated no disease and 13 indicated a completely defoliated, dead plant.

RESULTS AND DISCUSSION

The mean Verticillium wilt severity score for each peanut accession is given in Table 1 for both the greenhouse and growth chamber tests. Significant correlation coefficients were obtained between the results of the greenhouse and growth chamber, indicating comparable results in both studies. All inoculated plants became infected but the degree of disease severity, however, was quite variable in different entries. Thus, with the aid of multiple range tests for mean disease severity score, entries were divided into tolerant, intermediate and susceptible groups.

The Spanish peanut variety, Argentine, and 9 of the introductions: P-338, P-425, P-431, P-436, P-442, P-446, P-535, P-559, and P-628 were placed in the tolerant group. In contrast the line 'Georgia Bunch 182-28' previously reported (4) to be highly resistant, ranked in the intermediate group. Entries P-361, P-362, P-860, and P-870 were placed in the susceptible group. Under less inoculum pressure such as under field conditions, entries of the tolerant group might be considered resistant. These findings suggest that resistance to Verticillium wilt may exist in some lines of peanuts and further investigations may lead to desirable levels of resistance to Verticillium wilt.

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Table 1. Verticillium wilt mean severity score of 24 peanut accessions in greenhouse and growth chamber tests.[1/]

Okla. P-No.	Variety or P.I. No.	Greenhouse	Growth Chamber	Average
Tolerant Group				
0431	268778	6.9	6.7	6.8
0446	268825	6.8	7.0	6.9
0338	259671	7.1	6.9	7.0
0425	268759	7.4	6.7	7.1
0559	240555	7.4	7.1	7.2
0442	268818	8.3	6.9	7.6
0628	268707	7.9	7.4	7.6
0555	248768	7.9	7.4	7.6
0002	Argentine	8.4	7.4	7.9
0436	268795	8.4	7.4	7.9
Intermediate Group				
0624	268703	8.4	7.6	8.0
0664	268742	8.6	7.5	8.0
0719	268801	8.1	8.2	8.1
0552	248763	8.4	8.0	8.2
1436	Dixie Spanish	8.9	7.5	8.2
0422	268749	9.0	7.5	8.2
0701	268785	8.1	8.9	8.5
0730	268811	8.6	8.5	8.5
0614	268686	8.9	8.3	8.6
2399	Georgia Bunch 182-28	8.9	8.6	8.7
Susceptible Group				
0870	268706	9.7	9.8	9.7
0361	268616	10.3	9.3	9.8
0362	268626	10.3	9.6	9.9
0860	268680	9.5	10.6	10.0

[1/] Rating scale: 1 = no disease and 13 = completely defoliated, dead plant.

PEANUT MYCORRHIZAE: A FUNGUS-ROOT INTERACTION

by

Charles R. Stichler, Robert E. Pettit, and Ruth Ann Taber
Department of Plant Sciences
Texas A & M University, College Station, Texas 77843

INTRODUCTION

In recent years there has been an increasing interest in mycorrhizal fungi and the effects of infection on plant growth (2,6,11,16,29). It has been well established that few plants are free of mycorrhizal infection. In general, mycorrhizal fungi are considered to be symbiotic with the host and cause little damage to it although conflicting reports exist concerning their beneficial (5,11,18,28,29), harmful or unimportant effects (17,18,21,23,31). Numerous workers have stated that under certain conditions these fungi are beneficial to plant growth (2,5,6,7,11,18,20,28,29) and the fungus is especially important in the uptake of phosphorus in deficient soils (11,15, 19,24). Ross and Harper (28) have shown increased amounts of P, N, Ca, Cu, and Mn in leaf samples from infected soybeans as well as yield increases of 29-40% from infected soybeans grown under field conditions. Mycorrhizae were of no significance in sulphur accumulation by Pinus radiata even after sulphur starvation (19). Deal et. al. (7), in field tests of replanting vineyards, reported that when fertilizer was added to soil the activity of the mycorrhizae decreased but that the mean fertilized root weight was twice that for infected roots without fertilizer. Marx (18) showed that under fertilized pot conditions sour orange seedlings did not increase significantly in size when infected with mycorrhizae. Daft and Nicolson (6) stated that the mycorrhizal association would "confer greater relative benefit to the host under poor nutrient conditions". They found that the extent of the stimulus in tobacco, maize, and tomato was dependent on nutrient conditions and level of root infection.

Mycorrhizal fungi are divided into three main categories: (1) ectomycorrhizae, which form a dense mantle of hyphae (Hartig net) around the roots but never penetrate the root, (2) endomycorrhizae, which grow extensively within the root tissue but do not form a Hartig net and (3) ectendomycorrhizae, which both penetrate the root cells and form a Hartig net. The host range of the endomycorrhizae includes many field crops, including maize, forage crops, cotton, soybeans, citrus (12) and peanuts (1,4,16). Although the hyphae grow between as well as inside the cells, little damage is caused to the root (12). The hyphae often form distinct structures inside the roots, arbuscules and vesicles (hence the name vesicular-arbuscular mycorrhizae). The arbuscules are composed of large "trunk" hyphae with many smaller branches that fill the invaded cell and function as haustoria. The branches may eventually be digested and a dense granular material deposited in their place (11). Vesicles are generally round to oblong sacs filled with a lipid-like material and probably function as storage organs for the fungi. If the vesicles form a thickened wall they are termed chlamydospores and function as survival structures.

There are four kinds of spores or fruiting structures formed by vesicular-arbuscular mycorrhizae. These are chlamydospores, azygospores, zygospores and sporocarps. Chlamydospores are oval to round spores with thickened cell wall; azygospores are large spores with abortive subtending hyphae reminiscent of the monoclinous (or androgynous) condition in certain phycomycetes; zygospores are sexual spores resulting from the union of two compatible hyphae or suspensors; and sporocarps are aggregates of spore types grouped together either loosely and randomly or inside or submerged in sporocarps of varying complexities. These fungi are considered to be phycomycetes,

in the family Endogonaceae.

The purpose of our work was to examine peanut roots and soils in Texas for incidence of endomycorrhizae, to characterize any spore types found and relate incidence to fertilization levels.

MATERIALS AND METHODS

Both soils and peanut roots were examined for the presence of mycorrhizae spores. Soil samples were obtained from peanut fields during the fall of 1971 and examined for spores by the wet sieving and decanting technique used by Nicolson and Gerdemann (10). Only a limited number of spores was obtained using this method and therefore a sugar gradient technique, modified from that described by Ross and Harper (28) and Ohm (27) was developed. Peanut roots were blended for 30 seconds in a Waring Blendor, 2-3 mls of the comminuted roots were added to 50% sucrose in a 50 ml centrifuge tube and centrifuged at 1700 rpms for 3 minutes. The sugar solution containing the spores was washed thoroughly through a # 200 U. S. standard sieve (74 u, Tyler equivalent 200 mesh) and the spores were picked from the remaining debris with a controlled suction device (8). Collected spores were inoculated into pots, containing sand and vermiculite (2:3), about 1" below surface-sterilized Starr peanut seed. Approximately 100 chlamydospores were inoculated into each pot. Plants were removed weekly from individual pots beginning after three weeks of growth in controlled environmental chambers. Other plants were grown in pots containing natural peanut field soil and others in pots with sand and vermiculite inoculated with chopped infested roots. All were examined after 3 months, either by direct observation of the roots after gentle washing or after clearing of the roots by soaking 3-5 minutes in a 3% solution of slightly HCl-acidified NaOCl. A weak solution of toluidine blue was used to stain the fungal structures after soaking for 1 hour or more. Paraffin sections (10u) of root tissues were also examined for mycorrhizal structures.

RESULTS

Examination of the roots and soils from peanut fields in Texas revealed the presence of several mycorrhizal spore types (Table 1). The type "A" chlamydospores (Figs 1,2,3) are thick-walled spores that are borne on thick-walled coenocytic hyphae and develop from thin-walled vesicles in the cortical root tissue as well as in the potting media or soil. The outer wall of the spore is colorless, brittle and sometimes laminated (arrow Fig. 1). The wall can be cracked and rolled off the inner wall by applying slight moving pressure to the coverslip on a slide. The inner wall is membranous, yellow, slightly pliable, and if broken folds rather than shatters like the outer wall. The spores contain many small oil-like droplets; however, with age the oil may coalesce into a single large globule. Arbuscules were present in the cortical tissue but not observed in the vascular region of the root. The spore attachment is simple; not "funnel" or "bulbous"-shaped like the spores described by Mosse and Bowen (22). This species is probably a species of the genus Glomus (14,21,30) but has not been previously described.

The type "B" spores (Table 1, Fig. 4) represent another species. The spores have only one thin wall and may be vesicles. They do not form a double wall or even a thickened wall. The spores are formed both in the soil and roots. In the soil they develop in groups of 20-110. This species is probably also a member of the genus Glomus.

The type "C" spores (Table 1) differ from the type A in that they have only one thick brown wall and the vesicles in the root do not develop into chlamydospores. At the present time these are being investigated further.

The type "D" azygospores (Figs. 5,6,7,8) are characterized by their large size and a distinct bulbous swelling at the base of the spore. This species does not produce vesicles in the root, but only on hyphae in the soil (Fig. 9). The vesicles are quite small, in tight groups, and have small echinulations (Figs. 10, 11). This species is probably a member of the genus Gigaspora.

TABLE I

MYCORRHIZAL SPORE TYPES ASSOCIATED WITH PEANUTS IN TEXAS

Type	Figs.	Kind	Shape and Color	Size u	Walls Inner	Walls Outer	Where Found
A	1,2,3	chlamydospores	globose yellow	(80)120-240(260)	1-2u	12-20u	all over Texas in roots and soil.
B	4	vesicles	oval to globose yellow 20-110 in group.	60-110	none	1-2u	soil from Stephenville Texas
C		chlamydospores	globose brown	125-200*	*	8-14u*	roots and soil, Bryan and Waller,
		sporocarp		ca 3mm			Texas
D	5,6,7, 8	azygospore	globose dark brown	(300)350-450(475)	2-4u	hyaline ca 1u	roots and soil Bryan and Stephen-
	9,10, 11	vesicles	oval echinulate up to 15 in a cluster	30	very thin	very thin	ville, Texas

* Paucity of spores prevented accurate measurement of size range.

DISCUSSION

The finding of several species of mycorrhizae fungi in Texas peanut roots and soil necessitates a study of the effects of their presence there. Consideration will have to be given to their distribution, influence on the peanut plant growth, and relationship with other soil microorganisms. The effects of the addition of fungicides and fertilizers to peanut fields will need study. Nesheim and Linn (25) working with the mycorrhizal fungus Endogone fasciculata Thaxter on corn, showed that this fungus is slightly sensitive to the fungicide Captan and moderately sensitive to Terraclor. If the mycorrhizae on peanuts are significantly beneficial, these mycorrhizae should not be inhibited by broadcast application. Nesheim speculated that, since fungicides are usually banded in a row, that once the roots grow through the treated zone they would probably control peanut root diseases without exerting a permanent detrimental effect on the mycorrhizae. In speculating, where soil pathogens are a limiting factor in production, it would be better to band fungicides for possible pathogen control rather than be concerned with eliminating the mycorrhizae. Since peanuts have a lower fertility requirement than most other field crops the influence of the mycorrhizae on peanut plant nutrition may be less important than on that of other crops.

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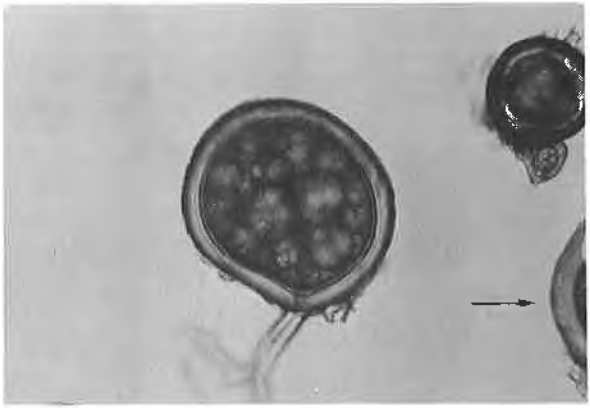

Fig. 1. Type "A" chlamydospores. Arrow, laminated wall.

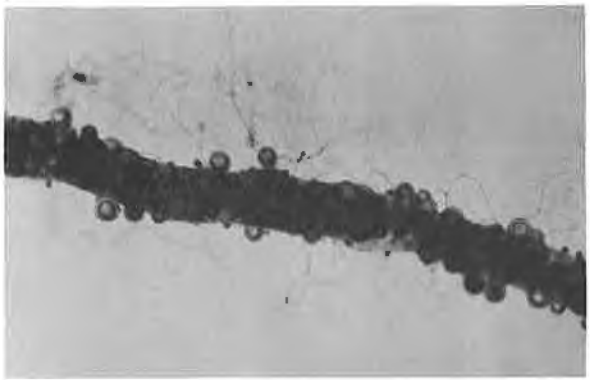

Fig. 2. Concentration of type "A" chlamydospores in the peanut root.

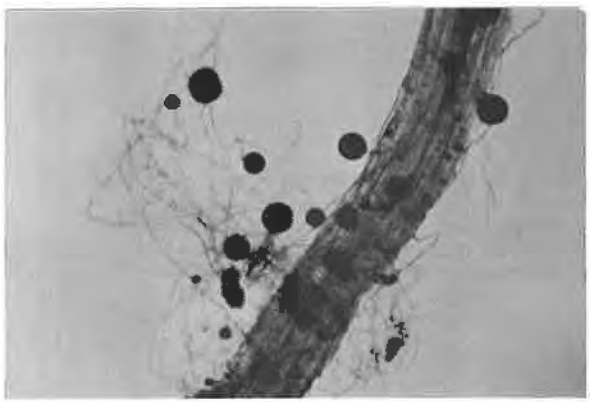

Fig. 3. Stained type "A" chlamydospores on hyphae outside peanut root.

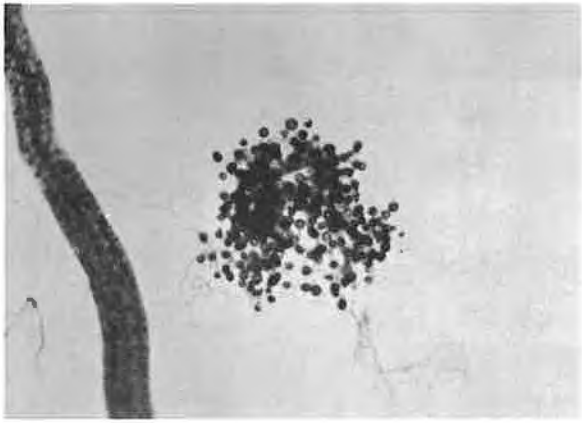

Fig. 4. Type "B" grouped vesicles (loose sporocarp ?)

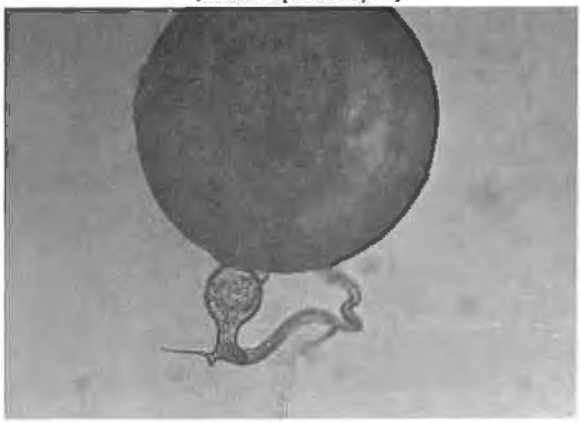

Fig. 5. Type "D" azygospore.

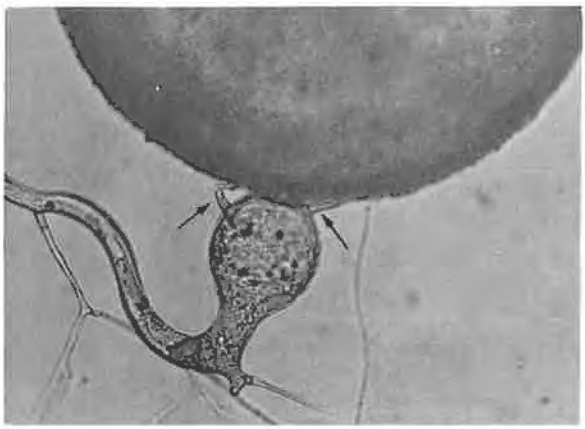

Fig. 6. Base of type "D" azygospores (arrow abortive hyphae). Note rough surface of azygospore.

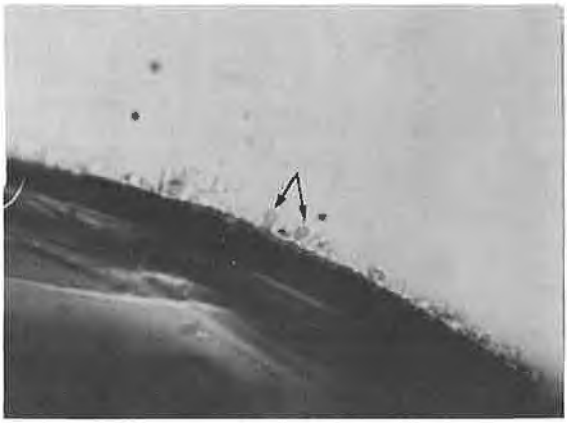

Fig. 7. Projections on surface of type "D" azygospore.

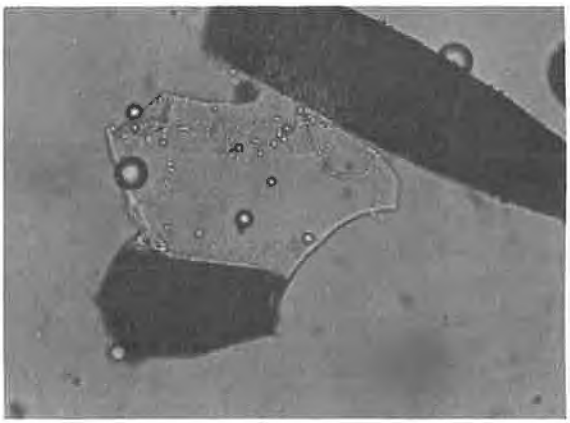

Fig. 8. Fragments of crushed type "D" azygospore. Note thin hyaline wall.

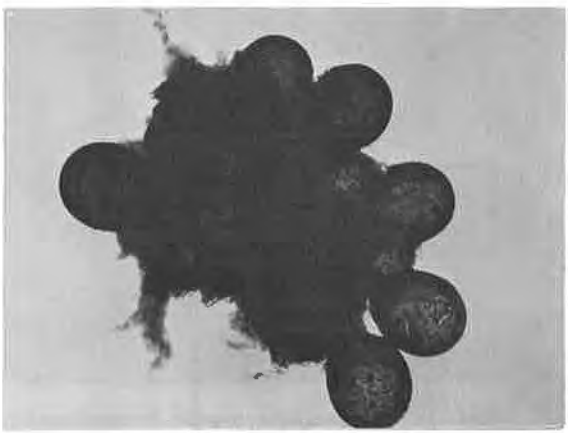

Fig. 9. Cluster of type "D" vesicles. Compare with Figure 10.

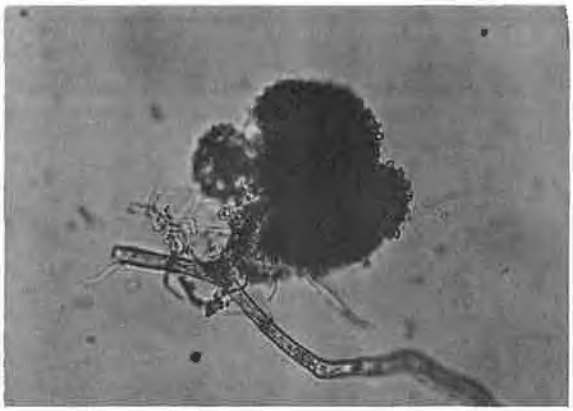

Fig. 10. Cluster of echinulate type "D" vesicles.

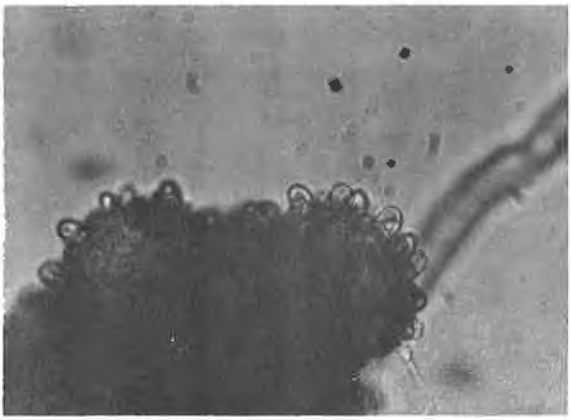

Fig. 11. Close-up of cluster of echinulate type "D" vesicles.

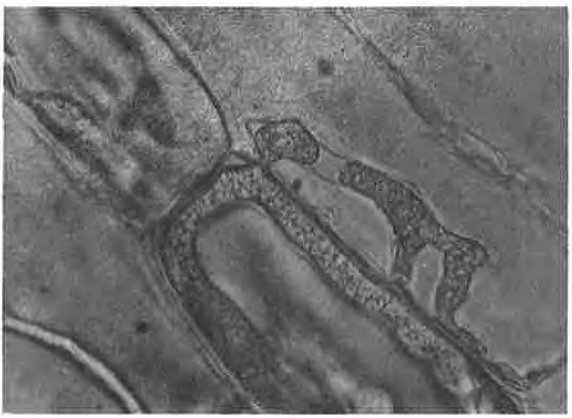

Fig. 12. Hyphae of a typical peanut mycorrhiza fungus in peanut root.

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EVALUATION OF SAMPLING ERRORS IN DETERMINING GERMINATION PERCENTAGES: APPLICATION TO PEANUTS[1/]

by
J.H. Young
Associate Professor, Biological and Agricultural Engineering Department
North Carolina State University, Raleigh, North Carolina

Determination of the germination percentage of a lot of seed is an important step in its quality evaluation. The result of a germination test is often used to make important decisions concerning the marketability of a lot of seed or the feasibility of practices used in the production of the seed. Thus it is important that the germination test be accurate. This accuracy has been seriously questioned in several phases of the peanut industry in recent years due to variations in test results of different samples from the same lot. It is the belief of the author that the major portion of the variation between samples may be attributed to sampling error rather than to the testing procedure itself. It is the purpose of this paper to discuss the magnitude of the errors which may be expected due to sampling alone and the adequacy of test results based upon certain sampling schemes.

The adequacy of test results depends not only on accuracy but also on the purpose for which the result is to be used. For example, a sampling and testing procedure may be quite adequate for determining whether the germination percentage of a particular lot is greater than some critical germination percentage while at the same time being completely inadequate for estimating the true germination percentage with a high degree of confidence. The various reasons or purposes for which germination tests are conducted may be classified into the following three groups:

1. Estimation of the true germination percentage of a seed lot.
2. Prediction of whether the true germination percentage is above or below some predetermined level.
3. Estimation of the differences in germination percentages of two or more lots of seed.

The errors involved in testing for each of the above listed reasons will be evaluated using the binomial probability distribution. The analysis is based upon the following assumptions:

1. A seed either germinates or does not germinate.
2. There are no errors due to variations in the germination test itself.
3. Samples are taken in a random manner such that all seeds have an equal chance of being chosen.

If the above assumptions are not met, then additional errors will be introduced. Thus, the errors to be evaluated here may be described as minimum expected errors due to the random sampling process. If lots of seed are not well mixed so that the samples are biased in some manner or if there are variations in germinator conditions or analyst readings, the errors involved in germination testing will be higher than those to be evaluated here.

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Theory

If random samples of size n are selected from an infinite binomial population (a population in which each individual unit is either good or bad, red or black, etc.) the sampling distribution obtained will be:

$$f(x) = C(n,x)\ p^x(1 - p)^{n - x}; x = 0,1,\ldots\ldots, n, \qquad (1)$$

$$0 < p < 1,$$

where

$f(x)$ = the probability of having x good units in the sample of size n,

$C(n,x) = n!/x!(n - x)!$ = binomial coefficients,

p = probability of a success (i.e. a good unit), and

x = number of successes (good units).

In the case of testing seed for germination a success is a seed which will germinate and p is the decimal portion of the total population which will germinate.

Other important parameters of the binomial probability distribution are the mean and the variance of the sampling distributions. The mean is given by:

$$\mu = n\ p, \qquad (2)$$

where

μ = mean nnmber of successes in a sample of size n.

The variance of the distribution is given by:

$$\sigma^2 = n\ p\ (1 - p), \qquad (3)$$

where

σ^2 = variance of resnlts of samples of size n.

Equation (3) has a maximum value for any given n when the value of p is 0.5. Thus, the greatest variability between germination samples will be found when the true germination percentage is 50%. The variability decreases to zero for populations having true germination percentages of either 0 or 100%.

Estimation of True Germination Percentage

Figure 1 illustrates the sampling distribution obtained by repetitive 200-seed samples of a population having a true germination of 80%. The figure was plotted using tabular values of the binomial distribution published by the staff of Harvard University Computation Laboratory (1). It can be seen that the values of germination obtained range from approximately 69 to 90% bnt that 99% of the values fall between 73 and 87%. Thus, a 200-seed sample may be described as having an accuracy of $\pm$ 7% at the 99% confidence level when the true germination is 80%. The accuracy (plus or minus deviation from the true value) of the germination percentage determined by a test depends upon the true germination percentage and upon the confidence level specified. Although not obvious from Figure 1, it is of interest to note that if the true germination of a lot is greater than 50%, it is more probable that the result of a sample will be too high than that it will be too low. This bias is due to the skewed binomial distribution.

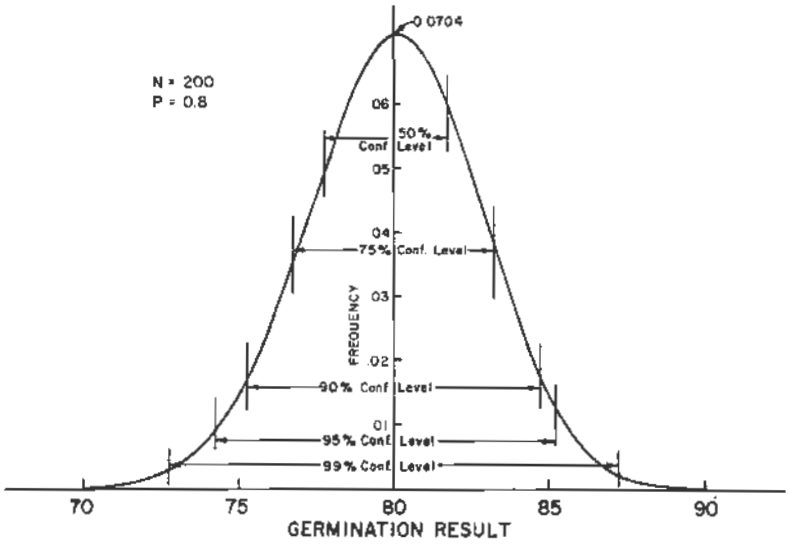


Figure 1. Sampling distribution for 200-seed samples from a population having a true germination of 80%. Intervals containing 50, 75, 90, 95, and 99% of the sample results are shown.

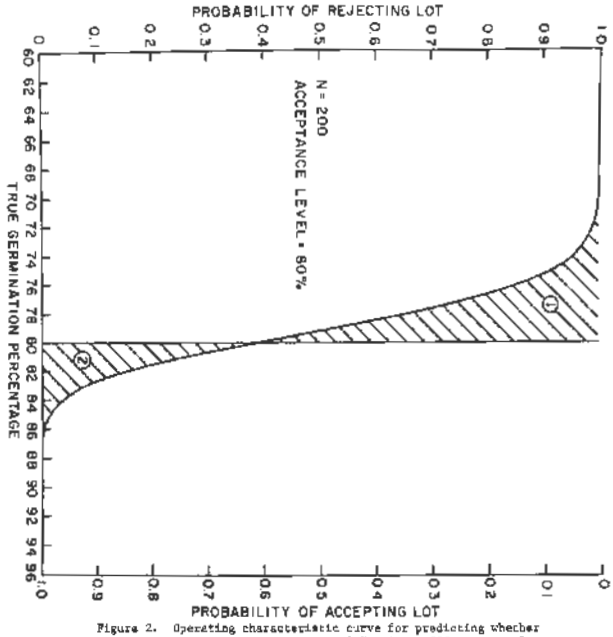


Figure 2. Operating characteristic curve for predicting whether the germination is above 80% using a 200-seed sample.

The accuracies may be quickly predicted by approximating the binomial distribution with a normal distribution having the same mean and variance. This approximation results in a symmetrical distribution rather than the slightly skewed binomial distribution. However, the magnitudes of the sampling errors are similar for the two distributions. Thus, the normal approximation was used to estimate the sampling errors to be expected for various sample sizes. The magnitude of the error is given by:

$$E = 100\ Z \sqrt{\frac{p(1 - p)}{n}}, \tag{4}$$

where

E = error (in %) associated with sampling, deviation from true percentage,

Z = number of standard deviations from the mean of the normal distribution which are required to give the desired confidence level,

p = true germination probability (true germination percentage expressed as a decimal), and

n = number of seed in sample.

The values of Z required to give 50, 75, 90, 95, and 99% confidence levels are 0.675, 1.15, 1.645, 1.96, and 2.575 respectively (Ostle, 2). Table 1 gives the resulting accuracies for various sample sizes, true germinations, and confidence levels. Thus, the accuracy based on the normal distribution is $\pm$ 7.3% for a 200-seed sample at the 99% confidence level when the true germination is 80%. This corresponds closely with the value obtained above using the actual binomial distribution.

Inspection of Table 1 reveals that, even with a 500-seed sample, the accuracy at the 99% confidence level is only approximately $\pm$ 4.6% when the true germination is 80%. Thus, if more accuracy in estimation of true germination percentage is desired, the sample size must be increased still further. In order to determine the sample size required for a given accuracy, equation (4) may be solved for n to obtain:

$$n = \frac{10{,}000\ Z^2\ p(1 - p)}{E^2}\ . \tag{5}$$

Table 2 gives the sample sizes required for accuracies of $\pm$ 1, 2, 3, 4, and 5% for various true germination percentages and confidence levels. Thus, in order to insure that the sample result is within $\pm$ 1% of the true germination 99% of the time, a sample size of 10,700 seeds is required when the true germination is 80%. Since the true germination is not known when sampling occurs, the worst case of a true germination of 50% must be assumed. With this assumption, a sample of 16,600 seeds must be tested to give an accuracy of $\pm$ 1% at the 99% confidence level. A reduction in the confidence level to 95% reduces the sample size required to 9,700 seeds. The commonly used sample size of 200-seeds is within $\pm$ 3% of the true germination only about 50% of the time if the true germination is 50%. Thus, it is apparent that in order to accurately predict the true germination percentage of a lot of seed, much larger samples must be used and care should be taken to assure that the sample is a randomly-selected representative of the lot.

Table 1. Accuracy of germination tests based upon samples of various sizes. (Expressed as a plus or minus deviation from true percentage)

Confidence Level	True Germination Percentage	Sample Size				
		100	200	300	400	500
.50	50	3.4	2.4	1.9	1.7	1.5
	70	3.1	2.2	1.8	1.5	1.4
	75	2.9	2.1	1.7	1.5	1.3
	80	2.7	1.9	1.6	1.4	1.2
	85	2.4	1.7	1.4	1.2	1.1
	90	2.0	1.4	1.2	1.0	0.9
	95	1.5	1.0	0.8	0.7	0.7
.75	50	5.8	4.1	3.3	2.9	2.6
	70	5.3	3.7	3.0	2.6	2.4
	75	5.0	3.5	2.9	2.5	2.2
	80	4.6	3.3	2.7	2.3	2.1
	85	4.1	2.9	2.4	2.1	1.8
	90	3.5	2.4	2.0	1.7	1.5
	95	2.5	1.8	1.4	1.3	1.1
.90	50	8.2	5.8	4.7	4.1	3.7
	70	7.5	5.3	4.4	3.8	3.4
	75	7.1	5.0	4.1	3.6	3.2
	80	6.6	4.7	3.8	3.3	2.9
	85	5.9	4.2	3.4	2.9	2.6
	90	4.9	3.5	2.8	2.5	2.2
	95	3.6	2.5	2.1	1.8	1.6
.95	50	9.8	6.9	5.7	4.9	4.4
	70	9.0	6.4	5.2	4.5	4.0
	75	8.5	6.0	4.9	4.2	3.8
	80	7.8	5.5	4.5	3.9	3.5
	85	7.0	4.9	4.0	3.5	3.1
	90	5.9	4.2	3.4	2.9	2.6
	95	4.3	3.0	2.5	2.1	1.9
.99	50	12.9	9.1	7.4	6.4	5.8
	70	11.8	8.3	6.8	5.9	5.3
	75	11.2	7.9	6.4	5.6	5.0
	80	10.3	7.3	6.0	5.1	4.6
	85	9.2	6.5	5.3	4.6	4.1
	90	7.7	5.5	4.5	3.9	3.5
	95	5.6	4.0	3.2	2.8	2.5

Table 1. Accuracy of germination tests based upon samples of various sizes. (Expressed as a plus or minus deviation from true percentage).

Table 2. Sample sizes required to give various accuracies of testing for germination percentage.*

Confidence Level	True Germination Percentage	Accuracy (±%)				
		1	2	3	4	5
.50	50	1200	300	200	80	50
	70	1000	300	200	60	40
	75	900	300	100	60	40
	80	800	200	80	50	30
	85	600	200	70	40	30
	90	500	200	50	30	20
	95	300	60	30	20	10
.75	50	3400	900	400	300	200
	70	2800	700	400	200	200
	75	2500	700	300	200	100
	80	2200	600	300	200	90
	85	1700	500	200	200	70
	90	1200	300	200	80	50
	95	700	200	70	40	30
.90	50	6800	1700	800	500	300
	70	5700	1500	700	400	300
	75	5100	1300	600	400	300
	80	4400	1100	500	300	200
	85	3500	900	400	300	200
	90	2500	700	300	200	100
	95	1300	400	200	80	60
.95	50	9700	2400	1100	600	400
	70	8100	2100	900	600	400
	75	7300	1800	800	500	300
	80	6200	1600	700	400	300
	85	4900	1300	600	400	200
	90	3500	900	400	300	200
	95	1900	500	300	200	80
.99	50	16600	4200	1900	1100	700
	70	14000	3500	1600	900	600
	75	12500	3200	1400	800	500
	80	10700	2700	1200	700	500
	85	8500	2200	1000	600	400
	90	6000	1500	700	400	300
	95	3200	800	400	200	200

*Sample sizes have been increased to the next higher hundred for sample sizes greater than 100 and to the next higher ten for sample sizes less than 100.

Table 2. Samples sizes required to give various accuracies of testing for germination percentage.*

Predicting Germinations Above or Below a Predetermined Level

Fortunately, germination tests are not conducted primarily for estimation of true germination percentage in many cases. Often, the information desired from the test is whether or not the lot has a true germination percentage above or below some predetermined level. For example, in North Carolina peanut seed must test 80% or above in order to be sold as certified seed. Thus if a lot has a true germination of 50%, a testing accuracy of $\pm$ 29% is sufficient to insure that the sample would not pass the critical test. If a lot has a true germination of 90%, a testing accuracy of $\pm$ 10% is sufficient to insure that the sample will equal or exceed the required level of performance. Thus, it is in the region near the predetermined standard level that sampling errors become important.

Figure 2 illustrates the probabilities of rejecting or accepting lots of seed based upon the germination result of a 200-seed sample for various true germination percentages when it is required that the sample germinate 80% or higher for acceptance. The curve is plotted from tabulated values of the binomial distribution (1) and assumes that a sample germination of 79.5% would be rounded to 80% and thus would be acceptable. The curve is called an operating characteristic (or OC) curve. An ideal OC curve would have a probability of 1.0 of rejecting any lot with a true germination percentage less than 80% and a probability of 0.0 of rejecting a lot with a true germination greater than or equal to 80%. Thus, the shaded areas in Figure 2 represent regions of errors due to sampling. In area 1 lots are accepted which should not be accepted (consumer risk) and in area 2 lots are rejected which should be accepted (producer's risk). Thus, the range of true germinations in which the probability of an error in rejecting or accepting the lot is greater than 0.01 is from 73 to 85%. The probability of accepting lots of seed having germination percentages of 79, 78, 77, 76, 75, 74, and 73% are 0.47, 0.34, 0.23, 0.14, 0.08, 0.04, and 0.02 respectively. The probabilities of rejecting seed lots having germination percentages of 80, 81, 82, 83, 84, and 85% are 0.39, 0.26, 0.16, 0.08, 0.04, and 0.01 respectively.

After a peanut seed lot in North Carolina has been sampled and a 200-seed sample has successfully germinated 80% or higher, the lot may be "tagged" as "certified" seed. It is still subject to additional sampling and testing to insure proper labeling. In this case, a 400-seed sample is used and a tolerance is allowed for possible sampling error. Figure 3 shows the operating characteristic curve for a 400-seed sample with a tolerance of 5% when the acceptable level is 80%. With the 5% tolerance in effect, the seed lot would not be rejected (sale would not be stopped) if at least 74.5% of the sample germinated. Figure 3 indicates that some seed lots having germination percentages below 80%, but which had passed the initial testing, would be rejected by the second or "official" test. However, virtually none of the seed lots having true germination percentages equal to or higher than 80% would be rejected by the second test. Figure 4 shows the resultant OC curve when seed lots are subjected to the "certification" testing and then the accepted lots are subjected to the "official" testing. The curve in Figure 4 is only slightly different from that of Figure 2 with the differences being slightly higher probabilities of rejecting seed lots having true germination percentages less than 80%.

If all seed lots accepted for sale as "certified" seed were subjected to the "official" test and if all true germinations were equally probable, areas 1 and 2 in Figure 4 would be respectively proportional to the number of seed lots accepted which should have been rejected and to the number of seed lots rejected which should have been accepted. Since the OC curves of Figures 2 and 4 are

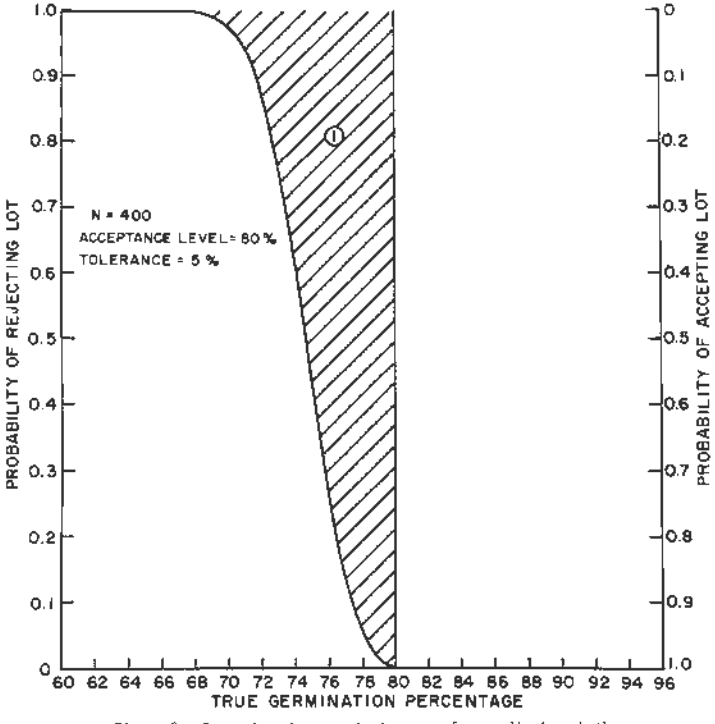


Figure 3. Operating characteristic curve for predicting whether seed is properly labeled at 80% germination using a 400-seed sample and a tolerance of 5%.

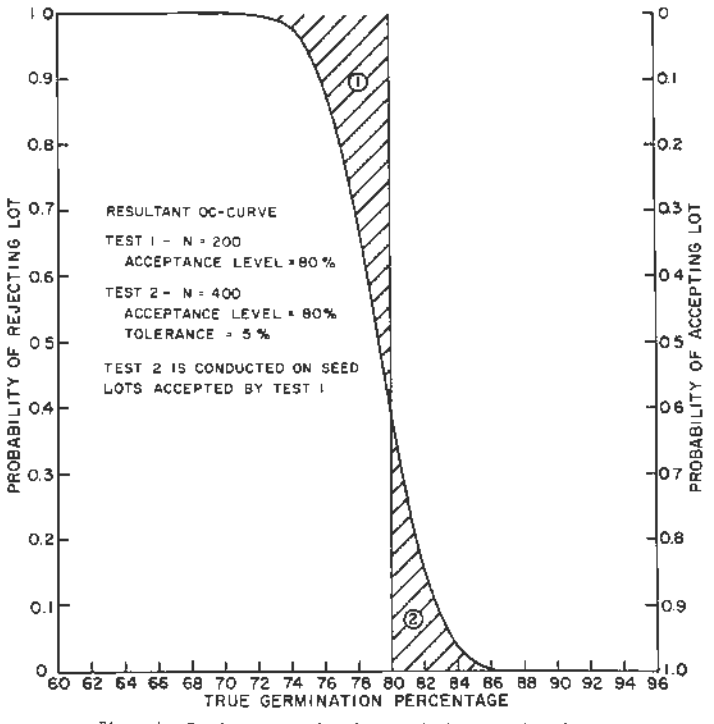


Figure 4. Resultant operating characteristic curve when the test illustrated by Figure 2 is followed by the test illustrated by Figure 3 for those lots passing the first test.

only slightly different, little error is introduced by assuming that all the seed lots accepted by the "certification" test are retested by the "official" test. However, all true germination percentages are not equally probable in nature and some distribution of these true percentages must be known in order to convert the probabilities of Figure 4 to numbers of lots rejected or accepted.

In order to obtain estimates of the prior distribution of true germination percentages, the results of peanut germination tests conducted by the Seed Testing Division of the North Carolina Department of Agriculture during the crop years of 1965-1970 were analyzed to determine what portion of the samples resulted in germinations of each value between 0 and 100%. There were considerable differences between the distributions obtained for the six years analyzed. Figure 5 is a plot of the frequency distribution for the 1967 crop year which appeared to be near the average of the six year period. The distribution is skewed toward the higher germinations with the peak occuring at 96%. The mean and the standard deviation are 84.5% and 12.9% respectively. A summary of the statistics found for the frequency distributions of all six years is presented in Table 3.

The frequency distributions found for the test results are not the true prior distributions since sampling error was involved in each of the tests which tended to bias the distribution toward the extremes of 0 or 100%. However, the distributions should be near enough to the true prior distributions to be used in estimating the number and percentage of peanut lots which are affected by the errors in areas 1 and 2 of Figure 4. Table 4 gives estimates of these errors. The estimated number of lots having a true germination less than 80% which were accepted by the testing procedure varied with the prior distributions of the various years. The estimated "bad" lots accepted as a percent of the total lots tested varied between 0.94 and 2.95% with an average of 1.96%. The estimated "good" lots rejected as a percent of the total lots tested varied between 1.03 and 3.30% with an average of 2.14%. The estimated percentage of lots having true germinations in the range of 73-85% which were misclassified was relatively constant and averaged 16.18%. Over the six-year period approximately 25% of all lots were in the 73-85% range of true germinations.

Thus, it appears that sampling errors are not unreasonable in the present tests for "certification" of peanut seed and the subsequent retesting for proper labeling. The percentage of the total lots which were mis-classified was estimated to average 4.1% over the six-year period studied. This percentage would increase if a higher percentage of the total lots had true germinations in the critical range of 73-85% and would decrease if a lower percentage of the total lots had true germinations in the critical range.

Estimating Differences in Germination Percentages

In seed quality research, the aim of germination testing is often not to determine true germination percentages or to determine whether the germination is above some predetermined level. Rather the primary purpose for conducting germination tests is often to estimate differences in germination percentages which may be related to differences in production practices or other variables. In these cases, the accuracy in predicting differences between lots is of interest.

If two equal samples are taken from the same lot of seed, the probability of getting no difference between the sample results is given by:

$$G(0) = \sum_{i=0}^{n} P(i) \cdot P(i), \qquad (6)$$

where

$G(0)$ = probability of getting zero difference between samples,

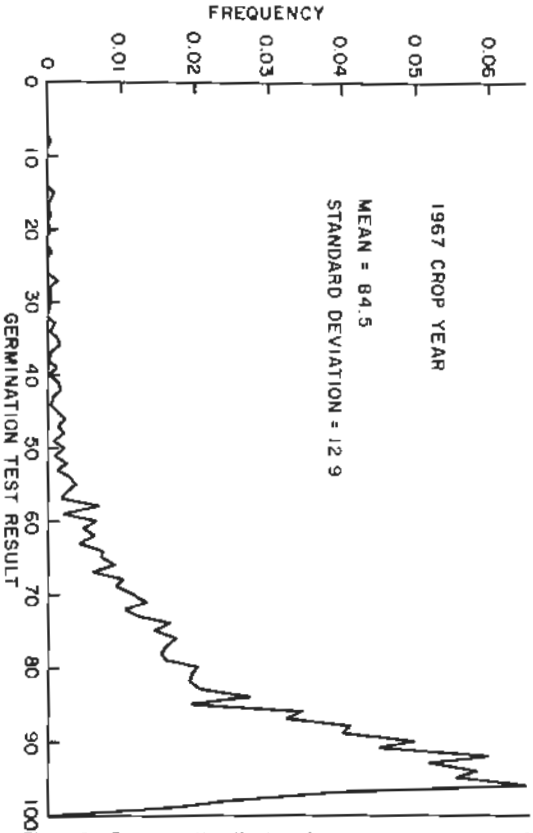
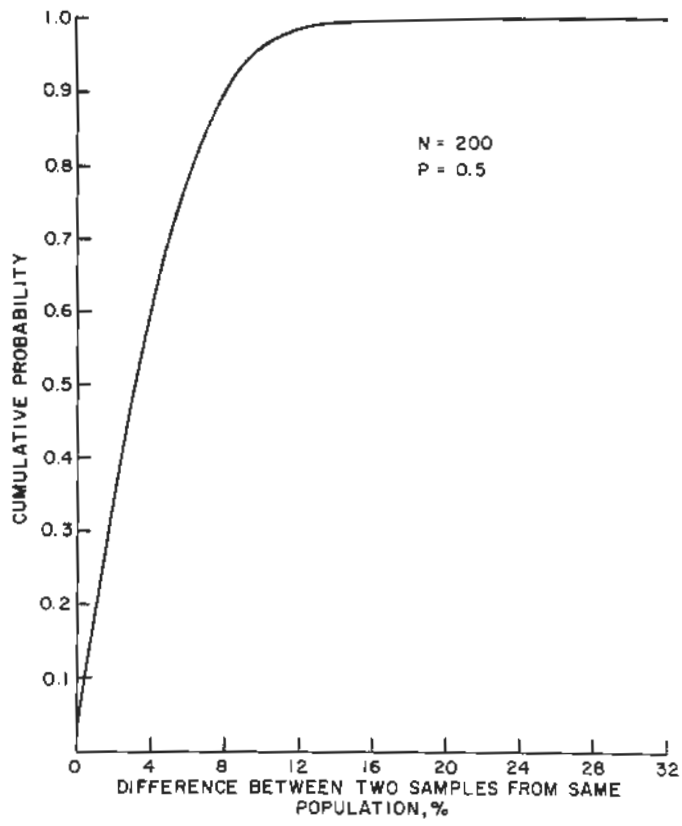


Figure 5. Frequency distribution of germination test results for samples tested by the Seed Testing Division of the North Carolina Department of Agriculture from peanuts of the 1967 crop.



Figur 6. Cumulative probability distribution for differences between two 200-seed samples taken from a population having a true germination of 50%

Table 3. Germination percentage statistics for peanut seed tested by the Seed Testing Division of the North Carolina Department of Agriculture.

Year	Total Number of Samples	Avg. Germ.	Std. Dev.	% Less than 70	% Less than 75	% Less than 80	% Less than 85	% Less than 90	% Less than 95
1965	2028	86.8	11.6	8.0	12.6	18.9	29.4	47.6	74.4
1966	1742	78.3	15.1	22.5	29.7	41.6	56.0	75.3	94.9
1967	2366	84.5	12.9	12.0	18.3	26.2	36.8	53.4	79.8
1968	2574	78.5	13.1	22.3	31.0	42.9	60.9	80.5	95.3
1969	2340	91.9	8.0	1.9	3.4	7.0	12.6	23.4	52.7
1970	2340	84.8	12.7	12.1	17.5	26.0	37.6	53.0	76.7

Table 3. Germination percentage statistics for peanut seed tested by the Seed Testing Division of the North Carolina Department of Agriculture.

Table 4. Estimates of numbers and percentages of peanut lots mis-classified during the 1965-70 period due to sampling errors.

	Year						Total
	1965	1966	1967	1968	1969	1970	
No. of lots tested	2028	1742	2366	2574	2340	2340	13390
Bad[1] lots accepted							
Number	27	50	43	76	22	45	263
% of Total	1.33	2.87	1.82	2.95	0.94	1.92	1.96
Good[2] lots rejected							
Number	38	48	45	85	24	47	287
% of Total	1.87	2.76	1.90	3.30	1.03	2.01	2.14
Total lots improperly categorized							
Number	65	98	88	161	46	92	550
% of Total	3.21	5.63	3.72	6.25	1.97	3.93	4.11
Number of lots in 73-85 range of true germinations	447	585	551	975	266	576	3400
% of lots in 73-85 range of true germinations	22.04	33.58	23.29	37.88	11.37	24.62	25.39
% of lots in 73-85 range of true germinations which were improperly categorized	14.54	16.75	15.97	16.51	17.29	15.97	16.18

1 - A "bad" lot is a lot having a true germination less than 80%.

2 - A "good" lot is a lot having a true germination of 80% or higher.

Table 4. Estimates of numbers and percentages of peanut lots mis-classified during the 1965-70 period due to sampling errors.

n = number of seed in each sample, and

P(i) = probability of having i germinable seeds in the sample of size n.

Likewise, the probability of getting a difference, D, between the two samples is:

$$C(D) = \sum_{i=o}^{n} P(i) \cdot P(i - D) + \sum_{i=o}^{n} P(i) \cdot P(i + D), \quad (7)$$

where

C(D) = probability of getting a difference of D between the samples.

Figure 6 is a plot of the cumulative probability distribution for differences between two 200-seed samples taken from a population having a true germination percentage of 50%. Approximately 1% of the time the two samples will differ by more than 13% in germination. This means that in order to test for differences between two lots of seed, differences greater than 13% must be observed in order to be 99% confident that any difference exists. Thus, it is apparent that larger sample sizes are required to verify differences in germination of different seed lots.

The distribution of sample differences may also be approximated by a normal probability distribution. In this case the variance is the sum of the variances of the individual sample distributions. When both samples come from the same population, the variance is:

$$\sigma_D^2 = 2\, n\, p(1 - p), \quad (8)$$

where

σ_D^2 = variance of the sample differences.

Then the magnitude of the error involved in estimating differences between germination of lots becomes:

$$E_D = 100\, Z \sqrt{\frac{2p(1 - p)}{n}}, \quad (9)$$

where

E_D = error associated with sampling for difference between seed lot germinations.

Comparison of equations (9) and (4) reveal that the error associated with estimating differences is related to the error in estimating true germinations by:

$$E_D = \sqrt{2}\ E \quad (10)$$

Table 5 gives the resulting accuracies for various sample sizes, true germinations, and confidence levels. The accuracies are calculated based upon the assumption that the samples come from populations having equal true germination percentages.

Table 5. Accuracy of estimates of differences between germination percentages based upon samples of various sizes. (Expressed as a plus or minus deviation from the true difference in germination.)

Confidence Level	True Germination Percentage*	Sample Size				
		100	200	300	400	500
.50	50	4.8	3.4	2.8	2.4	2.1
	70	4.4	3.1	2.5	2.2	2.0
	75	4.1	2.9	2.4	2.1	1.8
	80	3.8	2.7	2.2	1.9	1.7
	85	3.4	2.4	2.0	1.7	1.5
	90	2.9	2.0	1.7	1.4	1.3
	95	2.1	1.5	1.2	1.0	0.9
.75	50	8.1	5.7	4.7	4.1	3.6
	70	7.5	5.3	4.3	3.7	3.3
	75	7.0	5.0	4.1	3.5	3.1
	80	6.5	4.6	3.8	3.3	2.9
	85	5.8	4.1	3.4	2.9	2.6
	90	4.9	3.5	2.8	2.4	2.2
	95	3.5	2.5	2.0	1.8	1.6
.90	50	11.6	8.2	6.7	5.8	5.2
	70	10.7	7.5	6.2	5.5	4.8
	75	10.0	7.1	5.8	5.0	4.5
	80	9.3	6.6	5.4	4.7	4.2
	85	8.3	5.9	4.8	4.2	3.7
	90	7.0	4.9	4.0	3.5	3.1
	95	5.1	3.6	2.9	2.5	2.3
.95	50	13.9	9.8	8.0	6.9	6.2
	70	12.7	9.0	7.3	6.4	5.7
	75	12.0	8.5	6.9	6.0	5.4
	80	11.1	7.8	6.4	5.5	5.0
	85	9.9	7.0	5.7	4.9	4.4
	90	8.3	5.9	4.8	4.2	3.7
	95	6.0	4.3	3.5	3.0	2.7
.99	50	18.2	12.9	10.5	9.1	8.1
	70	16.7	11.8	9.6	8.3	7.5
	75	15.8	11.2	9.1	7.9	7.1
	80	14.6	10.3	8.4	7.3	6.5
	85	13.0	9.2	7.5	6.5	5.8
	90	10.9	7.7	6.3	5.5	4.9
	95	7.9	5.6	4.6	4.0	3.5

* - Accuracies are calculated with the assumption that samples come from lots having the same true germination percentages.

Table 5. Accuracy of estimates of differences between germination percentages based upon samples of various sizes. (Expressed as a plus or minus deviation from the true difference in germination.)

Table 6. Sample sizes required to give various accuracies of testing for differences in germination percentage of two lots.[1/]

Confidence Level	True Germination Percentage[2/]	Accuracy (±%)				
		1	2	3	4	5
.50	50	2300	600	300	200	90
	70	2000	500	300	200	80
	75	1800	500	200	200	70
	80	1500	400	200	90	60
	85	1200	300	200	80	50
	90	900	300	90	50	40
	95	500	200	50	30	20
.75	50	6700	1700	800	500	300
	70	5600	1400	700	400	300
	75	5000	1300	600	400	200
	80	4300	1100	500	300	200
	85	3400	900	400	300	200
	90	2400	600	300	200	100
	95	1300	400	200	80	50
.90	50	13600	3400	1600	900	600
	70	11400	2900	1300	800	500
	75	10200	2600	1200	700	500
	80	8700	2200	1000	600	400
	85	6900	1800	800	500	300
	90	4900	1300	600	400	200
	95	2600	700	300	200	200
.95	50	19300	4800	2200	1200	800
	70	16200	4100	1800	1100	700
	75	14500	3600	1600	900	600
	80	12300	3100	1400	800	500
	85	9800	2500	1100	700	400
	90	7000	1800	800	500	300
	95	3700	1000	500	300	200
.99	50	33200	8300	3700	2100	1400
	70	27900	7000	3200	1800	1200
	75	24900	6300	2800	1600	1000
	80	21300	5400	2400	1400	900
	85	17000	4300	1900	1100	700
	90	12000	3000	1400	800	500
	95	6300	1600	700	400	300

1 - Sample sizes have been increased to the next higher hundred for sample sizes greater than 100 and to the next higher ten for sample sizes less than 100.

2 - Sample sizes are calculated with the assumption that samples come from lots having the same true germination percentage.

Table 6. Sample sizes required to give various accuracies of testing for differences in germination percentage of two lots.[1/]

If no knowledge of the true germination percentages is available, the accuracy based upon a 50% true germination (the worst case) should be used as an estimate of the sampling error. If the populations are known to have germinations higher than 50%, the accuracies may be estimated based upon the higher true germination percentages. Table 6 gives the sample sizes required for various accuracies of determining differences in germination of two lots of seed. The sample sizes required for estimating differences are twice as large as those required for estimating true germination percentages. For example, if it is desired to estimate the difference in germination of two lots of seed for which no prior knowledge of the true germination is available, sample sizes of 33,200 seeds must be used to be 99% confident that the estimated difference is within $\pm$ 1% of the true difference. If the two lots are known to have true germinations of approximately 80%, a sample size of 21,300 seeds may be used for the same accuracy and confidence level.

The sample sizes required to give high accuracies are much higher than those which are normally used in germination tests. However, replicate samples are often used to increase accuracy. It can be shown though that the sampling errors obtained by testing four 200-seed samples are the same as the errors obtained by testing one 800-seed sample. Thus, it is the total number of seed tested that determines the accuracy in both estimates of true germination and in estimates of differences in germination between lots.

Summary and Conclusions

The binomial probability distribution and its approximation by the normal probability distribution were used to evaluate the sampling errors to be expected in conducting germination tests for various purposes. Major findings of the study are:

1. In order to accurately estimate the true germination percentage of a lot of seed, it is necessary to test relatively large numbers of seed. Tables 1 and 2 were prepared to give the accuracy to be expected when samples of various sizes are used and to give sample sizes required for certain accuracies.
2. Sampling errors were evaluated for the situation in which the purpose of testing is to predict whether the germination is above or below a predetermined level. Based upon these evaluations, it was estimated that, due to sampling error alone, approximately 4.1% of the peanut seed lots in North Carolina would have been improperly classified as above or below 80% during the years 1965-70 based upon the present testing procedures.
3. In order to accurately estimate differences in germination percentages of two seed lots as is often the purpose in seed quality research, it is necessary to test samples twice as large as those needed in estimating true germination percentages. Tables 5 and 6 were prepared to give the accuracy to be expected when samples of various sizes are used and to give sample sizes required for certain accuracies.

Two additional interesting observations bear repeating. They are:

1. If the true germination percentage is greater than 50%, all predictions of the true germination are slightly biased toward the higher germinations.
2. Replications of truly random samples of a given size do not decrease sampling errors any more than increaseing the sample size to contain the same total number of seed.

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INFLUENCE OF SEED QUALITY AND ENVIRONMENT ON PEANUT INJURY BY HERBICIDES[1/]

Paul W. Santelmann, Professor
Department of Agronomy, Oklahoma
State University, Stillwater, Oklahoma 74074

INTRODUCTION

Herbicides are used extensively for controlling weeds in peanuts in order to maintain economically high production levels. Farmers have learned through experience that properly used herbicides usually provide good weed control without crop injury. However, anyone who grows plants has learned that many plant and environmental factors may effect the yield level obtained, as well as how the plant will react to fertilizer or other materials. Thus, it is reasonable to expect that some of these factors will influence the ability of a herbicide to either kill weeds or injure the crop.

Factors such as rainfall, soil type, temperature and moisture have been shown to influence the phytotoxicity of some herbicides to peanuts (5, 1, 7, 3). Other factors may also be involved - such as the quality of the seed used, interactions of the herbicides with other pesticides, or various application factors (11). Most of the pesticide interaction research has been conducted using trifluralin with crops other than peanuts. Some have reported no interaction (8, 6, 4) whereas others have reported that some interactions between insecticides and herbicides could occur (1, 9, 2, 8).

There has been little research on the influence of peanut seed quality on herbicide phytotoxicity. Some (6, 11, 12) have shown that planting low quality seed may result in a reduction in crop growth and yield.

Experiments have been conducted over the past several years in Oklahoma to determine the influence of environmental factors and peanut seed size, quality, and injury on the susceptibility of peanut seedlings to herbicide injury. Since these experiments have been conducted in several different ways in both the greenhouse and field, the research procedure used for each experiment will be discussed with the results of that experiment.

METHODS AND RESULTS

Seed Size: Four seed sizes of Starr peanuts were used in field and greenhouse experiments to determine if seed size variation resulted in seedlings that were more susceptible to herbicide injury. Seed sizes used were: (a) small (retained by 13/64" sieve), (b) medium (retained by 15/64" sieve), (c) regular (retained by 17/64" sieve), and (d) large (retained by 19/64" sieve). The seeds were planted in greenhouse pots or in field soil treated with Treflan at 1/2 or 1 lb/A, or were treated after planting with Amiben at 2 or 4 lb/A.

In the greenhouse both herbicides caused some slight stunting for all seed sizes 10 days after treatment. More top and root injury occurred when using small seeds in Treflan treated soil than when medium, regular, or large seeds were planted. There was little difference in root injury between the various seed sizes when Amiben was used.

[1/] Contribution from the Oklahoma Agricultural Experiment Station, Stillwater. Appreciation is expressed to Loyd V. Hill, Thomas Peeper, Roland Cargill, and Robert Matthiesen for their help in these various studies, and to the Oklahoma Peanut Commission for partial financing of this research.

In the field there was more root injury to seedlings from small seeds than large seeds, but there were no significant differences when comparing either extreme with the intermediate sizes. As size increased, top growth increased with all treatments involved. There were no yield differences with any of the seed sizes planted in soil treated with Treflan at 1/2 lb/A or with Amiben. There was a yield reduction when small or medium size seeds were planted in soil treated with 1 lb/A of Treflan.

Seedcoat Removal Treatments: Various seedcoat removal treatments were tried to determine if they caused young peanut plants to be more susceptible to injury from Treflan and Amiben in the greenhouse. The following treatments were made to regular size Starr peanut seed: (a) visibly sound - normal seed with a full seedcoat, (b) seedcoat partially removed - 1/2 of the seedcoat was removed, (c) seedcoat absent - the seedcoat was completely removed, (d) splits with a seedcoat - one cotyledon and radical with the seedcoat present, and (e) splits without a seedcoat - one cotyledon and radical with the seedcoat absent. Seeds with these various treatments were planted in the greenhouse and treated.

Stunting of the peanut seedlings occurred when using one-half of a seed with and without a seedcoat with all herbicide treatments. There was generally greater top growth when whole seeds rather than half seeds were planted. However, all seeds without a seedcoat planted in soil treated with Amiben at 4 lb/A resulted in stunting and severe root injury. There was less root growth from plants at half seed without a seedcoat than any other seedcoat removal treatment. However, this reduction was not significant when comparing the herbicide treatments to the similar untreated check.

Mechanical Seed Damage: Various means of mechanically injuring Starr peanut seed were used to determine if seedlings from damaged seed were more susceptible to herbicide injury. The following were the treatments: (a) visibly sound shelled seed (mechanically shelled), (b) shelled seeds dropped 10 feet through a 3/8 inch brass pipe onto a concrete floor, with the germ end of the seed placed in a downward position, (c) seeds dropped 10 feet through the pipe with the germ end in an upward position, (d) seeds dropped 10 feet through a 3/4 inch aluminum pipe onto a concrete floor with the side of the seed placed in an upward position, (e) the germ end of the seed passed across a flat file to cause abrasions of the germ end, (f) unshelled seed dropped 10 feet through the aluminum pipe, and (g) unshelled sound seed. Seeds for treatments (f) and (g) were shelled by hand prior to planting. The seeds were then planted in soil and treated with either Amiben or Treflan.

Plants from the untreated check plot and the various mechanical injury treatments were more vigorous and had more top growth than plants from the same seed injury treatments treated with herbicides. This was not true of root growth. There was a reduction in top dry weights from seedlings whose seed were dropped on the germ end or side, dropped while in the shell, or when the germ end was mechanically abused. Taproot length was reduced from seed dropped on the germ end and from mechanical abuse to the germ end compared to sound shelled seed when averaged across all treatments.

Pesticide Interactions: Experiments were conducted in the greenhouse and field in which either Treflan at 1/2 and 1 lb/A, Vernam at 1/2 and 3 lb/A, or Amiben at 2 and 4 lb/A were applied or incorporated into the soil where other pesticides had been used. The insecticides, fungicides, and nematocides were used as recommended on the label.

No reduction in peanut root or top growth occurred as a result of combination treatments of herbicides with the fungicides PCNB, chloronitropropane, or combinations of the two fungicides in the greenhouse. Root growth stunting occurred when 1 lb/A of Treflan was used either alone or with some insecticides. Some stunting of peanut seedlings occurred when using Treflan and 2 lb/A of Disulfoton. There was no apparent top or root growth reduction with 1/2 lb/A of either Treflan or Vernam when used in combinations with Phorate, Aldicarb, or Disulfoton in the greenhouse. Soil treated with dibromochloropropane at 1 or 1½ gpa caused as much injury to peanut roots as Vernam or Treflan

treatments. There was a reduction from root growth from plants grown in soil treated with Treflan and D-D at 8 gpa when compared to the check pots where soil was treated with the nematocide alone. Very little difference in plant injury was noted when using Treflan or Amiben on peanut seed treated with Ceresan, Arasan, or Captan seed treatments in the greenhouse. There was some root injury from the herbicides alone which might have masked any interactions.

Disulfoton, Phorate, Dibromochloropropane, and PCNB were used with Amiben and Treflan treatments in the field for two years. Little difference in root injury was noted from the treatments used in these experiments. In one year the nematocide alone reduced top and root growth more than most of the other treatments, but this difference was not generally statistically significant. Little difference in plant growth was observed within each herbicide treatment for the various pesticides used in this study.

Depth of Incorporation: Treflan (at 1/2, 1, and 1½ lb/A) and Vernam (2, 3, and 4 lb/A) were incorporated either 0, 1, 2, or 3 inches deep in the field. All were incorporated immediately prior to planting with a power rotary tiller set at the desired depth. The soil type was a Norge sandy loam.

The activity of the Vernam was greatly improved by incorporation and was directly related to the depth of incorporation and the rate of herbicide application. Very little crop injury and no significant yield reductions were noted either year that the experiments were conducted. The weed control obtained with Treflan was also drastically improved by incorporation, as the 0 inch depth (preemergence) had the poorest weed control. Surprisingly little crop injury was noted with Treflan at any rate or depth of incorporation. However, there was a yield reduction at the high rate of Treflan when there was no incorporation.

Method of Incorporation: Treflan was applied prior to the planting of peanuts and then incorporated with either a ground driven rotary hoe, a tandem disk, or a spring toothed harrow. Immediately after incorporation peanuts were planted in the usual manner.

On a sandy loam soil incorporation 1 to 2 inches deep with a disk harrow provided better weed control without crop injury both years the experiment was conducted. Results with spring toothed harrow incorporation were somewhat similar to those with disk incorporation, but were not quite as good. The ground driven rotary hoe provided poor incorporation and poor weed control. None of the incorporation procedures used with 1/2 lb of Treflan per acre resulted in significant crop damage.

Soil Organic Matter Content: A greenhouse experiment was conducted to determine the effect of organic matter content on the phytotoxicity of Treflan and Amiben to young peanut seedlings. Pure white quartz sand was used as a basic plant growing medium. The organic matter used consisted of a 1:1 mixture of alfalfa meal and ground wheat straw. The organic matter was added to the sand in sufficient quantity to achieve organic matter levels of 0, .5, 1, 2, or 4%. Herbicides were then applied to the soils and peanuts planted.

Peanut root injury from the herbicides decreased as the soil organic matter level increased. There was a greater incidence of peanut seedling disease at the higher organic matter levels. Both peanut top and root growth were reduced with the use of the herbicides at the 0% organic matter level. Plant growth was optimum when 1/2 and 1% organic matter levels were used. Plants growing in the 0% organic matter and treated with herbicides were stunted as compared to either plants grown in untreated soil or to plants with the same herbicide grown in soil with the higher organic matter levels. This was particularly true with Treflan.

Soil Temperature: Experiments were conducted in the greenhouse and field to evaluate the influence of soil temperature on peanut injury by herbicides. In the greenhouse Amiben at 2, 4, and 6 lb/A applied preemergence, Vernam incorporated at 1½, 3, and 4½ lb/A, and Treflan incorporated at 1/2, 1, and 1½ lb/A were applied to the soil. The planted and treated pots were then placed in

water baths maintained at 70, 80, 90, or 100° F. The plants were grown for 21 days and then the soil washed from the roots and the injury evaluated. In the field 4 dates of planting were used to approximate different soil temperature levels. Treflan was incorporated prior to planting or Amiben was applied as a preemergence treatment immediately after planting. Soil temperature was measured at the soil surface and at 2 and 4 inches beneath the surface. Root injury evaluations were made two weeks after each planting and treatment.

In the greenhouse soil temperature variations significantly effected the degree of root injury peanut seedlings suffered. As an average of all treatments the least peanut injury occurred at 90°, and this was significantly less than at 70 or 100°. Injury at 80° was significantly less than at 100°. Almost all treatments showed significant differences due to soil temperature. Amiben caused the greatest degree of root injury, particularly with the 4 and 6 lb/A rates at a 70° soil temperature. Vernam caused the least root injury at all rates, although at both temperature extremes more root injury occurred. Treflan at the 1/2 lb/A rate was very similar to Vernam, but at the higher rates caused more injury.

In the field the average minimum and maximum temperature values were tabulated for four two week periods. In general as the temperature of the soil increased, root injury from either Amiben or Treflan decreased. More injury was noted at the earlier application date, i.e. cooler soil and air temperature. As soil temperatures increased from 55 to 75°, peanut injury decreased from a very severe condition at 55° to negligible injury at 75°.

Soil Moisture: Two experiments were conducted in the greenhouse to evaluate the influence of soil moisture on herbicide phytotoxicity to peanuts. In one experiment approximate soil moisture tensions were maintained by adding known amounts of water through a straw to the soil in the pots. In a second experiment soil moisture was controlled by saturation frequency. Twenty-one days after treatment the soil was washed from the roots and the roots visually rated. Significantly more Treflan and Amiben injury occurred with the driest soil conditions. Less root injury occurred with Vernam under the varying moisture conditions.

Postemergence Herbicides: Experiments were conducted to determine the influence of the time of application of groundcrack and postemergence herbicides to growing peanuts in the field. Dinoseb (dinitro), 2,4-DB, and a formulated mixture of Alanap + dinitro were applied at different times after peanut emergence. Peanut injury was observed through the season and yields collected at the end of the season.

Dinoseb treatments following emergence caused slight crop injury, but the plants recovered within two weeks. Treatments applied at the groundcrack stage showed no injury in two of the three years. Treatments 14 and 28 days after groundcrack caused some initial injury in the form of leaf necrosis, but it dissipated within two weeks. Yield data showed differences only with the 28 day treatment.

When used at the groundcrack stage, 2,4-DB caused no peanut injury. Treatments 7, 14, or 28 days following emergence produced very slight injury (leaf and stem curl and chlorosis) all of which dissipated within two weeks. There was no significant influence on yields from any stage of treatment. A combination of dinoseb and 2,4-DB produced no injury symptoms when applied at the groundcrack stage.

Mixtures of diphenamid, Amiben, or Alanap with dinoseb caused no injury when used at the groundcrack stage. Some leaf necrosis and chlorosis developed on plants treated 7 or more days after emergence. However, these symptoms dissipated within two weeks. With all these combinations if more than 1½ lb/A of dinoseb was used some yield reduction and continued plant injury occurred when applied 28 days after plant emergence. The optimum time to apply these chemicals to minimize crop injury appears to be during peanut emergence. Treatments caused greater injury which persisted longer as applications were made later into the growing stages of the crop.

CONCLUSION

The herbicides used in these studies caused various degrees of injury to peanut seedlings, depending on the conditions. In most instances where the recommended rate of the herbicides were applied root or top injury was held to a minimum. Frequently, however, where rates exceeded the recommended level for the soil type used there was considerable root pruning or top stunting. There were definite interrelationships between seed size or seed injury and the degree of peanut susceptibility to herbicide injury.

Various field cultural practices had some relationship to peanut injury by the herbicides used. Little consistent interaction was found between the various types of pesticides that were compared. However, practices such as the depth and method of soil incorporation, the soil organic matter level, and soil temperature and moisture conditions had direct influence on the amount of plant injury that occurred. In particular, soil temperature conditions that varied from optimum planting temperatures seem to increase the chances for peanut seedling injury. Postemergence herbicides only caused peanut seedling injury when applied after the plants had grown out of the seedling stage.

It would appear that peanut injury from herbicides used for weed control may increase when combinations of two or more adverse conditions occur at the same time. If conditions are such - either through seed influences or environmental factors - that a less vigorous peanut seedling may result then the plant apparently is more susceptible to herbicide injury.

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CORRELATION OF VOLATILE COMPONENTS OF PEANUT BUTTER WITH FLAVOR SCORE

by
Sara P. Fore, L. A. Goldblatt, and H. P. Dupuy
Southern Regional Research Laboratory
Southern Marketing and Nutrition Research Division
ARS, USDA, P. O. Box 19687, New Orleans, Louisiana 70179

ABSTRACT & PAPER

A direct gas-chromatographic method for the preparation of peanut butter volatiles profiles has been developed. An aqueous slurry of peanut butter is injected onto a plug of glass wool in a glass liner in the heated inlet of a gas chromatograph. After 20 minutes, the glass liner containing the spent sample is removed from the inlet. The volatiles which have been eluted from the peanut butter and collected on the top portion of a Porapak P column are resolved by temperature programmed gas chromatography (GC) between 40 and 180°C. Volatiles which have been tentatively identified included 2-methylpropanal, 2- and 3-methylbutanal (unresolved), C-2 through C-10 n-aldehydes, pyrazine, methylpyrazine, dimethylpyrazine, benzaldehyde and phenylacetaldehyde.

GC volatiles profiles were determined for 14 peanut butters which had been flavor scored by a taste panel on a scale of 1 to 10 with 10 as the best score. When the ratios of the methylpropanol to the hexanal peak areas were plotted against the taste panel flavor scores, 9 of the 14 points were almost on the regression line, and the other 5 points were within one flavor score unit of the regression line. When the ratios of the methylbutanal to the hexanal peak areas were plotted against the taste panel flavor scores, 9 of the 14 points were almost on the regression line, and the other 5 points were within a half unit of the regression line.

INTRODUCTION

Because most of the peanuts produced in this country are used for food, flavor of peanuts and peanut products is very important. A number of studies have been made of components which may be related to the characteristic flavor of raw and roasted peanuts and also to off-flavors in peanuts (1-13). Recently, Singleton et al. (14) have related the ratio of acetaldehyde and pentane to methanol in volatiles from raw peanuts to curing temperatures of peanuts and also to the development of off-flavors in peanuts. For these studies concentrates of volatile compounds were prepared and then were analyzed by gas chromatography (GC) or other means. Since large samples of peanuts are required and since preparation of concentrates is time consuming, these procedures are not suitable for quality control of peanuts or peanut products. We have recently developed a direct gas chromatographic method for the quantitative determination of residual hexane in oilseed meals and flours (15), and we have also demonstrated that volatiles profiles can be obtained for vegetable oils (16), peanuts and a number of other foods by direct GC (17). We have now adapted this method for the evaluation of peanut butters.

MATERIALS AND METHODS

Materials

Unopened, peanut butter samples were provided by Procter & Gamble Company[1/], Cincinnati, Ohio. These samples had been flavor scored on a scale of 1 to 10

1/ Use of this or other company or trade name by the Department does not imply approval or recommendation to the exclusion of others that may also be suitable.

with 10 being the best score obtainable. Evaluations of the strength of peanut flavor and of degree of staleness were also given for each sample. Samples of peanut butter evaluated by the taste panel had been taken from other jars of the same batch of peanut butter as those used for GC evaluation. Samples for both tests were taken a half inch below the surface of the peanut butter.

Microliter syringes were from the Hamilton Company, Whittier, California; disposable, 20-gage, Nanojeck needles from Roehr Products Company, Deland, Fla., butyl rubber stoppers, aluminum retainer rings and a crimper for securing the rings from Wheaton Glass Company, Millville, N. J.; Porapak P, 80-100 mesh, from Waters Associates, Framingham, Mass. Silicone O-rings which were from Tek Labs, Baton Rouge, La. were conditioned for 2 hours at 200°C before they were used. Pyrex brand glass wool manufactured by Corning Glass Works, Corning, N. Y. was heated at 200°C for about 16 hours to remove volatiles.

Sample Preparation

A 10-ml serum bottle containing about 10 small glass beads was weighed with a butyl rubber stopper and aluminum retainer ring. About 1 ml of distilled water was added to the bottle and reweighed. The serum bottle and the peanut butter to be sampled were placed in a glove bag which was flushed three times with nitrogen gas. The jar of peanut butter was opened, the top half inch was removed from a small section of the surface, and a 1-to-3-gram sample was removed from this point and placed in the serum bottle. The bottle was capped with the stopper which was secured by crimping the retainer ring, removed from the glove bag and weighed. Enough water was then added by syringe to bring the ratio of water to peanut butter to 1.5 to 1 and the sample was shaken by hand until a smooth slurry was obtained.

Gas Chromatography Procedure

A MicroTek 2000 MF gas chromatograph which was equipped with dual flame ionization detectors, a Westronics recorder and an Infotronics CRS integrator was used. A silicone O-ring was placed at the base of the inlet of the gas chromatograph. A borosilicate glass liner which was carefully packed with a tight plug of volatile-free glass wool at the bottom and a loose plug just above it was inserted above the silicone O-ring in the heated inlet. The liner was then tightened in position with the inlet retainer nut to produce a seal between the lower lip of the liner and the base of the inlet. On closing the inlet system with the septum and septum nut, the carrier gas was forced to flow upward and through the liner as shown in Figure 1.

A 500-µl syringe fitted with a 20-gage needle was filled to the 50-µl mark with distilled water, taking care to remove all air bubbles from the needle. The syringe was then filled to the 350-µl mark with the aqueous slurry of peanut butter, and its contents were injected onto the loose plug of glass wool in the liner of the inlet which had been heated to about 140°C. The sweep of the carrier gas and the steaming action of the water promoted rapid elution of the volatiles which were swept onto the top portion of the column maintained at 40° during an initial hold period of 20 minutes. The liner containing the spent sample was then removed from the inlet, and the volatiles were resolved by temperature programming the column oven from 40 to 180°.

A 1/8" X 6' stainless steel U-tube packed with Porapak P was used to resolve the volatiles. The column oven was programmed at 5° per minute for 18 minutes, at

2° per minute for 10 minutes, at 15° per minute for 2 minutes, and then was held at 180° for 20 to 30 minutes. The temperature of the inlet was set at 140° and of the detector at 250°. The flow of helium carrier gas was set at 70 ml per minute, the hydrogen at 60 ml per minute, and the air at 1.2 cubic foot per hour. About 70 minutes after the aqueous slurry of peanut butter had been injected, 50 µl of water was injected into the liner to clean the column. The column was then cooled to 40° for the next run.

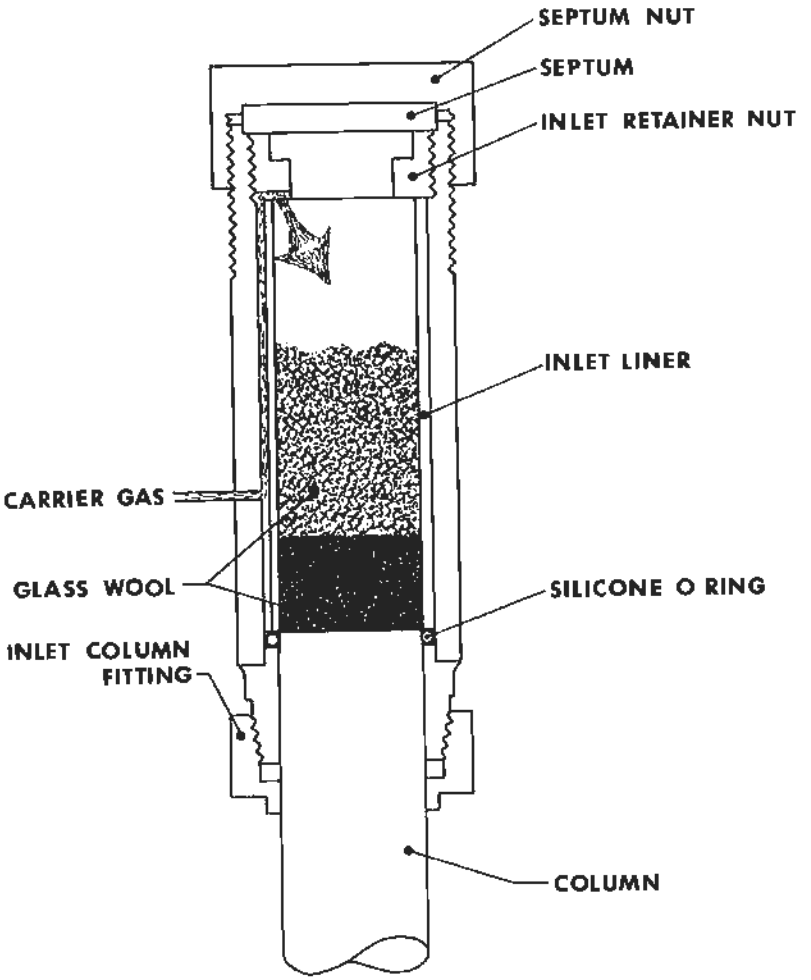

Figure 1. Cross section of gas chromatograph inlet with inlet liner containing glass wool.

Results and Discussion

To achieve rapid and maximum elution of volatile components from peanut butters by direct gas chromatography, it was necessary to force the carrier gas to flow through the aqueous slurry of peanut butter which was injected upon volatile-free glass wool in the liner of the properly heated injection port of the gas chromatograph. It was also necessary to prepare the aqueous slurry of peanut butter under a nitrogen atmosphere and to concentrate the volatiles on a cool gas-chromatographic column to obtain reproducible results.

In preliminary experiments, the sample of peanut butter was spread over the inner surface of the inlet liner which had a small plug of volatile-free glass wool at the bottom to prevent seepage of oil or migration of solid peanut material onto the column. When the liner containing the sample was inserted into the heated inlet and the carrier gas was forced through the sample, a fairly good volatile profile was produced, but the elution of volatiles was poor. If the peanut butter was dispersed in two parts of high quality salad oil, and the slurry was inserted in the inlet liner above the plug of glass wool, the elution of volatiles was greatly improved; but the results were still not satisfactory.

Since the injection of water above samples of meals and flours from oilseeds resulted in quantitative elution of residual hexane (15), dispersion of the peanut butter in water instead of oil was tested. The amount of volatiles eluted by this technique more than doubled. The results were further improved if the slurry was placed on a loose plug of glass wool which allowed better diffusion of sample. However, a tight plug of glass wool was placed as usual at the bottom of the liner to prevent oil seepage or migration of peanut butter material onto the column.

The recovery of aldehydes such as hexanal was more reproducible when the aqueous slurry of peanut butter was prepared under a nitrogen atmosphere, and the sample was injected into the liner after it had been positioned in the heated inlet and the inlet system closed. The best recovery and resolution of volatiles was achieved by heating the inlet to about 140° prior to injecting the sample on the loose plug of glass wool in the inlet liner. It was also necessary to allow the liner with sample to remain in the heated inlet for about 20 minutes while maintaining the column oven at 40° to concentrate the volatiles on the top portion of the cool column. After the spent liner was removed from the inlet and the inlet was closed, the column oven was temperature programmed between 40° and 180° to resolve the volatiles.

Volatiles profiles were prepared in duplicate for 14 flavor-scored peanut butters. The elution times of 20 compounds reported to be present in roasted peanuts (1,2,4,5,7-13) were checked by adding 5 to 25 parts per million of these compounds to the aqueous slurry of the peanut butter. The compounds checked were methanol, pentane, acetone, ethanal, propanal, methylpropanal, butanal, 2-methylbutanal, pentanal, hexanal, heptanal, octanal, nonanal, decanal, benzaldehyde, phenylacetaldehyde, pyrazine, pyridine, methylpyrazine and 2,4-dimethylpyrazine. Compounds that were tentatively identified by their retention times are illustrated in three representative volatiles profiles as shown in Figure 2. The upper chromatogram was produced by a peanut butter which had a taste panel score of 9; the middle chromatogram was produced by a peanut butter which has a taste panel score of 5; and the lower chromatogram was produced by a rancid peanut butter.

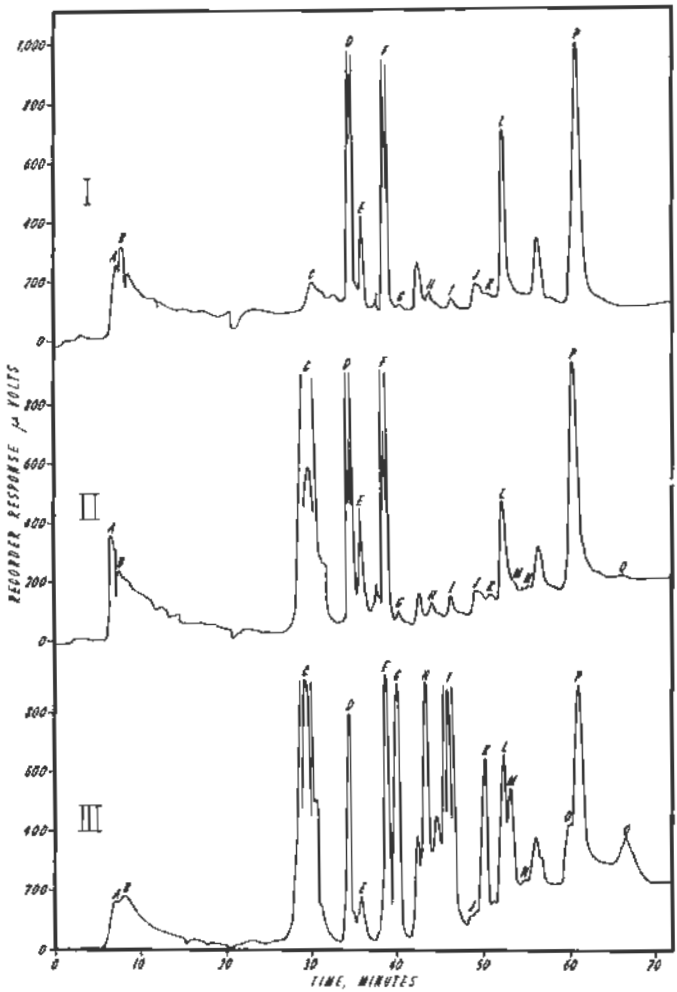

Figure 2. GC volatiles profiles for peanut butter samples: (I) a peanut butter which had a taste panel score of 9, (II) a peanut butter which had a taste panel score of 5, and (III) a peanut butter which was rancid. Tentative identification of peaks: (a) methanol, (b) ethanal, (c) propanal, acetone and pentane, (d) methylpropanal, (e) butanal, (f) 2- and 3-methylbutanal, (g) pentanal, (h) pyrazine and pyridine, (i) hexanal, (j) methylpyrazine, (k) heptanal, (l) dimethylpyrazine, (m) octanal, (n) benzaldehyde, (o) nonanal, (p) phenylacetaldehyde, and (q) decanal.

Although the steam volatile fraction of roasted peanuts is a complex mixture of many compounds (10), the peak area of the components having retention times comparable to methylpropanal, methylbutanal, 2,4-dimethylpyrazine and phenylacetaldehyde which are prominent in the volatiles profiles of roasted peanuts (17), and hexanal which is associated with oil oxidation (18) appear to be of most interest. When areas of these peaks were compared with the taste panel scores of the peanut butters, there did not appear to be any correlation. However, when the ratios of the methylpropanal to the hexanal peak areas were plotted against the taste panel flavor scores, 9 of the 14 points were almost on the regression line, and the other points were within one flavor score unit of the regression line as shown in Figure 3. The correlation coefficient was 0.93. When the ratios of the methylbutanal to the hexanal peak areas were plotted against the taste panel flavor scores, again 9 of the 14 points were almost on the regression line, and the other 5 points were within a half unit of the regression line as shown in Figure 4. The correlation coefficient was 0.96. The peak area of the major volatiles, the GC and taste panel flavor scores, and the taste panel description of the peanut butters are shown in Table 1.

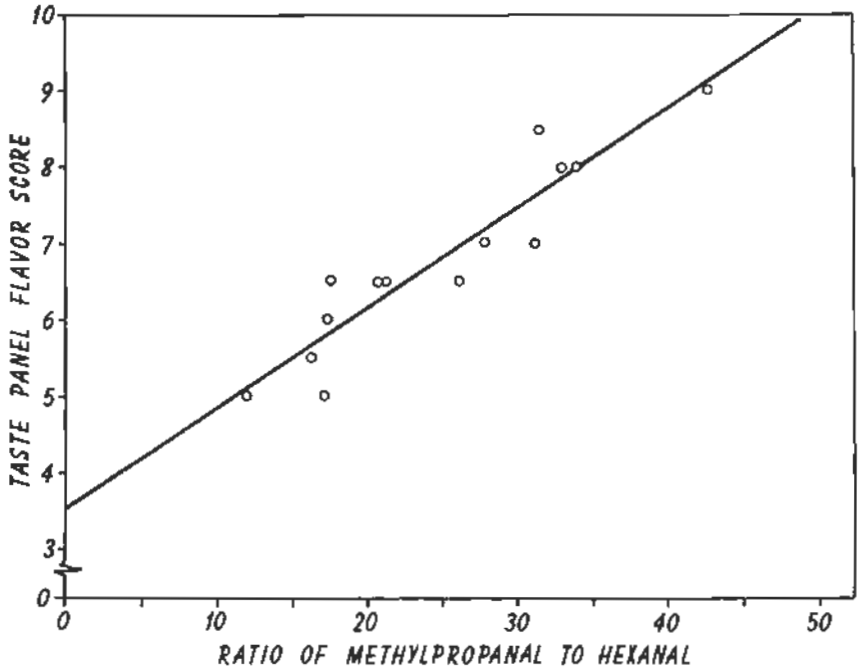

Figure 3. A linear regression line of plot of ratios of methylpropanal to hexanal peak areas against taste panel flavor scores of peanut butters.

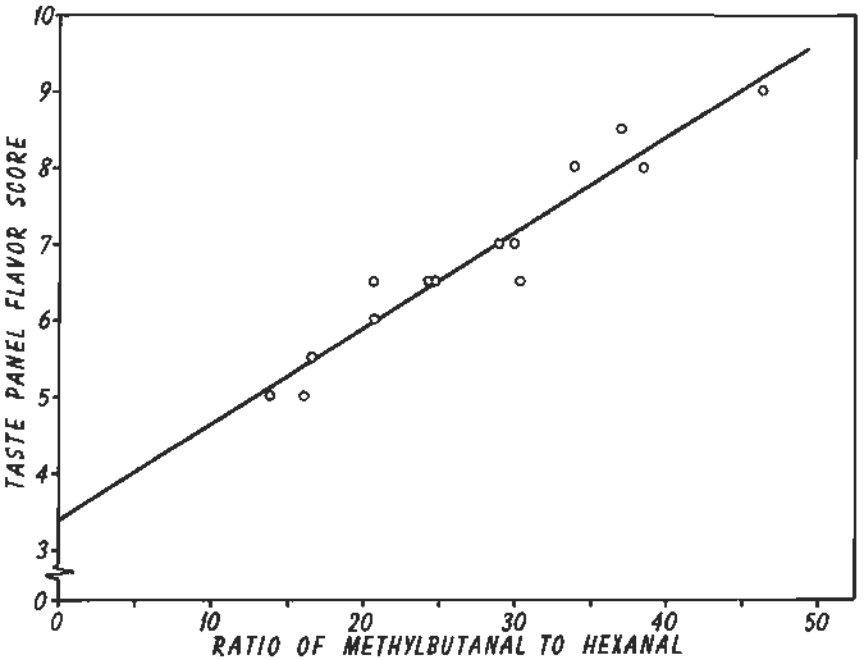

Figure 4. Linear regression line of plot of ratios of methylbutanal to hexanal peak areas against taste panel flavor scores of peanut butters.

Based on these data, the ratio of the methylbutanal to hexanal peak areas appears to be a good indicator of flavor quality of peanut butter. However, since peanut butters from only one source were used in this study, it is possible that other factor or factors will have to be considered when analyzing peanut butters from other sources which have been made from different types of peanuts or stored under other conditions. Additional studies are in progress to determine whether this procedure is generally applicable.

ACKNOWLEDGEMENT

The authors are most grateful to W. H. Koester, Procter & Gamble Company, Cincinnati, Ohio for his cooperation and generous supply of flavor-scored peanut butters used in this study, to J. H. Conkerton for drawing the figures and to J. I. Wadsworth for performing the regression analysis.

Table I. Gas chromatography and taste panel evaluations of peanut butters

Sample	Peak area of major volatiles[1]					GC score[2]		Taste panel evaluation		
	MPA	MBA	DMP	PAA	HA	A	B	Flavor score	panel description Peanut	Stale
1	47	51	24	64	1.1	9	9	9.0	strong	none
2	44	52	21	63	1.4	7.5	8	8.5	strong	none
3	61	61	25	66	1.8	8	7.5	8.0	moderate	none
4	46	54	21	61	1.4	8	8	8.0	moderate	none
5	56	52	25	83	1.8	7.5	7	7.0	weak	trace
6	50	54	31	104	1.8	7	7	7.0	weak	trace
7	49	58	26	59	2.8	7	6	6.5	weak	weak
8	62	73	42	94	3.0	6.5	6.5	6.5	weak	weak
9	36	42	20	39	1.7	6	6.5	6.5	weak	weak
10	73	85	42	94	2.8	6	7	6.5	weak	weak
11	26	31	27	32	1.5	6	6	6.0	weak	weak
12	57	58	22	73	3.5	5.5	5.5	5.5	weak	moderate
13	48	45	11	38	2.8	6	5.5	5.0	weak	moderate
14	38	44	17	57	3.2	5	5	5.0	weak	moderate

1/ Thousands of integrator counts, average of 2 determinations; MPA, methylpropanal; MBA, methylbutanal; DMP, dimethylpyrazine; PAA, phenylacetaldehyde; HA, hexanal.

2/ Obtained from regression lines in plot of MPA/HA vs taste panel score (A) and plot of MBA/HA vs taste panel score (B) in figures 3 and 4, respectively, and rounded to nearest half unit.

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A COMPARISON OF MINOR CONSTITUENTS IN PEANUT BUTTER AS POSSIBLE SOURCES OF FATTY ACID PEROXIDATION

by
Allen J. St. Angelo, Robert L. Ory, and Lawrence E. Brown
Southern Regional Research Laboratory
Southern Marketing and Nutrition Research Division
ARS, USDA, P. O. Box 19687, New Orleans, Louisiana 70179

ABSTRACT AND PAPER

ABSTRACT

Enzymic and nonenzymic causes of lipid oxidation (rancidity or staling) in peanut butter that may possibly affect shelf life of the product were investigated. Various minor constituents were added either in water or in peanut oil to peanut butter samples that were stored and analyzed at intervals for lipid peroxidation contents by two methods. The first, a spectrophotometric method, measures oxidation of the polyunsaturated fatty acids present in peanut butter; the second method reports oxidation as peroxide values. Additives included salts (e.g. NaCl, KCl, $FeCl_3$, etc.), purified metal-containing enzymes (e.g. cytochrome-C, tyrosinase, and peroxidase), and peanut extracts (containing peroxidase, lipoxygenase, and linoleic acid hydroperoxidase). The effects of these additives were followed over a period of four weeks. Results indicated that the metal-containing enzymes, whether added in water or in oil, appeared to cause the greatest increase in peroxidation. All additives when emulsified in oil caused the greatest increase in peroxidation. A correlation of the two analytical methods and interpretation of these results are discussed.

INTRODUCTION

Although peanuts are used in many different food products, one of the most important uses in this country is in peanut butter. In 1970, the three billion-pound crop was valued at $379 million, of which, approximately 25% went into peanut butter (1). This past school year, the U. S. Department of Agriculture alone purchased 23 million pounds of peanut butter, exceeding the old mark of 17 million pounds (2).

Since peanuts contain 26% protein and are exceptionally high in the B vitamins, they are both wholesome and nutritious. However, the main reason Americans eat peanuts is not for health reasons, but for their enjoyable flavor and pleasant aroma. Naturally, preserving these characteristics is of major importance.

Shelf life can be described as the time elapsing before the onset of rancidity, or staling, a phenomenon associated with oxidation of unsaturated fatty acids. The initial step in oxidation is the addition of oxygen to form peroxides or hydroperoxides at or near the points of unsaturation. Since peroxides are highly reactive unstable compounds, they readily decompose into various acids, alcohols, aldehydes, ketones, and other hydrocarbons, which are the substances responsible for off-flavors and rancid odors. In general, the higher the degree of unsaturation, the more susceptible the product is to oxidation. Since peanut oil contains approximately 80% unsaturated fatty acids, peanut products are subject to the development of oxidative rancidity.

As part of our program to preserve the desirable characteristics and high quality of peanut products, experiments were begun to investigate both enzymic and nonenzymic factors that may affect the shelf life of peanut butter.

MATERIALS AND METHODS

Peanut butter used in these studies was a commercial product to which the various materials were added. Enzymes were purchased from Nutritional Biochemical Corp., Ohio, and spectrophotometric grade hexane from Mallinckrodt Chem. Works, Missouri. Peanut oil was a commercial sample purchased locally.

Peanut lipoxygenase extracts were prepared by the procedure of St. Angelo and Ory (3) except that the 25-50% ammonium sulfate precipitate was employed as the source of enzyme in these experiments. This crude extract contains two enzymes associated with lipid oxidation, lipoxygenase and linoleic acid hydroperoxide isomerase, and possibly a third enzyme, peroxidase.

For each series of tests, 20 g samples of peanut butter were weighed into previously autoclaved small glass jars to which various materials were added and mixed well. The jars were tightly closed and stored in the dark at ambient temperatures until analyzed. The additives were dissolved or suspended in either deionized water or peanut oil, then added to butter, and mixed by manual stirring. Those additives suspended in peanut oil were emulsified by sonication for about 15 seconds with a Branson sonifier.

In studies on the effects of additives dissolved in water and reported in Tables 1 and 2, all additives were suspended or dissolved in 2.5 ml of deionized water. The sample with no additives and the sample with only water added were used as controls. In studies for Tables 3 and 4, only 1 ml of water was employed, while in Table 5, 1 ml of peanut oil was used.

On predetermined days (0, 7, 14, and 28) a small portion (about 1.2 g) of the peanut butter samples was accurately weighed into large centrifuge tubes and 30.0 ml of hexane added to each. After thorough stirring of each sample, they were allowed to stand for one hour, then centrifuged at 12,000 x g for 15 min at 4°C. The precipitates were discarded and the supernatants, which contained the lipid, were immediately analyzed for total peroxide and conjugated diene hydroperoxide contents.

Peroxide values (P.V.) were determined by an adaptation of the official method of the American Oil Chemists' Society (4) greatly scaled down to permit determination of 150 ± 5 mg of oil. The sample was dissolved in 1.00 ml of the official solvent in a 10 ml erlenmeyer flask. One drop of freshly prepared saturated aqueous potassium iodide was added and the mixture stirred for exactly one minute with a micro stirring bar and a magnetic stirrer. The reaction was then quenched with 1 ml of boiled deionized water, and the liberated iodine was titrated with 0.002 N thiosulfate to a colorless end point with indicator starch. Blanks were determined, and the results were calculated as milliequivalents of peroxide per kg of oil as in the official method. The thiosulfate was standardized daily. Approximately 0.5 g of a w/w solution of primary standard potassium biniodate (ca. 0.5 mg/g water) was weighed into 10 ml erlenmeyer flasks, and iodine was liberated with 1 ml of boiled deionized water, 3 drops of glacial acetic acid, and 1 drop of saturated aqueous KI.

Conjugated diene hydroperoxide (CDHP) contents of the hexane-soluble fractions were determined by measuring their absorption at 234 nm with a Beckman DU spectrophotometer equipped with a Gilford Model 2000 Multiple Sample Absorbance Recorder. Each sample was assayed by diluting a 0.2 ml portion of the supernatant to 3.0 ml with fresh hexane and reading against a hexane blank. The concentrations of CDHP were calculated from an ϵ_{max} of 24,500 (5). Values are given in μmoles of CDHP per g of peanut butter.

RESULTS AND DISCUSSION

Oxidation of unsaturated fatty acids has long been a problem in the food industry because of the development of rancid odors and flavors. In the present study, two methods were used to determine the degree of rancidity in the peanut butter samples. The first is the well established peroxide value determination, which measures the total amount of peroxide in a given sample. The second is a spectrophotometric method, which determines the conjugated diene hydroperoxide content formed. During the oxidation of the unconjugated fatty acids, a shift of a double bond occurs to form a conjugated acid. These compounds absorb strongly in the ultraviolet region and can be accurately measured spectrophotometrically. The close correlation of these two methods used to follow the development of rancidity and the effects of additives on peroxidation of fatty acids is shown in the following tables.

Table 1. Effect of additives on peroxidation of fatty acids in peanut butter

ADDITIVE	PEROXIDE VALUE (meq/kg)			
	DAYS STORED			
	0	7	14	28
NONE	18.2	--	30.1	37.4
PEANUT EXTRACT	13.5	16.4	18.0	17.2
BOILED EXTRACT	7.5	6.3	5.8	7.3
FERRIC CHLORIDE[1]	8.2	6.0	5.5	7.2
CUPRIC CHLORIDE[1]	4.9	3.5	2.4	3.4
HEMOGLOBIN[2]	4.2	3.3	2.1	4.5
BOILED PEROXIDASE[2]	2.6	18.1	25.8	38.2
BOILED CYTOCHROME[2]	3.1	2.5	2.3	4.1
EDTA[3]	3.9	3.6	3.9	6.5
RANEY NICKEL[1]	2.6	2.4	2.7	4.4
DEIONIZED WATER	2.2	2.0	2.4	3.4

1/ 0.02 mmoles
2/ 0.1%
3/ 0.01 mmoles

Table 2. Effect of additives on peroxidation of fatty acids in peanut butter

ADDITIVE	CONJUGATED DIENE HYDROPEROXIDE CONTENT (μmoles/g)			
	DAYS STORED			
	0	7	14	28
NONE	8.0	10.0	9.5	11.0
PEANUT EXTRACT	6.5	8.0	7.5	7.5
BOILED EXTRACT	4.0	5.0	4.0	4.5
FERRIC CHLORIDE 1/	4.0	5.0	4.5	4.5
CUPRIC CHLORIDE 1/	4.0	4.0	4.0	4.0
HEMOGLOBIN 2/	4.5	4.5	4.0	4.0
BOILED PEROXIDASE 2/	4.0	7.5	7.5	10.0
BOILED CYTOCHROME C 2/	4.0	4.5	3.5	4.0
EDTA 3/	4.5	4.5	3.5	4.0
RANEY NICKEL 1/	4.0	4.0	4.0	4.5
DEIONIZED WATER	4.0	4.0	3.5	3.5

1/ 0.02 mmoles
2/ 0.1%
3/ 0.01 mmoles

Results in Tables 1 and 2 show a steady rise in peroxidation for the untreated control, which represents the rate found under normal conditions. All peanut butter samples with water added, except one, showed a stabilizing effect with no observable increase in peroxidation. This antioxidant-like effect of water was also noted by Lebuza and coworkers (6).

Peanut lipoxygenase, the enzyme considered to be a prime cause of lipid oxidation, did not produce as great an increase in oxidation as might be expected. This was observed for both heat-treated and untreated enzyme extracts. Ferric chloride and cupric chloride, salts of two metals that have been strongly implicated in fatty acid oxidation (7), also did not show any increase in oxidation of the oil in peanut butter. Perhaps the "peroxide lowering" effect of water is strongly overriding the effect of the additives. The reasons for this is unknown, but the effect of water on peroxidation is being investigated further.

Since hemoproteins (e.g., peroxidase and catalase) are reported to catalyze the oxidation of unsaturated fatty acids (8,9), the effects of some of these compounds were also examined. In 1970, Eriksson and associates (9) reported that the increased ability of heat-inactivated metalloenzymes to oxidize linoleic acid was retained after storage at 2°C for at least four months. They proposed that the heat treatment possibly increased unfolding of the protein, causing a greater exposure of the heme group to the unsaturated fatty acid substrate, thereby increasing lipid oxidation.

The three heme-containing proteins employed in our experiments were hemoglobin, peroxidase, and cytochrome-c. The latter two are known to be present in peanuts. Results in Tables 1 and 2 demonstrate that only one of these proteins, the boiled peroxidase, actually caused an increase in peroxidation of the peanut butter samples. This indicates that the heme group must be in some particular configuration to be an effective catalyst of fatty acid oxidation in roasted peanut products and to overcome the effect of water.

On the assumption that some of the Raney Nickel catalyst used in hydrogenation of the oil which is added to peanut butter as a stabilizer during the manufacturing process might also be a possible cause of increased peroxidation, Raney Nickel was also tested. Results showed that this metal did not increase oxidation of fatty acids in the oil.

While studying the *in vitro* oxidation of fatty acids catalyzed by peanut lipoxygenase earlier, we noticed that certain inorganic salts enhanced activity. Experiments were therefore undertaken to investigate the effect, if any, of some salts on nonenzymic oxidation of fatty acids in peanut butters. The results are summarized in Table 3. Each salt was dissolved in 1 ml of

Table 3. Effect of salts on peroxidation of fatty acids in peanut butter

ADDITIVE*	P.V. (meq/kg)		CDHP (μmoles/g)	
	DAYS		DAYS	
	0	28	0	28
NONE	22.4	28.0	8.7	10.1
DEIONIZED WATER	11.1	9.6	6.5	6.1
SODIUM CHLORIDE	8.6	7.8	5.9	5.9
POTASSIUM CHLORIDE	7.1	6.5	5.5	5.5
CALCIUM CHLORIDE	5.8	5.6	5.4	5.1
SODIUM ACETATE	3.4	1.9	4.3	4.5
SODIUM DIHYDROGEN PHOSPHATE	3.0	2.1	4.6	4.5
POTASSIUM CARBONATE	2.1	1.7	4.2	4.2

* Conc. of all salts, 0.02 moles

deionized water, then added to a 20 g sample of peanut butter. The untreated control sample showed the only increase in oxidation during the first 28 days of storage. None of the salts tested, including sodium chloride which is a normal ingredient of peanut butter, had any effect on fatty acid oxidation. These results were the same whether measured by the chemical or the spectrophotometric methods used. It is possible that the concentrations of salts employed were not high enough to overcome the apparent inhibiting effect of the water. This will be explored further using higher concentrations of salts.

Table 4 shows another series of materials investigated for their effects on peroxidation in peanut butter. The additives were dissolved in 1 ml of water. A second control consisted of 1 ml of water added to the peanut butter. In this series, untreated peroxidase as well as boiled peroxidase, were added. Two other enzymes, a commercial lipoxygenase and a commercial tyrosinase (both are found in peanuts) were also added. Tyrosinase is a copper-containing enzyme unlike the iron-containing enzyme, peroxidase. EDTA, a known chelating agent acceptable by F.D.A. as a food additive, was added with the boiled peroxidase to determine if it would offset the peroxidizing effect of the boiled enzyme.

Table 4. Effect of additives on peroxidation of fatty acids in peanut butter

ADDITIVE	P. V. (meq/kg)		CDHP (μmoles/g)	
	DAYS		DAYS	
	0	28	0	28
NONE	31.8	52.2	10.5	15.1
DEIONIZED WATER	34.6	32.9	11.0	11.2
FERRIC CHLORIDE[1/]	16.2	14.4	6.8	7.1
FERROUS SULFATE	23.4	20.6	8.1	8.2
CUPRIC ACETATE	19.1	37.0	7.7	11.4
CUPROUS CHLORIDE	22.4	20.7	8.2	8.3
PEROXIDASE[2/]	16.1	35.4	6.9	11.4
BOILED PEROXIDASE	17.5	24.8	7.3	9.1
BOILED PEROXIDASE + EDTA[3/]	22.4	23.9	8.2	9.0
SOYBEAN LIPOXYGENASE	5.0	4.3	4.7	4.6
TYROSINASE	2.4	2.5	4.2	4.2
BOILED TYROSINASE	2.6	3.3	3.9	4.4

1/ Conc. of all salts, 0.02 mmoles
2/ Conc. of all enzymes, 0.1%
3/ Conc. of EDTA, 0.1 mmoles

Results showed that the control sample increased in P.V. from 31.8 to 52.2 meq/kg of oil during the first four weeks of storage, for a difference between the two of 20.4. The CDHP values showed an increase of 4.6 μmoles/g of peanut butter. The peanut butter control containing water again did not show any increase in peroxidation, nordid ferric chloride, ferrous sulfate, cuprous chloride, soybean lipoxygenase, or the copper-containing enzyme, tyrosinase. There was, however, a very significant increase in peroxidation with added cupric acetate, peroxidase, and to a lesser degree, boiled peroxidase. A most interesting point in this series is the fact that EDTA added with the boiled peroxidase appeared to offset the oxidizing effect of the boiled enzyme. Determination of the optimum concentration of EDTA necessary to reverse the effects of peroxidase already present in peanuts is being pursued further.

In the first four series, materials were either dissolved or suspended in water, but the water itself had an inhibiting effect on peroxidation. We, therefore, added some of the same materials in peanut oil, emulsifying them by sonication and adding the emulsions to peanut butter samples and assaying their effects over a four-week period. All concentrations were the same as used for Table 4, except sodium chloride, which was 0.04 mmoles.

Table 5. Effect of additives on peroxidation of fatty acids in peanut butter

ADDITIVE	P.V. (meq/kg)			CDHP (μmoles/g)		
	DAYS			DAYS		
	0	28	Δ	0	28	Δ
NONE	30.0	31.1	0.1	10.5	11.1	0.6
PEANUT OIL	16.4	24.9	8.5	8.2	9.8	1.6
SODIUM CHLORIDE[1/]	14.3	24.9	10.6	8.2	9.8	1.6
CUPRIC ACETATE[2/]	11.8	33.1	21.3	7.7	11.0	3.3
FERRIC CHLORIDE[2/]	10.3	36.8	26.5	6.6	10.7	4.1
SOYBEAN LIPOXYGENASE[3/]	7.0	21.0	14.0	6.1	9.4	3.3
TYROSINASE	6.3	24.9	18.6	5.8	10.2	4.4
CHLOROPHYLL	7.9	26.6	18.7	6.0	9.8	3.8
PEROXIDASE	5.4	27.0	21.6	5.5	10.1	4.6
BOILED PEROXIDASE	7.3	26.6	19.3	5.8	9.9	4.1

1/ 0.04 mmoles
2/ 0.02 mmoles
3/ Conc. of enzymes and chlorophyll, 0.1%

These results, in Table 5, differ considerably from those in Table 4. When only peanut oil was added, there was an increase in peroxidation by both assay methods, P.V. and CDHP. Using the values shown in the third and sixth columns as a basis for comparison, the most significant changes occurred in samples that contained ferric chloride, cupric acetate, soybean lipoxygenase, tyrosinase, peroxidase, and a magnesium-containing pigment found in plants, chlorophyll. In comparison to results shown in Table 4, the effect of untreated peroxidase was again greater than the effect of boiled peroxidase. Ferric chloride in peanut oil greatly increased peroxidation, while the same salt added in water did not affect lipid peroxidation (Tables 1, 2, and 4). Tyrosinase and lipoxygenase, which seemingly had no effect when dissolved in water, had a large effect on lipid oxidation when dissolved in peanut oil. Chlorophyll, which was reported to oxidize linoleic acid (10) showed an increase in peroxidation when dissolved in peanut oil. The effect of lipoxygenase, which does not contain a metal cofactor, is less than those substances that contain a metal-chelate complex. Since peanut oil alone increased peroxidation and some of these materials when suspended in water did not, these substances when added in oil to peanut butter may produce some sort of synergistic effect. Another possibility is that the oil, or some component in the oil, such as unsaturated fatty acids, may be acting as an initiator of peroxidation.

SUMMARY

Water prevents peroxidation of unsaturated fatty acids in peanut butter as measured by two different methods, a chemical and a spectrophotometric method. Peroxidase and cupric acetate increase peroxidation of the fatty acids whether dissolved in water of in peanut oil. The increase in peroxidation caused by boiled peroxidase is probably due to the metal-protein complex, and can be overcome by adding the chelating agent, EDTA. Added peanut oil causes an increase in peroxidation in stored peanut butters. Certain salts, enzymes, and chlorophyll emulsified in peanut oil, had an additive effect on peroxidation of unsaturated fatty acids when added to peanut butter.

While the peroxide value method is probably the most widely used for following fatty acid oxidation in food products, the spectrophotometric method can also be used to provide a quick, accurate, and easy procedure for obtaining comparable results.

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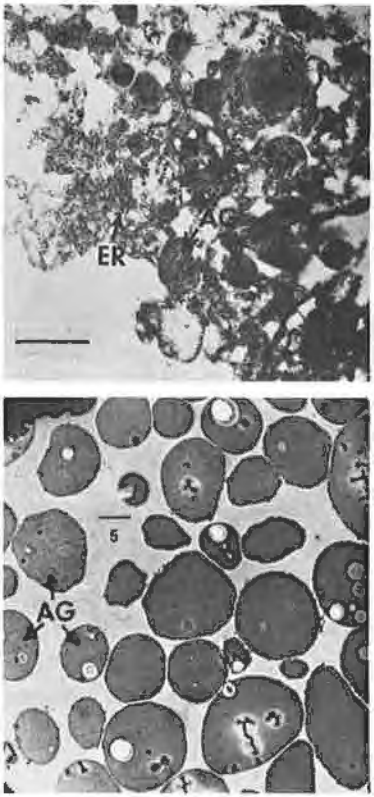


Figure 1

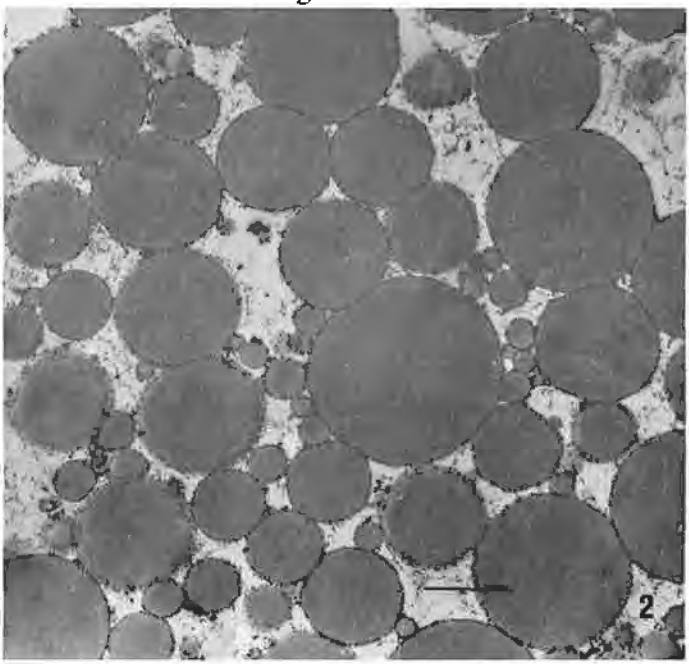


Figure 2

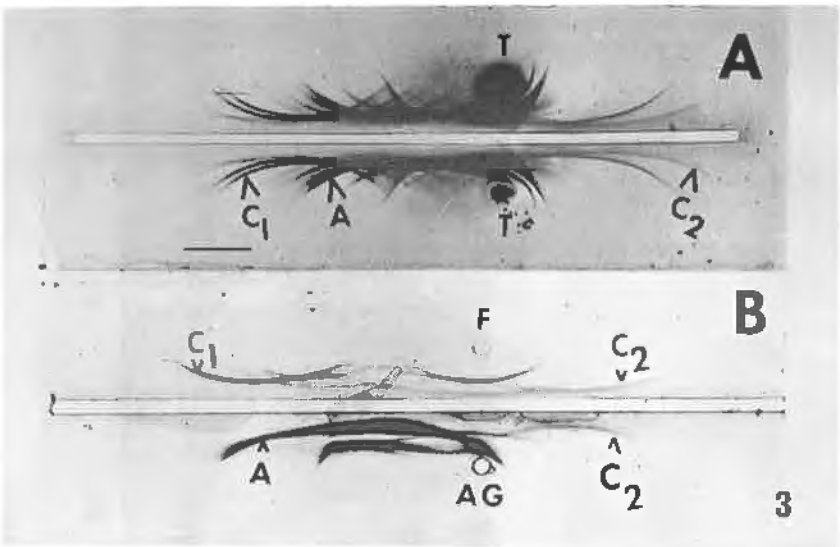


Figure 3

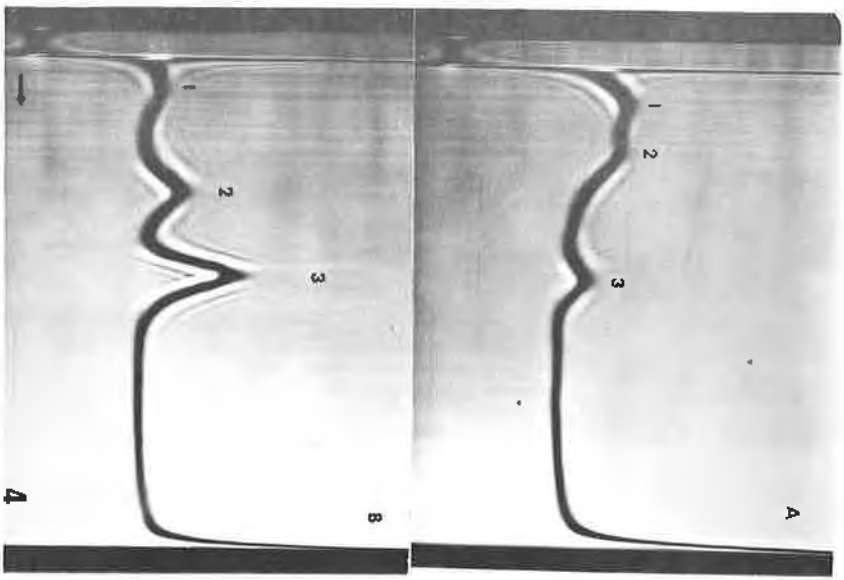
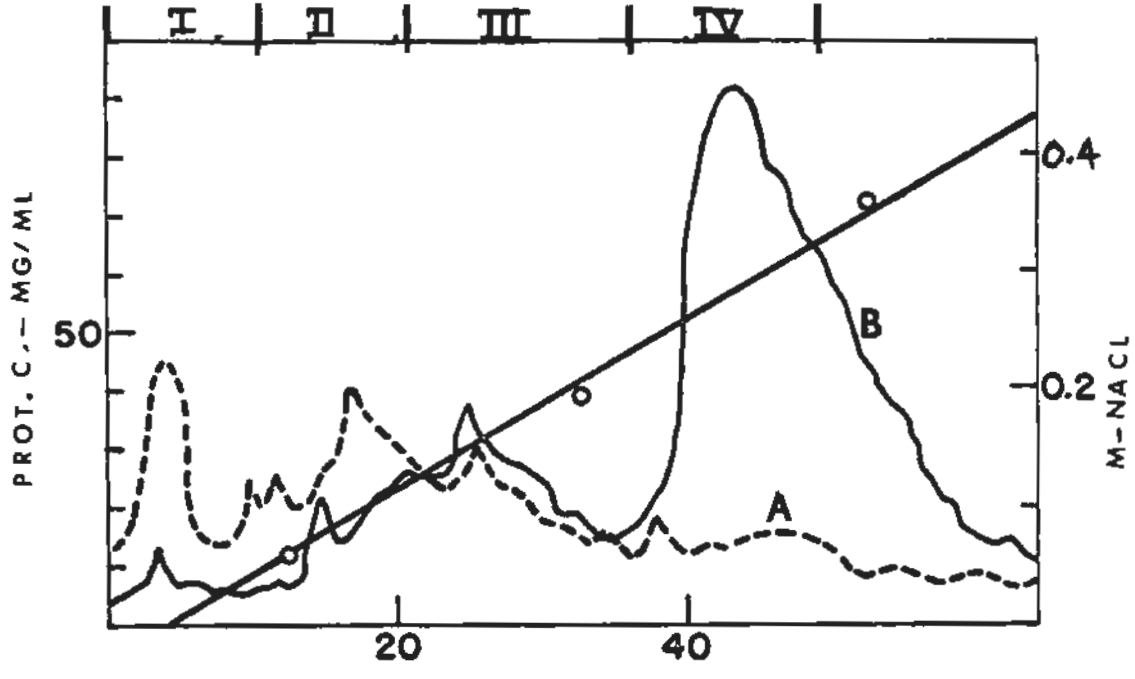


Figure 4


I
II
III
IV
PROT. C. — MG/ML
50
0.4
0.2
M-NA CL
B
A
20
40
FRACTION NUMBER (5 mls.)

5

CHARACTERIZATION OF PROTEINS FROM SUBCELLULAR FRACTIONS OF PEANUTS[1/]

by

T. J. Jacks, N. J. Neucere and L. Y. Yatsu
Southern Regional Research Laboratory[2/]
New Orleans, La. 70179

ABSTRACT

Cotyledonary tissue of peanut seeds were mechanically separated into three subcellular fractions. Examinations of the fractions with the electron microscope showed that the heavy, light, and intermediate ("fines") fractions were composed of aleurone grains (protein bodies), spherosomes, and heterogeneous cytoplasm, respectively. Results from immunochemistry, chromatography and ultracentrifugation indicated that, principally, arachin comprised the aleurone grain fraction, conarachin the "fines" fraction, and structural protein the spherosomal fraction. Results from amino acid analyses indicated large differences in amino acid contents and A/E ratios among the three fractions. The E/T ratios for the aleurone grain, "fines" and spherosomal fractions were 1.85, 2.05, and 3.37 respectively.

INTRODUCTION

About 5% of the total world supply of peanuts is produced in the United States, where around three-fourths of the supply is used directly as food. Nearly one-third of the total supply is produced in India, where 10% or less is consumed directly as food (1). When not consumed directly, peanuts are used primarily as a source of oil and secondarily as a source of protein. In view of the increasing demand for food protein, however, this order might soon reverse. Since oilseed proteins will be used for food only if they can be presented in appealing and acceptable forms (2), research concerning the preparation and properties of these proteins has greatly increased in magnitude. It is thought that relatively purified proteins can be incorporated in a broad variety of foods with greater consumer acceptance.

The heterogeneity of peanut proteins is well known. However, the intracellular locations of the various proteins are not known with certainty. In this report, we describe several physicochemical properties of the proteins associated with physically and morphologically different subcellular fractions isolated mechanically from dormant peanut cotyledons.

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2/ One of the laboratories of the Southern Marketing and Nutrition Research Division, Agricultural Research Service, U.S. Department of Agriculture.

MATERIALS AND METHODS

Virginia 56-R peanut cotyledons were blended in cottonseed oil (100 g of tissue per 200 mls of oil) and fractionated according to Dieckert, et al. (3). In brief, the cell-free homogenate was centrifuged at 2600 g for 15 min to produce a supernatant and a pellet. The pellet, resuspended in oil, was layered over a mixture of oil and CCl_4 having a density of 1.43 g/ml and centrifuged at 2600 g for 15 min. Particles at the interface were isolated to yield the aleurone grain (protein body) fraction. The "fines" fraction was prepared from the supernatant by centrifugation at 20,000 g for 30 min. Analyses of the fractions were performed after oil was removed with cold acetone or hexane.

Oil-rich spherosomes were isolated from cotyledons by the procedure of Jacks, et al. (4). In brief, a cell-free preparation of tissue homogenized in water was centrifuged at 15,000 g for 20 min. The resultant "fat pad," washed several times by resuspension and centrifugation, was the spherosomal fraction. For chemical analysis, the fraction was dried and then defatted with hexane or hexane-acetone (3:2, v/v).

Examinations of the subcellular particles with the electron microscope was done as follows. The dried "fines" and aleurone grain fractions and the spherosomal fraction in water were fixed at room temperature for 1 hr in 0.1 M phosphate buffer, pH 7.2, containing 1% OsO_4, then thoroughly rinsed in 0.1 M phosphate buffer. The fixed materials were serially dehydrated with aqueous acetone solutions and embedded in Maraglas according to Erlandson (5).

Immunoelectrophoresis was performed according to Grabar and Williams (6) in 0.025 M Vernal buffer, pH 8.2, using 1.5% Ionagar. Electrophoresis was carried out at room temperature with a voltage gradient of 4 v/cm for 2 hr and antibodies were prepared and applied to the gels as described previously (7).

Sedimentation analyses were performed in phosphate buffer, pH 7.9, ionic strength 0.03, and sedimentation constants were calculated according to Schachman (8).

DEAE cellulose chromatography was carried out by the procedure of Dechary, et al. (9). In brief, 10 mg of protein in phosphate buffer, pH 7.9, ionic strength 0.03, was adsorbed on 2 g of DEAE cellulose. Elution was with a linear gradient of 0 to 0.6 M NaCl.

Amino acid compositions were determined by Worthington Biochemical Corp. (10) or in our laboratory by the Moore and Stein procedure (11). Nitrogen content was measured by the Kjeldahl method and protein was determined according to Lowry, et al. (12).

RESULTS AND DISCUSSION

To determine what intracellular components of peanut cells are contained in each subcellular fraction, the fractions were examined with an electron microscope. Figure 1A shows that the "fines" fraction contained aleurone grain fragments (or small aleurone grains) and morphologically unidentified material that probably corresponds to cytoplasm between aleurone grains and that contains such organelles as ribosomes and endoplasmic reticulum (ER). The aleurone grain fraction (Figure 1B) contained particles ranging in diameter from 5 to 10μ which are morphologically recognizable as aleurone grains (13). The spherosomal fraction (Figure 2) consisted of osmiophilic globules ranging from 1 to 2μ in diameter that correspond to typical oil-rich spherosomes (4,14).

The subcellular fractions were analyzed immunochemically to determine which peanut proteins comprised each fraction. Original characterization of the major peanut proteins by this technique, shown in Figure 3A, was described in detail by Daussant, et al. (15). Results presented in Figure 3B indicate that the bulk of the "fines" proteins is categorized in the conarachin system. The aleurone grain fraction contains mostly α-arachin, an "α-arachin contaminant" (15), and a trace of α_2- conarachin. The "fines" fraction contains a trace of α-arachin and is more heterogeneous in composition than the aleurone grain fraction. The spherosomal fraction consists of only one major antigenic protein, which corresponds to structural protein of membranes.

To estimate the molecular weights (MW) of the proteins comprising each subcellular fraction, the sedimentation rates of the component proteins of the fractions were measured in the ultracentrifuge. From the studies of Johnson and Naismith (16), who correlated observed sedimentation rates of peanut proteins to MW, we estimate that the principal proteins of the "fines" fraction are generally smaller than 100,000 MW and those of the aleurone grains are greater than 200,000 MW. Peak 3 in Figures 4A and 4B corresponds to α-arachin which in the associated state has MW of about 390,000 (17). The presence of α-arachin in the "fines" fraction is in accord with the aleurone grain component observed in the electron microscope (Figure 1A). Peak 2 of the aleurone grain fraction (Figure 4B) is either a subunit of α-arachin or the "α-arachin contaminant" (15) that is observed by immunoelectrophoresis (Figure 3B). Only one peak, which corresponds to about 20,000 MW, was observed during the sedimentation of spherosomal protein in the ultracentrifuge.

To further determine which peanut proteins are contained in the subcellular fractions, the proteins of the "fines" and aleurone grain fractions were chromatographed on DEAE-cellulose. Results, shown in Figure 5, indicate that the "fines" fraction (line A) predominately contains proteins of the classic conarachin system (groups I, II, and III). However, some overlapping of "fines" proteins with aleurone grain proteins (line B), which consist mainly of group IV proteins (α-arachin) occurs under these conditions. Again, the presence of arachin in the "fines" fraction was expected from results by electron microscopy (Figure 1A), immunoelectrophoresis (Figure 3B), and ultracentrifugation (Figure 4A).

Proteins comprising the subcellular fractions were also characterized with respect to amino acid compositions. Results of determinations of amino acids in meal and in subcellular fractions are shown in Table I.

Meal and aleurone grains of peanut, as oilseed meals and globulins in general, are rich in arginine, aspartic acid, and glutamic acid. Indeed, the amino acid composition of the aleurone grain fraction corresponds well to that of purified α-arachin (18), which is expected from immunochemical and ultracentrifugal analyses (Figures 3B and 4B). The major differences between the "fines" fraction and the previously mentioned two fractions are the lesser amount of arginine and the greater content of lysine in the "fines" than in the other fractions. Of particular interest is the amino acid composition of spherosomal protein (Table I). This protein is particularly rich in leucine and alanine,

which render the protein hydrophobic, and threonine and glycine.

To assess the peanut proteins nutritionally, the amino acid compositions of meal and subcellular fractions (Table I) were evaluated according to the joint expert group of the Food and Agriculture Organization and World Health Organization (19). The ratios of the content of each essential amino acid to the content of the total essential amino acids, the A/E ratios (19) are shown in Table II.

These data indicate that the meal and aleurone grain fraction are deficient in lysine and sulfur-containing amino acids, as are most other oilseed meals and storage proteins. The "fines" fraction appears adequate in lysine but both the "fines" and spherosomal fractions are also deficient in sulfur-containing amino acids.

A protein that is unduly rich in the ten essential amino acids would not provide sufficient nitrogen for metabolic processes without obligatory catabolism of the essential amino acids. Thus, the proportion of the total nitrogen intake that essential amino acids form indicates how a given protein fulfills nutritional requirements for proteins. This proportion, the E/T ratio (19), is (in g of essential amino acids per g of nitrogen) 1.49 for meal, 1.85 for aleurone grains, 2.05 for "fines," and 3.37 for spherosomes. The value for aleurone grains is similar in magnitude to that for wheat gluten, the value for "fines" is similar to the FAO pattern, and the value for spherosomes is greater than those for casein, eggs, and milk (19).

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Table I

Amino Acid Contents[a] of Meal and Subcellular Fractions of Peanut Cotyledons

Amino Acid	Meal	Aleurone grains	Fines	Spherosomes	FAO Pattern[b]
lysine	2.8	2.9	5.8	5.1	4.3
histidine	2.2	2.2	1.9	2.0	
arginine	10.0	12.2	4.6	7.0	
aspartic acid	10.6	12.7	7.7	7.5	
threonine	3.4	2.4	4.7	10.0	2.9
serine	4.2	4.5	4.1	7.7	
glutamic acid	18.6	23.2	11.7	8.8	
proline	2.9	5.4	3.1	4.8	
glycine	5.4	4.5	4.8	9.6	
alanine	3.4	3.9	5.0	9.7	
cysteine	0.4	trace	0.6	0.3	2.0[c]
valine	4.1	4.2	4.1	6.7	4.3
methionine	0.9	0.9	1.5	1.9	2.3[c]
isoleucine	3.2	3.5	3.4	5.5	4.3
leucine	5.9	6.3	5.9	11.6	4.9
tyrosine	3.4	4.0	3.2	7.4	2.9
phenylalanine	3.8	5.4	3.6	5.4	2.9

a/ Values are g of amino acid per 16 g of nitrogen

b/ From reference 19

c/ Probably too high (19)

Table II

A/E Ratios[a] of Meal and Subcellular Fractions of Peanut Cotyledons

Amino Acid	Meal	Aleurone grains	Fines	Spherosomes	FAO Pattern[b]
lysine	117	98	177	95	134
threonine	143	81	143	186	89
cysteine	17	--	18	6	62[c]
valine	172	142	125	124	134
methionine	38	51	46	35	71[c]
isoleucine	134	115	104	102	134
leucine	248	213	180	215	152
tyrosine	143	135	98	137	89
phenylalanine	160	182	110	100	89

a/ Values are mg of amino acid per g of total essential amino acids

b/ From reference 19.

c/ Probably too high (19)

Fig. 1. Electron micrographs of subcellular fractions. A, "fines" fraction; B, aleurone grain fraction. Abbreviations: ER, endoplasmic reticulum; AG, aleurone grains. In all figures the bar represents 1μ.

Fig. 2. Electron micrograph of spherosomal fraction.

Fig. 3. Immunoelectrophoresis of total peanut proteins (A) and isolated fractions (B). Abbreviations: T, total proteins; C_1, α_1-conarachin; C_2, α_2-conarachin; A, α-arachin; F, fines; AG, aleurone grains. Troughs were filled three times with antibodies against the total peanut proteins after electrophoresis.

Fig. 4. Sedimentation patterns of isolated fines (A) and aleurone grains (B). Sedimentation constants in A, (1) 3.0 S, (2) 5.4 S, (3) 14.8 S; in B, (1) 2.5 S, (2) 9.5 S, (3) 14.8 S. The photographs were taken 28 min after top speed (59,780 rpm). No corrections were made to reduce sedimentation coefficients relative to viscosity and density of water at 20°C and for zero concentration; S refers to the observed Svedberg unit.

Fig. 5. Chromatograms on DEAE-cellulose of subcellular fractions. A, "fines" fraction; B, aleurone grain fraction. The sloping straight line indicates the sodium chloride gradient as measured on the eluate. Roman numerals refer to the classic isolated fractions reported by Dechary, et al. (9).

132-72
(CP)

INTROGRESSIVE HYBRIDIZATION IN ARACHIS VIA THE BRIDGE CROSS TECHNIQUE[1/]

Donald J. Banks, Research Geneticist, USDA, ARS
and Associate Professor, Agronomy Department,
Oklahoma State University, Stillwater, Oklahoma 74074

ABSTRACT

Thus far, the transfer of much of the valuable germ plasm, such as resistance to nematodes, viruses, leafspots, and other fungi, from the wild species of Arachis directly to cultivated peanuts, Arachis hypogaea L., has not been achieved. The failure to accomplish these goals is due, in part, to post-fertilization abortions on the part of the interspecific hybrid embryos or to sexual sterility of the surviving hybrid plants (when the crosses are successful) owing to chromosomal imbalances.

Fortunately, cross-compatibility studies of Arachis species by Drs. W. C. and M. P. Gregory, and their co-workers, North Carolina State University, have revealed that a few wild species of Arachis (without appreciable pest resistance, themselves) can be crossed with several of the pest resistant wild species and with cultivated peanuts. Thus, there is the possibility of using some wild species as bridges over which the pest resistant germ plasm can be directed into A. hypogaea.

We have succeeded in producing some putative allohexaploids and allotetraploids involving A. hypogaea and some of the bridge species. Presently, we are pursuing several of the possible routes of introgression which may allow this valuable wild germ plasm to be incorporated into future peanut cultivars.

[1/] Based on cooperative investigations of the Plant Science Research Division, Agricultural Research Service, U. S. Department of Agriculture and the Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma 74074.

INHERITANCE OF POD PUBESCENCE IN ARACHIS HYPOGAEA L.

Nguyen V. Tan, Graduate Assistant
A.J. Norden, Professor
Agronomy Department
University of Florida, Gainesville, Florida 32601

ABSTRACT

Pubescence (epidermal hairs) on the pod of the cultivated peanut, Arachis hypogaea L., results in soil particles remaining attached to the pod at harvest and after storage. This characteristic reduces market appearance of unshelled peanuts and may be related to susceptibility of the peanuts to pod and seed disease organisms and to yield. Crosses were made between heavily pubescent (tomentose) lines F 458-4-9-2 and F 458-4-1-9 and the glabrous lines F 416-2-8-1, F 431A-13-1-4, Ga 119-20 and PI 279956. Pod tissues are maternal in origin, and therefore the genotype of the F_1 is expressed in the pods that contain the F_2 seeds.

The F_1 plants bore pubescent pods. Data in the F_2 generation indicated that in each cross two loci segregating independently and acting additively were involved in the development of pod pubescence. In crosses involving F 416-2-8-1 and F 413A-13-1-4 a ratio of 5 tomentose: 6 pubescent: 4 puberulent: 1 glabrous was obtained. In crosses involving Ga 119-20, a ratio of 5 tomentose: 6 pubescent: 5 glabrous was obtained. F_3 data supported the above hypothesis. In crosses involving PI 279956, F_2 and F_3 data did not fit either of the above ratios. Ratios in favor of the glabrous phenotype and other distorted ratios were obtained. In these latter crosses, differential segregation and/or differential fertilization, chlorophyll deficiency, seed size, or some other factor may have been involved. These latter crosses are being studied further.

INHERITANCE OF OLLIC/LINOLEIC FATTY ACID RATIO IN PEANUTS, *Arachis hypogaea* L.

Yai-po Tai, Former Research Assistant,
J. S. Kirby, Assistant Professor,
and R. S. Matlock, Professor and Head
Department of Agronomy, Oklahoma State University
Stillwater, Oklahoma 74074

ABSTRACT

F_1's, F_2's, F_3's and backcrosses involving several peanut cultivars were used to determine the inheritance pattern of the O/L ratio in peanuts. The cultivars used varied widely in O/L ratio and ranged from "very low" (approximately 0.93) to "high" (approximately 3.00). Most of the peanut seed populations were produced in the greenhouse. Both a rapid microanalytical procedure and a half-seed technique were used to determine the O/L ratio on an individual seed basis. According to the reciprocal crosses and backcrosses, no apparent and consistent evidence was obtained to support maternal influence on the O/L ratio in peanuts. Data from F_1, F_2, F_3 and backcross populations indicated that inheritance of the O/L ratio in peanuts is controlled by genes acting quantitatively. In F_2 seed populations, crosses between "low" and "low" O/L ratio cultivars showed, as expected, the narrowest continuous range of variation whereas crosses between "very low" and "high" O/L ratio cultivars gave the widest continuous range of variation.

RELATIONSHIP OF SHELL DAMAGE TO COLONIZATION OF PEANUT SEED BY ASPERGILLUS FLAVUS

by

D. M. Porter, F. S. Wright and J. L. Steele
Southern Region, Agricultural Research Service, USDA
Tidewater Research and Continuing Education Center
Holland, Virginia 23391

ABSTRACT

Differences in colonization of seed by *Aspergillus flavus* were noted when comparisons were made between seed from sound or damaged peanut fruit with different moisture contents. Seed from fruit with visible damage (shell damage detected visually) and invisible damage (shell damage detected by a staining technique) were colonized more frequently by *A. flavus* than those from sound fruit (no visible or invisible damage). Seed from invisibly damaged fruit were colonized almost as rapidly as seed from visibly damaged fruits. In fact, the isolation frequency of *A. flavus* from invisibly and visibly damaged fruit was 23% and 26%, respectively. *A. flavus* was isolated at a frequency of 8% from nondamaged fruit.

After incubation at a temperature and relative humidity conducive to the rapid proliferation of *Aspergillus* spp. for a period of 24 to 48 hours, *A. flavus* was isolated just as readily from seeds from invisibly damaged fruit as from visibly damaged fruit. Although the isolation frequency of *A. flavus* from seed from sound fruit increased with time, the frequency did not approach that obtained from seed from damaged fruit. Before incubation, the isolation frequency of *A. flavus* from seed from non-inoculated fruit with moisture contents of 10%, 30% and 50% was 4%, 7% and 10%, respectively. Following incubation the isolation frequency of *A. flavus* from seed was greater in partially dried fruit than in fruit with a high moisture content. The isolation frequency of *A. flavus* from seed from partially dried fruit with a moisture content of 10% and 30% was 20% and 25%, respectively, following incubation. Due probably to competition with other fungi during incubation, *A. flavus* was isolated less frequently (12%) from seed from fruit with a 50% moisture content.

ECOLOGY AND CONTROL OF THE BURROWING BUG, *PANGAEUS BILINEATUS* (SAY)

J. W. Smith, Jr.
Texas Agricultural Experiment Station
C. L. Cole
Texas Agricultural Extension Service
Texas A&M University
College Station, Texas 77843

ABSTRACT

Ecological studies were conducted to determine wild alternate host plants, cultivated alternate host plants, field invasion patterns, overwintering habitats, and natural biological control agents for the burrowing bugs, *Pangaeus bilineatus* (Say), *Pangaeus congruus* (Uhler) and *Cyrtomenus ciliatus* (Palisot de Beauvois). Results show that several Cydnidae invade peanuts with *P. bilineatus* being the only economically important invader. Several existing cultural practices were found that may cause high winter survival. Surveys of habitats adjacent to peanut fields revealed some invasion patterns. Only one parasite and one predator have been found to date.

The use of field scouting and proper timing of granular insecticides proved adequate in controlling this pest. Increases of $300 per acre were demonstrated. Effective control was highly dependent upon application timing.

Resistance of Peanuts to the Southern Corn Rootworm

W. V. Campbell, Professor of Entomology
and
D. A. Emery, Professor of Crops Science
North Carolina State University
Raleigh, North Carolina

ABSTRACT

Peanut accessions and varieties have been evaluated for resistance to the southern corn rootworm *Diabrotica undecimpunctata howardi* Barber in field trials since 1961. Accessions were planted in single row, replicated plots. The criterion for resistance was the number of rootworm penetrated pegs and pods on five randomly selected plants per entry compared with the damage on NC 2 susceptible check.

Accessions with low rootworm damage were retested several years to confirm the damage rating and several accessions designated as having moderate resistance to the rootworm were crossed with commercial varieties of peanuts. Selections for rootworm resistance were made from the F_5, F_6, and F_7 progenies. Some of the hybrids have good agronomic qualities, are high yielding, and possess moderate resistance to the rootworm.

A study was made of the nature of rootworm resistance. Lignin, a chemical imparting hardness to cells, was identified in the hulls by histochemical technique. Chemical extraction of lignin from the hulls revealed resistant varieties in general had a higher lignin content than susceptible peanuts. These data suggest resistance to the rootworm may be improved by selecting peanuts with highly lignified hulls.

A PEST MANAGEMENT PROGRAM FOR INSECTS ATTACKING PEANUTS IN TEXAS

Clifford E. Hoelscher
Texas Agricultural Extension Service
Stephenville, Texas 76401
J. W. Smith, Jr.
Texas Agricultural Experiment Station
Texas A&M University
College Station, Texas 77843
Paul W. Jackson
Texas Agricultural Experiment Station
Stephenville, Texas 76401

ABSTRACT

Data will be presented on the effects of leaf removal on irrigated peanuts in Texas. These studies aid in establishing possible yield reduction guidelines from leaf-feeding insects. Information will be provided on the current peanut grower education program for insect pest management on peanuts. The pest management program uses several types of biological control agents with properly timed insecticide application based on frequent field inspections. Results of a survey of insecticide use on peanuts in the West Cross Timbers area will be presented. This survey covers a three year period (69, 70, and 71) for both dryland and irrigated cultures.

THE EFFECTS OF NEMATODES UPON YIELD AND QUALITY OF SPANISH PEANUTS WITH CONTACT AND FUMIGANT TYPE NEMATICIDES

T. E. Boswell, Associate Professor
Texas A&M University Plant Disease Research Station
Yoakum, Texas

and

W. H. Thames, Jr., Professor
Department of Plant Sciences
Texas A&M University
College Station, Texas

ABSTRACT

Granular and fumigant type nematicides were compared in field trials to investigate their effectiveness for controlling nematodes on peanuts.

Nematicides were applied as preplant, planting time and pegging time treatments or combinations of these. Nematode determinations were made from soil samples taken pre-treatment, 50 days after planting and at harvest time and from shells at harvest. Root knot indices were recorded. Partial regressions were run to determine if correlations existed between the various nematodes and yield, quality and value.

Nematicide treatments significantly increased yield and value per acre in a test with moderate numbers of lesion and ring nematodes. Furadan 10G incorporated at planting gave the highest value per acre and the lowest count of lesion nematodes in shells at harvest. The dichloropropene nematicides did not control ring nematodes as well as the more persistent nematicides. Significant positive correlations occurred between numbers of Criconemoides in soil 53 days after planting and percent damaged kernels.

Mocap applied at pegging gave better control of lesion in pods than Mocap applied at planting. Significant negative correlations between yield and value at harvest and pre-treatment Pratylenchus counts indicate that early soil sampling using a bioassay technique is promising and may eventually be used to predict yield.

Yield and value per acre were significantly different due to treatment in a test with a root knot nematode problem. The dichloropropene nematicides gave the highest yields (up to 70 percent above the check) followed by DBCP and by DBCP plus phosphorothioate types. When used alone the phosphorothioate nematicides were grouped near the bottom of the treatments. Furadan and Mocap, applied at pegging or planting time, were less effective than the dichloropropenes or DBCP against Meloidogyne aronaria.

SPANISH PEANUT YIELD RESPONSE TO NEMATICIDES APPLIED AT PEGGING FOR LESION NEMATODE CONTROL

by

R. V. Sturgeon, Jr., Extension Plant Pathologist,
and C. C. Russell, Nematologist, Botany and Plant Pathology
Department, Oklahoma State University, Stillwater, Oklahoma 74074

ABSTRACT

Root lesion nematode, Pratylenchus brachyurus, control studies carried out in Southern Oklahoma over the past four years show economical yield increases with pegging-time nematicide application. Studies consisted of replicated tests and large field plot nematicide trials comparing pegging-time applications of fumigants and non-fumigants to a standard preplant fumigant-nematicide. The nematicide trials were carried out in fields showing heavy infestations of lesion nematode with a very light infestation of Northern root-knot, Meloidogyne hapla, and ring, Criconemoides sp., nematodes. Soil and plant samples analyzed indicate the population of lesion nematode began to increase within the plots mid-season (July 15-20), becoming quite heavy in late August. Pegging-time applications have produced increased yields of 230 to over 900 lbs. per acre more than non-treated plots and 170 to 600 lbs. more per acre than at-plant nematicide applications. The continued increased yields obtained from pegging-time applications over at-plant applications indicate that growers can expect to increase yields from nematicides applied at pegging-time in fields having heavy populations of lesion nematode; however, when damaging infestations of root-knot and lesion nematodes are present, at-plant and mid-season pegging-time applications are needed for greatest increase in yield.

Results of studies carried out during 1969 and 1970 encouraged large-scale lesion nematode control demonstrations; hence, during the 1971 season five-acre grower demonstrations were carried out in three locations over the State. These studies consisted of two cleared materials--Dasanit 15G at 3 lbs. ai/acre and Mocap 10G at 3 lbs. ai/acre applied mid-season on approximately five acres at each location and a non-treated area within the field. Analysis of root and soil samples taken prior to nematicide applications showed heavy populations of lesion nematode were present. Increased yields of 260 to 900 lbs./acre more than the non-treated area were reported at the various locations.

These grower demonstrations further substantiate the merits of mid-season pegging-time application of a nematicide when heavy infestations of lesion nematode are present.

SOME OBSERVATIONS ON LEAF RUST AND LEAF SPOTS OF PEANUTS UNDER EPIPHYTOTIC CONDITIONS

A. L. Harrison, Plant Pathologist
Texas A&M University Plant Disease Research Station
Yoakum, Texas

ABSTRACT

Leaf rust, Puccinia arachidis, was first observed in Western Frio County in early July in 1971 nearly 30 days earlier than it had ever been observed before. A second rust area was found in Eastern Atascosa County in early August. Both areas appeared to start independently of each other. The rust spores that started these infection sites appeared to have come from some outside source, possibly from the Yucatan Peninsula. Rust spread rapidly from these two areas

so that by early September rust was found in every field examined in the South Texas peanut belt, and caused serious losses in many fields. Before the end of the season, verbal reports stated that rust had been found in many of the peanut areas of Texas and in Oklahoma.

Losses from leaf rust and Cercospora leaf spots, Cercospora personata and C. arachidicola, were greatly reduced with eight sprays applied at approximately weekly intervals with Bravo 75WP, Bravo 6F, Manzate 200, Dithane M45, Fungi Sperse and combinations of Benlate + Manzate 200, Benlate + Bravo 75WP and Dithane M45 + Du-Ter even under the extremely high disease pressures experienced in 1971. In one test good control was obtained even though both leaf rust and Cercospora leaf spots were present when the first spray application was made August 11 on 34 day old peanuts. The foliage on the check and buffer rows was severely affected by the time the plants were 90 days old in this test.

The results of the 1971 tests verified the preliminary report in 1971 that peanut rust in the near absence of Cercospora leaf spots can be a serious economic disease of peanuts, and furthermore, it appears as though the initial infection has come from some outside source. All evidence to date is negative that rust will overwinter in the South Texas area.

SHRINKAGE OF PEANUTS IN STORAGE

Whit O. Slay and Reed S. Hutchison
Industrial Engineer and Investigations Leader, respectively
National Peanut Research Laboratory
Transportation and Facilities Research Division
Handling and Facilities Research Branch
ARS, USDA, P. O. Box 110, Dawson, Georgia 31742
Roy Heatwole, Mathematical Statistician
Biometrical Services Staff
ARS, USDA, Beltsville, Maryland 20705

ABSTRACT

Spanish-, Runner-, Florunner-, and Virginia-type farmers' stock peanuts were collected at buying points in Georgia, Florida, and Alabama, and stored for periods of 5, 30, 60, and 90 days at the National Peanut Research Laboratory. At the end of each storage period, a representative part of each sample was graded. The results were compared with the grade factors obtained from the grade made at the buying point to determine changes that occurred during the storage periods. Each type of peanut was sized over screens of four different sizes to determine the screen needed to indicate the same percent sound mature kernel (SMK) outturn after storage as was shown by the first grade. Following each storage period, shelled kernels from each sample were returned to storage and rescreened along with the farmers' stock samples stored for longer periods. The shelled samples were used to represent loose shelled kernels (LSK) in farmers' stock.

The research was a cooperative study between Transportation and Facilities Research Division, ARS, and the Federal-State Inspection Service.

INFLUENCE OF PHOTOPERIOD ON FLOWERING AND FRUITING IN PEANUTS

J. C. Wynne, R. J. Downs and D. A. Emery
Instructor of Crop Science; Professor of Botany and
Director of Phytotron; and Professor of Crop Science and Genetics
North Carolina State University, Raleigh 27607

ABSTRACT

Present-day peanut varieties flower and produce fruit progressively throughout the growing season. Consequently each plant has developing fruit of varying degrees of maturity which results in lower yield and quality. Plants that flower over a short period of time subsequently producing fruit of similar maturity would be desirable and possible through genetic alteration of photoperiodic response.

In order to determine the photoperiodic response of peanuts, plants of six lines of Arachis hypogaea L. representing the two subspecies and two of the wild species of Arachis were subjected to two long-day (9 hr + 3 hr interruption) and two short-day (9 hr) photoperiodic treatments in the North Carolina State unit of the Southeastern Environment Laboratories. All treatments were at constant day-night temperatures of 30°C day-26°C night over a period of 64 days.

Vegetative growth for plants of the A. hypogaea lines was reduced by short-day treatments. Plants grown under short days also began flowering slightly later than plants grown under long days. However, plants grown under short days produced more fruit than plants subjected to long-day treatments.

Both vegetative and reproductive growth of the two wild species, A. villosa and A. duranensis, was favored by long-day treatments. A. villosa did not flower under short-day treatments.

The quantitative short-day photoperiodic response for yield of frnit of the six A. hypogaea lines probably cannot be used to increase uniformity of fruit maturity under field conditions. Peanuts are commonly grown under long-day conditions. However, better adapted varieties may be selected throngh differential responses to photoperiod.

BREAKING DORMANCY OF SEED OF PEANUTS (ARACHIS HYPOGAEA L.)

J. E. Bear and W. K. Bailey
Plant Genetics and Germplasm Institute, Agricultnral Research Service
U.S. Department of Agricultnre, Beltsville, Maryland 20705

ABSTRACT

Treatment of peannt seed by coating them with a slurry consisting of the seed protectant thiram (bis (dimethylthiocarbamoyl) disulfide) and ethrel (2-chloroethylphosponic acid), was highly effective in inducing dormant seed of the breeding line NC Acc 344 to germinate promptly when planted in a sandbed in greenhouse.

Thiram dust was applied to seed at rate of 6 ounces per 100 ponnds of seed. Ethrel in water at a concentration of 10^{-3}M, adjusted to pH of 6.0, was applied to the dusted seed in sufficient volume to give a slurry that covered the surface of every seed when the seed-chemical mixture was stirred. Treatment with this slurry resnlted in 99 to 100% germination when seed were planted immediately or when they were dried and stored for as long as 2 months before planting, in contrast to 2 to 4% germination for seed treated with thiram dust only.

Ethrel used at this concentration in this mixture had no apparent adverse effect on foliar or root development of 10-day old seedlings or on dry weight of above ground parts of 24-day old seedlings.

SEED DORMANCY OF DIFFERENT BOTANICAL TYPES OF PEANUTS (ARACHIS HYPOGAEA L.)

W. K. Bailey and J. E. Bear
Plant Genetics and Cermplasm Institute, Agricultural Research Service
U.S. Department of Agriculture, Beltsville, Maryland 20705

ABSTRACT

Spanish and Valencia peanut cultivars (subspecies fastigiata) are frequently described as haviug no post-harvest seed dormancy; whereas Virginia cultivars (subspecies hypogaea) are described as having post-harvest seed dormancy.

We have found that following curing at 20-32° (70-90°F) for 8 to 16 days, mature seed of the Valencia and Spanish cultivars 'Tennessee Red', 'Argentine', 'Starr', 'Comet', 'Spanhoma', 'Spancross', and 'Tifspan' grown at Holland,

Virginia, in 1970 and 1971, showed from 29 to 78% dormancy when planted in a sandbed in greenhouse at 20-32° (70-90°F). When grown, cured, and handled in a similar manner in 1969 and 1970, mature seed of the Virginia cultivars and breeding lines 'Florigiant', 'Florispan', 'NC 2', F393-9, and F393-6 showed from 11 to 68% dormancy. In our studies, seed dormancy of the Valencia and Spanish cultivars frequently was fully as great as that of the Virginia cultivars tested.

However, a dormancy characteristic which clearly distinguishes between these two groups of cultivars is the capacity of the seed to sprout prematurely prior to digging while still in pods attached to living plants. Under certain environmental conditions, seed of the Valencia and Spanish cultivars sprout prematurely prior to digging; seed of the Virginia types rarely sprout prematurely.

EFFECT OF SEED SIZE AND SEEDING RATE ON PERFORMANCE OF STARR SPANISH PEANUTS

Lewis E. Clark, Assistant Professor
Department of Soil and Crop Sciences, Texas
A&M University, College Station, Texas 77843

ABSTRACT

This investigation was conducted to determine the effect of seed size on germination, field emergence, stand establishment, and yield of 'Starr' Spanish peanuts.

Commercially processed seed lots, including large (ride 19/64 in. slot), regular (pass 19/64 and ride 17/64 in. slot), medium (pass 17/64 and ride 15/64 in. slot), and small (pass 15/64 and ride 13/64 in. slot) size seed were used. Germination tests were conducted at three laboratories in 1970 and at four laboratories in 1971. Three seeding rates were used in field plantings at five locations in 1970 and at three locations in 1971. All tests were planted one row per bed on 36 to 40 inch beds, and all were irrigated except at one location in 1971.

There were differences in germination percentages among laboratories and among seed sizes both years. Mean germination percentages over laboratories in 1970 showed that medium size seed germinated less than the large and regular sizes. Medium and small size seed germinated significantly less than large and regular size seed in 1971.

In field tests, seed sizes did not respond the same at all locations nor in both years. Regular and medium size seed performed more consistently over all tests than either large or small size seed. There were no significant differences in yield associated with seed size when populations of 60,000 plants per acre from large, regular, and medium size seed were established. Populations of 70,000 to 80,000 plants per acre from small size seed were necessary to provide comparable yield.

OBSERVATIONS ON THE DEVELOPMENT OF ENDOSPERM IN PEANUTS[1/]

J. M. Kubicek, Graduate Research Assistant and
D. J. Banks, Research Geneticist, USDA, ARS
Agronomy Department, Oklahoma State University
Stillwater, Oklahoma 74074

ABSTRACT

An investigation of endosperm development, behavior, and composition was initiated in the genus Arachis. The main objective was to establish a better understanding of the factors controlling normal endosperm development and to detect some possible differences (genetic markers) in the physical and chemical characteristics of the endosperm components in several diverse peanut genotypes.

Several studies, involving histochemical and biochemical analyses, were conducted on non-cellular endosperm. Developing embryos and endosperms from some interspecific hybrids and self-pollinated plants were studied to ascertain the behavior of the endosperm in relation to the developing embryo and to clarify the extent of endosperm tissue in mature seeds.

These studies were part of a Master of Science thesis by the senior author[2/]. Results of these studies follow:

(1) Cellular endosperm appears to exist as a single layer of cells covering the embryo (cotyledons) of fresh mature seeds.

(2) Hybrid endosperms and embryos between Arachis hypogaea and A. sp. (P.I. 262133)[3/] were found to be retarded when compared to the endosperms and embryos from developing selfed ovules. Hyperplastic activity of the maternal tissue was noted in aborting hybrid ovules of the above cross when the wild species was the pollen parent.

(3) Starch granules are conspicuous components of non-cellular peanut endosperm. Birefringence end-point temperature data revealed that the starch granules in the endosperms of two A. hypogaea genotypes (narrowleaflet and P.I. 280688) differed in physical structure from the other endosperms examined. Variations in starch granule size by genotype were observed in a size distribution study using endosperm starches at three stages of development (approximately 14, 24, and 28 days after pollination).

(4) The non-cellular endosperm of A. sp. (P.I. 262133) appeared to be devoid of valine, methionine, and arginine but these amino acids were present in the other endosperms studied.

[1/] Based on cooperative investigations of the Plant Science Research Division, Agricultural Research Service, U. S. Department of Agriculture and the Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma 74074.

[2/] Some Anatomical, Histochemical and Biochemical Analyses of Endosperm in the Genus Arachis, Oklahoma State University, Stillwater, Oklahoma, May, 1972.

[3/] Undescribed wild, diploid, annual species (10038). See Smartt, J. and W. C. Gregory, Oléagineux 22:1-5 (1967).

NEW METHOD TO ESTIMATE SHELF-LIFE OF PEANUTS AND PEANUT PRODUCTS

Charles E. Holaday and Phillip C. Barnes, Jr.
Peanut Quality Investigations
National Peanut Research Laboratory
ARS, USDA, P. O. Box 637, Dawson, Ga. 31742

ABSTRACT

The active oxygen method (AOM) of the American Oil Chemists' Society, most widely used to estimate the shelf-life of peanuts and peanut products, is time consuming and results occasionally differs among laboratories. The National Peanut Research Laboratory has developed a simple method that requires only 75 minutes. Light transmittances at 315 mμ of a sample of freshly pressed oil is measured before and after heating for 1 hour at 150°C. The ratio of the two readings is significantly correlated (r = 0.85) with results from the AOM method. Oils with AOM values above 20 hours have a comparatively long shelf-life while those with AOM values below 20 hours have a shelf-life of short duration. An AOM value of 20 hours corresponds to a transmittance ratio of .640.

UTILIZATION OF PEANUT FLAKES IN FOOD PRODUCTS

J. H. Mitchell, Jr., Professor
and
R. K. Malphrus, Laboratory Technician
Food Science Department, Clemson University,
Clemson, South Carolina 29631

ABSTRACT

In view of the popularity of peanuts in the form of peanut butter, salted peanuts, and in confections, psychological factors should be favorable for the introduction of peanut materials in other foods, provided they have high quality in terms of flavor, texture, and appearance and can compete in the economy of the food marketing system. In an effort to expand the utilization of peanuts, we have developed precooked peanut flakes which are essentially flavorless and white in color. Thus, they may be utllized in formulating a wide variety of food items. The full-fat flakes, which have a shelf-life of at least six months at 100°F when packaged in air, have been used to the extent of fifty percent in the formulation of boneless chicken and turkey rolls which have excellent acceptability as judged by consumer-type taste panels. Ingredient costs for these types of products are reduced substantially, as compared to the all meat products, by incorporating peanut flakes. Among other products which have received excellent acceptance ratings in taste tests are simulated coconut candy, cheese-peanut flakes, and meat analogs of the bologna type.

CHEMICAL DETOXICATION OF AFLATOXINS DURING WET-PROCESSING OF PEANUTS

Khee Choon Rhee, K. R. Natarajan
Carl M. Cater and Karl F. Mattil

ABSTRACT

The frequent occurrence of aflatoxins in peanuts has posed a serious problem in the utilization of peanut products as a source of protein to supplement low-cost protein diets. The present investigation is the first definitive study of the distribution of aflatoxins in peanut protein concentrates and isolates prepared by wet-processing directly from raw peanuts. The results indicate that majority of the aflatoxins present in the peanuts tend to remain with the protein fractions during wet-processing. For example, in the concentrate process, the concentrates contained about 80-90% of the total aflatoxins; oil about 4-8%; and whey solids about 7-11%. In the case of the isolate process, the isolate contained about 50-56%; fibrous residue about 20-30%; oil about 6-8%; and whey solids about 10-20%.

In order to determine the effectiveness of various chemicals to detoxicate or remove the aflatoxins in protein concentrates and/or isolates, certain chemicals were incorporated into the processing systems at the protein extraction step. Thus far, for protein concentrates, hydrogen peroxide proved to be the most effective detoxicating agent. At the 0.5% hydrogen peroxide concentration, the reduction of aflatoxins B_1 and B_2 was 97% and 96%, respectively. In the case of protein isolates, sodium hypochlorite was most effective. At the 0.2% concentration level or higher, virtually all of the aflatoxins in the isolates was detoxicated.

An aqueous solution of a 35% isopropyl alcohol reduced the aflatoxin content of the concentrates by about 80% and this can be used effectively in conjunction with other chemicals. Higher concentrations of isopropyl alcohol proved to be undesirable because of the formation of protein gels. Methylamine was also tested but was less effective than isopropyl alcohol when used for the isolate preparation procedure.

MYCOTOXIN GROUP DISCUSSION

Morris Porter, leader

Plant Pathologist, Southern Region, ARS, USDA
Tidewater Research Center, Holland, Virginia 23391

This discussion group was well attended and the selected topic participants stimulated much discussion by their presentations on mycotoxins concerning different segments of the peanut industry. Many questions were raised and comments were made by members of the audience. The first topic discussed was "Mycotoxin problems from a sheller's standpoint". Bill Birdsong, topic leader, pointed out several mycotoxin problems that face the sheller. It was noted that aflatoxin detection and elimination is costly not only in manhours but also in capital and space.

Ed Sexton and Wilbur Parker led the discussion on "Mycotoxin problems from a processor's standpoint". The main point made in this discussion was that the solution to the mycotoxin problem must be based on prevention rather than elimination.

The next item discussed was "Mycotoxin problems from a foreign standpoint". Ken Garren, topic leader, related how certain countries do not consider aflatoxins to be a real problem in peanuts imported from the United States. It was noted that Japan has a lower aflatoxin tolerance than does the United States.

Following discussion on these specific problems several persons were asked to inform the group of mycotoxin research currently underway. Bill Dickens provided brief summaries of research being conducted by the Agricultural Research Service of the United States Department of Agriculture. USDA mycotoxin research is being conducted at many different locations throughout the country and involves projects dealing with toxin identification, characterization, isolation of toxic factors, detection, resistance to fungal colonization, drying, etc.

Bob Pettit of Texas A&M University reported on research designed to discover methods of reducing aflatoxin contamination of peanut seed under field conditions.

Durham Bell reported on research involving Aspergillus flavus currently underway at the University of Georgia.

Mycotoxin research at Auburn University in Alabama involves several departments and many staff members according to Urban Diener. Research is currently being conducted on many different toxins including aflatoxin, ochratoxin, citrinin and rubratoxin. Slides of data from recent publications and equipment were shown.

VARIETIES AND BREEDING DISCUSSION GROUP

Donald J. Banks
Leader

There were 45 persons in attendance representing all commercial peanut-producing areas in the United States, as well as workers in Central America, France, and England. Many different subject matter specialists were represented.

The informal discussion was preceded by the presentation of a paper written by W. A. Carver, Agronomist Emeritist, Florida Agricultural Experiment Station. Dr. Carver, who resides in Gainesville, Florida was unable to attend the meeting. The paper, "Observations of a practical peanut breeder," was read by A. R. Norden.

Reports were given by states indicating estimates of the major varieties being grown in 1972:

Alabama (Rogers)	Florunner	85-88%
	Florigiant	12-15%
Florida (Norden and Gorbet)	Florunner	98%
Georgia (Hammons)	Florunner	71%
	Starr	12%
	Tifspan and Spancross	8%
	Argentine	1%
	Florigiant	8%
North Carolina (Wynne)	Florigiant	48%
	NC 5	19%
	NC 2	15%
	NC 17	10%
	Avoca 11	2%
	Florunner	1%
	Others	5%
Oklahoma (Kirby and Tripp)	Comet	35%
	Starr	25%
	Spanhoma	20%
	Argentine	15%
	Dixie Spanish and Spantex	5%
Virginia (van Schaik and Allison)	Florigiant	60%
	Virginia 61R	15%
	Virginia 56R	10%
	NC 17	10%
	Others	5%
Virginia 72R is a newly released variety.		
Texas (Simpson and Smith)	Starr	60%
	Comet, Spanhoma, Argentine, Spancross, Spantex, Wilco I, and Florunner	40%
Two new breeding lines from Starr parentage that outyield Starr by 10% are entered in the National Regional Variety Tests.		
Wilco I Acres (Conway and Warnken)	Texas	4,500
	Georgia	4,000
	Oklahoma	500
New Mexico (Hsi)	Valencia	8,000 acres
Valencia A is a new variety release.		

Wallace Bailey (Beltsville, Maryland), Agricultural Research Service, U. S. Department of Agriculture, discussed the National Regional Variety Tests. Because of the reorganization of ARS, plans for the 1973 tests are uncertain at present but seeds are being produced for them. The 1972 tests are continuing as planned.

F. H. Smith (South Carolina) indicated that although South Carolina grows only about 14,000-15,000 acres of peanuts, they are very interested in the peanut research and education activities of APREA. He expressed great concern about the disease, Cylindrocladium, in his state.

Clyde Young (Georgia) discussed his work in peanut chemical composition and speculated that sometime in the future, peanuts may be analyzed in such a way that their parentage and the area in which they were produced can be determined.

Pierre Gillier, Director of the Peanut Department, I.R.H.O., Paris, France, discussed peanut research for which he is responsible in Senegal, Mali, Upper Volta, and Niger. They are developing high oil content peanuts with Rosette disease resistance and drought-tolerant Spanish varieties.

Ron Gibbons, Team Leader of the Grain Legume Productivity Unit, Agricultural Research Council, Malawi, discussed the peanut research being conducted by his team. Malawi produces about 40,000 tons of shelled nuts. Chief varieties are Chalimbana, a jumbo type for confectionary uses, Mani Pintar for the oil trade, and Malimba, a Spanish type for salted nuts.

W. E. Bolton of the United Fruit Company discussed their work in Nicaragua and Honduras.

There was a discussion of some of the important peanut diseases and insects and breeding programs aimed at finding and utilizing resistance or tolerance to these pests which included: leafspot, rust, Pythium pod rot, pod breakdown, Cylindrocladium, blackhull, Verticillium wilt, nematodes, foliage-feeding insects, lesser cornstalk borer, burrowing bug, potato leafhopper, and southern corn rootworm.

D. J. Banks (Oklahoma) described a new breeding technique employing plant growth chambers which allows for crossing (emasculation and pollination) during the day (8:00 a.m. to 10:00 a.m.) rather than at night as done conventionally.

PEANUT VARIETIES REGISTERED IN CROP SCIENCE, 1969-1972

Variety	Registration No.	Registration Year	Originating institutions, agencies, or organizations	Author(s) of registration articles	Crop Science Reference vol. no. pages
Florigiant	1	1969	Florida AES	W. A. Carver	9(6):849-850
Florunner	2	1969	Florida AES A.J. Norden,	R. W. Lipscomb, W. A. Carver	9(6):850
Spancross	3	1970	Georgia Coastal Plain & Oklahoma AES & ARS, USDA	R. O. Hammons	10(4):459
Tifspan	4	1970	Georgia Coastal Plain & Okla AES & ARS, USDA	R. O. Hammons	10(4):459
NC 2	5	1970	North Carolina AES	W. C. Gregory	10(4):459-460
NC 5	6	1970	North Carolina AES	D.A. Emery,W.C. Gregory	10(4):460
NC 17	7	1970	North Carolina AES	D. A. Emery	10(4):460
Virginia Bunch 67	8	1970	Georgia AES & ARS,USDA	R. O. Hammons	10(4):460-461
Southeastern Runner 56-15	9	1970	Georgia AES & ARS,USDA	R. O. Hammons	10(6):727
Virginia 56R	10	1970	Tidewater Res. Station VPI, Holland, Va.	M. W. Alexander A. H. Allison	10(6):727
Virginia 61R	11	1970	Tidewater REs. Station VPI, Holland, Va.	M. W. Alexander A. H. Allison	10(6):728
Georgia 119-20	12	1971	Georgia AES & ARS,USDA	R. O. Hammons	11(2):313
Virginia 72R	13	1972	Tidewater Res. Station VPI, Holland, Va.	M. W. Alexander R. W. Mozingo	12(1):127
New Mexico Valencia A	14	1972	New Mexico State U. AES	D.C.H. Hsi R. E. Finkner	12(2):256
Spantex	15	1972	Texas A&M U., AES	C. E. Simpson	12(3): 395
Starr	16	1972	Texas A&M U., AES	C. E. Simpson	12(3): 395
			REGISTRATION OF GERMPLASM		
GP-NC 343	GP 1	1971	North Carolina AES	W. V. Campbell D. A. Emery W. C. Gregroy	11(4): 605

REGISTRATION OF PARENTAL LINES: None

List prepared by R. O. Hammons, Chairman CSSA Subcommittee for Peanut Variety Registration.

WEED CONTROL DISCUSSION GROUP

by

J. R. Bone, Discussion Leader
Product Development Representative, Rhodia, Inc., Chipman Division

Interest centered on control of weeds escaping currently available herbicides. Weeds receiving the most comment were Yellow Nutsedge, Texas Panicum, Texas Star Bur and Florida Beggarweed.

In the Southeastern peanut producing areas considerable effort has been placed on soil injection application of Vernam for Yellow Nutsedge control. Those reporting cited promising control, but indicated additional evaluation of injection methods will be necessary. The Texas delegation reported interesting activity on Yellow Nutsedge with the experimental herbicide MBR 8253.

Texas Panicum remains a problem in many peanut producing areas. Effective control from experimental applications of Sutan was reported from Georgia: Vernam followed by Balan was also effective. Cobex and A-820 were reported to have effectively controlled Texas Panicum in experimental trials in the Southwest. Lasso applied preemergence or postemergence in combination with Dinitro reportedly controls Texas Panicum as well as a number of other weeds.

Discussion produced little new information relative to the control of Texas Star Bur or Florida Beggarweed; few registered and fewer experimental herbicides offer adequate control.

Postemergence broadleaf weed control in peanuts was a topic of considerable interest. Reports of experimental evaluations conducted in most peanut producing areas indicated 2-4 DB Amine effective on a number of broadleaf weed species. A petition requesting registration of 2-4 DB Amine for usage on peanuts has been submitted to the Environmental Protection Agency, but to date 2-4 DB Amine is not registered for peanuts. BASF 3512 was also reported as effectively controlling a wide spectrum of broadleaf weeds when tested as a postemergence treatment.

This summary in no way constitutes a recommendation or endorsement of any practice or product discussed.

DISEASE DISCUSSION GROUP

by
R. V. Sturgeon, Jr., Discussion Group Leader
Extension Plant Pathologist, Oklahoma State University
Stillwater, Oklahoma

The panel members were:

1. K. H. Garren, USDA, Holland, Virginia.
2. D. M. Porter, USDA, Holland, Virginia.
3. S. S. Thompson, Georgia Experiment Station, Tifton, Georgia.
4. D. H. Smith, Georgia Experiment Station, Experiment, Georgia.
5. C. Wendell Horne, Texas A & M University, College Station, Texas.
6. R. E. Pettit, Texas A & M University, College Station, Texas.
7. P. A. Backman, Auburn University, Auburn, Alabama.
8. D. F. Wadsworth, Oklahoma State University, Stillwater, Oklahoma.
9. David C. H. Hsi, New Mexico State University, Clovis, New Mexico.
10. R. V. Sturgeon, Jr., Oklahoma State University, Stillwater, Oklahoma.

The Disease Discussion Group panelists from across the peanut-producing area of the United States reported on disease problems in their areas. Reports were made on research programs now in progress. K. H. Garren, Holland, Virginia, reported on Cylindrocladium black rot problem in Virginia and North Carolina. D. M. Porter, Holland, Virginia, reported on disease problems during 1971 and the conditions in the Northeast Area at this time.

Sam Thompson, Tifton, Georgia, reported that Cercospora leafspot was quite damaging in Georgia during 1971; however, little disease could be found at this time. He reported that rust was found throughout the Georgia peanut area and did not feel that it was heavy enough to cause serious damage. Don Smith presented research work on the epidemiology of Cercospora leafspot and discussed some of the methods used in his studies. He and Sam Thompson both mentioned the development of rust and how it was perhaps related to the large acreage of peanuts sprayed with Benlate in Georgia during 1971. Don discussed the development of leaf scorch (Leptosphaerulina) as did D. M. Porter from Holland, Virginia. Don also reported on a new leafspot infecting peanuts in the area of the Georgia Experiment Station.

Paul Backman, Auburn, Alabama, stated that Cercospora leafspot was quite extensive throughout Alabama during 1971; however, as in the Georgia area, it was slow developing this year. He reported that Alabama was now suggesting the use of only two fungicides--Bravo and Benlate; however, if growers did not have spraying equipment available, they could go to a sulfur-copper dust. Paul also reported on his seedling disease control studies. Southern Blight was reported to be extensive through the Southeastern Area, causing serious damage in many fields.

Wendell Horne, Texas, reported that Cercospora leafspot was quite extensive throughout Texas during 1971 and had been reported early this year in many areas of the State. Rust was quite extensive during 1971; however, only in the Yoakum area was it serious enough to cause extensive damage. He mentioned that nematodes were a problem in Texas; however, growers should utilize their nematode detection laboratory for proper identification before making chemical controls. Wendell reported a foliar disease problem, thought to be caused by air pollution, and introduced R. E. Pettit from College Station, who discussed a new foliar disease problem appearing in Texas which resembled air pollution damage but appeared to be caused by fungi. He stated that this foliar disease problem had the potential of being quite serious; however, they were not ready to name the pathogen until positive identification of the problem could be made.

R. V. Sturgeon reported that Oklahoma had one of its more serious leafspot epidemics during 1971 and that the disease had been identified earlier this year than before. With the proper environmental conditions, Oklahoma could expect another damaging year from Cercospora leafspot. Rust was found throughout the State in 1971; however, it was not severe and caused little if any damage. Various foliar diseases, such as Leaf Scorch and Botrytis, developed during the season, especially under cool, moist fall conditions. A foliar disease similar to that reported by Wendell Horne of Texas, thought to be caused by air pollution (called Leaf Bronzing), was quite evident across the State during the year. It is felt that secondary organisms, Alternaria and Fusarium, invade the damaged tissue and cause serious defoliation of the peanut plant. Sturgeon also gave a progress report on applications of soil fungicide through the irrigation system.

D. F. Wadsworth discussed a new disease problem developing in Oklahoma, caused by Verticillium, and showed slides of the developing microsclerotia within the peanut pods. Even though infection occurs readily within pods, the fungus has not been isolated from seed.

David C. H. Hsi, Clovis, New Mexico, reported that leafspot was serious in the New Mexico Area in 1971, and that a soil root-rot problem, Blackhull, caused by Thielaviopsis, could be controlled by Benlate incorporated at high rates in the soil.

In summary, Cercospora leafspot was reported to be a serious problem in all areas during 1971. However, it seems to be developing quite slowly in the South and Eastern Area. Oklahoma and Texas reported that Cercospora leafspot was showing up early this year. Peanut rust was reported to be widespread throughout the peanut-producing areas, yet only in a limited area in Texas was it considered to cause serious damage. A number of foliar diseases were discussed and considered to be causing extensive damage in many areas. Various pod and root-rot problems were common to all areas; however, the diseases seemed to differ with reporting areas. Nematodes were reported to be a serious problem in most areas. The need for additional research on the various disease problems was quite evident. The disease discussion session was well attended, and it was quite obvious that diseases are an important factor in peanut production, and there are many problems yet unanswered.

HARVESTING AND CURING DISCUSSION GROUP

J. L. Butler, Leader
Agricultural Engineer, Forage and Oilseeds Investagator, Leader, USDA

This discussion was started by Extension Agricultural Engineers pointing out the major harvesting and curing problems in their particular areas. This was followed by a report from a design engineer. The program was concluded by agricultural engineers giving reports of their research on harvesting and curing.

Pete Blume, from Oklahoma State University, reported that one of the major problems facing the industry in Oklahoma was the lack of adequate drying facilities. Consequently, it was not uncommon, especially in eastern Oklahoma for loads of peanuts to get hot enough to smoke while waiting to get to the drier. One other problem on the horizon is that of complying with the anti-pollution laws. The response from the group indicated that this is a very real problem in states other than Oklahoma.

Nat Person, from Texas A&M reported that the two widely separated production areas in Texas had different problems. The conditions in south Texas are such that peanuts may be allowed to over-dry in the windrow. In the northern production area, the problems are very similar to those in Oklahoma, since only the Red River separates the two. The number of ISK's and sound splits appears to be excessive in both areas.

Billy Mayfield, from Auburn University, reported that the number of farm driers in Alabama was increasing rapidly but that more were needed. The salvaging attachment, available on the Long combine, has created much interest and he thought that more information on this unit was desirable.

J. L. Butler reported that Mr. L. E. Samples, from Tifton, thought that timely digging and reducing the time in the windrow were two very important aspects of harvesting and curing for Georgia conditions.

Mr. James Keel, producer, reporting on conditions in eastern North Carolina stated that the salvaging attachment for combines also salvaged oyster shells, roots and other foreign material which the combine could not separate from the peanuts. When the question of a satisfactory cleaner was put to the audience, no suggestions were offered. It appears that research effort should be directed to solving this problem.

Andy Lambert, of Virginia, reported on observations of the salvaging attachment under Virginia conditions last fall. More than 11 inches of rainfall occurred during October. As a result, the fields were so wet that the salvager pick-up could not comb the soil, it was set to just skim the surface. On peanuts which had been in the windrow for 17-18 days, the salvaging attachment recovered an average of 160-203 pounds per acre, if only unshelled sound mature pods are considered. He also reported that when inverted windrows, which had been dug for 18 days were reshaken, just prior to combining, the number of pods lost did not appear to be excessive.

George Frushour, engineer with Lilliston Corporation, reported on the sequence of developing a combine. In this interesting talk it was pointed out that suggestions from AIRE\A Discussion Groups, requests from farmers and sales people and research engineers all had a significant bearing on the design. He then described the design features of the new combine, stating that unless used properly, these design features would be of no value. Practically all combines, regardless of make or model can be adjusted to do a better job than most of them are presently doing.

Bobby Clary, Oklahoma State University, stated that ventilated bodies on trucks and trailers, often accompanied by small fans had met with good acceptance and were successful in helping keep the temperature of peanuts, awaiting the drier, in the safe range. He also stated that the loss of windrowed peanuts to varmints, particularly crows, was considerable. No solutions to this problem were suggested.

Nat Person, again reporting for Texas A&M stated that not all splits and LSK's could be attributed to the combining and drying operations. Under south Texas conditions, the splits will increase while the peanuts are in the windrow awaiting combining. Much of this problem can be solved by combining before the moisture content of the peanuts in the windrow drops below 16 percent, he stated.

J. L. Butler reported that cooperative work, between the ARS engineers at Tifton and the former MQRD group at Dawson, was being conducted on two different methods for accurately, quickly, simply and cheaply determining the optimum maturity for harvesting. One method utilizes a methanol extract of freshly dug, ground whole pods. The other is based on the ratio of electrical impedance at 5 Hz and 500,000 Hz. Although both show promise, more research will be conducted before recommendations can be made. The same groups are also trying to determine exactly what takes place in the curing operations. Work is also underway at both Tifton, Ga. and Holland, Va. (Scott Wright) on units which combine the digging and picking operations. Both, operating with slightly different principles, are reasonably successfully picking peanuts with no more damage than hand picking. More development of the units will be done this year. The reports of Session 1 of Tuesday morning were recommended as being especially pertinent to this discussion group.

INSECT CONTROL IN PEANUTS DISCUSSION GROUP

by

J. W. Smith, Jr., Discussion Group Leader
Assistant Professor, Entomology
Texas A and M University, College Station,
Texas

The discussion group was attended by 25 persons and represented by Entomologists from all major peanut producing areas. Dr. John C. Smith and Dr. W. V. Campbell representing the East Coast, Dr. John C. French and Dr. Loy W. Morgan representing the Southeast, and Dr. C. E. Hoelsher and Dr. J. W. Smith, Jr. representing the Southwest. A representative from each area gave a brief informal overview of the insect problems from their area. Such topics as (1) key pests, minor pests, their status and control, (2) current and future research aimed at solving pest problems, (3) educational programs involved in obtaining grower acceptance of control practices, were discussed for each geographic region.

In the Virginia-Carolina producing area, thrips, Southern corn rootworm and Potatoe leafhopper are considered the major pests. Numerous other minor pests were named. Insecticides used for control of Southern corn rootworm and thrips are usually used as preventative measures. Although in the case of Southern corn rootworm, weather conditions play a major role. The use of insecticides for control of potatoe leafhopper is considered a "cosmetic" program. Producers do not tolerate the foliage discoloration produced by this insect. Research in North Carolina, by Dr. Campbell, has shown that Southern corn rootworm populations can be predicted as used in a control program.

In the Southeastern region foliage feeders present the major insect pest problem. Granulate cutworm, corn earworm, and loopers comprise the majority of the foliage feeding complex. Under drouth conditions the lesser cornstalk borer can be a problem. White fringe beetle is a pest in certain areas.

In the Southwest, the lesser cornstalk borer is the key pest. A pest management program available to producers for controlling this insect on dryland and irrigated peanuts was presented. The system is based on economic thresholds, selective insecticides and natural biological control. Economic thresholds for foliage feeding insects was also presented. A major problem facing entomologists in the Southwest was grower acceptance of control practices.

A general problem arising from all areas concerned spider mites. Spider mites are becoming more abundant in peanuts in the Southeast and East. During 1970, the Southwest had a major outbreak of spider mites, but this problem has been solved by not overusing foliar insecticide applications. The use of regular scheduled foliar treatments induced its outbreak in the Southwest. In most cases no registered acaracide is available for controlling spider mites, especially where organophosphorous resistance has been detected.

QUALITY

Discussion Group
by
Clyde T. Young, Discussion Leader
Department of Food Science
Georgia Experiment Station
Experiment, Georgia 30212

Quality has many faces and means something different to each of us, and each of us has our own definition as it relates to our research. Our ideas do not change much from year to year but these small changes can have an important impact on the improvement of quality of peanuts and peanut products. We shall discuss quality as it relates primarily to the finished product although it is also related to seed quality. Some individual aspects of quality presented by members of the discussion group were as follows:

1: Laboratory and biochemical techniques that can aid the peanut breeder.

2: Consumer quality of peanut butter and salted peanuts including freedom from molds and pesticides, and adequate in methionine.

3: Relationship of oleic/linoleic ratio to quality.

4: Seed quality including germination and oleic/linoleic ratio.

5: Effect of mechanical handling equipment on organoleptic values.

6: Effect of flavor volatiles on quality.

7: Effect of drying and storage on quality.

8: Changes in flavor, aroma and staling and nutritional qualities of peanut products.

9: Influence of physiological and growth factors, and the synthesis of flavors by enzymatic reactions.

10: Effect of various harvesting and curing treatments on quality.

11: Quality factors related to production, drying and curing; especially splits and aflatoxins.

12: Quality as related to chemical and microbiological control of mycotoxins.

13: Manipulation of fatty acids, amino acids, and other qnality factors in various wild species of Arachis by genetic control.

14: Quality as related to consumer acceptance.

15: Control of oxidative rancidity.

16: Subjective and objective methodology for determining peanut quality.

17: The various phases of quality related to the end product.

18: Effect of roasting, roasting reactions and roasting defects on flavor.

19: Utilization quality including the incorporation of flavor, functional and nutritional characteristics at a price that the product will penetrate the market.

20: Quality of the raw material that will provide end products with good flavor, appearance, texture, stability and free from natural toxins.

21: Quality as related to organoleptic values, mycotoxins, and blanching treatments.

22: Effect of fungicides, herbicides, environment, variety, maturity processing, storage, and chemical composition on quality of peanuts and peanut products.

The key point in quality at present appeared to be utilization since one-third of the peanuts are surplus.

One company reported on the production of food grade peanut grits and flour on pilot plant scale indicating that technical literature and samples were available. Protein content of the products was 57% (when using the 6.25 conversion factor which is standard for the food industry). PER values were lower than desired. It was suggested that some research was needed in which PER values are obtained using the proper conversion factor of 5.46.

The peanut crop in the United States provides an excellent source of protein available since one-third of the production is above that required for domestic consumption. Several laboratories are now examining the possible development of food grade protein from this readily available source. For example, the Southern Regional Lab has developed an air classification method for separation of protein fractions. The Texas A & M group is using aqueous separation of oil and protein to preserve the functionality of the protein in natural form for the food industry.

Since it requires the peanut breeder about 15 years to develop a new variety thus it is essential that processing techniques be developed to use the present available peanuts.

Better methods are needed to measure iodine values. There was some question as to what iodine values were desirable. How important are behenic and arachidic fatty acids to health? These fatty acids are low and vary among varieties.

At present, the peanut industry does not have a means to adequately grade quality so that the farmers, shellers and processors may sell and buy accordingly. The tobacco farmer does not receive the same price for every pound of his tobacco. For example, if he cures his tobacco at too high a temperature, he receives considerably less for his product. Also different lots of peanuts are mixed and lose their identity at the warehouse which makes it difficult after shelling to determine the source of poor quality. There is a need to improve the present grading system to either reward the "good" quality and/or penalize the "poor" quality.

What do we need in the peanut industry to initiate such a grading system so that we can upgrade the quality to the Consumer and divert the poor peanuts to non-consumer uses?

We need a chemical test that can provide results in no more than 15 minutes, and preferably in 5 minutes. The measure of maturity by the free arginine method (AMI) takes about 15 minutes from start to finish and can analyze about 100 samples/day. This procedure will be further automated to analyze 40-50/hour. Bins are needed at buying stations to keep different lots segregated. There are generally too many varieties at present to be most efficient. If "lots" of peanuts are segregated, then it would not be as important to rush the grading and analysis. There appears to be a definite need to keep lots segregated so as to preserve identity. This will definitely cost money and it is a question of who is willing to pay for it? The need to establish a rapid method for maturity is evident. Other possible factors that need to be considered may be starch or sucrose levels. In the potential production of a good roasted product, it may help to have growers grow a single variety for a given area. A point may be reached where industry contracts growers.

There is a need also to speed up measurement of volatile profiles. At present most quality measurements are primarily based on physical appearance and moisture. To go forward, we will need to measure maturity, flavor, roast level and fatty acid composition. The first need is to develop reliable methods and then speed these up through automation. Protein level may be important and is used to some extent in the wheat industry. With present control methods for diseases, the farmer no longer knows when to dig his peanuts. Higher yields may complicate the control of maturity in the Florunner. Maturity as based on screen size was not an important factor on flavor of peanut butter.

SOIL FERTILITY AND IRRIGATION DISCUSSION GROUP

by

L. E. Samples, Extension Engineer, Peanut Mechanization
Cooperative Extension Service, College of Agriculture
University of Georgia, Tifton, Georgia

Reports were made to the group by Mr. Allen Allison and also by Mr. R. M. Carter on Soil Fertility. It was noted that the use of minor elements, lime amendments, and general soil fertility was a matter of discussion for the entire group and interest was very, very high. It was noted that in the State of Florida minor elements, such as Boron, were added to peanut fertilizer. Mr. Ben Spears from the State of Texas also discussed the use of minor elements in fertility.

Mr. J. R. Stancil, University of Georgia, Coastal Plains Experiment Station, made a report on peanut irrigation which was also shared in by the group. Mr. Stancil mentioned that there were now some 12,000 acres of peanuts under irrigation in the State of Georgia and the use of water from 30 to 45 days before digging has shown the greater response. In general, the peanut requirement is about .3 inches of water per day. Irrigation frequency for most soils in Georgia would average a five-day irrigation interval.

The discussion concluded with questions and answers and participation was very good by the group.

SEED QUALITY DISCUSSION GROUP

by

Robert R. Pender, Discussion Group Leader
Pender Peanut Corporation, Greenwood, Florida

Peanut seed quality is uppermost in the minds of all producers. Good quality seed with high germinating, vigorous growth and healthy plants are the first prerequisites for harvesting a successful peanut crop. Maintaining excellent qualities in peanut seed is a continuing effort which seedmen and the industry must lend themselves to year by year. The industry must draw heavily upon the research efforts of Plant Pathologists, Plant Breeders, and Extensive Service personnel for direction and guidance. Our sophisticated peanut varieties of today, coupled with an increasing amount of mechanical handling that our peanuts experience, presents an even greater challenge to us in preserving all the vigor, vitality and other favorable characteristics that make up what we refer to as a good, high quality, peanut seed.

It was established first that a peanut plant when provided the proper balanced plant nutrients in favorable environmental surroundings will produce and develop healthy strong seedlings. The hard fact that we must recognize is that once these sound seedlings are produced, it's from the time they fall into man's hands--our hands-- the digging, harvesting, curing, storing, shelling, treating, bagging, and hauling operations that we, as we move through each of the aforementioned processes, lend some amount of damage and abuse to the seedling kernel that can never be replaced or recovered. This fact we recognize, consequently, we direct our efforts toward minimizing these problems at all levels throughout the process. It's also, in these areas that much of our discussion and thoughts should be centered, the areas in which seed peanut quality is effected tha most.

Discussion was directed towards the various stages in handling seed peanuts. Attention to adjustments of machinery and equipment during the harvesting and curing operations are often sacrificed for the sake of quantity rather than quality. More attention must be given in these areas if we are to preserve high quality seed peanuts.

Concern was also related to the use of liquid calcium applications in lieu of applied gypsum and the plant's ability to translocate liquid calcium absorbed through the Foliar System as to applied gypsum which is fed to the plant through the Root System. It was agreed that peanut varieties requiring additional calcium for production of healthy seedling kernels, producers should maintain use of gypsum using the liquid form of calcium in conjunction with gypsum. The peanut plant has ability to utilize calcium applied both ways, but it was decided that gypsum absorbed through the Root System was the better method to provide calcium for producing high quality seed peanuts.

Other discussion was directed toward the extended prolific life of the multi-cross varieties over the single-cross variety peanuts. The multi-cross varieties possess various favorable characteristics from each strain introduced into the line, consequently, it was determined that extreme close sizing of seed for reproduction of the multi-cross variety peanuts could possibly attribute to more rapid degeneration of the variety. To minimize this possibility it was the opinion of the group that close sizing of seed kernels in the multi-cross varieties is not recommended and that producers and seedmen engaged in the production and sale of high quality peanut seed should maintain programs as close to Breeder and Foundation seed as possible.

Healthy discussion prevailed during this forum. Keen interest and concern was expressed for the maintenance of high quality seed peanuts by the approximately 25 in attendance.

NEW PEANUT PRODUCTS DISCUSSION GROUP

BY

Julius L. Heinis, Discussion Group Leader
School of Agriculture and Home Economics
Florida A & M University
Tallahassee, Florida

Peanut producers, processors and researchers are highly interested in developing new products which find good market acceptance. This has been the case starting with George Washington Carver, the great black peanut scientist of Tuskegee Institute. Some "new products" may in fact not be so new, rather they are in need of further development.

In my opinion it is important that we devote some effort to develop other than conventional uses for peanuts. For instance, in my reading I discovered that a group at Cornell University studied fermented peanut press cakes (1). They reported that in Indonesia there is a product called "ontjam" and prepared it in their laboratory by extracting peanut cakes with hot water. After pasteurization, 1% tapioca and spores of either Neurospora or Rhizopus were added and the pH adjusted to 4.5. Fermentation progressed aerobically at room temperature for 24-48 hours. It is preferable, of course, to start with clean peanut cakes. But either fungus caused a decrease of 50% of aflatoxin when this substance was inoculated into peanut cakes.

What can we do with the hulls or shells besides use as fuel, litter or roughage for cattle? The skin contains thiamin and tannin which could be extracted. There may also be medicinal uses of peanut products. Woodroof (2) wrote about a peanut factor which plays a role in reducing bleeding time in hemophiliacs, and a purine which causes relaxation of excised smooth muscles. From the hulls we could possibly extract the chemotherapeutic drugs nitrofurans. Leaf proteins also deserve further investigation.

The following experts agreed to appear on this panel: Professor Hubert Harris, Auburn University; Joseph Pominski, USDA, New Orleans; Dr. Carl M. Cater, Texas A & M University; and Dr. Franklin Barton, USDA, Athens, Georgia.

Professor Hubert Harris demonstrated the step by step products in his procedure for preparing peanut flour with oil contents from less than 1 to 22%. This procedure consists in dipping peanuts for a short time in boiling water, deskinning and defatting by screw pressing and hexane extration. The resulting flour is devoid of peanut flavor and can be used in making cookies and bakery goods.

Joseph Pominski reported on the development of a process in which roasted, partially defatted peanuts contained nitrogen instead of air in the interstices of pores. At the Southern Regional Research Laboratory processes are being developed for making peanut flours (60% protein, moisture-free basis, MFB), and peanut concentrates (70% protein MFB). A pilot plant to produce protein insolate from oilseed flours is under construction.

Dr. Carl Cater discussed the method of processing peanuts in an aqueous system to separate a high quality oil and either a concentrate containing 67% or an isolate containing 88% proteins. These are essentially native proteins since they are not subjected to degradation by heat or solvent. The resulting products will soon be made available to the food industry for evaluation. A method of neutralizing the effect of aflatoxin was reported in a paper given earlier.

One difficulty of acceptance, according to Dr. Ed Sexton, is that peanut protein is more expensive than soybean protein. However, this handicap may be overcome by stressing special properties of peanuts.

Dr. Franklin Barton reported that the Russel Research Center in Athens, Georgia is making studies to find new uses for hulls. Peanut hulls were given in various proportions in a feeding trial with steers. Pesticide residues must be considered in animal feeding, and efforts are made to improve the digestibility of peanut hulls.

Peanut hulls have been processed into fireplace logs. A combination of hulls and waxes yields a product that gives clean burning for about three hours.

Ronnie Balkcom reported that peanut flour is used by one company for the production of barbecue sauce. Joe Sugg, also from the floor, expressed a desire that APREA and Peanut Commissions and Associations cooperate in every way possible to see that ideas for new products are followed through to successful development.

To get an idea of the contents of protein and other major constituents of various peanut products, see the following table 1 which has been drawn up. Lest I forget it, my own interest lately has been with increasing the methionine content of peanuts through selection or addition of molybdenum to plants.

REFERENCES

1. van Veen, A.G., D.C.W. Graham, and K.H. Steinkraus. Fermented peanut press cake. Cereal Science Today 13 (3); 1968.

2. Woodroof, J.G. Peanuts: Production, Processing, Products. Avi. Publishing Company, Inc. Westport, Connecticut, 291 p., 1966.

TABLE 1. CHEMICAL COMPOSITION OF PEANUT PRODUCTS IN % (*).

	Kernels	Cake Meal	Defatted	Spread	Fermented Ontjom	Skins	Shells	Hay	Fresh Leaves
Protein	28.5	45.0	43.2	20.3	20 - 30	12.7	6.7	11.2	0.5
Oil, lipids	47.5	8.8	16.6	52.1	3 - 9	11.8	1.1	5.1*	-
Moisture (H_2O)	5.6	6.2	2.7	2.2	70.0±	9.0	7.5	10.0	-
Crude fiber	2.8	12.1	-	(1.5)	2.0	34.8	60.8	21.9	-
N-free extract	13.3	23.1	-	-	-	20.5	19.7	42.1	-
Ash	2.3	4.8	6.3	3.4	1.0	11.2	4.2	9.7	-
Carbohydrates	(18.0)	(32.0)	31.2	22.0	4.0	-	-	-	-
Others	vitamins; B-complex, E,K					thiamin tannin		*ether extract	
Possible uses	food vitamins, medicinal	feed	low calory food	food	food in Indonesia	source of thiamin and tannin	fuel, mulch, litter, roughage, abrasive, crown for bottles nitrofurans	animal feed	food feed

* Compiled from 'Woodroof and other sources

SUMMARY OF DISCUSSION

SHELLING PLANT OPERATION AND POLLUTION CONTROL DISCUSSION GROUP

BY

R. S. Hutchison, Discussion Leader,
Agricultural Engineer, U.S.D.A., Dawson, Georgia

The group of approximately 40 people discussed problems in the following areas: (1) cleaning of farmers' stock peanuts; (2) shelling of Florunner peanuts; (3) grading and sorting; (4) pollution and worker safety, and (5) bulk handling.

Cleaning: Cleaning was discussed from the standpoint of removal of rocks, berries, sand, and large sticks. The general concensus was that cleaning was beneficial to reduce the volume to be stored, improved insect control and improved quality. However, most agreed that cleaning as a general practice is dependent upon a more strict requirement than the present 10 percent maximum foreign material content. Some of the participants brought out the fact that buying points do not use cleaners because they cannot regain the investment from cleaning charges.

Shelling of Florunner: The main point brought out on shelling Florunner was that the rate of shelling with currently used equipment often overtaxes the separating equipment.

Grading and Sorting: Problems in making count-per-pound were discussed and the concensus was that finding the proper size of separating screens is generally a trial and error procedure. Improvements in separating can be made by using a uniform flow of material to the screens or cylinders and best sizes of screens available.

Pollution and Worker Safety: The discussion centered around the noise level factor in shelling plants, and methods of reducing the noise level or use of plugs and ear muffs. There was a brief discussion on the worker safety law and its implementation.

Bulk Handling: Mainly, shipping in bulk was discussed and the relative merits of containers and burlap bags for shelled peanut handling, storing, and shipping.

MINUTES OF THE REGULAR BUSINESS MEETING OF THE
AMERICAN PEANUT RESEARCH AND EDUCATION ASSOCIATION
Downtowner Motor Inn, Albany, Georgia, July 18, 1972

President Bill Mills called the meeting to order at 8:30 A.M.

The minutes were approved as appears in the 1971 Journal.

President Mills recognized the assistance of Mrs. Ruth Sturgeon and Mrs. Bernie Tripp for their part in helping with the registration.

President Mills then asked for committee reports.

Finance--Harry Schroeder--See Appendix I.

Harry Schroeder moved that the report be accepted. Seconded by Ray Hammons. Passed.

Publications and Editorial--Joe Sugg--See Appendix II.

Peanut Quality--Charles Holaday--See Appendix III.

Public Relations--Astor Perry--See Appendix IV.

Nomination--Bill Dickens--See Appendix V.

Bill Conway moved that we elect the group by acclamation. Seconded by Frank Dollear. Passed.

Program--Olin Smith--See Appendix VI.

A resolution was adopted by assembly action with a letter of appreciation going to Elizabeth Edmonds and Wallace Bailey for their many hours spent in compiling, printing, and distribution of the publication known as "Peanut Research."

A resolution was also adopted by assembly action with a letter of appreciation going to the National Peanut Council for the financial support in publishing the "Peanut Research." The presentation was made to Wayne Eaves.

The Long Renge planning report was reported upon with action noted by President Mills.

Ammendments to the by-laws were adopted by assembly action by unanimous accord.

Olin Smith was introduced as the new President of the Association.

An announcement was made that the 1973 meeting of the Association would be at the Lincoln Plaza in Oklahoma City, July 15-18.

The meeting was adjourned at 9:30 A.M.

REPORT OF THE FINANCE COMMITTEE
Harry W. Schroeder, Chairman

The Finance Committee operates primarily in an advisory capacity. In addition, it has the responsibility of making a limited audit of the Association's Financial Records. The Committee's audit of the APREA records found them to be in agreement with financial statements from the First National Bank and Trust Company of Stillwater, Oklahoma. The Committee commends our executive secretary-treasurer for the excellent and efficient service he is giving the association concerning financial transactions and records.

APREA has been steadily increasing its financial reserve and it is still the recommendation of this Committee that a formal "Reserve Fund" be established to further strengthen our financial base. Recent actions of the Association through its Executive Committee will perhaps make this possible. A contract for the publication of the book "The Peanut" has been authorized. Although publication will be partially financed by pre-publication sales and by utilizing some of the Association's cash reserve, deficit financing will be required. However, even moderately successful promotion and sales will enable the APREA to quickly retire this debt with a profit that could be substantial if the sales are highly successful. The Finance Committee recommends therefore, that such profits should be invested in blue chip securities to initiate the aforesaid formal "Reserve Fund."

The Executive Committee has increased the registration fees for the annual meeting for both members and non-members. This action should provide an additional income to meet inflationary pressures on normal expense items. However, it is recommended that the effect of increased registration fees on attendance at the annual meeting be evaluated to determine the real impact of this action on the income of the Association.

A review of the 1971 budget shows the year ended with a cash balance of $4,403.79. Our budget for 1972 projects an income of $5,850.00 and expenditures of $5,468.00. The income estimate may be revised upward as a result of the increase in registration fees. The Association will probably end the year with a cash balance in excess of $5,000.00. On this basis we present the 1972 budget for your approval.

Early reports from the Publication Committee indicate pre-publication sales of "The Peanut" are proceeding at a better than expected rate. However it will probably still be necessary to borrow funds to meet the total publication costs. Your Finance Committee has canvassed various sources associated with the organization and are pleased to report that a loan can be obtained at equal or less than regular commercial rates. Sales of the book should enable replacement of all moneys advanced for its publication in a relatively short time.

1971 Budget Report
Assets & Income

	Budgeted	Transacted
Reserve – January 1, 1971	$2,895.00	$2,894.11
Membership & Registration (Annual Meeting)	5,000.00	5,077.00
Proceedings Sales	600.00	633.95
Special Contributions	250.00	240.00
TOTAL	$8,745.00	$8,845.06

Liabilities and Expenditures
January 1, 1971 – December 31, 1971

Item		Budgeted	Expended
1	Proceedings - Printing	$2,500.00	$3,343.17
2	Annual Meeting - Printing - Catering - Misc.	750.00	470.57
3	Secretarial Services	350.00	370.00
4	Postage	300.00	191.71
5	Office Supplies	250.00	6.82
6	Position Bond for $5,000 (Exec. Secretary-Treasurer)	15.00	13.00
9	Registration - State of Georgia	5.00	5.00
10	Miscellaneous	800.00	41.00
	SUB-TOTAL	$4,970.00	$4,441.27
	Reserve – December 31, 1971	$3,775.00	$4,403.79
	TOTAL	$8,745.00	$8,845.06

AMERICAN PEANUT RESEARCH AND EDUCATION ASSOCIATION

1972 Budget

Item	Budget
Assets and Income	
Balance - December 31, 1971	$ 4403.79
Membership and Registration (Annual Meeting)	5000.00
Proceedings and Reprint Sales	600.00
Special Contributions	250.00
TOTAL	$10253.79
Liabilities and Expenditures	
Proceedings - Printing	$ 3500.00
Annual Meeting - Printing - Catering - Miscellaneous	600.00
Secretarial Services	350.00
Postage	200.00
Office Supplies	100.00
Position Bond for $5,000 (Exec. Secretary-Treasurer)	13.00
Travel - President	300.00
Travel - Executive Secretary-Treasurer	300.00
Registration - State of Georgia	5.00
Miscellaneous	100.00
SUB-TOTAL	$ 5468.00
Reserve - December 31, 1972	$ 4785.79
TOTAL	$10253.79

APPENDIX II

PUBLICATIONS AND EDITORIAL COMMITTEE REPORT
Joe S. Sugg, Chairman

The Publications and Editorial Committee contined its duties with the publication of the 1971 Journal which was distributed and should be in the hands of all parties desiring one. In reviewing the suggestions from members on how to improve publications and editorial activites of APREA, your Committee, through correspondence and a telephone conference call meeting, has reviewed opinions in this area concerning the following:

1. Publication of the Journal.
2. Publication of "Peanut Research."
3. Publishing a refereed Journal
4. Report by Coyt Wilson and go ahead on publishing "The Peanut."

As a report on the activities of the approved listed items in order presented, I submit the following:

1. It was felt that the cost of publishing the Journal could be reduced by approximately 50% and the time required to get the Journal published could be brought within 30 days from the adjournment of APREA's annual conference by using a special format for all papers, abstracts, and addresses.

The size and format of the Journal would remain the same. The Committee felt that this proposal had a sufficient merit to try out this year. Dr. Olin Smith was supplied prints of blue lined paper with a detailed outline of the format, which was distributed to all authors. It remains to be seen how successful this will be for the 1972 Jonrnal.

2. "Peanut Research," which has been printed and distributed by the National Peanut Council from material gathered and supplied to the Council by Wallace Bailey, has taken a change in direction. The National Peanut Council recognizing the independent activity of APREA, which needed strengthening by more activities for its members, informed the Publications Committee that after Jnly 1, 1972 it would no longer print and distribute "Research." Likewise, the burden of gathering material for "Research" was quite heavy on Wallace Bailey. Your President was notified of this decision and has asked that this committee come up with a proposal.

3. The Committee recognized that there has been considerable pressure from the members of APREA for the publication of a recognized Scientific Journal. This within itself is no small task. Several ideas have been put forth and the Chair appointed Wallace Bailey, Chairman, Coyt Wilson and Astor Perry, committee members, with Terry Reel, Peanut Journal and Nut World, Publications Consultant, to the committee.

Wallace Bailey's report is attached hereto and will be reported by Bailey at the Committee meeting and to the Board of Directors in that he has the advantage of the committee discussions.

Charges or page limits for published papers was deferred subject to recommendations developed by the Ad Hoc Committee as proposed in Bailey's subcommittee report.

4. Coyt Wilson at the time of our telephone conference call meeting described the status of the book "The Peanut." I might add that the conference

call was an inexpensive method of having an effective meeting of a relatively small committee, when the subject to be discussed was studied before hand by the members. Our call which amounted to 34 minutes cost $74.00 which is much cheaper that a six man committee meeting.

Dr. Wilson stated that he needed some kind of authority to authorize the printer to begin printing. Each of the committee members felt that Coyt had done a good job and as far as this Committee was concerned that we would give him the go ahead, subject to his getting approval from Bill Mills. Report on the publishing of "The Peanut" and its sales preceded this Committee report.

Recommendations Relating to Publications Policy for American Peanut Research and Education Association
Wallace K. Bailey, Chairman

We, members of a subcommittee of the Publications Committee of APREA, charged with developing recommendations relating to a publications policy for APREA, present the following report:

It is our feeling that something should be done to enhance the prestige of the APREA Journal. Towards such an end we recommend that it be converted into a recognized scientific journal by requiring that all full-length research papers published therein, other than invitational papers, be critically reviewed for content by an editorial board before being published, and that the Journal publish results of original research only.

We further recommend that the Proceedings of the Annual Meeting of APREA, including abstracts of papers presented be included as a section of one issue of the Journal each year.

We recommend that an ad-hoc committee composed of the people listed below be appointed to develop standards for the Journal, standards for use of authors in preparing manuscripts for publication, and standards for use of editors in reviewing manuscripts:

Ralph Matlock	Olin Smith	Al Norden
Curtis Jackson	James Butler	Ray Hammons
Leo Goldblatt	Max Bass	Darold Ketring
Peter Tiemstra	Don Emery	Preston Reed, Chairman

Among the items for which this committee should develop recommendations are:

Editor of the Journal
Physical size of the Journal
Quality of paper
Type size and style
Page charges
Length of articles
Subscription price
Policy with respect to availability of reprints
Format for literature citations, etc.
Others

We recommend that Peanut Research be issued on a monthly basis and that the scope of its contents be enlarged to include:

(1) more research achievements;
(2) systematic listing in every issue of selected current references relating to research with implications for peanuts;

(3) a systematic listing of all CRIS research projects that involve peanuts, first those now in effect in individual States and in different USDA agencies, and subsequently all new and revised projects as CRIS reports of them become available. These capsule reports should include location; project title; objective; research approach; scientist-man-year per year of effort involved; funds involved; duration; and name of principal investigator or project leader;

(4) short full length general papers, review papers, articles describing results of preliminary research towards which no additional research is to be applied, and articles submitted for publication in APREA Journal which the editorial board feels can be published more appropriately in Peanut Research.

We propose the Peanut Journal and Nut World as a logical place for publication of Peanut Research.

We recommend that assembling and organizing of material for Peanut Research, other than the full length articles, be handled by Ray Hammons and Emory Cheek at the Georgia Coastal Plain Station, Tifton.

We recommend that the editorial board for the APREA Journal solicit, receive, review, and designate full length articles for inclusion in Peanut Research.

We are keenly aware that cost of publication is an important factor in relation to the cahnges that we are proposing. With this in mind, we sought from Mr. Terry Reel of Peanut Journal and Nut World estimates of cost to APREA (1) for printing 300, 400, or 500 copies of each issue of the APREA Journal; and (2) for printing Peanut Research as a portion of PJ&NW and distributing a copy of same to all names on the APREA mailing list who do not subscribe to the PJ&NW. These estimates are as follows:

Printing APREA Journal, up to 500 copies per issue - $25 per page

Printing and mailing copies of Peanut Journal and Nut World to recipients on mailing list for Peanut Research who do not subscribe to Peanut Journal and Nut World, up to about 500 copies:

Printing - No charge
New mailing plates (non-recurrent) - 19¢ each
Addressing and delivery to post office - 13¢ each
Postage, domestic - 13¢ each
Overseas airmail - Variable, but about 90¢ to $1.10 each

Mr. Reel stated that Peanut Research would be printed under this title beginning on a page with no advertising or other printed material and continue thus until all Peanut Research material for that issue has been completed, except that any space left at bottom of the last page containing Peanut Research material would be filled with some other material.

Mr. Reel stated by telephone that if APREA desired to handle distribution of the extra copies of Peanut Journal and Nut World containing Peanut Research, he would be glad to make these copies available to us at no cost.

REPORT OF THE PEANUT QUALITY COMMITTEE
Charles E. Holaday, Chairman

According to the constitution and by-laws of APREA the Quality Committee shall actively seek improvement in the quality of raw and processed peanuts and peanut products through promotion of mechanisms for the elucidation and solution of major problems and deficiencies. Since the organization of APREA the Quality Committee has endeavored to carry out this mandate. Although much work remains to be done some progress has been made toward developing procedures for measuring quality factors.

Last year's Committee recommended four specific areas of endeavor for this year's Committee. They are as follows:

1. Further improve the accuracy of the optical and refractive index methods for measuring maturity and iodine number, respectively. Both methods were tentatively approved by the Board of Directors for inclusion in the 1971 Journal. The Committee this year ran collaborative studies comparing the refractive index method with the Wijs method. Results showed that the refractive index method had a higher standard error and averaged about one and one-half points lower in iodine number than the Wijs procedure. No additional work was done on the optical density procedure.

2. Develop equipment and methodology for measuring milling quality. The Committee was again unable to locate suitable equipment for making this measurement.

3. Develop appropriate methodology for measuring seed quality. This is an area in which the Quality Committee has expended little, if any, effort. To correct this, Dr. Lewis E. Clark, agronomist with Texas A&M, was appointed to the Committee this year. At the annual meeting of the Quality Committee Dr. Clark discussed some of the problems in connection with seed quality and agreed to canvass the various states on seed quality regulations and make recommendations to the Committee on needed areas of research.

4. Further discuss quality standards and work on the new maturity and peanut stability methods. The two new maturity methods, colorimetric measurement of a methanol extract of green pods and electrical impedance measurement of green pods were discussed by Dr. Jim Butler. Work on both of these methods was continued this past year and results showed that both had considerable promise. Two peanut stability methods, light transmittance of cold pressed peanut oil and the oxygen bomb test, were discussed by Charles Holaday. Both Both procedures appear to show promise.

Dr. Tom Whitaker, Chairman of the Subcommittee on Sampling, submitted a report on the activities of his Committee which is given below:

With the approval of the APREA Board of Directors, the membership of the Subcommittee could be expanded by the chairman as long as the individuals were APREA members. In this spirit, the membership was expanded in 1971 from a chairman and two members to a chairman and six members.

The Subcommittee met in Raleigh, North Carolina to plan future activities. Various problem areas related to sampling were defined by both the Quality

Committee and the Sampling Subcommittee. As a result, the following individuals were assigned to investigate the following areas:

1. Aflatoxin Sampling – Whitaker and Dickens (USDA)

2. Sampling to Estimate Germination Percentages – J. H. Young (Agricultural Engineer, N. C. State University)

3. Sampling to Estimate Damage – P. J. Tiemstra (Derby Foods)

4. Sampling to Estimate Moisture Content – Dr. G. Brusewitz (Agricultural Engineer, Oklahoma State University)

5. Sampling Finished Product (raw or roasted) for Aflatoxin – Dr. Larry Atkin (Consultant Arthur D. Little Inc.)

It is the desire of the Subcommittee to have all findings and recommendations on the above areas be made available to APREA members through presentations at annual APREA meetings, publication in the Proceedings, and documentation in a Sampling Handbook prepared by the Subcommittee.

Dr. Young has written a paper concerning sampling of seed peanuts to estimate germination. This paper will be presented at the 1972 APREA meetings and published in the Proceedings. Dr. Atkin has prepared a paper applying the sampling statistics developed by Dr. Whitaker and Mr. Dickens to sampling finished goods such as salted peanuts. This paper will appear in APREA in the future. Dr. Whitaker and Mr. Dickens have continued their studies developing sampling statistics to be applied to sampling shelled peanuts for aflatoxin. From their studies the variability of aflatoxin test results dne to sampling, subsampling, and TLC analysis have been qnantified.

In addition, Whitaker and Dickens worked with the Peanut Administrative Committee (PAC) in reviewing the aflatoxin sampling program used last year by the peanut industry. Several new sampling plans were evaluated (estimation of industry cost, consumer risk, and processor risk) by Whitaker and Dickens at the request of PAC. As a result PAC initiated new aflatoxin sampling procedures to be used on the 1972–73 crop. The plan is very similar to the one used last year. A single sample of 48 pounds is drawn from the lot. The entire sample is ground and approximately four 280 gm subsamples, two for the processor and two for PAC, are taken from the ground material for analysis. The processor will analyze the first subsample. If the concentration is less than 15 ppb, the lot is accepted and no further testing is made. If the subsample analyzes greater than 15 ppb, the second subsample is analyzed by the processor. If the average of the two subsamples is less than 25 ppb, the lot is accepted. If the average is greater 25 ppb PAC will analyze its two subsamples and make final determination. If PAC's two analyses average less than 25 ppb, regardless of the Processors results, the lot is accepted. However, if the average is greater than 25 ppb, the lot is indemnified by PAC.

It is estimated that the new plan will accept fewer bad lots (consumer risk), reject more good lots (processor risk), and reduce the average concentration of aflatoxin in the accepted lots than the plan used last year. The operating characteristic curves for all sampling plans used by the industry since 1968 are shown in the enclosed reports along with papers describing Dr. Young's and Dr. Atkin's work.

The Quality Committee recommended to the Board of Directors that members of the Subcommittee be made members of the Quality Committee. The recommendation was approved by the Board. There are four areas that this year's Quality Committee recommends for consideration by the incoming committee:

1. Promote more research on the handling of seed peanuts and improve techniques for measuring germination and vigor.

2. It is generally recognized that peanut protein is deficient in certain essential amino acids. The committee recommends that this problem be looked into.

3. Determine if there is a need for new equipment to measure milling quality.

4. Further study the new methods for measuring maturity.

APPENDIX IV

REPORT OF THE PUBLIC RELATIONS COMMITTEE
Astor Perry, Chairman

One of the major objectives of the Public Relations Committee is the securing and maintenance of membership. The Committee has engaged in the following activities this year to accomplish these objectives:

1. Contacted each old member whose membership had lapsed and encouraged them to renew their membership in APREA. It was found that many of these were people with only secondary interests in peanuts who have attended APREA meetings held in their areas and do not wish to become continuous members.

2. Compiled a list of 493 shellers, processors, and manufacturers who to our knowledge had not been previously contacted concerning membership in APREA. Letters were sent to each of these outlining the advantages of membership. Each prospective member was invited to attend the meeting in Albany and a copy of the program and a motel reservation form was included in each letter. The response to this membership campaign has been encouraging although it is not known how many members were obtained in this way.

Membership in APREA as of July, 1972 was as follows as compared to 1971.

Category	1971	1972
Sustaining Members	17	16
Organizational Members	58	46
Individual Members	207	265
Student Members	13	12

In addition to the above activities monthly articles concerning the activities of APREA have been printed in the Peanut Journal and Nut World. The committee suggests that this policy be continued in the future as it provides members of APREA to promote our activities to the broad readership of this Journal.

Report of "The Peanut" Committee

"The Peanut" Committee is a new committee formed in March 1972 to sell the APREA sponsored book "The Peanut" which is due to be published in November 1972. Since APREA has insufficient funds to pay the printing costs which will amount to approximately $15,600, a rather large committee was appointed by President Mills in order to sell as many copies as possible before publication. Prepublication cost of "The Peanut" was set by the Executive Committee at $12.50/copy and postpublication cost at $15.00/copy. "The Peanut" Committee

is composed of 31 members, consisting of extension, research, grower, industry, and foreign representatives.

In May, 1972, 2000 copies of a one-page brochure was prepared which gave a complete description of "The Peanut." A handy order form was included as a part of the brochure. Copies of these were sent to each committee member with suggestions on what specific audience each committee member should contact. In addition to personal contacts made by committee members several specialty publications such as the Oklahoma Peanut Grower, The Virginia-Carolina Peanut News, Oleagineux, and The National Peanut Council's Newsletter have printed the brochure in their publications, free of charge.

As of July 18, 1972 orders totaling $5800.00 have been received which has been extremely pleasing to the Committee. Indications are that by the time the book is printed pre-publication orders will amount to $8000.00 or more.

Once the printer delivers the book we have a period of 30 days to pay the bill. Hopefully by that time 1250 copies or enough to pay the bill will be sold. At this point it needs to be pointed out that this goal will not be reached unless each member of APREA makes a conscious effort to get his order in prior to November 1 and to encourage his colleagues and all other personal contacts to do the same. The potential market for a technical book such as "The Peanut" is limited but it is our firm belief that a book of the excellence of "The Peanut" with its 20 chapters covering every phase, from its history to its consumption as a finished product, well illustrated with both color and black and white photographs should be on the desk of everyone connected with the peanut industry.

As Chairman of "The Peanut" Committee, I would like to commend each committee member for their efforts in contacting their audiences, and the members of the industry who have sent in their early orders. Writing, pulling together, and selling "The Peanut" represents the most difficult project undertaken by APREA. If every member does his part, this project can be a successful one.

RESOLUTION

WHEREAS, the National Peanut Council, has for the past ten years published and mailed to all members of APREA and its predecessor organization PIWG copies of "Peanut Research" on a regular basis without charge or obligation to either organization,

THEREFORE, BE IT RESOLVED that we the members of APREA express our sincere appreciation for this act of kindness and generosity on the part of the National Peanut Council. Without their help there would not have been a Peanut Research bulletin since PIWG existed without any operating funds. The APREA now in its third year and with some operating funds can now assume this responsibility. Thank you, National Peanut Council, for giving us a wonderful helping hand in our early years as an organization.

RESOLUTION

WHEREAS, during the past 10 years the publication "Peanut Research" has been sent to all members of APREA and its predecessor organization PIWG on a regular basis, and,

WHEREAS, the entire burden of compiling, writing, and editing said Peanut Research bulletin was borne by one of APREA's and PIWG's charter members,

Mr. Wallace K. Bailey of the USDA Research Center at Beltsville, Maryland, and his secretary, Mrs. Elizabeth Edmunds;

THEREFORE, BE IT RESOLVED that we the members of APREA wish to express our sincere appreciation to Mr. Bailey and Mrs. Edmunds for the excellent job they have performed in reporting in a brief and concise manner the results and status of peanut research work in this country and in keeping all of us abreast of new and significant happenings in other areas of the peanut industry as well.

APPENDIX V

REPORT OF THE NOMINATING COMMITTEE

The Nominating Committee of APREA has selected the following slate of nominees:

President Elect - Edwin L. Sexton
USDA Representative - Reed S. Hutchison
Executive Secretary-Treasurer - Leland Tripp

APPENDIX VI

PROGRAM COMMITTEE REPORT

O. D. Smith, Chairman

Program Planning	Local Arrangements
C. M. Cater	P. C. Barnes, Jr.
L. E. Clark	P. D. Blankenship
W. C. Conway	R. J. Cole
Wayne Eaves	J. I. Davidson, Jr.
C. W. Horne	J. W. Greene
N. K. Person	Martha Harwood
C. E. Simpson	C. E. Holaday
J. W. Smith, Jr.	R. S. Hutchison
B. R. Spears	J. W. Kirksey
	F. P. McIntosh
	W. T. Mills, Chairman
	J. L. Pearson
	W. O. Slay
	J. D. Woodward

The program committee, comprised of 24 members, was divided into subcommittees on Program Planning and Local Arrangements as shown above. Each of these subcommittees was further divided into subcommittees in March and charged with specific responsibilities. Participation by the entire membership was excellent and appreciation is extended for the time and effort given and the good job they have done.

A call for paper titles with brief summaries of the subject materials to be presented was issued in early February to the Association membership. The titles and summary of each paper proposed was reviewed by 3 or more members of the Program Planning Subcommittee with participation by all members of the subcommittee. Each paper was discussed before the entire subcommittee on March 15. Fifty-two papers were proposed of which 44 appear on the program. Those proposing papers which were not included on the program were encouraged to participate in the Discussion Session related to their subject.

A request was issued to the membership for response on subject areas for Discussion Sessions. A total of 92 responses was received. On the basis of the information gathered 11 Discussion Sessions were planned.

The program planned and arranged by the Program Committee follows:

SUNDAY AFTERNOON, July 16

1 - 5 Registration
3 - 5 Committee Meetings
- Peanut Quality
- Public Relations and "The Peanut"
- Publications
- Finance
- Long Range Planning

7 - 10 Board of Directors Meeting

MONDAY, July 17

8 - 5 Registration

GENERAL SESSION. W. T. Mills, Presiding

8:30 President's Welcome - W. T. Mills
8:45 Domestic Peanut Production and Pricing - Mr. Laurel C. Meade
9:25 Peanut Exports and Their Future - Mr. John Dehne
10:00 Coffee Break
10:30 - 11:50 Two Concurrent Sessions

Session 1. D. Gorbet, Presiding

10:30 Introgressive Hybridization in Arachis via the Bridge Cross Technique - D. J. Banks
10:50 Potential Sources of Resistance to Pod Breakdown in Peanuts - P. H. van Schaik, K. H. Garren and D. M. Porter
11:10 Inheritance of Pod Pubescence in Arachis hypogaea L. - N. V. Tan and A. J. Norden
11:30 Inheritance of Oleic/Linoleic Fatty Acid Ratio in Peanuts, Arachis hypogaea L. - Yai-po Tai and J. S. Kirby

Session 2. U. L. Diener, Presiding

10:30 Chemicals in the Windrow for Controlling Aflatoxins in Peanuts - D. K. Bell and B. Doupnik, Jr.
10:50 Relationship of Shell Damage to Colonization of Peanut Seed by Aspergillus flavus - D. M. Porter, F. S. Wright and J. L. Steele
11:10 Chemical Detoxication of Aflatoxins during Wet-Processing of Peanuts - K. C. Rhee, C. M. Cater and K. F. Mattil
11:30 Proteins from Peanut Cultivars (Arachis hypogaea) grown in different Areas. VI. Changes Induced in Gel Electrophoretic Patterns by Aspergillus Contamination - J. P. Cherry, H. L. Ory and R. Y. Mayne
11:50 Lunch

Discussion Groups. J. W. Smith, Jr., Coordinator for All Sessions

1:15 1. Mycotoxins - D. M. Porter, Leader
2. Varieties and Breeding - D. J. Banks, Leader
3. Weed Control - J. R. Bone, Leader
2:45 Coffee Break
3:10 - 5:10 Two Concurrent Sessions

Session 1. L. Redlinger, Presiding

3:10 The Damage and Control of the Lesser Cornstalk Borer, Elasmopalpus lignosellus (Zeller) - J. C. French and L. W. Morgan
3:30 Ecology and Control of the Burrowing Bug, Pangaeus bilineatus (Say), in South Texas - J. W. Smith, Jr. and C. L. Cole
3:50 Control of the Granulate Cutworm, Feltia subterranea (Fabricius), a Foliage Feeding Pest of Peanuts - L. W. Morgan and J. C. French
4:10 Chemical Control of Southern Corn Rootworms on Peanuts in Tidewater Virginia - J. C. Smith
4:30 Resistance of Peanuts to the Southern Corn Rootworm - W. V. Campbell and D. A. Emery
4:50 A Pest Management Program for Insects Attacking Peanuts in Texas - C. E. Hoelscher, J. W. Smith, Jr. and P. W. Jackson

Session 2. D. F. Wadsworth, Presiding

3:10 The Effects of Nematodes upon Yield and Quality of Spanish Peanuts with Contact and Fumigant Type Nematicides - T. E. Boswell and W. H. Thames, Jr.
3:30 Spanish Peanut Yield Response to Nematicides Applied at Pegging for Lesion Nematode Control - R. V. Sturgeon, Jr. and C. C. Russell

3:50 The Possible Effect of Fungicides on the Maturity Index of Peanuts - C. T. Young and D. H. Smith
4:10 Peanut Disease Control in Malawi, Central Africa - R. W. Gibbons and P. C. Mercer
4:30 The Cylindrocladium Blackrot of Peanut in Virginia and North Carolina - K. H. Garren, M. K. Beute and D. M. Porter
4:50 Some Observations on Leaf Rust and Leaf Spots of Peanuts under Epiphytotic Conditions - A. L. Harrison
5:10 Adjourn

TUESDAY, July 18

8 - 12 Registration
8:30 - 9:40 Business Meeting - W. T. Mills, Presiding
Committee Reports
Election of Officers
By-Law Amendment
9:40 Coffee Break
10:00 - 12:00 Two Concurrent Sessions

Session 1. N. K. Person, Presiding

10:00 Development and Evaluation of Peanut Salvaging and Cleaning Equipment - G. B. Duke
10:20 Curing Peanuts with Periodic High Temperature - J. M. Troeger, J. L. Butler and J. L. Pearson
10:40 The Effect of Drying Rates on Separation of Cotyledons of Bald Kernels - J. D. Woodward and R. S. Hutchison
11:00 Evaluation of Di-l-p-menthene for Potential Uses on Farmers' Stock Peanuts - J. I. Davidson, Jr., F. P. McIntosh and L. M. Redlinger
11:20 Shrinkage of Peanuts in Storage - W. O. Slay, R. E. Hoalwole and R. S. Hutchison
11:40 Certain Physical and Mechanical Properties of Virginia 61R Peanuts - J. L. Steele, F. S. Wright and P. H. van Shaik

Session 2. J. F. McGill, Presiding

10:00 A Plow-Plant System - J. L. Shepherd
10:20 Effect of Calcium Sources and a Fungicide on Peanut Production - F. R. Cox
10:40 Comparative Nutrient Contents of Lateral versus Central Branch Leaves of 10 Virginia-Type Peanut Lines and Cultivars - D. L. Hallock and D. C. Martens
11:00 Influence of Photoperiod on Flowering and Fruiting in Peanuts - J. C. Wynne, R. J. Downs and D. A. Emery
11:20 Screening Peanut Germ Plasm for Resistance to Verticillium Wilt - B. M. Khan, D. F. Wadsworth and J. S. Kirby
11:40 Peanut Mycorrhizae: A Fungal Root Interaction - C. R. Stichler, R. E. Pettit and R. A. Taber
12:00 Lunch

Discussion Groups.

1:15 1. Diseases - R. V. Sturgeon, Leader
2. Harvesting and Curing - J. Butler, Leader
3. Insects - J. W. Smith, Jr., Leader
2:45 Coffee Break
3:10 - 5:10 Two Concurrent Sessions

Session 1. A. H. Allison, Presiding

3:10 Sampling Problems in Determining Germination Percentages - J. H. Young

3:30 Breaking Dormancy of Seed of Peanuts (Arachis hypogaea) - J. E. Bear and W. K. Bailey
3:50 Seed Dormancy of Different Botanical Types of Peanuts (Arachis hypogaea L.) - W. K. Bailey and J. E. Bear
4:10 Effect of Seed Size and Seeding Rate on Performance of Starr Spanish Peanuts - L. E. Clark
4:30 Observations on the Development of Endosperm in Peanuts - J. M. Kubicek and D. J. Banks
4:50 Influence of Seed Quality and Environment on Peanut Injury by Herbicides - P. W. Santelmann

Session 2. Edwin Sexton, Presiding

3:10 New Method to Estimate Shelf-Life of Peanuts and Peanut Products - C. E. Holaday and P. C. Barnes, Jr.
3:30 Determination of Flavor Profiles of Peanut Butters by Direct Gas Chromatography - S. P. Fore, L. A. Goldblatt and H. P. Dupuy
3:50 A Comparison of Minor Constituents in Peanut Butter as Possible Sources of Fatty Acid Peroxidation - A. J. St. Angelo, R. L. Ory and L. E. Brown
4:10 Characterization of Proteins from Subcellular Fractions of Peanuts - T. J. Jacks, N. J. Neucere and L. Y. Yatsu
4:30 Proteins from Peanut Cultivars (Arachis hypogaea) grown in Different Areas. V. Biochemical Observations on Electrophoretic Patterns of Proteins and Enzymes - R. L. Ory and J. P. Cherry
4:50 Utilization of Peanut Flakes in Food Products - J. H. Mitchell, Jr. and R. K. Malphrus
5:10 Adjourn

WEDNESDAY, July 19

Discussion Groups.

8:15 1. Quality Measurement - C. T. Young, Leader
2. Soil Fertility and Irrigation - L. E. Samples, Leader
3. Seed Quality - H. Pender, Leader
9:30 Coffee Break

Discussion Groups.

9:45 1. New Products - J. L. Heinis, Leader
2. Shelling Plant Operations and Pollution Control - R. S. Hutchison, Leader

GENERAL SESSION. W. T. Mills, Presiding

11:00 Tour Information - R. S. Hutchison
11:10 Committee Appointments and Concluding Remarks - O. D. Smith
11:45 Lunch
1:00 - 5:00 Tours

BY-LAWS
of
AMERICAN PEANUT RESEARCH AND EDUCATION ASSOCIATION, INC.

Article I. Name

Section 1. The name of this organization shall be "AMERICAN PEANUT RESEARCH AND EDUCATION ASSOCIATION, INC."

Article II. Purpose

Section 1. The purpose of the Association shall be to provide a continuing means for the exchange of information, cooperative planning, and periodic review of all phases of peanut research and extension being carried on by State Research Divisions, Cooperative State Extension Services, the United States Department of Agriculture, the Commercial Peanut Industry and supporting service businesses, and to conduct said Association in such manner as to comply with Section 501 (c)(3) of the United States Internal Revenue Code of 1954 and Acts amendatory thereto. Upon the dissolution of the Association, all of the assets of the Association shall be transferred to an organization whose purposes are similar to those of this Association or to such other charitable or educational organization exempt from Federal income tax under the provisions of Section 501 (c)(3) of the United States Internal Revenue Code of 1954 and Acts amendatory thereto as the directors may appoint provided that no director, officer or member of this organization may in any way benefit from the proceedes of dissolution.

Article III. Membership

Section 1. The several classes of membership which shall be recognized are as follows:

a. Individual memberships: Individuals who pay dues at the full rate as fixed by the Board of Directors.

b. Organizational memberships: Industrial or educational groups that pay dues as fixed by the Board of Directors. Organizational members may designate one representative who shall have individual member rights.

c. Sustaining memberships: Industrial organizations and others that pay dues as fixed by the Board of Directors. Sustaining members are those who wish to support this Association financially to an extent beyond minimum requirements as set forth in Section 1b, Article III. Sustaining members may designate one representative who shall have individual member rights. Also, any organization may hold sustaining memberships for any or all of its divisions or sections with individual member rights accorded each sustaining membership.

d. Student memberships: Full-time students that pay dues at a special rate as fixed by the Board of Directors. Persons presently enrolled as full-time students at any recognized college, university or technical school are eligible for student membership. Post doctoral students, employed persons taking refresher courses or special employee training programs are not eligible for student membership.

Section 2. Any member, participant, or representative duly serving on the Board of Directors or a Committee of this Association and who is unable to attend any meeting of the Board of such Committee may be temporarily replaced by an alternate selected by the agency or party served by such member, participant, or representative upon appropriate written notice filed with the president or Committee chairman evidencing such designation or selection.

Section 3. All classes of membership may attend all meetings and participate in discussions. Only individual members or those with individual membership rights may vote and hold office. Members of all classes shall receive notification and purposes of meetings, and shall receive minutes of all Proceedings of the American Peanut Research and Education Association.

Article IV. Dues and Fees

Section 1. The annual dues shall be determined by the Board of Directors with the advice of the Finance Committee subject to approval by the members at the annual meeting. Minimum annual dues for the four classes of membership shall be:

a. Individual memberships: $5.00
b. Organizational memberships: $25.00
c. Sustaining memberships: $100.00
d. Student memberships: $2.00

Section 2. Dues are receivable on or before January 1 of the year for which the membership is held. Members in arrears on April 1 for dues for the current year shall be dropped from the rolls of this Association provided prior notification of such delinquency was given. Membership shall be reinstated for the current year upon payment of dues.

Section 3. A $5.00 registration fee will be assessed at all regular meetings of this Association. The amount of this fee may be changed upon recommendation of the Finance Committee subject to approval by the Board of Directors.

Article V. Meetings

Section 1. Annual meetings of the Association shall be held for the presentation of papers and/or discussions, and for the transaction of business. At least one general business session will be held during regular annual meetings at which reports from the executive secretary-treasurer and all standing Committees will be given, and at which attention will be given to such other matters as the Board of Directors may designate. Also, opportunity shall be provided for discussion of these and other matters that members may wish to have brought before the Board of Directors and/or general memberships.

Section 2. Additional meetings may be called by the Board of Directors either on its own motion or upon request of one-fourth of the members. In either event, the time and place shall be fixed by the Board of Directors.

Section 3. Any member may submit only one paper as senior author for consideration by the program chairman of each annual meeting of the Association. Except for certain papers specifically invited by the Association president or program chairman with the approval of the president, at least one author of any paper presented shall be a member of this Association.

Section 4. Special meetings or projects by a portion of the Association membership, either alone or jointly with other groups, must be approved by the Board of Directors. Any request for the Association to underwrite obligations in connection with a proposed special meeting or project shall be submitted to the Board of Directors, who may obligate the Association to the extent they deem desirable.

Section 5. The executive secretary-treasurer shall give all members written notice of all meetings not less than 60 days in advance of annual meetings and 30 days in advance of all other special project meetings.

Article VI. Quorum

Section 1. Until such time as the membership association reaches 200 voting members, 20% of the voting members of this Association shall constitute a quorum for the transaction of business. When the membership exceeds 200, a quorum shall consist of 40 voting members.

Section 2. For meetings of the Board of Directors and all Committees, a majority of the members duly assigned to such Board or Committee shall constitute a quorum for the transaction of business.

Article VII. Officers

Section 1. The officers of this organization shall be:

a. President
b. President-elect
c. Executive Secretary-Treasurer

Section 2. The president and president-elect shall serve from the close of the annual general meeting of this Association to the close of the next annual general meeting. The president-elect shall automatically succeed to the presidency at the close of the annual general meeting. If the president-elect should succeed to the presidency to complete an unexpired term, he shall then also serve as president for the following full term. In the event the president or president-elect or both should resign or become unable or unavailable to serve during their terms of office, the Board of Directors shall appoint a president or both president-elect and president to complete the unexpired terms until the next annual general meeting when one or both offices, if necessary, will be filled by normal elective procedure. The most recent available past president (previously PIWC chairman) shall serve as president until the Board of Directors can make such appointment. The president shall serve without monetary compensation.

Section 3. The officers and directors shall be elected by the members in attendance at the annual general meeting from nominees selected by the Nominating Committee or members nominated for this office from the floor. The president-elect shall serve without monetary compensation.

Section 4. The executive secretary-treasurer may serve consecutive yearly terms subject to re-election by the membership at the annual meeting. The tenure of the executive secretary may be discontinued by a two-thirds majority vote of the Board of Directors who then shall appoint a temporary executive secretary to fill the unexpired term.

Section 5. The president shall arrange and preside at all general meetings of the Board of Directors and with the advice, counsel, and assistance of the president-elect and secretary-treasurer, and subject to consultation with the Board of Directors, shall carry on, transact and supervise the interim affairs of the Association and provide leadership in the promotion of the objectives of this Association.

Section 6. The president-elect shall be program chairman responsible for development and coordination of the overall program of the educational phase of the annual meetings.

Section 7. (a) The executive secretary-treasurer shall countersign all deeds, leases and conveyances executed by the Association and affix the seal of the Association thereto and to such other papers as shall be required or directed to be sealed. (b) The executive secretary-treasurer shall keep a record of the deliberations of the Board of Directors, and keep safely and systematically all books, papers, records, and documents belonging to the Association, or in any wise pertaining to the business thereof. (c) The executive secretary-treasurer shall keep account for all monies, credits, debts, and property, of any and every nature, of this Association, which shall come into his hands or be disbursed and shall render such accounts, statements, and inventories of monies, debts, and property, as shall be required by the Board of Directors. (d) The executive secretary-treasurer shall prepare and distribute all notices and reports as directed in these By-laws, and other information deemed necessary by the Board of Directors to keep the membership well informed of the Association activities.

Article VIII. Board of Directors

Section 1. The Board of Directors shall consist of the following:

a. The president
b. The most immediate past president able to serve
c. The president-elect (elected annually)

d. State employees' representative - This director is one whose employment is state sponsored and whose relation to peanuts principally concerns research, and/or educational, and/or regulatory pursuits.

e. United States Department of Agriculture representative - This director is one whose employment is directly sponsored by the USDA or one of its agencies and whose relation to peanuts principally concerns research, and/or educational, and/or regulatory pursuits.

f. Three Private Peanut Industry representatives - These directors are those whose employment is privately sponsored and whose principal activity with peanuts concerns: (1) the production of farmers' stock peanuts; (2) the shelling, marketing, and storage of raw peanuts; (3) the production or preparation of consumer food-stuffs or manufactured products containing whole or parts of peanuts.

g. A person oriented toward research - to be named by the chairman of the Board of Directors of the National Peanut Council.

h. The executive secretary-treasurer - non-voting member of the Board of Directors who may be compensated for his services on a part or full-time salary stipulated by the Board of Directors in consultation with Finance Committee.

i. The president of the National Peanut Council - a non-voting member.

Section 2. The Board of Directors shall determine the time and place of regular and special meetings and may authorize or direct the president to call special meetings whenever the functions, programs, and operations of the Association shall require special attention. All members of the Board of Directors shall be given at least 10 days advance notice of all meetings; except that in emergency cases, three days advance notice shall be sufficient.

Section 3. The Board of Directors will act as the legal representative of the Association when necessary and, as such, shall administer Association properties and affairs. The Board of Directors shall be the final authority on these affairs in conformity with the By-laws.

Section 4. The Board of Directors shall make and submit to this Association such recommendations, suggestions, functions, operations and programs as may appear necessary, advisable, or worthwhile.

Section 5. Contingencies not provided for elsewhere in these By-laws shall be handled by the Board of Directors in a manner they deem desirable.

Article IX. Committees

Section 1. Members of the Committees of the Association shall be appointed by the president and shall serve 2-year terms unless otherwise stipulated. The president shall appoint a chairman of each Committee from among the incumbent committeemen. The Board of Directors may, by a two-thirds vote, reject Committee appointments. Appointments made to fill unexpected vacancies by incapacity of any Committee member shall be only for the unexpired term of the incapacitated committeeman. Unless otherwise specified in these By-laws, any Committee member may be reappointed to succeed himself, and may serve on two or more Committees concurrently but shall not hold concurrent chairmanships. Initially, one-half of the members, or the nearest (smaller) part thereto, of each Committee will serve one-year terms as designated by the president.

a. Finance Committee: This Committee shall include at least four members, one each representing State-, and USDA-, and two from Private Business - segments of the peanut industry. This Committee shall be responsible for preparation of the financial budget of the Association and for promoting sound fiscal policies within the Association. They shall direct the audit of all financial records of the Association annually, and make such recommendations as they deem necessary or as requested or directed by the Board of Directors. The term of the Chairman shall close with preparation of the budget for the following year, or with the close of the annual meeting at which a report is given on the work of the Finance Committee

under his Chairmanship, whichever is later.

b. Nominating Committee: This Committee shall consist of at least three members appointed to one-year terms, one each representing State-, USDA-, and Private Business - segments of the peanut industry. This Committee shall nominate individual members to fill the positions as described and in the manner set forth in Articles VII and VIII of these By-laws and shall convey their nominations to the president of this Association on or before the date of the Annual Meeting. The Committee shall, insofar as possible, make nominations for the president-elect that will provide a balance among the various segments of the Industry and a rotation among Federal, State, and Industry members. The willingness of any nominee to accept the responsibility of the position shall be ascertained by the Committee (or members making nominations at general meetings) prior to the election. No person may succeed himself as a member of this Committee.

c. Publications and Editorial Committee: This Committee shall consist of at least three members appointed for indeterminate terms, one each representing State-, USDA-, and Private Business - segments of the peanut industry. This Committee shall be responsible for the publication of the proceedings of all general meetings and such other Association sponsored publications as directed by the Board of Directors in consultation with the Finance Committee. This Committee shall formulate and enforce the editorial policies for all publications of the Association, subject to the directives from the Board of Directors.

d. Peanut Quality Committee: This Committee shall include at least seven members; one each actively involved in research in peanut - (1) varietal development-, (2) production and marketing practices related to quality-, and (3) physical and chemical properties related to quality-, and one each representing the Grower-, Sheller-, Manufacturer-, and Services- (Pesticides and Harvesting Machinery, in particular) segments of the Peanut industry. This Committee shall actively seek improvement in the quality of raw and processed peanuts and peanut products through promotion of mechanisms for the elucidation and solution of major problems and deficiencies.

e. Public Relations Committee; This Committee shall include at least six members, one each representing the State-, USDA-, Grower-, Sheller-, Manufacturer-, and Services-, segments of the peanut industry. This Committee shall provide leadership and direction for the Association in the following areas:

(1) Membership: Development and implementation of mechanisms to create interest in the Association and increase its membership.

(2) Cooperation: Advise the Board of Directors relative to the extent and type of cooperation and/or affiliation this Association should pursue and/or support with other organizations.

(3) Necrology: Proper recognition of deceased members.

(4) Resolutions: Proper recognition of special services provided by members and friends of the Association.

Article X. Divisions

Section 1. A Division within the Association may be created upon recommendation of the Board of Directors, or members may petition the Board of Directors for such status, by a two-thirds vote of the general membership. Likewise, in a similar manner a Division may be dissolved.

Section 2. Divisions may establish or dissolve Subdivisions upon the approval of the Board of Directors.

Section 3. Divisions may make By-laws for their own government, provided they are consistent with the rules and regulations of the Association, but no dues may be assessed. Divisions and Subdivisions may elect officers (chairman, vice-chairman to succeed to the chairmanship, and a secretary) and appoint committees, provided that the efforts therof do not overlap or conflict with those of the officers and Committees of the main body of the Association.

Article XI. Amendments

Section 1. Proposed amendments to these By-laws must be submitted to the Board of Directors whose recommendation will then be considered at the next regular annual meeting of the Association except as provided in Section 2.

Section 2. Amendments shall be adopted only when a majority of those holding individual membership rights vote and then only by the vote of two-thirds of those voting. If a majority of the individual members are not in attendance at the first regular annual meeting following announcement of proposed amendments, the executive secretary-treasurer shall mail to all such members of the Association ballots concerning such amendments. Members shall be allowed thirty days to return mailed ballots after which the vote of those returning such ballots shall be binding subject to the regulations above. Failure of a majority of the members to return their ballots within the allotted time denotes rejection of the proposed amendment.

Section 3. Proposed amendments slated for adoption or rejection must be brought to the attention of members either by letter or through Association publications at least thirty days prior to consideration for final adoption.

Adopted at the Annual Business Meeting of the American Peanut Research and Education Association, Inc., July 18, 1972, Albany, Georgia.

MEMBERSHIP LIST
AMERICAN PEANUT RESEARCH AND EDUCATION ASSOCIATION

July, 1972

SUSTAINING MEMBERSHIPS

Anderson's Peanuts
Division of Alabama Farmers Coop., Inc.
P.O. Box 1335
Andalusia, Ala. 36420
Attn: JOHN W. ANDERSON

CPC International
Best Foods Research Center
1120 Commerce Ave.
Box 1534
Union, N.J. 07083
Attn: DANIEL MELNICK, Vice-Pres.
Product Research & Quality
Control

Derby Foods, Inc.
3327 West 48th Place
Chicago, Ill. 60632
Attn: S. E. TIERNEY

Dothan Oil Mill Company
P.O. Box 458
Dothan, Ala. 36301
Attn: J. H. BRYSON, JR.

Paul Hattaway Company
P.O. Box 669
Cordele, Ga. 31015
Attn: R. F. HUDGINS
Sec.-Treas.

Hershey Foods Corporation
Hershey, Pa. 17033
Attn: E. W. MEYERS
Director of Research

Keel Peanut Company, Inc.
P.O. Box 878
Greenville, N.C. 27834
Attn: JAMES T. KEEL

Lilliston Corporation
Box 407
Albany, Ga. 31702
Attn: WILLIAM T. MILLS

M & M/Mars
P.O. Box 326
Albany, Ga. 31702
Attn: MRS. MARTHA HARWOOD

Oklahoma Peanut Commission
Box D
Madill, Okla. 73446
Attn: WILLIAM FLANAGAN
Exec. Secretary

Peanut Butter Manufacturers &
Nut Salters Assn.
807 Jefferson Bldg.
1225 Nineteenth St., N.W.
Washington, D. C. 20036
Attn: JAMES E. MACK

Pender Peanut Corporation
P.O. Box 38
Greenwood, Fla. 32443
Attn: ROBERT PENDER

H. B. Reese Candy Co., Inc.
Hershey, Pa 17033
Attn: GEORGE D. McCLEES
Vice-President

Stevens Industries
Dawson, Ga. 31742
Attn: C. M. CRUIKSHANK

Turner Sales & Supply
P.O. Box 847
Tifton, Ga. 31794
Attn: LUTHER TURNER

United States Gypsum Company
101 South Wacker Drive
Chicago, Ill. 60606
Attn: H. W. DAVIS

ORGANIZATIONAL MEMBERSHIPS

Alabama Peanut Producers Association
P.O. Box 1282
Dothan, Ala. 36301
Attn: JAMES EARL MOBLEY
President

Alford Refrigeration Warehouse
P.O. Box 5088
Dallas, Tex. 75222
Attn: WILLIAM L. CRADY
Vice-President

All American Nut Company
16901 Valley View
Cerritos, Calif. 90701
Attn: WILLIAM V. RITCHIE
President

Birdsong Storage Company
Lock Drawer 1400
Suffolk, Va. 23434
Attn: BEN M. BIRDSONG

A. H. Carmichael Company
Brokers & Manufacturer's Agents
Shelled Peanuts
2353 Christopher's Walk, N.W.
Atlanta, Ga. 30327
Attn: BROADUS CARMICHAEL

Jack Cockey Brokerage Co., Inc.
P.O. Box 1075
Suffolk, Va. 23434
Attn: JOHN COCKEY, JR.

Denison Peanut Company
Denison, Texas 74020
Attn: GEORGE MORROW

Fisher Nut Company
2327 Wycliff Street
St. Paul, Minn. 55114
Attn: LOUIS R. SMERLING

Frito-Lay, Inc.
Research Division
900 N. Loop 12
Irving, Texas 75060
Attn: B. W. HILTON
Vice Pres. & Director
of Research

General Foods Corp.
250 North Street
White Plains, N. Y. 10602
Attn: J. J. SHEEHAN

Georgia Agricultural Commodity
Commission for Peanuts
110 East Fourth Street
Tifton, Ga. 31794
Attn: GEORGE P. "PETE" DONALDSON
Executive Secretary

GFA Peanut Assn.
Rt. 19 South
Camilla, Ga. 31730
Attn: D. H. HARDEN
Manager

Gillam Bros. Peanut Sheller, Inc.
Windsor, N.C. 27983
Attn: H. H. GILLAM
Vice-President

Gorman Peanuts
P.O. Box 698
Gorman, Texas 76545
Attn: T. H. BIRDSONG III

Harrington Manufacturing Co., Inc.
Lewiston, N. C. 27849
Attn: J. J. HARRINGTON

George F. Hartnett & Company, Inc.
540 Frontage Road
Northfield, Ill. 60093
Attn: GEORGE F. HARTNETT

Hobbs Engineering Company
P.O. Box 1306
Suffolk, Va. 23434
Attn: JAMES C. ADAMS, JR.

Institut De Recherches
Pour Les Huiles et Oleagineaux II
13 Square Petrarque
75 Paris, France
Attn: PIERRE GILLIER
Director of Peanut Dept.

J. R. James Brokerage Co.
P.O. Box 214
Suffolk, Va. 23434
Attn: RUTH J. MOORE

Law & Company
Consulting & Analytical Chemists
P.O. Box 1558
Atlanta, Ga. 30301
Attn: WILLIAM W. McBEE

The Leavitt Corp.
P.O. Box 31
100 Santilli Highway
Everett, Mass. 02149
Attn: JAMES T. HINTLIAN
President

Charles Matthews Company
P.O. Box 4059
Dallas, Texas 75208
Attn: CHARLES S. MATTHEWS

National Peanut Corp.
Planters Peanuts
200 Johnson Ave.
Suffolk, Va. 23434
Attn: D. M. CARTER

National Peanut Council
Bender Building
1120 Connecticut Ave.
Washington, D. C. 20036
Attn: JOHN CURRIER
President

N. C. Crop Improvement Assn.
State College Station
Box 5155
Raleigh, N. C. 27607
Attn: FOIL W. McLAUGHLIN
Director in Charge

N. C. Peanut Growers Assn., Inc.
P. O. Box 1709
Rocky Mount, N. C. 27801
Attn: JOE S. SUGG

Oklahoma Crop Improvement Assn.
Oklahoma State University
Stillwater, Oklahoma 74074
Attn: ED GRANSTAFF
Secretary-Manager

Olin
Agriculture Division
P.O. Box 991
Little Rock, Ark. 72203
Attn: L. REID FAULKNER

Peanut Growers Coop Marketing Assn.
Franklin, Va. 23851
Attn: S. WOMACK LEE
Manager

Peanut Processors, Inc.
Box 158
Dublin, N. C. 28332

Pearson Candy Company
2140 West Seventh Street
St. Paul, Minnesota 55116
Attn: GEORGE PEARSON

Pert Lab, Inc.
P.O. Box 267
1108 N. Broad Street
Edenton, N. C.
Attn: J.R. BAXLEY

Pond Bros. Peanut Co., Inc.
P.O. Box 1370
Suffolk, Virginia 23434
Attn: RICHARD POND

Preferred Products Company
101 Jefferson Ave., South
Hopkins, Minn. 55343

Reeves Peanut Company
Eufaula, Ala. 30627
Attn: M.M. REEVES

Seabrook Blanching Corp.
Tyrone, Pa. 16686
Attn: C.B. SMITH

Shell Development Company
P.O. Box 4248
Modesto, California 95352
Attn: R. BLONDEAU, Mgr.
Pesticide Development Dept.

Southeastern Peanut Assn.
P.O. Box 1746
Albany, Ga. 31702
Attn: JOHN W. GREENE
Executive Director

Southwestern Peanut Growers Assn.
Gorman, Texas 76454
Attn: ROSS WILSON
Manager

Southwestern Peanut Shellers Assn.
6815 Prestonshire
Dallas, Texas 75225
Attn: SYDNEY C. REAGAN

Texas Peanut Producers Board
P.O. Box 398
Gorman, Texas 76454
Attn: WAYNE EAVES

Tom's Foods, Ltd.
900 8th Street
Columbus, Ga. 31902
Attn: GEORGE JENKINS
Peanut Purchasing & Selling

Uni-Royal, Inc.
Route #3
Donalsonville, Ga. 31745
Attn: SIDNEY FOX
Area Supervisor

Virginia-Carolina Peanut Assn.
Lock Drawer 499
Suffolk, Va. 23434
Attn: W. RANDOLPH CARTER
Executive Secretary

Virginia Peanut Growers Assn.
P.O. Box 149
Capron, Va. 23829
Attn: RUSSELL C. SCHOOLS
Executive Secretary

Wilco Peanut Company
P.O. Box 921
San Antonio, Texas 78206
Attn: W.G. CONWAY

INDIVIDUAL MEMBERSHIPS

Allison, Allen H.
Associate Professor of Agronomy
Tidewater Research Station
Holland, Va. 23391

Anderson, W.B.
Soil Chemistry
Texas A&M University
College Station, Texas 77840

Andress, C.R.
Stauffer Chemical Co.
Agric. Chemical Division
P.O. Box 7222
Houston, Texas 77008

Andrews, Olin N., Jr.
1731 Pineknoll Lane
Albany, Ga. 31705

Atkin, Lawrence
c/o Arthur D. Little Co.
Rockefeller Center - 630 Fifth Ave.
New York, N.Y. 10020

Ayres, James L.
Gold Kist Research Center
P.O. Box 388
Lithonia, Ga. 30058

Backman, Paul A.
Dept. of Botany & Microbiology
Auburn University
Auburn, Ala. 36830

Baikaloff, Alex
P.O. Box 26
Field Officer
Peanut Marketing Board
Kingaroy, Queensland
Australia

Bailey, W.K.
Plant Genetics & Germplasm Institute
ARS, USDA
Plant Industry Station
Beltsville, Md. 20705

Baker, W.R.
Peanut Belt Research Station
Box 177
Lewiston, N.C. 27849

Banks, Donald
Agronomy Department
Oklahoma State University
Stillwater, Okla. 74074

Barnes, George L.
Dept. of Botany & Plant Pathology
Oklahoma State University
Stillwater, Okla. 74074

Barnes, Phillip C.
USDA, ARS, MQRD, PQI
National Peanut Research Lab.
P.O. Box 637
Dawson, Ga. 31742

Barton, Franklin E. II
USDA R.B. Russell Research Center
P.O. Box 5766
Athens, Ga. 30604

Bartz, Jerry A.
Building 162
Plant Pathology Dept.
University of Florida
Gainesville, Fla. 32601

Baum, Glaude S.
Norfolk, Virginia 23500

Beach, Minton
N.C. Peanut Growers Assn.
Oak City, N.C. 27857

Bear, John E.
Plant Genetics & Germplasm Institute
ARS, USDA
Beltsville, Md. 20705

Belfield, Fred Jr.
Box 628
Nashville, N.C. 27856

Bell, Durham K.
Plant Pathology Dept.
Coastal Plain Station
Tifton, Ga. 31794

Beute, Marvin K.
3407 Gardner Hall
N.C. State University
Raleigh, N.C. 27607

Birdsong, W.M. Jr.
Birdsong Storage Co., Inc.
P.O. Box 776
Franklin, Va. 23851

Blankenship, Paul D.
TFRD, HFRB
National Peanut Research Lab.
P.O. Box 110
Dawson, Ga. 31742

Blondeau, R.
Pesticides Development Dept.
Shell Development Co.
P.O. Box 4248
Modesto, Calif. 95352

Bloome, Peter D.
216 Ag Hall
Oklahoma State University
Stillwater, Okla. 74074

Bolton, William Earl
Apartado 465
Managua, Nicaragua
Central America

Bond, M.D.
Peanut Specialist
Auburn University
Auburn, Ala. 36833

Bone, James R.
P.O. Box 96
Searcy, Arkansas 72143

Bordt, William H.
Research Chemist
CPC International, Inc.
1916 Webster Street
Alameda, Calif. 94501

Boswell, T.E.
Plant Disease Research Station
P.O. Box 755
Yoakum, Texas 77995

Brooks, Stanley N.
Plant Industry Station
Beltsville, Md. 20705

Brown, A.L. Jr.
CPC International
P.O. Box 460
Confederate Avenue
Portsmouth, Va. 23705

Brown, Lawrence W.
Tidewater Research Station
Holland, Va. 23391

Brown, R.H.
170 Broomsedge Trail
Athens, Ga. 30601

Bruce, W.M.
Coastal Plains Experiment Station
Tifton, Ga. 31794

Brusewitz, Gerald H.
Ag. Engineering Dept.
Oklahoma State University
Stillwater, Okla. 74074

Bryant, P.C.
County Agent
Martin County
Williamston, N.C. 27892

Buckley, Ellis C.
2720 W. Mockingbird Lane
Dallas, Texas 75235

Burnette, David J.
V.P.I. Extension Service
139-C Baker Street
Emporia, Va. 23847

Butler, James L.
AERD, ARS, USDA
Coastal Plain Experiment Station
Tifton, Ga. 31794

Campbell, W.V.
N.C. State University
Dept. of Entomology
Box 5215
Raleigh, N.C. 27607

Carter, Robert L.
Agronomy Dept.
Georgia Coastal Plain Exp. Station
Tifton, Ga. 31794

Carver, W.A.
605 N.E. 7th Terrace
Gainesville, Fla. 32601

Cater, Carl M.
Oilseed Products Division
Texas A&M University
F.M. Box 183
College Station, Texas 77843

Cecil, L.L.
International Marketing
Diamond Shamrock Chemical Co.
300 Union Commerce Bldg.
Cleveland, Ohio 44115

Cecil, Sam R.
Food Science Division
Georgia Station
Experiment, Ga. 30212

Chapin, John S.
Area Agronomist
Texas Agriculture Extension Service
P.O. Box 1177
Stephenville, Texas 76401

Cherry, John P.
Dept. of Biochemistry & Biophysics
Texas A&M University
College Station, Texas 77843

Childress, H.B.
CPC International
P.O. Box 460
500 Confederate Avenue
Portsmouth, Va. 23705

Clark, L.E.
Texas A&M University
College Station, Texas 77840

Clary, Bobby L.
Ag. Engineering Dept.
214 Ag Hall
Oklahoma State University
Stillwater, Okla. 74074

Cobb, Leonard
P.O. Box 218
Bronson, Fla. 32621

Coggsdale, Bob M.
V.P.I. Extension Service
104 E. Constance Road
Suffolk, Va. 23434

Cole, Joe E.
Area Agronomist
Texas Agriculture Extension Service
Box 490
Denton, Texas 76201

Cole, Richard J.
National Peanut Research Lab
P.O. Box 637
Dawson, Va. 31742

Coleman, H.R.
CPC International
P.O. Box 5056
Dallas, Texas 75222

Collier, Claude R.
P.O. Box 221
Fort Gaines, Ga. 31751

Conkerton, Edith J.
USDA-SRRL
P.O. Box 19687
New Orleans, La. 70179

Cox, F.R.
Soil Science Department
N.C. State University
Raleigh, N.C. 27607

Cullipher, Jack
1708 Rosewood Drive
Greenville, N.C. 27834

Daniels, Eston
P.O. Box 362
Lyons, Ga. 30436

Davidson, James I. Jr.
TFRD, HFRB
National Peanut Research Laboratory
P.O. Box 110
Dawson, Ga. 31742

Davis, Colin R.
Vice President
The Ferguson Mfg. Co., Inc.
Factory Street P.O. Box 1098
Suffolk, Va. 23434

Dees, Matt Jr.
Thompson-Hayward Chemical Co.
P.O. Box 8070
Wainwright Station
San Antonio, Texas 78208

Demuynk, Ty J.
Agronomy Dept.
University of Florida
402 Newell Hall
Gainesville, Fla. 32601

Dickens, J.W.
P.O. Box 5906
Raleigh, N.C. 27607

Diener, Urban L.
Botany & Microbiology Dept.
Auburn University
Auburn, Ala. 36830

Dollear, Frank G.
Route #2 Box 204
Pearl River, La. 70452

Duke, George B.
Agricultural Engineer
USDA, ARS
Tidewater Research &
Continuing Education Center
Holland, Va. 23391

Dunning, R.D.
Product Manager
Best Foods
Division of CPC International
International Plaza
Englewood Cliffs, N.J. 07632

Dupuy, Harold P.
Southern Regional Research Lab.
1100 Robert E. Lee Blvd.
New Orleans, La. 70119

Edwards, H.C.
H.T. McGill Inc.
P.O. Box 517
Brookshire, Texas 44234

Emery, Donald A.
Crop Science Dept.
N.C. State University
Raleigh, N.C. 27607

Fennell, John J.
1620 Post Oak Tower
Houston, Texas 77027

Foland, Edward
DuPont
3355 Lenox Road
Atlanta, Ga. 30326

Foraker, Rhea
Sandy Land Research Station
Mangum, Okla. 73554

Fore, Sara Pauline
Southern Regional Research Laboratory
P.O. Box 19687
New Orleans, La. 70179

Forrest, J.L.
4505 McEwen Road
Dallas, Texas 75234

Forrester, Glenn
Route #2
Columbia, Ala. 36319

Fox, Sidney W.
Uniroyal Chemical
Division of Uniroyal, Inc.
Route #3
Donalsonville, Ga. 31745

French, John C.
Extension Entomologist
P.O. Box 1209
Tifton, Ga. 31794

Fugate, Woodroe
P.O. Box 114
Williston, Fla. 32696

Fulenwider, Bruce
Research Products Co.
P.O. Box 1057
Salina, Kansas 67401

Garren, Kenneth H.
USDA, ARS
Tidewater Research Station
Holland, Va. 23391

Gibbons, R.W.
Agric. Research Council of Malawi
Grain Legume Res. Laboratory
P.O. Box 215, Chitedze Res. Station
Lilongwe
Malawi

Goldblatt, Leo
Southern Regional Research Lab.
P.O. Box 19687
New Orleans, La. 70119

Gorbet, Daniel W.
Agric. Research Center
P.O. Box 878
Marianna, Fla. 32446

Gray, James S.
Lance, Inc.
Charlotte, N.C. 28201

Greer, Howard
Extension Weed Control Specialist
Oklahoma State University
Stillwater, Okla. 74074

Griffin, William J. Jr.
P.O. Box 87
Hertford, N.C. 27944

Hallock, Daniel
Tidewater Research &
Continuing Education Center
Holland, Va. 23391

Hammerton, John L.
Faculty of Agriculture
Univ. of the West Indies
P.O. Box 113
Kingston 7, Jamaica

Hammons, R.O.
ARS, USDA
P.O. Box 748
Tifton, Ga. 31794

Hannemann, Ernst
P.O. Box 45
Quality Peanut Co.
Fredericksburg, Texas 78624

Harrell, B.H.
County Extension Chairman
Northhampton County
Jackson, N.C. 27845

Harris, Henry C.
Universidade Federal de Santa Maria
97.100 - Santa Maria/R.G.S.
Caixa Pastal 272, Brasil

Harrison, A.L.
Texas A&M University
Plant Disease Research Station
Route #3 Box 307
Yoakum, Texas 77995

Hartzog, Dallas L.
Research Associate
Agronomy and Soils Dept.
Wiregrass Substation
Headland, Ala. 36345

Haskins, Hatcher J.
DeLeon Peanut Company
DeLeon, Texas 76444

Hays, Al T.
U.S. Gypsum Co.
Box 50073
Atlanta, Ga. 30302

Hauser, Ellis W.
Coastal Plain Experiment Station
Tifton, Ga. 31794

Heinis, Julius L.
Professor of Bacteriology
Florida A&M University
Box 270
Tallahassee, Fla. 32307

Henning, Ron
Route #3
Belmont Road
Athens, Ga. 30601

Higgins, Dan
546 Godfrey Lane
Auburn, Ala. 36830

Hodges, Larry L.
920 Colony Avenue
Ahoskie, N.C. 27910

Hoelscher, Clifford E.
Area Entomologist
Box 1177
Texas A&M University
Agric. Extension Service
Stephenville, Texas 74601

Holaday, Charles E.
Peanut Quality Investigations
FCAP, MQRD, ARS, USDA
Forrester Drive, Box 637
Dawson, Ga. 31742

Holloway, Oris E. Jr.
2323 Meadow Brook Lane
Albany, Ga. 31700

Horne, Wendell
Extension Plant Pathologist
Texas Agricultural Extension Serv.
College Station, Texas 77843

Hsi, David C.H.
Professor
New Mexico State University
College of Agriculture
Star Route
Clovis, N.M. 88101

Hutchison, Reed
National Peanut Research Lab.
P.O. Box 110
Dawson, Ga. 31742

Inglett, William A.
P.O. Box 248
Colquitt, Ga. 31737

Jacks, Thomas
USDA
P.O. Box 19687
New Orleans, La. 70179

Jackson, C.R.
Director
Georgia Station
Experiment, Ga. 30212

Jackson, J.O.
Texas Peanut Producers Board
Route #3
Gorman, Texas 76454

Jackson, Paul. W.
119 W. Travis
Dublin, Texas 76446

Jenkins, George
Peanut Purchasing & Selling
Tom's Foods, Ltd.
P.O. Box 60
Columbus, Ga. 31902

Jennings, Swanson D.
Extension Agent
P.O. Box 246
Dinwiddie, Va. 23841

Johanson, Lamar
Dept. of Biological Sciences
Tarleton State College
Stephenville, Texas 76401

Johnson, Bobby R.
N.C. State University
Dept. of Food Science
Raleigh, N.C. 27607

Johnson, Dean Jr.
P.O. Box 126
Bronxville, N.Y. 10708

Johnson, G.R.
CPC International, Inc.
International Plaza
Englewood Cliffs, N.J. 07632

Johnson, W. Hal
The Progressive Farmer
3803 Computer Drive
Raleigh, N.C. 27609

Jones, B.L.
Tarleton Experiment Station
Texas A&M University
Box 292
Stephenville, Texas 76401

Jones, Michael
NOR-AM Agricultural Products, Inc.
2402 Nottingham Way
Albany, Ga. 31705

Jordan, C. Wayne
Mississippi Extension Service
P.O. Box 5425
State College, Miss. 39762

Ketring, Darold L.
USDA, ARS, OIC
Plant Sciences Dept.
Texas A&M University
College Station, Texas 77843

King, Thomas G.
1901 Kirkwood Circle
Shell Chemical Co.
Albany, Ga. 31701

Kirby, James S.
Agronomy Dept.
Oklahoma State University
Stillwater, Okla. 74074

Kirksey, Jerry W.
USDA, ARS MQRD, PQI
National Peanut Research Lab.
P.O. Box 637
Dawson, Ga. 31742

Kleinheksel, Orrie B.
Best Foods Div. of CPC International
5725 Highway No. 7
Minneapolis, Minn. 55416

Knight, W.C.
Route #1
Suffolk, Va. 23434

Knobel, Harold D.
210 Coldstream Ave.
Rhodia, Inc. Chipman Div.
Merritt Island, Fla. 32952

Kozicki, Jerome
Derby Foods, Inc.
3327 W. 48th Place
Chicago, Ill. 60632

Kozub, Daniel, J.
Curtiss Candy Company
3401 Mt. Prospect Road
Franklin Park, Ill. 60131

Kretzschmar, Carl
Information Service
General Mills, Inc.
James Ford Bell Res. Center
9000 Plymouth Ave. North
Minneapolis, Minn. 55427

Lambert, Andrew J.
Extension Specialist
Ag. Engineering
Seitz Hall, VPI & SU
Blacksburg, Va. 23061

Lariscy, W.H.
Sylvania Peanut Co.
P.O. Box 100
Sylvania, Ga. 30467

Larsen, Holger
Director
Skippy Laboratories
Best Foods
1916 Webster Street
Alameda, Calif. 94501

Lee, Clifford
County Agent
P.O. Box 73
Camilla, Ga. 31730

Liles, Harold
County Extension Director
Box 607
Anadarko, Okla. 73005

Lindsey, John
P.O. Box 230
Farmers Milling & Marketing Co.
Abbeville, Ala. 36310

Litten, J.A.
CPC International
500 Confederate Ave.
P.O. Box 460
Portsmouth, Va. 23705

Lyle, James
Auburn University
Botany & Microbiology Dept.
Auburn, Ala. 36830

McEwen, William T.
U.S. Gypsum Co.
101 S. Walker Drive
Chicago, Ill. 60606

McGill, J. Frank
Extension Agronomist - Peanuts
P.O. Box 48
Tifton, Ga. 31794

McIntosh, Freddie P.
TFRD, HFRB
National Peanut Res. Lab.
P.O. Box 110
Dawson, Ga. 31742

McKinley, W.W.
Box 402
Pearsall, Texas 78061

McNair, C.A.
Assistant Director
Gold Kist Peanuts, Inc.
3348 Peachtree Road N.E.
P.O. Box 2210
Atlanta, Ga. 30301

McWatters, Mrs. Kay
Food Science Dept.
Georgia Station
Experiment, Ga. 30212

Manley, G.N.
Manager
M&M/Mars
P.O. Box 326
Albany, Ga. 31702

Mann, Godfrey E.
Research Chemist
USDA, ARS, SMNRD
P.O. Box 19687
New Orleans, La. 70179

Martin, Archie
1406 Pearl Ave.
Albany, Ga. 31705

Mattil, Karl F.
Food Protein Research & Develpment
Faculty Box 63
Texas A&M University
College Station, Texas 77843

Mayfield, William
Cooperative Extension Service
Auburn University
Auburn, Ala. 36830

Mehlich, Adolph
N.C. Dept. of Agriculture
Soil Testing Division
Raleigh, N.C. 27602

Merritt, Allen
Gold Kist Inc.
P.O. Box 2210
Atlanta, Ga. 30303

Mitchell, J.H. Jr.
College of Agric. & Biological Sci.
Clemson University
Clemson, S.C. 29631

Mixon, Aubrey
Research Agronomist
Dept. of Agronomy
Alabama Agric. Experiment Station
Auburn, Ala. 36830

Moake, David L.
519 Lookout Drive
San Antonio, Texas 78228

Moore, R.P.
Professor, Research-Crop Stand
N.C. State University
Dept. of Crop Science
Box 5155
Raleigh, N.C. 27607

Morgan, Loy W.
Experiment Station
Tifton, Ga. 31794

Morgan, O.P.
c/o The Ferguson Mfg. Co., Inc.
P.O. Box 1098
Suffolk, Va. 23434

Mozingo, Walton
Tidewater Research Station
Holland, Va. 23391

Murphy, John H.
2855 Alpine Road
Gold Kist Industries, Inc.
Atlanta, Ga. 30305

Nemec, Charles
CPC International
P.O. Box 5056
Dallas, Texas 75222

Neucere, Navin J.
Southern Market. & Nutrition
Research Division
USDA
1100 Robert E. Lee Blvd.
New Orleans, La. 70119

Newman, James S.
Experiment Station
Texas A&M University, Box 292
Stephenville, Texas 76401

Norden, A.J.
Agronomy Dept.
402 Newell Hall
Gainesville, Fla. 32601

O'Neal, Henry
Agricultural Engineer
Texas A&M University
College Station, Texas 77843

Ong, Vic S.K.
Kelling Nuts, A Unit of CPC Int.
P.O. Box 1918
Paterson, N.J. 07509

Ory, Robert L.
USDA, SMNRD, ARS.
P.O. Box 19687
New Orleans, La. 70179

Parker, Wilbur A.
CPC International Inc.
1120 Commerce Ave.
Union, N.J. 07083

Pattee, Harold E.
278 Weaver Labs
P.O. Box 5906, NCSU
Raleigh, N.C. 27607

Pearman, Grady
PENCO
Pearman Engineering Co.
Route #1
Chula, Ga. 31733

Pearson, Jack L.
National Peanut Research Lab.
P.O. Box 637
Dawson, Ga. 31742

Perry, Astor
Extension Agronomy Specialist
N.C. State University
Raleigh, N.C. 27607

Person, Nat K. Jr.
Agric. Engineering Dept.
Texas A&M University
College Station, Texas 77843

Pettit, Robert E.
Asst. Professor
Plant Science Dept.
Texas A&M University
College Station, Texas 77843

Phelps, Richard
Anderson, Clayton & Company
P.O. Box 2538
Houston, Texas 77001

Pominski, Joseph
Southern Regional Research Lab.
Agric. Research Service
USDA
P.O. Box 19687
New Orleans, La. 70119

Porter, Morris
USDA, ARS
Tidewater Research &
Continuing Education Center
Holland, Va. 23391

Porterfield, Jay G.
Oklahoma State University
Agriculture Engineering Dept.
Stillwater, Okla. 74074

Rayner, Eric
Research Chemist
SURDD, USDA
1100 Robert E. Lee Blvd.
New Orleans, La. 70124

Reagan, Sidney C.
6815 Prestonshire
Dallas, Texas 75255

Redlinger, Leonard
Investigations Leader
Peanut & Southern Corn Insects Invest.
Coastal Plain Experiment Station
Tifton, Ga. 31794

Reid, Preston H.
Tidewater Research Station
Holland, Va. 23391

Rhee, Khee-Choon
Protein Chemistry Lab.
Texas A&M University
College Station, Texas 77843

Rice, Philip
436 Wayne Drive
Raleigh, N.C. 27600

Richards, Russell P.
CIBA-GEIGY Corporation
Route #11 Box 133
Gainesville, Ga. 30501

Riddick, Henry C.
Assoc. Ag. Extension Agent
Post Office Box 1427
Greenville, N.C. 27834

Rider, Allen R.
214 Ag Hall
Oklahoma State University
Stillwater, Okla. 74074

Rivenbark, E.P.
c/o The Ferguson Mfg. Co., Inc.
P.O. Box 1098
Suffolk, Va. 23434

Rodgers, W. Ralph
P.O. Box 26
Morgan, Ga. 31766

Roe, James C.
Tate & Roe, Inc.
P.O. Box 30607
Dallas, Texas 75230

Rogers, Charles C.
Texas Dept. of Agriculture
301 West Navarro
DeLeon, Texas 76444

Rogers, Kenneth M.
240 Finchess Hall
Auburn University
Auburn, Ala. 36830

Rogister, E.W. Jr.
County Extension Chairman
Winton, N.C. 27986

Romain, William R.
16 East Clark Place
South Orange, N.J. 07079

Romero, Julio
Division of Tropical Research
Tela Railroad Co.
LaLima, Cortez
Honduras
Central America

Rose, John T.
Mineral Research & Dev. Corp.
Box 911
Charlotte, N.C. 28201

Samples, L.E.
Extension Engineer
Cooperative Extension Service
University of Georgia
College of Agriculture
Tifton, Ga. 31794

Santelmann, P.W.
Agronomy Department
Oklahoma State University
Stillwater, Okla. 74074

Schroeder, Harry W.
USDA, ARS
P.O. Box ED
College Station, Texas 77840

Scott, Denuis
Sather Cookie Company
Round Lake, Minn. 56167

Scott, Victor
Gold Kist Inc.
Box 111
Comanche, Texas 76442

Jimmy Seay Farms
312 Lnllwood Street
Pleasanton, Texas 78064

Sexton, E.L.
CPC International Inc.
Best Foods Research Center
1120 Commerce Ave.
P.O. Box 1534
Union, N.J. 07083

Shea, William T.
Mineral Research & Dev. Corp.
Box 911
Charlotte, N.C. 28201

Shepherd, James L.
Agricultural Engineering Dept.
Coastal Plain Experiment Station
Tifton, Ga. 31794

Shuster, Herbert
54 Clayton Street
Dorchester, Ma. 02122

Simpson, Charles E.
Texas Agricultural Exp. Station
Box 292
Stephenville, Texas 76401

Singletery, R.C. Jr.
The Blakely Peanut Company
North Main Street
Blakely, Ga. 31723

Slay, Whit O.
TFRD, HFRB
National Peanut Research Lab.
P.O. Box 110
Dawson, Ga. 31742

Smith, D.H.
Georgia Experiment Station
Experiment, Ga. 30212

Smith, Fred H.
Room 208 Long Hall
Clemson University
Clemson, S.C. 29631

Smith, H. Ray
Diamond Shamrock Chemical Co.
Box 4950 Crosstown Station
Memphis, Tenn. 38104

Smith, John C.
Associate Professor of Entomology
Tidewater Research &
Continuing Education Center
Holland, Va. 23391

Smith, J.W. Jr.
Texas A&M University
Entomology Dept.
College Station, Texas 77840

Smith, Lloyd Erdman
Gold Kist Research Center
P.O. Box 388
Lithonia, Ga. 30058

Smith, Louis C.
H.B. Reese Co.
1426 Church Road
P.O. Box 181
Hershey, Pa. 17033

Smith, Olin D.
Dept. of Soil & Crop Sciences
Texas A&M University
College Station, Texas 77843

Sorenson, J.W. Jr.
Texas A&M University
Dept. of Agricultural Engineering
College Station, Texas 77843

Spadaro, James J.
Southern Regional Research Lab.
P.O. Box 19687
New Orleans, La. 70119

Spears, Ben R.
Extension Agronomist
Texas A&M University
College Station, Texas 77843

Stallings, John W.
Avoca Farm
Box 128
Merry Hill, N.C. 27957

St. Angelo, Allen J.
USDA
P.O. Box 19687
New Orleans, La. 70119

Stansell, J.R.
CPES
Ag Engineering Dept.
Tifton, Ga. 31794

Steele, James L.
USDA, ARS, AERD
Tidewater Research Station
Holland, Va. 23391

Sturgeon, R.V. Jr.
Extension Plant Pathologist
Oklahoma State University
115 Life Science East
Stillwater, Okla. 74074

Sullivan, Gene
3832 Corwin Road
Raleigh, N.C. 27610

T.E.C.H. Farm Inc.
c/o J.M. Phillips
Box 425
Pearsall, Texas 78061

Taber, Mrs. Ruth Ann
Dept. of Plant Sciences
Texas A&M University
College Station, Texas 77843

Thompson, Samuel S.
Area Ext. Plant Pathologist
P.O. Box 48
Tiftnn, Ga. 31794

Tiemstra, Peter
Derby Foods, Inc.
3327 W. 48th Place
Chicago, Ill. 60632

Tierney, S.E.
Derby Foods, Inc.
3327 W. 48th Plact
Chicago, Ill. 60632

Toalson, George
351 Margo Drive
Pearsall, Texas 78061

Toalson, Hubert
Box 394
Pearsall, Texas 78061

Tripp, Leland
Extension Crops Specialist
Oklahoma State University
Stillwater, Okla. 74074

Troeger, John M.
USDA-ARS
Coastal Plain Station
Tifton, Ga. 31794

Vanderlaan, Pieter W.
Product Manager
Occidental Chemical Co.
4671 S.W. Freeway
P.O. Box 1185
Houston, Texas 77001

Van Shaik, P.H.
USDA-ARS
Tidewater Research Station
Holland, Va. 23391

Wadsworth, D.F.
Botany & Plant Pathology Dept.
Oklahoma State University
Stillwater, Okla. 74074

Walker, Milton E.
Asst. Soil Scientist
Dept. of Agronomy
Univ. of Georgia College of Agric.
Tifton, Ga. 31794

Waller, George R.
Dept. of Biochemistry
Oklahoma State University
Stillwater, Okla. 74074

Warnken, C.H. Jr.
Wilco Peanut Co.
P.O. Box 23156
San Antonio, Texas 78223

Watson, S.A.
CPC International, Inc.
Box 345
Summit, Ill. 60501

Wells, J.C.
Extension Professor
Plant Pathology
N.C. State University
Raleigh, N.C. 27607

Westbrook, Ronald C.
Camilla Cotton Oil Co.
P.O. Box 271
Camilla, Ga. 31730

Westmoreland, William G.
713 Yarmouth Road
Raleigh, N.C. 27607

Whitaker, Thomas
MQRD, USDA
Box 5906
College Station
Raleigh, N.C. 27607

Whitty, E.B.
303 Newell Hall
University of Florida
Gainesville, Fla. 32601

Williams, E. Jay
AERD, ARS, USDA.
Georgia Coastal Plain Exp. Station
Tifton, Ga. 31794

Wilner, W.D.
PPG Industries
774 Wando Drive
North Augusta, S.C. 29841

Wilson, Coyt T.
VPI & SU Research Division
Blacksburg, Va. 24061

Wilson, Weldon
200 Blundell
Ranger, Texas 76470

Woodall, Morris
11 South Boylan Ave.
c/o The Peanut Farmer Spec. Agric.
Publ. Inc.
Raleigh, N.C. 27603

Woodward, John D.
TFRD, HFRB
National Peanut Research Lab.
P.O. Box 110
Dawson, Ga. 31742

Worthington, R.E.
Food Science Dept.
Georgia Station
Experiment, Ga. 30212

Wright, F. Scott
USDA, ARS, AE
Tidewater Research Station
Holland, Fa. 23391

Wynne, Johnny C.
Crops Science Dept.
N.C. State University
Box 5155
Raleigh, N.C. 27607

Young, Clyde T.
Assistant Chemist
Georgia Experiment Station
Experiment, Ga. 30212

Young, James H.
N.C. State University
Dept of Biological & Ag Eng.
Box 5906
Raleigh, N.C. 27607

Zavesky, Thomas C.
A-7 Regency Apts.
Tifton, Ga. 31794

Zekert, Gerry C.
c/o Planters Peanuts
Suffolk, Va. 23434

STUDENT MEMBERHIPS

Beg, Akhtar
108 Williams Hall
N.C. State University
Raleigh, N.C. 27607

Coffelt, Terry A.
Dept. of Agronomy
Connor Hall
University of Georgia
Athens, Ga. 30601

Gilman, Frank
Soil and Crop Science Dept.
Texas A&M University
College Station, Texas 77840

Khan, A.R.
108 Williams Hall
N.C. State University
Raleigh, N.C. 27607

Khan, Baz M.
Agronomy Dept.
Oklahoma State University
Stillwater, Okla. 74074

Kubicek, Mike
Extension Agent
Box 320, 301 N. Main
Guymon, Okla. 73942

Nowlin, Larry
Soil and Crop Sciences Dept.
Texas A&M University
College Station, Texas 77840

Philley, George
Box 934
College Station, Texas 77840

Slemchinski, Bill
Box 54
Leming, Texas 78050

Stichler, Charles
B-4-D College View
College Station, Texas 77480

Tai, Yai-po
Dept. of Agronomy
Oklahoma State University
Stillwater, Okla. 74074

Tan, Nguyen V.
Agronomy Dept.
215A Rolfs Hall
Gainesville, Fla. 32601