Chapter 10

PEANUT CULTURAL PRACTICES

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Cultural practices interact with cultivar, pest incidence, and environmental conditions to influence final peanut crop yield and quality. Until recently, peanut cultural practices have been viewed conservatively and producers generally have perceived that they had little latitude in selecting production practices if success was to be achieved. This view has changed slowly as alternative cultural practices have been developed. While producers cannot control all production factors, researchers are developing alternative cultural practices that will result in more efficient and profitable ways of producing the crop.

SOIL SELECTION

Little has changed in soil and land selection criteria for peanuts since U.S. commercial production started. Peanut production begins with the "right" soil. The ideal peanut soil is well-drained, light colored, with either sand, loamy sand, or sandy loam texture. Moist soil rubbed between the index finger and thumb should not ribbon out but should fall apart easily. Pods produced in these soils are bright and largely free of foreign material.

LAND AND SEEDBED PREPARATION

Conventional Tillage

Historically, peanuts have been grown as a conventionally planted, full season, summer annual crop. Production systems have included primary and secondary tillage operations resulting in a friable, residue free, flat or slightly raised seedbed (Samples, 1987). Primary and secondary tillage are accomplished to control weeds and to prepare a seedbed for planting.

Beginning in the 1950s, the benefits of primary and secondary (conventional) tillage for peanut production were demonstrated. This method begins with deep turning of the soil with a moldboard plow followed by secondary tillage (disking) to provide a seedbed that is relatively smooth and residue and weed-free. Compared to less intensive tillage systems, the conventional tillage system was shown to result in improved pod yields (Boyle, 1956; Garren and Duke, 1958; Garren, 1959; Mixon, 1963) and less loss to southern blight (*Sclerotium rolfsii* Sacc.) and root rot (*Rhizoctonia solani* Kuhn) (Boyle, 1952, 1956). Later Buchanan and Hauser (1980) showed that conventional tillage resulted in fewer weed problems.

During the past 40 years, the development and adoption of new or alternate tillage strategies for peanuts has been discouraged. Producers have had concerns about increased pest incidence and damage, potential yield and quality reductions, difficulty of obtaining a stand due to lack of equipment for special planting requirements, and anticipated harvesting difficulties. Beginning in the 1980s, limited research on tillage practices within conventional tillage systems has been conducted. Wright and Porter (1982) demonstrated in Virginia that peanuts show little or no response to differences in seedbed preparation. They evaluated underrow ripping in combination with four methods of seedbed preparation including (a) conventional (flat), (b) rotary tiller and bed shaper, (c) disk bedder, and (d) rolling cultivator. Underrow ripping did not result in higher peanut pod yields and appeared to increase the incidence of pod breakdown caused by *Pythium myriotylum* and *R. solani*. In fields with a history of pod breakdown, a small yield advantage was found with the rolling cultivator. In a later test in Virginia, Wright *et al.* (1986) compared the same four seedbed preparation methods and found no effect on peanut pod yield or crop values with the different methods.

Hallock (1975) suggested that fall plowing was beneficial because it reduced the amount of fresh plant material in the plow layer at planting time. However, if the residue from a corn (*Zea mays* L.) or grain sorghum [*Sorghum bicolor* (L.) Moench] crop is turned under in the fall and no winter cover crop is planted, the soil is then left exposed during the winter months and subject to erosion. Fall plowing is rarely practiced in any of the peanut growing areas unless the cultural plan includes seeding a winter cover crop. Spring plowing (March) is most commonly practiced.

Wright (1991) suggested that delaying moldboard plowing until just before planting could reduce soil erosion during the winter and reduce the number of secondary tillage operations prior to planting. He compared a conventional tillage system where moldboard plowing occurred several weeks (late March) before peanut planting with two alternative tillage systems where moldboard plowing was done immediately prior to planting. In one of the alternative tillage treatments, a power-driven rotary tiller with drag board and planters attached was used to both prepare a seedbed and plant in a single operation. In the second alternative system, an adjustable spider gang rolling cultivator with planters attached was used to shape a seedbed and plant in a single operation. Both peanut pod yield and gross returns were increased by approximately 10% with each alternative tillage system.

Conservation Tillage

The preponderance of tillage research in the past decade has been in the area of conservation tillage. Soil loss to wind and water erosion and large fuel and labor requirements for conventional systems have stimulated interest in developing alternative systems. These conservation tillage systems can conserve soil and increase production efficiency by reducing the need for expensive inputs.

Producing small grains during winter months on cultivated land, followed by conservation tillage culture for summer row crops, are accepted as excellent conservation practices (Anonymous, 1987). Conservation tillage is widely used in producing soybeans (*Glycine max* L.), corn, cotton (*Gossypium hirsutum* L.), and grain sorghum, and has reduced production costs, water runoff, and soil erosion (Sanford *et al.*, 1973; Fink and Wesley, 1974; Musick *et al.*, 1975; Melville and Rabb, 1976; Nelson *et al.*, 1977;). Unger *et al.* (1977) reported that crop residue on the soil surface can largely eliminate soil erosion problems.

Various terms including no-tillage, minimum tillage, reduced tillage, and strip tillage have been used to describe conservation tillage. Generally, these tillage systems consist of (a) seeding directly into previously undisturbed soil (no-till), (b) performing the least manipulation necessary for crop production or for meeting tillage requirements under existing soil conditions (minimum tillage), (c) planting in a system which consists of fewer or less energy intensive operations compared to conventional tillage (reduced tillage), or (d) planting in a system in which 30% or less of the soil surface (bands in the row) is tilled (strip tillage) (ASAE, 1990). Conservation tillage requires that crop residue be on the soil surface during the critical erosion period (ASAE, 1990). Conservation tillage systems usually involve planting crops into small grains stubble, but may involve planting into row crop residue.

The coarse texture of many peanut soils causes them to be inherently erodible. Conventional tillage systems which result in little crop cover of the soil for much of the early growing season contributes to the erodibility of these soils. Recent research indicates that conservation tillage may be feasible for peanuts. In several studies on conservation tillage, peanut yields have been equal to or superior to those from conventional tillage. Cheshire *et al.* (1985) compared conventional and no-tillage peanut production in Georgia. They found that when soil moisture was not limiting, pod yields and grade factors were higher for no-tilled peanuts as compared to conventional tilled peanuts. Soundara Rajan *et al.* (1981) reported that no-tillage culture did not reduce peanut yields in India and indicated that the sandy loam texture of the soil facilitated peg penetration and pod development. In 17 experiments in Alabama, peanut yields for reduced tillage systems increased at three locations, decreased at five sites, and were not different at nine sites as compared to conventional tillage systems. Reduced tillage did not affect grade factors (Hartzog and Adams, 1989). Grichar and Boswell (1987) compared minimum tillage, no-tillage, and full tillage peanut production in Texas. They reported difficulty with soil compaction in the reduced tillage treatments. No-tillage resulted in yield losses of almost 33% compared to full tillage. Minimum tillage yields fell between those of no-tillage and full tillage.

Colvin and Brecke (1988) compared the performance of several runner and virginia cultivars and a valencia cultivar under conventional and minimum tillage planting systems. They found that tillage system did not affect pod yield or grade. There was also no differential response of the cultivars to the tillage treatments. They concluded that breeding cultivars specifically for certain tillage systems was unwarranted. Grichar and Smith (1992) also evaluated genotype response to reduced tillage systems. They compared pod yield and grade of four spanish types and one early maturing runner type in reduced tillage, no-tillage, and conventional systems. These genotypes did not react differently to the tillage treatments. Conventional and reduced tillage systems produced similar yields while yields from no-tillage were lower in only 1 of 3 years of the study.

Sholar *et al.* (1993) compared the effects of conventional, reduced, and no-tillage treatments on pod yield and grade for the spanish cultivar, Spanco, and a runner cultivar, Okrun. Conventional tillage plots were prepared using a moldboard plow followed by disking to prepare a smooth seedbed. Reduced tillage plots were prepared using strip tillage, and no-tillage plots were established by planting directly into rye stubble. For the spanish cultivar, strip tillage produced yields equal to conventional tillage; however, the no-tillage plots yielded 18% less than conventional tillage plots. For the runner cultivar, pod yields were 20 and 14% lower for no-tillage and minimum tillage, respectively, compared to conventional tillage. Tillage treatments did not affect grade with either cultivar.

Despite the potential benefits of reducing erosion and production inputs, conservation tillage does not consistently produce yields equal to conventional tillage. Generally, factors such as uncontrolled weeds, compacted soils, or poor stands are responsible when reduced yields occur with conservation tillage. In general, conservation tillage systems which involve no-tillage systems have produced lower peanut yields than those involving conventional tillage or some form of strip, reduced, or minimum tillage.

Varnell *et al.* (1976) found that compared to conventional tillage, no-tillage culture reduced pod yield and quality by 64 and 62%, respectively. They attributed the poor performance in no-tillage to a compacted planting zone resulting in shallow planting and increased weed competition. Colvin *et al.* (1988) compared several tillage systems which included combinations of conventional tillage, strip-tillage, and no-tillage with subsoiling or subsurface slitting. They found that either surface or sub-surface tillage was necessary for peanut germination and growth. Plots which received some surface tillage had higher yields than plots which received no surface treatment. Therefore, they concluded that for maximum peanut growth and pod yields, surface tillage was necessary. They also found that subsurface tillage was important in dry years and on soils with hardpans where low water-holding capacity was a problem.

Wright and Porter (1991) compared the effects of two conservation tillage systems (band and in-row) with a conventional tillage system on a virginia-type cultivar. They found no yield difference between the two conservation tillage systems; however, both conservation tillage systems reduced pod yields as compared to conventional tillage. Peanut pod yields were 19% less with conservation tillage as compared to yields with conventional tillage. The tillage systems had an inconsistent effect on grade factors.

Minton (1985) found that peanut yields were greater with moldboard plowing as compared with rip-planting. Minton *et al.* (1991) compared several factors in a 3-year study at Tifton, Georgia. They found that conventionally tilled peanuts produced yields 17% greater than those from a minimum tillage system.

Weed management posed problems early in the development of conservation tillage systems for peanuts. Sanford *et al.* (1973) reported that failure to control weeds was the most important problem encountered in conservation tillage cropping systems. Grichar and Boswell (1987) in Texas indicated that controlling grassy weeds was a problem with reduced tillage. However, Minton *et al.* (1991) in Georgia reported that reduced tillage posed no additional problems for weed control compared to conventional tillage.

Despite weed management problems, Colvin *et al.* (1985) indicated that acceptable weed control systems which are cost effective can be developed for minimum tillage peanut production. However, these systems require several herbicide applications at various crop growth stages. Wilcut *et al.* (1987) also developed weed management systems for minimum tillage peanuts which resulted in greater yields and net returns with equal weed control when compared to a conventional tillage herbicide system. Their research indicated that more intensive weed management efforts would be required for minimum tillage production as compared to conventional tillage.

Insect and disease incidence and plant and pod damage resulting from the use of conservation tillage systems have been somewhat inconsistent. In general, these pests have not increased with the adoption of conservation tillage. Cheshire *et al.* (1985), Minton (1985), Grichar and Boswell (1987), Grichar and Smith (1992), Colvin *et al.* (1988), Colvin and Brecke (1988), Minton *et al.* (1991), and Porter and Wright (1991) found that conservation tillage did not increase the incidence of southern blight. Minton *et al.* (1991) reported that Rhizoctonia limb rot was less damaging with minimum tillage as compared to conventional tillage. Sholar *et al.* (1993) found the severity of early leaf spot (*Cercospora arachidicola* Hori) in a spanish cultivar (Spanco) was significantly higher with minimum tillage and no-tillage as compared to conventional tillage. However, tillage treatments did not affect early leaf spot severity in a runner cultivar (Okrun).

Minton (1985) reported that tillage systems did not affect soil insects. In a later study, Minton *et al.* (1991) found that thrips (*Frankliniella fusca* Hinds) damage was less with minimum tillage as compared to conventional tillage. Campbell *et al.* (1985) found that with no-till culture, thrips populations and potato leafhopper damage (*Empoasca fabae* Harris) to foliage was less than in conventionally planted peanuts. Corn earworm (*Helicoverpa zea* Boddie) damage did not differ between the tillage treatments. Insects caused slightly higher pod damage in no-tillage while pod rot (*Pythium myriotylum* Drechs.) was less than in conventionally planted peanuts. In a later study, Campbell (1986) found that insects posed no greater problems in conservation tillage than in conventional tillage. No-till peanuts had less thrips damage and less corn earworm damage than conventionally planted peanuts.

Minton *et al.* (1990, 1991) reported more damage from root-knot nematode [*Meliodogyne arenaria* (Neal) Chitwood] in minimum tillage peanuts than in conventional tillage. Lesion nematode [*Pratylenchus brachyurus* (Godfrey)

Filipjev and Schuurman-Stekhoven] damage was unaffected by tillage (Minton *et al.*, 1990).

CROP ROTATIONS AND CROPPING SYSTEMS

Crop rotation is an important cultural practice of peanuts. Since peanuts are a legume and sensitive to the effects of other crops immediately preceding it in rotation, other legumes should not be included in the rotation. Peanuts are susceptible to many diseases and nematodes, and continuous planting on the same land results in reduced yields (Rodriguez-Kabana *et al.*, 1987; Ayers *et al.*, 1989). The term "rotational effect" has been used to describe the increase in crop yield that occurs when crops are rotated as compared to yields obtained with continuous cropping under similar conditions (Heichel, 1987). Several factors contribute to this effect when peanuts are in an appropriate rotation: (a) more effective use of residual soil fertilizer, (b) improved efficiency in controlling certain weeds, and (c) reduction in soil-borne disease and nematode problems.

The peanut taproot can reach a depth of 1.8 m and its deep-rooting nature causes it to be very effective in utilizing residual fertility. The most common practice for meeting the nutrient requirements for peanuts has been to fertilize the rotation crop preceding peanuts.

Broadleaf weeds in peanuts that are difficult to control with herbicides can be readily controlled in corn and grain sorghum. If weeds are controlled in the rotation crop preceding peanuts, weed problems in the peanut crop can be reduced. However, ineffective weed control in the rotation crop can result in severe weed problems. Johnson (1991) utilized a corn-corn-peanut rotation to evaluate the effects of weed control in corn on weed populations and their control in the succeeding peanut crop. He found that the level of weed management in corn influenced the level of subsequent herbicide use. Low input control in the corn crop required higher inputs for weed control in the succeeding peanut crop.

Crop rotation is used as a cultural control method for reducing the effects of diseases and nematodes. Rotations are usually the most economical approaches where sufficient land is available to produce both the rotation crop and to avoid reducing the amount of land committed to peanut production.

When rotation crops of low economic value replace peanuts and cause reduced peanut plantings, net farm income will likely decline. On a fixed area basis, continuous peanut production, which requires moderate to high levels of pest control inputs is likely to be more profitable than production systems where peanuts are rotated with lower-value grass crops such as corn and grain sorghum. Rotations with high value crops such as cotton may not result in reduced net income.

Extensive research has been conducted in Alabama on the use of rotation crops to manage nematodes in peanuts and increase peanut yields. The effects of rotation crops on root-knot nematode (*M. arenaria*) populations has been studied most extensively. This nematode is a serious problem in the

Southeast but occurs to some degree in all production areas. Root-knot nematode resistant germplasm has been identified, but cultivars resistant to this pest have not been released. Corn and grain sorghum may serve as hosts for root-knot nematode, but these crops are less desirable than peanuts for root-knot nematode development (Trivedi and Barker, 1986). Rodriguez-Kabana and Ivey (1986) have shown that where low populations are present, corn may be used as a rotation crop but this crop is ineffective when nematode populations are high (Rodriguez-Kabana and Touchton, 1984). Baldwin (1992) also showed the value of rotating peanuts with a grass crop. Yields from 3 years of continuous peanuts were compared to peanut yields following 2 years of either bahiagrass (*Paspalum notatum* Flugge) or corn and peanut yields were 19 and 41% greater, respectively, compared to continuous peanuts. Grade factors including total sound mature kernels (TSMK) were not affected by these rotations.

Cotton rotated with peanuts suppressed development of root-knot nematode populations and increased peanut yields (Rodriguez-Kabana *et al.*, 1987). A significant reduction in nematode populations was obtained and peanut yields were 19% higher following a single year of cotton compared to continuous peanuts. The authors also reported that the cotton-peanut rotation resulted in reduced incidence of southern blight. In a more extensive study, Rodriguez-Kabana *et al.* (1991b) investigated the use of cotton as a rotation crop for the management of root-knot nematode and southern blight. A rotation plan that included either 1 or 2 years of cotton resulted in lower populations of root-knot nematode, lower incidence of southern blight, and higher peanut yields when compared to continuous peanuts.

Using an old, established peanut field, Rodriguez-Kabana *et al.* (1989) studied the effects of several green manure and row crop species as potential rotation crops with peanuts. They found that American jointvetch (*Aeschynomene americana* L.), castorbean (*Ricinus communis* L.), partridgepea (*Cassia fasiculata* Michx.), and sesame (*Sesamum indicum* L.) rotated with peanuts resulted in increased peanut yields compared to peanuts following peanuts. All of the crops reduced juvenile nematode population densities to almost zero levels.

The effects of bahiagrass and castorbean rotations on nematode populations, southern blight, and peanut yields have also been evaluated in Alabama (Rodriguez-Kabana *et al.*, 1991a). They found that following 2 years of castorbean or 2 years of bahiagrass, southern blight incidence was significantly reduced and peanut yields were 44 and 37% greater, respectively, than those for continuous peanuts.

The effectiveness of crop rotation for nematode control is greatest in fields where multiple pest problems exist. Ayers *et al.* (1989) examined this in a North Carolina study of peanut-corn rotation effects on nematodes and crop yield. Crop rotation was more effective in increasing peanut yields at a site with several pest problems than at a site where nematodes were the only major problem.

Lamb *et al.* (1993) conducted an extensive survey of Georgia producer practices including rotation sequences. They found that due to large capital investment requirements for irrigation systems, irrigated fields are typically under shorter rotation sequences than nonirrigated fields. The grower survey showed that length of rotation affected nonirrigated and irrigated peanuts differently. Longer rotations were more beneficial in irrigated peanuts as compared to nonirrigated peanuts. One, 2, and 3 years without peanuts in nonirrigated fields resulted in 11, 25, and 28% yield increases, respectively, as compared to continuous peanuts. One, 2, and 3 years without peanuts in irrigated fields resulted in 7, 36, and 34% yield increases, respectively, as compared to continuous peanuts.

BOTANICAL TYPES, MARKET TYPES, AND CULTIVARS

Botanical Types

Commercial cultivars in the U.S. are marketed from two distinct botanical types. These are the *hypogaea* botanical type (*Arachis hypogaea* L. subsp. *hypogaea*) and the *fastigiata* botanical type (*A. hypogaea* subsp. *fastigiata*).

Hypogaea Botanical Type

In the *hypogaea* botanical type, the seed size is medium to large with mostly two but occasionally three seed/pod. This type has moderate cured seed dormancy. Floral axes or branches are absent from the mainstem. The pattern of branching is alternating pairs of vegetative and reproductive axes or branches. Vegetative branching is moderate to profuse. The primary lateral branches are longer than the mainstem. The growth habit is spreading, intermediate, or erect. The pod distribution is scattered and is not concentrated near the base of the mainstem. The *hypogaea* botanical type consists of two market types which are runner and virginia.

Fastigiata Botanical Type

In the *fastigiata* botanical type, seed size is small to medium with two to four seed/pod. There is little cured seed dormancy. Flowering axes or branches are present on the mainstem. The pattern of branching is irregularly reproductive and vegetative with reproductive branches predominating. Vegetative branching is sparse to moderate and the primary lateral branches are shorter than the mainstem. The growth habit is upright (bunch) and the pod distribution is usually concentrated near the base of the mainstem. The *fastigiata* botanical type consists of two market types. These are the spanish market type and the valencia market type.

Applying proper and profitable cultural practices begins with selecting the market type(s) best adapted to a particular production area. Historical trends in market demand, long-term weather conditions, and soil types of the region impact the market types selected. A consistent supply for a particular market type is necessary for profitability to be assured.

Production in the Virginia-Carolina (Virginia, North Carolina, South Carolina) area has been limited exclusively to large-seeded virginia-type cultivars, while production in the Southeast (Georgia, Alabama, Florida)

Table 1. Percentage of peanut acreage devoted to various market types by U.S. production region.

Region	Market type			
	Runner	Virginia	Spanish	Valencia[a]
	% of planted area			
Southeast	97	3	0	0
Virginia-Carolina	0	100	0	0
Southwest	46	5	49	0

[a]7000 ha grown in New Mexico. Represents <1% of total U.S. production area.

region is dominated by the runner type, and in the Southwest (Texas, Oklahoma), production is a mix of runner- and spanish-type cultivars (Table 1). New Mexico produces virtually all of the U.S. valencia-type peanuts.

Over the past decade, changes have occurred in the runner cultivars planted. In 1985, Florunner dominated plantings with 84.2% of the runner market area. By 1994, this had declined to 40.8% of the runner market area but still contributed 29.3% of the total U.S. production area. In 1994, GK 7, a privately released runner cultivar made up 24.7 and 34.4% of the total U.S. production area and runner market area, respectively. In 1994, the top two cultivars accounted for 75.2% of the runner production area.

Changes also have occurred with virginia market type cultivars. In 1985, NC 7 and Florigiant accounted for 80% of the production area planted to virginia cultivars. In 1994, NC 7 was planted on 31.5% of the virginia production area but Florigiant was grown on <1% of the virginia production area.

In 1985, two spanish cultivars, Comet and Starr, were planted on 82.5% of the spanish production area. By 1994, Tamspan 90 (a spanish cultivar with resistance to Sclerotinia blight), Spanco, and Pronto accounted for 81.6% of the spanish production area.

In 1985, runner, virginia, and spanish market types were planted on 61, 16, and 22%, respectively, of the total acres planted (Table 2). In 1994, runner, virginia, and spanish market types were planted on 72, 18, and 9%, respectively, of the total acres planted. Valencia types made up the other 1% of the acreage planted.

Runner Market Type

Prior to the early 1970s, the peanut industry was dominated by cultivars from the spanish and virginia market types. The release of the Florunner cultivar in 1970 was responsible for a dramatic increase in runner market-type peanut production in the U.S. In the market place, runners are popular because of their desirable size range. The runner type is grown primarily in Georgia, Alabama, Florida, Texas, and Oklahoma and account for 75% of total U.S. production. Approximately 50% of runner peanuts produced are used for peanut butter.

Table 2. Summary of peanut cultivars in the U.S. released since 1982 plus the most widely grown cultivars in each market type (1994 U.S. acreage).

Cultivar	Year released	Mean seed size	Total U.S. production area	% of area of market type	Relative yield	Basis for release
		Seed/oz	%	%	%	
Runner cultivars						
Florunner	1969	46	29.3	40.8	100	High yield and grade
Sunrunner	1982	43	2.5	3.5	102	High yield and grade, oil quality
GK 7	1984	46	24.7	34.4	106	High yield, genetic diversity
Southern Runner	1986	48	4.8	6.7	107	High yield, disease resistance
Okrun	1986	49	2.2	3.1	104	High yield and grade
Tamrun 88	1988	51	1.7	2.4	103	High yield and grade, uniformity of emergence
Marc I	1990	47	1.2	1.7	110	High yield, early maturity, taste
Georgia Runner	1990	48	3.9	5.4	107	High yield and grade (ELKs), genetic diversity
AT 127	1990	45	<1	<1	100	Early maturity, high % jumbos, genetic diversity
Georgia Browne	1993	67	<1	<1	110	High yield, multi-disease resistant, small seed
Andru 93	1993	43	1.3	1.8	114	High yield, early maturity, seed size
Virginia cultivars						
NC 7	1978	32	5.7	31.5	100	High yield, early maturity, high ELK %, high O/L ratio
VA 81B	1981	36	0	0	93	Early maturity, Sclerotinia blight resistance
NC 8C	1982	40	0	0	94	CBR resistance
NC 9	1985	36	2.4	13.3	100	High yield, early maturity
NC 10C	1985	38	<2	8.2	96	CBR resistance
NC-V11	1988	38	3.5	19.7	104	High yield
AT VC-1	1991	39	<2	<11.1	105	High yield
VA-C 92R	1992	34	2.0	10.9	106	High yield and value
VA 93B	1993	36	<1	<1	95	Early maturity, Sclerotinia blight resistance
Spanish cultivars						
Spanco	1981	66	2.5	27.7	118[a]	High yield
Tamspan 90	1990	63	4.3	47.7	109[b]	High yield, Sclerotinia and Pythium resistance
Valencia cultivars						
Georgia Red	1986	55	<1	<1	110[c]	High yield, compact plant type, large pods

[a]Percent of Comet.
[b]Percent of Starr.
[c]Percent of Val A and C.

Georgia, Florida, Texas, and Oklahoma have breeding programs for the runner market-type cultivar. In recent years, numerous cultivar releases have come from the breeding programs in these states. Listed below are the public cultivars released since 1981 along with cultivar descriptions. The description for Florunner, the industry standard since the early 1970s is included as a basis of comparison.

Florunner. Florunner was derived from a cross made in 1960 of Early Runner x Florispan. Florunner was released in 1969 (Norden *et al.*, 1969) by the Florida Agricultural Experiment Station as a commercial runner type that was superior to Early Runner in sound mature seed percentage, flavor, quality and yield. Yields of Florunner averaged 18% greater than Early Runner in Alabama, Florida, and Georgia tests from 1965 through 1968. Florunner also produced slightly better yields than Early Runner in close row spacing patterns.

The plant growth habit of Florunner is prostrate with the typical branching pattern (alternate pairs of reproductive and vegetative nodes on the lateral branches and no fruiting nodes on the terminal branch) of the *hypogaea* botanical type. Florunner has the prolific fruiting habit of Early Runner but the pods are concentrated nearer the central branch or tap root and the foliage is slightly less dense. The seed mature in approximately 134 days after planting.

The pods of Florunner are more uniform than those of Florispan, but are somewhat larger and thicker than pods of Early Runner. Pods of Florunner are free of the pubescence which often causes soil to cling to pods during harvest. The seed weight for Florunner is approximately 10% greater than for Early Runner. The percentage of shriveled seed is slightly lower for Early Runner. Both cultivars have an inherently low amount of seed damage.

Chemical analyses of the seed oils, as well as taste tests, show that Florunner possesses the chemical qualities desired in a runner-type peanut to a greater degree than Early Runner. The average sensory scores for peanut butter made from Florunner when judged on aroma, color, texture, flavor, general acceptance, and general appearance were higher in nearly every aspect than those for Early Runner.

Okrun. Okrun was developed and released cooperatively by the USDA, ARS and the Oklahoma Agricultural Experiment Station in 1986 (Banks *et al.*, 1989). It was the first commercial runner-type peanut cultivar developed in Oklahoma. This cultivar was selected from the 1973 cross of Florunner x Spanhoma, a spanish-type peanut.

Plant, pod, and seed morphology of Okrun resemble that of Florunner and the two cultivars require about the same length of growing season. It is susceptible to all common peanut diseases. Shelling data and end-use quality tests have shown Okrun is acceptable for industry uses. Okrun has shown small, but consistent advantages in yield and commercial grade over the industry standard, Florunner.

Sunrunner. Sunrunner was developed by the Florida Agricultural Experiment Station and released in 1982 (Norden *et al.*, 1985). It is a multiline cultivar formed from compositing three sister lines derived from the hybrid Florunner x an experimental virginia-type line (cross of Florispan Runner derivative and Jenkins Jumbo).

Sunrunner is similar to Florunner in maturity, disease and insect resistance, and physical characteristics. Over an 8-year period, Sunrunner yields averaged 3% higher than Florunner. Using farmers stock market-grade standards, Sunrunner averages 18% fancy pods and 29% extra large seed as compared with 12 and 25%, respectively, for Florunner. Both cultivars are characterized by a high shelling percentage (80%) and a low percentage of damaged seed (0.3% visible and 0.2% concealed).

Marc I. Marc I is an early maturing runner market-type peanut cultivar that was released by the Florida Agricultural Experiment Station in 1990 (Gorbet *et al.*, 1992). It was derived from a cross made in 1972 between a sister line of Florunner and a component line of Early Bunch. Maturity is approximately 10 days earlier than Florunner with a 6 to 12% higher pod yield. Marc I has about 1.5% more oil with a higher oleic/linoleic (O/L) acid ratio (2.00 for Marc I as compared to 1.74 for Florunner). Its foliage tends to produce less vine than Florunner and has slightly smaller leaves but Marc I is highly susceptible to the leaf spot diseases. Marc I has more uniform pod and seed size than Florunner.

Tamrun 88. Tamrun 88 was selected from a 1973 cross of Goldin I x Florunner and was released by the Texas Agricultural Experiment Station in 1986 (Smith and Simpson, 1989). Emergence is more uniform and stand establishment is more rapid for Tamrun 88 than for Florunner. Maturation of Tamrun 88 is approximately the same as that of Florunner. The mature pods and seed of the two cultivars are very similar in average size but the pod size of Tamrun 88 is slightly more uniform. Compared with Florunner, Tamrun 88 averaged 3.4% higher yield and 2.0% higher grade, resulting in a 5.3% increase in total shelled stock in 22 Texas yield tests during seven seasons, 1980-1986. This resulted in a 6.3% higher average gross return than that of Florunner.

Southern Runner. Southern Runner, released in 1984 (Gorbet *et al.*, 1987) by the Florida Agriculture Experiment Station, was derived from a 1972 cross of PI 203396 x Florunner. It was selected as a parent based on field tests in 1971 at Marianna with emphasis on leaf spot resistance. Southern Runner matures 5 to 7 days later than Florunner under similar production systems. Pod and seed size are slightly smaller than Florunner. It has clean, uniform pods with more prominent longitudinal venation on the pod surface. Seeds are generally more rounded and pods more symmetrical in appearance than those of Florunner, having predominantly two seed per pod, rarely one or three.

Georgia Runner. Georgia Runner was released by the Georgia Agricultural Experiment Stations in 1990 (Branch, 1991). Most important commercial runner cultivars in the U.S. are related to the Florunner cultivar. Since it is unrelated to the Florunner cultivar, it has greater genetic diversity than other currently available U.S. runner-type cultivars. It originated from a cross made in 1980 between a spanish mutant type (krinkle-leaf) and a peanut introduction from Bolivia (PI 331334).

Georgia Runner is highly productive and has a large percentage of jumbo runner size seed. Four-year (1986-89) mean field performance (20 tests) of Georgia Runner was found to be significantly higher (by *ca.* 5%) in yield and dollar return than Florunner. It also produced a significantly higher percentage (*ca.* 7%) of extra-large seed (>0.85 by 2.54-cm screen) than Florunner. Its maturity, grade, disease incidence, blanchability, protein, oil, and iodine value are similar to Florunner and Sunrunner.

Georgia Browne. Georgia Browne is a small-seeded cultivar originating from a 1973 cross of Southern Runner x Sunbelt Runner. It was developed for the confectionery or candy market and was released by the Georgia Agricultural Experiment Station in 1993 (Branch, 1994). Georgia Browne is a distinctively unique peanut cultivar in that it is a *hypogaea* botanical type, but has a fruit size similar to spanish types with a large portion of mature No. 1 seed. It averaged significantly higher yield with significantly smaller seed as compared to Florunner in 32 tests over 5 years in the southern U.S.

Georgia Browne differs from Florunner in having less vegetative canopy, more decumbent spreading growth habit, darker green foliage, and slightly later maturity (0-7 days) in south Georgia. It has resistance to stem rot or white mold (caused by *S. rolfsii*), limb rot (caused by *R. solani*), and tomato spotted wilt virus (TSWV).

Georgia Browne has longer shelf-life than Florunner as indicated by significantly larger ratios of oleic to linoleic fatty acids (2.5 vs. 1.8) and lower iodine values (90 vs. 94).

Andru 93. Andru 93 was developed by the Florida Agricultural Experiment Station and approved for release in 1993 (Gorbet and Knauft, 1995). It was selected from a cross made in 1972 between a sister-line of Florunner and a component line of Early Bunch. The female parent came from the same cross as Florunner but had somewhat smaller seed size and better oil quality. The male parent produced excellent pod yields and was earlier in maturity with less pod damage than other selections.

Andru 93 plants have a spreading runner or prostrate growth habit with a more prominent main stem, lighter green foliage and somewhat smaller vines and leaves than Florunner. Plants of Andru 93 are very similar in appearance as Marc I but may produce somewhat more vine with slightly taller main stems in some years. The pods and seed mature approximately 10 days earlier than Florunner with maturity similar to Marc I. The seed and pods of Andru 93 are very similar in shape, color, and texture to Marc I but significantly larger. Andru 93 averaged 79.9% total SMK, 21.4% extra large kernels (ELK), and 68.8 g/100 seed, compared to 78.8% SMK, 13.0% ELK, and 60.6 g/100 seed for Marc I in 1987-92 tests at Marianna, FL. Yield advantages of 2.5 and 13.7% over Marc I and Florunner, respectively, were recorded in tests at Marianna, FL. Results from Gainesville, FL, tests gave similar relative results.

Privately Released Runner Cultivars

Since 1982, several privately developed runner cultivars have been released. Of these, two have been grown commercially.

GK 7. GK 7 has become an important commercial runner cultivar in the Southeast U.S. It was released in 1984 by AgraTech Seeds, Inc. In company trials, GK 7 produced 5 to 7% higher yields as compared to Florunner in 6 years of testing. It has uniform pod and seed size and a high percentage of jumbo runner size kernels. It is similar in maturity to Florunner. It produces slightly larger pods and less vegetative growth as compared to Florunner. The plant type of GK 7 is more prostrate than Florunner and has a prominent mainstream.

AT 127. AT 127 was released by AgraTech Seeds, Inc. in 1990. It has less vegetative growth, matures 10-12 days earlier than Florunner or GK 7, and has uniformly large pod and seed size. It provides genetic diversity for the runner peanut industry.

Virginia Market Type

The virginia market type is classified as a *hypogaea* botanical type which was described earlier in this chapter. Cultivars in the virginia market type have the largest pods and kernels of any commercial type. In order to be classified as a virginia market type, at least 40% of the peanut pods must ride a 13.5- by 25.4-mm opening on a pre-sizer. Virginia-type peanuts account for most of the roasted in-shell trade. Most of the production of the large-seeded virginia market-type peanut is in the Virginia-Carolina production area. Approximately 3-5% of the acreage of the Southeast and Southwest production areas, respectively, is also devoted to production of this peanut type. Virginia-type peanuts account for about 18% of total U.S. production.

With the dominance of large-seeded peanuts in the Virginia-Carolina area, most of the new virginia market-type cultivar releases have come from the breeding programs in these states. Cultivars developed from the beginning of these breeding programs up to 1985 have been described previously (Mozingo *et al.*, 1987). Listed below are the cultivars released since 1981 along with cultivar descriptions. The earlier released cultivars Florigiant and NC 7 are also included for comparison, since they have been used as the industry standards.

Florigiant. Florigiant was released by the Florida Agriculture Experiment Station in 1961 (Carver, 1969). It is a composite of seven sister lines developed from a cross of (Jenkins Jumbo x F230) x F334. Its ancestry includes spanish, runner, and virginia market types and is closely related to the Early Runner cultivar. Plants of Florigiant have a spreading growth habit with a prominent main stem. Lateral branches are long and fewer than in some cultivars with pods set along the length of these laterals. Pods are large, moderately constricted, and uniform in shape and size. Seeds are elongated, uniform, and medium in size with a light pink outer seed coat color.

Florigiant's yield performance, uniform pod shape and size, and general good appearance made it the industry standard from the mid-1960s until the late 1980s. Shelf-life, flavor, blanchability, and medium maturity also were favorable characteristics.

NC 7. NC 7 was developed by the North Carolina Agricultural Research Service and released in 1978 (Wynne *et al.*, 1979). It was selected in the fourth generation following a cross of Fla 393 x NC 5. Plants of NC 7 have a decumbent or intermediate growth habit and mature about 10 days earlier than Florigiant. It has shown 50% less damage caused by the southern corn rootworm (*Diabrotica undecimpunctata howardi* Barber) than Florigiant.

Yields are slightly higher than Florigiant; however, value per land area is much higher due to its high ELK percentage. The thin hulled pods are large and somewhat irregular shaped. Seeds are large and more irregular shaped than Florigiant. They have a tan outer seedcoat color which has brown flecks at maturity. Oil quality, as determined by shelf-life, is excellent along with good flavor and texture. These factors, in addition to favorable milling and blanching characteristics, have made NC 7 the new industry standard for large-seeded virginia-type peanuts.

NC 8C. NC 8C peanut was released by the North Carolina Agricultural Research Service in 1982 (Wynne and Beute, 1983). It originated as an F_3 plant selection from a cross made between NC Ac 3139 and Florigiant. NC 8C is moderately resistant to Cylindrocladium black rot (CBR) caused by *Cylindrocladium crotalariae* (Loos) Bell and Sobers and has some resistance to southern stem rot caused by *S. rolfsii*. The plant type and growth habit is similar to Florigiant with about the same maturity of 150 days in the Virginia-Carolina production area. The pods and seed of NC 8C are smaller than those of the industry standard of Florigiant and in some environments the percentage of fancy size pods may not meet the 40% required for a virginia market-type peanut. For this reason, production of NC 8C was recommended only on CBR-infested fields. Seed production was phased out in 1988 with the release of the replacement cultivar NC 10C, which has comparable CBR resistance and more acceptable quality characteristics.

NC 9. NC 9 was released in 1985 (Wynne *et al.*, 1986) by the North Carolina Agricultural Research Service. It was developed by the pedigree breeding method from a cross of NC 2 and Florigiant. This large-seeded virginia-type peanut has a runner growth habit similar to Florigiant, but matures approximately 10 days earlier. During the growing season, the plants have a slight yellow cast which makes it distinguishable from other virginia market-type cultivars. At earlier digging dates it produces higher yield, more fancy size pods and ELKs, and greater value than does Florigiant. Quality characteristics show NC 9 to produce a 1% higher total mill outturn from straight shelling than does Florigiant.

NC 10C. NC 10C is a large-seeded virginia-type peanut released by the North Carolina Agricultural Research Service in 1988 (Wynne *et al.*, 1991a). It was derived from the F_3 generation of a cross between NC 8C x Florigiant. The cultivar has moderate resistance to CBR. The level of resistance to CBR is slightly lower than in NC 8C, but NC 10C has superior pod and seed size and improved milling quality. The plants of NC 10C are slightly more erect than the plants of Florigiant and have a spreading growth habit. Maturity is considered to be a few days later than Florigiant. Yield of NC 10C is higher, percentage of ELKs lower, O/L acid ratio higher, and percentage of fancy pods, blanchability, and flavor scores equal when compared to Florigiant.

NC-V11. NC-V11 was derived from a cross of two North Carolina breeding lines (Wynne *et al.*, 1991b). The first parent was a pure line selection from the cross of cultivars Florigiant and NC 5 and the second parent was a pure line selection from the cross of Florigiant and a valencia-type introduction PI 337396. The release was made cooperatively by the North Carolina Agricultural Research Service, the Virginia Agricultural Experiment Station, and the USDA, ARS in 1989.

Plants of NC-V11 have a spreading growth habit. Maturity is earlier than Florigiant and similar to NC 7. High yield (4 to 7% advantage over other cultivars) and value (3 to 11% advantage) per land area are the major advantages of this cultivar. Percentage of fancy pods is lower than Florigiant, NC 7, and NC-V11; however, percentage of ELKs is greater than Florigiant or NC 9. Flavor scores rate somewhat better for NC-V11 than for other large-seeded cultivars.

VA-C 92R. VA-C 92R is a high yielding, large-seeded virginia-type cultivar released in 1992 jointly by the Virginia Agricultural Experiment Station, the North Carolina Agricultural Research Service, and USDA, ARS (Mozingo *et al.*, 1994). It was developed from a cross of the North Carolina breeding line NC Ac. 17213 and the cultivar NC 7. The cultivar was derived by the pedigree breeding system and originated from a single plant selection made in the F_4 generation in 1980. In the F_7 generation plants appeared uniform and seed testa color was mostly pink, although some plants produced seed with tan testa. Plants of VA-C 92R have a runner (spreading) to intermediate growth habit, although not as spreading as the Florigiant cultivar, but more spreading than NC 7. Under similar production practices, maturity of VA-C 92R is considered to be about the same as NC 9 and NC-V11, 10 days earlier than Florigiant, and 7 days later than VA 81B. VA-C 92R is similar to NC 7 in disease and insect susceptibility.

Six-year (1986-1991) averages show VA-C 92R averaged 7.8 and 4.6% higher yield than NC 7 and NC 9 at the first harvest date, and 8.5 and 5.8% higher at the second date, respectively. Support price ($/cwt) and total kernel percentage were equal to those of NC 7 at both digging dates. SMKs were equal to those of NC 7 at the first digging date and significantly higher at the second digging date. The percentage of ELKs, while not as high as that of NC 7, was superior to all other cultivars. Fancy pod percentage was not as high as that of NC 7 or NC 9, but was higher than that of NC-V11.

Milling data show that VA-C 92R has a higher percentage of ELK and total outturn and a lower percentage of mediums and No. 1's than Florigiant (Mozingo *et al.*, 1993). Blanchability of VA-C 92R is improved over its parent NC 7 with more whole blanched kernels and fewer not blanched and partially blanched kernels.

VA-C 92R has better shelf life than Florigiant, NC 9, and NC-V11 as indicated by lower iodine values and higher O/L acid ratios for all grades. Analysis of the chemical composition of the peanut seed shows VA-C 92R has 47.9% oil and 26.7% protein compared to 47.6 and 26.2%, respectively, for NC 7. Seed calcium content is greater for VA-C 92R than for other popular cultivars grown today. Four-year averages show a 37.5, 49.2, and 53.7% increase in seed calcium content for VA-C 92R over NC-V11, NC 7, and NC 9, respectively.

VA 93B. VA 93B was jointly released by USDA, ARS and the Virginia Agricultural Experiment Station in 1993 (Coffelt *et al.*, 1994). It was developed from a cross between the cultivar VA 81B and the Virginia breeding line VA 780839. Va 81B was derived from a cross of F 392-8 x GA 119-20. The breeding line VA 780839 is a sister line to the cultivar NC-V11.

The maturity of VA 93B is earlier than any other large-seeded, virginia-type cultivar currently available and is considered to be approximately 7 days earlier than NC 7. Plants are similar to VA 81B, which are characterized by an erect growth habit. It is less susceptible to Sclerotinia blight, which is a major disease caused by *Sclerotinia minor*, than any other large-seeded virginia-type cultivar but is susceptible to other diseases and insect pests.

VA 93B yields more and has a slightly higher dollar value when dug early as compared to other cultivars. The percentage of fancy pods, ELKs, and total SMKs are not different from VA 81B. Pods and seed are smaller than those of NC 7. However, pods are larger than those of NC-V11 or VA-C 92R and seed are larger than those of NC 9 or NC-V11. ELKs do not blanch as well as for other cultivars, but the medium-grade kernels blanch better than for most cultivars. Shelf life is good and considered better than for NC 9 and NC-V11.

Privately Released Virginia-Type Cultivars

AgraTech Seeds, Inc., is the only private commercial company hybridizing virginia-type peanuts. Their work resulted in the recent release of a cultivar which currently is being grown commercially.

AT VC-1. AT VC-1 is a virginia-type peanut cultivar released by AgraTech Seeds, Inc. in 1991. Its pedigree includes breeding lines from the Florida and Georgia Breeding Programs as follows: [F393 x (F334 x F393)] x [(F392 x GA 186-28) x F439]. In addition to early maturity, it offers high yield and value per land area and good grades. It is considered to be 7 to 10 days earlier than Florigiant. Plants are very vigorous and have a spreading growth habit.

Yield and value are higher although the percentage of fancy pods is lower than some popular virginia-type cultivars. Seeds are somewhat round in shape and ride the extra-large screen size even though the pod is smaller than other large-seeded virginia-type cultivars.

Spanish Market Type

Cultivars in the spanish market type have small kernels and reddish-brown testa. Spanish peanuts are used primarily for peanut candy, salted nuts, and peanut butter. They are grown primarily in Oklahoma and Texas and account for about 6% of total U.S. production.

Spanco. Spanco peanut was developed cooperatively by the Oklahoma Agricultural Experiment Station and the USDA, ARS and released in 1981 (Kirby *et al.*, 1989). It is a composite of two phenotypically similar selections which originated from a cross of Chico x Comet. Both parents and descendent lines are spanish types and are sister lines to Pronto. Although plant types of Spanco and Pronto are similar, the Spanco lines have a green foliage color when mature, typical of spanish types, where Pronto turns decidedly yellow-green.

In nine irrigated trials in Oklahoma, the average increase of the Spanco component lines over Comet and Tamnut 74 (two leading spanish cultivars at the time of testing) was 18.7 and 26.2%, respectively, for pod yield. Seed size and quality analyses for end-use products showed Spanco to be similar to common spanish peanut cultivars.

Tamspan 90. Tamspan 90 was released by the Texas Agricultural Experiment Station, Texas A&M University, and the USDA, ARS in 1990 (Smith *et al.*, 1991). It has good resistance to both pod rot (*P. myriotylum*) and Sclerotinia blight. Pods of Tamspan 90 are slightly larger and have less constriction than Starr. Pod reticulation is moderate, and most pods have two seeds, but the percentage of three-seeded pods is greater in Tamspan 90 (2-5%) than in Starr (<1%). Seed are round and tan in color, but are slightly larger than Starr.

Tamspan 90 averages 10.5% higher gross value/ha than Starr, and grades for the two cultivars were similar. Under varying levels of Sclerotinia blight disease, Tamspan 90 produced 10 to 48% higher value/ha than Starr.

Valencia Market Type

Valencia cultivars are characterized by having three or more kernels/pod. Typically, valencia peanuts are roasted and sold in the shell. They are also used in the fresh market trade as boiled peanuts. The valencia market type is produced primarily in New Mexico and west Texas. Valencias account for about 1% of total U.S. production. Only one valencia cultivar has been released in the period since 1982.

Georgia Red. Georgia Red was jointly released by the Georgia Agricultural Experiment Station and USDA, ARS in 1986 (Branch, 1987). It was developed at the Coastal Plain Experiment Station for the fresh market trade. Georgia Red was derived from a cross made in 1975 between a component line of Florunner and New Mexico Valencia A.

Since 1980, Georgia Red has equaled or exceeded New Mexico Valencia A, New Mexico Valencia C, and Valencia McRan in state yield trials by an average of about 10%. It has a more compact bunch growth habit, darker green foliage, considerably more branching, distinctively larger fruit size (*ca.* 20%), and a uniformly deeper red testa color compared to these other currently available U.S. valencia cultivars. Preliminary data also suggest a 3 to 5% higher oil content. In Georgia, it is similar to the other U.S. valencia cultivars in maturity, grade, seed per pod, flavor, protein, iodine value, and susceptibility to diseases and insects.

PLANTING REQUIREMENTS

Planting Date

Peanut planting dates vary somewhat by production area. In the Southeast production area, planting typically begins around the last of March or very early April, but planting doesn't begin until around 20 April in the Virginia-Carolina area. In the Southwest, plantings in south Texas begin in April, but in the more northern production areas of central and north Texas and all of

Oklahoma, planting doesn't begin until early May. The objective in all production areas has been to plant sufficiently early to maximize yield and quality. Planting date studies frequently show year x planting date or location x planting date interactions, making it difficult, if not impossible, to determine the "best" planting date for peanuts.

Soil temperature and moisture are the most critical factors for determining when peanuts are planted. The planting season in any of the production areas may be delayed due to unfavorable environmental conditions including low soil temperature or excessive or insufficient rainfall. Peanuts should not be planted until the average soil temperature at 10 cm is 18 C or greater for a minimum of 3 consecutive days and favorable air temperatures are forecast. These conditions promote rapid germination and emergence (Beasley and Baldwin, 1994). Unfavorable weather conditions may also interrupt planting after it has begun. Significant work was done in this area in the 1960s and 1970s, but limited research has been conducted in the past decade. Recent research that has been conducted on planting dates has been part of more complex evaluations of multiple factors such as plant populations, locations, and harvest dates.

Mozingo *et al.* (1991) determined the planting and digging dates at which optimum yield, grade, and value could be obtained for four large-seeded virginia-type cultivars. Their results indicated that cultivar selection and digging dates are more important than planting dates in years with normal environmental conditions. In 2 out of 3 years of their study when adequate moisture was present, yield was higher at the second planting date (approximately 1 May) than at the earliest planting date (approximately 24 April). However in 1 year when moisture stress was evident during critical flowering and pegging stages, yield was higher with the earlier planting date. Since environmental stress conditions cannot be anticipated, they suggested early planting dates would seem to be an advantage if soil temperature and moisture level are conducive to good germination and seedling growth.

Kvien and Bergmark (1987) conducted a study in Georgia on the effects of plant population, planting date, location, and water availability on plant growth and development. They used a range of planting dates beginning with 14 April and continuing approximately every 2 weeks, with the last planting made on 15 June. They determined that April and May plantings produced greater yields than June plantings and that late planting had a greater effect on yields than did plant population.

Mixon and Dowler (1984) tested two spanish cultivars (Pronto and Comet) and one runner cultivar (Florunner) in short growing periods for possible use in multiple cropping sequences with other crops in Georgia. They found that all cultivars consistently produced greater pod yield with a 114-day growing season as compared to a 99-day growing season. Pronto and Comet produced significantly greater pod yields than Florunner under the 99-day growing period. However, the 114-day growing period always resulted in greater total SMK percentages for all cultivars.

Planting date effects on peanut diseases have been studied on a limited basis in Virginia. Mozingo *et al.* (1986) reported that for the 1985 growing season, earlier plantings were more susceptible to leaf spot, Sclerotinia blight, and a condition called plant deterioration than later plantings. Their planting dates were 22 April and 1, 10, and 20 May. Phipps (1987) compared the effect of two planting dates (23-25 April and 14-15 May) and two seeding rates (78 and 157 kg/ha) over 2 years on Sclerotinia blight. He reported that Sclerotinia blight appeared first in the early planting. The high seeding rate also had the highest disease incidence early in the season. However, when the plots were not treated with a fungicide, by harvest there was no difference in disease incidence in plots not treated with a fungicide regardless of planting date or seeding rate. Porter *et al.* (1988) reported on a 2-year study with planting dates of 24 April and 3, 13, and 23 May. They found that, at specific intervals throughout the growing season, older plants exhibited a higher disease index to leaf spot, higher defoliation and plant infection percentages, and a higher number of leaf spot lesions/plant than younger plants. However, Sclerotinia blight "hits", taken at harvest or 151 days after planting for each planting date, were more severe in later plantings of 3, 13, and 23 May than for early planted peanuts on 24 April.

Late planting may offer an advantage for improving weed control. Linker and Coble (1990) indicated that the recommended planting period for peanuts in North Carolina is 20 April to 10 May . They found that later planting did not alter the weed species complex, but the efficiency of postemergence herbicides was improved. With late planting, weeds emerged over a shorter period of time and many weeds could be treated simultaneously with postemergence herbicides.

Plant Populations

Peanut yields and market quality response to planting patterns was evaluated extensively in the 1960s (Sturkie and Buchanan, 1973). Recent research has generally confirmed that more dense populations, whether obtained by reducing interrow spacing or reducing intrarow spacing, result in greater pod yields if diseases do not limit yield in the denser stands.

Seeding Rates and Intrarow Plant Spacings

Wells *et al.* (1992) found that maximum yields for runner types required a minimum seeding rate of 100 kg/ha, with lower planting rates incrementally reducing pod yields. They found that southern blight incidence increased at higher seeding rates but that TSWV was more prevalent at lower seeding rates. Thrips (which vector TSWV) are attracted to an open plant canopy that results from a lower seeding rate.

Knauft *et al.* (1981) tested six runner genotypes grown in 91-cm rows at three intrarow spacings of 10.2, 15.2, and 30.5 cm. They found that intrarow spacings could be increased from 10.2 to 15.2 cm with no yield loss. Florunner and Florigiant yields were lower at 30.5 cm compared to narrower spacings; however, yields for other genotypes were not reduced even at 30.5 cm. They suggested that intrarow spacings could be increased and result in economic savings for growers.

Mozingo and Steele (1989) used intrarow spacings of 5.1, 7.6, 10.2, and 15.2 cm to determine the effects of seed spacing on morphological characteristics, yield, grade, and value of five cultivars. They found that main stems were taller and cotyledonary lateral branches were longer with closer intrarow seed spacings. Seed spacing had little effect on grade characteristics. Pod yield increased with closer intrarow seed spacings as all cultivars had significantly greater yields at the 5.1-cm spacing than at the 15.2-cm spacing. However, net value (gross value minus seed cost) was not significantly different among intrarow seed spacings for four of the five cultivars studied. The exception was VA 81B, with its erect growth habit, which had a significantly greater net value at 5.1- and 7.6-cm seed spacings than at wider spacings. Their research shows the importance of considering increased seed cost for closer intrarow seed spacings. Although yield might be increased, net return per land area may not increase for all cultivars.

Mozingo and Coffelt (1984) showed that yields could be increased with a higher seeding rate for VA 81B, which has a bunch growth habit, in a twin row pattern. However, they did not find a significant difference between seeding rates or row pattern with Florigiant, which has a spreading growth habit.

Interrow Spacing

Since the 1890s (Bennett, 1899), studies have been conducted intermittently to evaluate the effects of interrow spacing on peanuts. Most early researchers were concerned about the inability to cultivate and control weeds in narrow rows (see Sturkie and Buchanan, 1973). The yield advantage for narrow rows was documented for both spanish- and virginia-type cultivars which have an erect or bunch growth habit. Since that time, limited work has continued with spanish, virginia, and runner types. Yield increases from narrowing row spacing have been greatest and most consistent with erect plant types as compared to prostrate growth types

Narrow Rows. Chin Choy *et al.* (1982) reported that narrow row spacing of 15 cm consistently produced the highest yields and net returns for both irrigated and nonirrigated conditions compared to wider row spacings of spanish peanuts grown in the semi-arid Southwest. They also found that an intrarow spacing of 10 cm produced relatively high yields with or without irrigation.

Researchers have reported yield increases from narrow row spacing from cultivars with runner and bunch (erect) growth habits. Kirby and Kitbamroong (1986) used a runner-type and four spanish-type peanuts to study the effects of row spacings and within-row plant density on pod yield and quality factors. Yields for all cultivars were greatest when row spacing was reduced from 91.4 to 45.7 cm and when within-row plant density was increased from two to four plants/30.5 cm of row. Further narrowing of rows or increasing plant density failed to increase peanut yields.

Hauser *et al.* (1982) found that in areas of high weed pressure, narrow rows provide significant yield increases. They reported yield increases of 42 and 52% as row spacings were decreased from 80 to 40 and 20 cm, respectively. They indicated that narrow rows produced complete canopy earlier in the growing season compared to wider rows and provided competition for weeds. They found that narrow row culture was highly effective in reducing competition from sicklepod (*Cassia obtusifolia* L.) and Florida beggarweed [*Desmodium tortuosum* (S.W.) D.C.].

Colvin *et al.* (1985) reported that Pronto was more responsive to narrow row spacings than Florunner. They also found row spacing had a significant effect on weed control. A twin row pattern (18 cm) provided more effective weed control than a conventional pattern of 91-cm rows. Twin rows produced approximately 14% greater yield than the conventional row spacing. This agrees with the findings of Hauser and Buchanan (1981) that narrow rows resulted in a 15% yield advantage as compared to more conventional wider row spacings.

Jaaffar and Gardner (1988) compared narrow, twin, and conventional rows at constant plant populations of 150,000 plants/ha. Compared to the conventional row spacing, narrow and twin row spacings had greater ground cover, leaf area indices, canopy light interception, crop growth rates, and pod yields. Row pattern had no effect on market quality. They concluded that planting patterns that approximate equidistant spacing or a square arrangement can be more productive than conventional (wide) rows.

Modification of spatial arrangements of cultivars with different growth habits can result in optimizing yield. Mozingo and Wright (1994) in a 1986-88 study in Virginia determined the effects of seeding in a diamond-shaped configuration on the yield, value, market grade, and plant growth of six peanut cultivars. Diamond-shaped seed configurations of 15.2 x 15.2, 30.5 x 30.5, and 45.7 x 45.7 cm resulted in significantly taller main stems (39.4, 30.5, and 22.9 cm) and longer cotyledonary lateral branches (50.3, 48.0, and 45.5-cm), respectively. The 15.2 x 15.2-cm seed configuration resulted in higher yield, value, SMKs, and total kernels and lower percentage of other kernels. The 15.2 x 15.2, 30.5 x 30.5, and 45.7 x 45.7-cm seed configurations had yields of 5935, 5497, and 4874 kg/ha and values of 4192, 3804, and 3342 \$/ha, respectively. SMKs were 69.7, 68.2 and 67.4% and total kernels were 73.2, 72.3, and 71.8% for the 15.2 x 15.2, 30.5 x 30.5, and 45.7 x 45.7-cm seed configurations, respectively. Percentages of other kernels were 1.7, 2.0, and 2.3 for the 15.2 x 15.2, 30.5 x 30.5, and 45.7 x 45.7-cm seed configurations, respectively. Significant cultivar by seed configuration interactions were obtained for yield and value. This research validates that of Jaafar and Gardner (1988) concerning equidistant spacing being a way to increase productivity. It also indicates peanut yields can be increased by selecting cultivars which respond to diamond-shaped seed configurations or, more importantly, that seeding rate and configuration should be matched to the cultivar selected.

Twin Rows. Twin-row planting is a modification of narrow rows. Sullivan (1991) reported that twin row planting has increased in North Carolina. Field tests were conducted to compare four virginia cultivars in twin and conventional single row patterns. Plant populations were 25% higher in the twin row pattern. Yields were higher with twin rows for all cultivars and grades were unaffected by row spacing. Mozingo and Coffelt (1984) studied the cultivars Florigiant and VA 81B in single and twin rows. They used two seeding rates but did not increase the seeding rate for the twin rows. They found no differences in yield between the row patterns for Florigiant with its runner growth habit, but did report higher yield and value in the twin row pattern over the conventional single row for VA 81B with its small, erect (bunch) growth. The single row pattern produced a higher percentage of fancy pods and total kernel content than the double row pattern.

Hauser and Buchanan (1981) reported that under varying levels of weed control, twin rows increased Florunner yield from 12 to 15% as compared to single rows. Wehtje *et al.* (1984) compared Florunner grown in twin 18-cm rows to conventional 91-cm rows under a series of weed control systems. They concluded that twin rows reduced competition from grasses; however, reductions in broadleaf weeds and peanut yield increases were too erratic for the reductions in herbicide usage. Kvien and Bergmark (1987) reported that twin rows produced a faster canopy closure at high populations but not at low populations and they also found no significant yield differences between single and twin row patterns. In contrast to the work of Hauser and Buchanan (1981), their work was conducted in a weed-free environment.

Skip Rows. Just as twin rows are a modification of narrow row culture, skip rows are a modification of wide row culture. Schubert *et al.* (1983) studied skip-row culture under rainfed conditions in a low rainfall area in Texas. They compared two rows planted, two rows fallow and two rows planted, one row fallow planting systems with solid or conventional plantings. Both skip row systems produced higher yields and crop values on a planted area basis than solid plantings. They found that Florunner was more responsive than Tamnut 74 to skip row planting, particularly for increased market-grades. They also found that skip row culture had no advantages under full irrigation or during years with higher than normal rainfall.

Mozingo (1984) reported a 3-year study in Virginia with skip row planting in combination with single and twin rows using the virginia-type cultivars Florigiant and NC 7. He compared solid (all rows planted) with skip rows where two 91-cm rows were planted and one 91-cm row was left fallow. Skip row planting produced a higher yield and value on a planted land area basis than did solid planting. Peanut quality was not affected by row spacing.

Hewitt and Gorbet (1985) evaluated skip row culture under irrigation and rainfed conditions in Florida. Their treatments consisted of (a) solid planted peanuts in 91-cm rows; (b) two rows of peanuts 91 cm apart, two skip rows (182 cm); (c) four rows of peanuts (362 cm), two skip rows (182 cm); (d) two rows of peanuts (182 cm), four rows of soybeans (364 cm); and (e) four rows of peanuts (364 cm), four rows of soybeans (362 cm). Skip row systems produced higher yields and crop values on a planted area basis than solid plantings. The greatest advantage was achieved with the two rows of peanuts and two skip rows as compared to conventional 91-cm rows. On a planted area basis, this skip row system resulted in a 30% yield increase over the conventional row system. When four rows of peanuts were planted together, half of the yield advantage for the skip row system was lost. The skip row system required greater production inputs in terms of land, machinery, chemicals, irrigation and fertilizer. However, they concluded that increased production would make skip row systems cost effective under land values of the Southeast.

Although skip row production has been shown to increase yields in all three peanut production areas of the U.S., it has not become an established practice. The additional use of land area in some production areas where land for peanut rotation is already limited is probably the main factor for the grower's reluctance to change to this practice. Extra costs associated with this practice may also be a factor.

MATURITY AND HARVEST DATE

Determining peanut maturity and the harvest date at which maximum yield and quality can be obtained is very complex. However, failure to harvest at the optimum time is often cited as a reason for yield and quality reduction. Sanders *et al.* (1982) described several methods used in determining peanut crop maturity. Williams and Drexler (1981) developed the hull-scrape method (based on pod mesocarp color), using the runner-type peanut. This method for determining maturity has gained favor and is used extensively in production areas where the runner-type peanuts are grown. In the Virginia-Carolina area where the runner-type is not grown, it has not yet been widely used. In this area, the standard method of internal hull color or total heat units accumulated is preferred. However, growers are showing a willingness to change to the hull scrape method as research is underway to perfect this method for other peanut types and cultivars (C. W. Swann and G. A. Sullivan, pers. commun., 1992).

Research has been done using the number of days after planting to determine optimum harvest date. Knauft *et al.* (1986) tested five genotypes harvested at three dates averaging 105, 118, and 132 days after planting. Fungicides were not used to control leaf spot. Digging date did not affect fatty acid composition and had only a very slight effect on oil content and iodine value. They found a complex interaction of genotype with digging date. Genotypes without leaf spot resistance produced acceptable yields when dug at 105 or 118 days after planting, but yields sharply declined at the last harvest. Genotypes with leaf spot resistance were late maturing and produced their lowest yield at the first digging date. Yields improved as harvest was delayed.

Wright and Porter (1991) conducted a digging date study with three digging times, including early (8 to 11 days before normal digging date), medium (normal digging date), and late (8 to 11 days after normal digging date). Compared to the medium digging date, early digging resulted in yield and crop value reductions of 15 and 21%, respectively, whereas late digging resulted in yield and crop value reductions of 6 and 5%, respectively. Early digging reduced the grade factors of ELK, SMK, and total meat content.

Early digging has been used to advantage when disease pressure is severe. Sholar and Jackson (1990) investigated the effects of cultivar and digging date on yield and Sclerotinia blight incidence in a spanish and a runner cultivar. They found that in the absence of Sclerotinia blight, yields from both cultivars were improved by delaying harvest. However, when Sclerotinia blight was a severe problem, yields from both cultivars were greater with earlier digging. The runner cultivar was more susceptible to Sclerotinia blight and consequently delaying digging beyond the normal optimum for each cultivar caused greater yield losses with the runner than with the spanish cultivar.

Mixon and Branch (1985) found that yields were greater from a short-season spanish cultivar than for a full-season runner cultivar when both were harvested at 90 days after planting. However, the runner cultivar produced greater yields, more SMKs, and higher market value for harvests at 110 days and for each succeeding 10-day period up to 140 days after planting.

Mozingo *et al.* (1991), working with large-seeded virginia-type cultivars, used five digging dates at 10-day intervals beginning around 10 September through 20 October. They reported increased yield, value, total kernels, and ELKs with each delay in digging date in a growing season in which moisture stress delayed maturity. In a growing season where adequate rainfall was received, they reported increased yield and value through the fourth digging date. Yield and value increases were not significant after the second digging date in the third year of the study. In their study, grade factors improved with later digging dates. This research reflects the importance of the growing season on the maturity of the crop and selection of the proper digging date.

Determining maturity and the proper harvest date are important management decisions which have a direct effect on net return per land area. Researchers have determined that delaying harvest until optimum maturity increases yields as well as grade and quality characteristics. Environmental conditions during the growing season will have a tremendous effect on maturity. Moisture levels and temperatures are two important factors which affect the maturation process. Irrigation to provide supplemental moisture is beneficial, but must be accompanied by favorable temperatures.

Growers must weigh numerous factors when determining the correct harvest date. In some production areas where the growing season is limited, harvest date may be before physiological maturity in order to complete harvesting before frost. Therefore, weather plays an important role in profitability to the grower and also quality of the crop harvested.

LITERATURE CITED

Anonymous. 1987. The 1986 National Survey of Conservation Tillage Practices. Conservation Tillage Information Center, Ft. Wayne, IN.

ASAE. 1990. Terminology and Definitions for Soil Tillage and Soil-Tool Relationships. EP 291.2. Amer. Soc. Agric. Engrs., St. Joseph, MO.

Ayers, A.R., H.E. Duncan, K. R. Barker, and M.K. Beute. 1989. Effects of crop rotation and nonfumigant nematicides on peanut and corn yields in fields infested with *Criconemella* species. J. Nematol. 21:268-275.

Baldwin, J.A. 1992. Yield and grade of Florunner peanut following two years of 'Tifton 9' bahiagrass. Proc. Amer. Peanut Res. Educ. Soc. 24:32 (Abstr.).

Banks, D.J., J.S. Kirby, and J.R. Sholar. 1989. Registration of 'Okrun' peanut. Crop Sci. 29:1574.

Beasley, J.P., Jr., and J.A. Baldwin. 1994. Planting tips for peanut. Univ. of Georgia Coop. Ext. Serv. Bull. 1109.

Bennett, R.L. 1899. Experiments with peanuts, legume manuring, cotton meal, whole and

crushed cotton seed manuring, and varieties of cotton. Arkansas Agric. Exp. Stn. Bull. 58.
Boyle, L.W. 1952. Factors to be integrated in control of southern blight on peanuts. Phytopathology 42:282 (Abstr.).
Boyle, L.W. 1956. Fundamental concepts in the development of control measures for southern blight and root rot on peanut. Plant Dis. Rep. 40:661-665.
Branch, W.D. 1987. Registration of 'Georgia Red' peanut. Crop Sci. 27:1090.
Branch, W.D. 1991. Registration of 'Georgia Runner' peanut. Crop Sci. 31:485.
Branch, W.D. 1994. Registration of 'Georgia Browne' peanut. Crop Sci. 34:1125-1126.
Buchanan, G.A., and E.W. Hauser. 1980. Influence of row spacing in competitiveness and yield of peanuts (*Arachis hypogaea*). Weed Sci. 28:401-409.
Campbell, W.V. 1986. Effect of no-till and double-cropped peanuts on insect population, damage, and peanut yield. Proc. Amer. Peanut Res. Educ. Soc. 18:44 (Abstr.).
Campbell, W.V., G.A. Sullivan, and E.W. Rogister. 1985. Comparison of pests and pest damage in no-till and conventionally-planted peanuts. Proc. Amer. Peanut Res. Educ. Soc. 17:61 (Abstr.).
Carver, W.A. 1969. Registration of Florigiant peanut. Crop Sci. 9:849-850.
Cheshire Jr., T.M., W.L. Hargrove, C.S. Rothrock, and M.E. Walker. 1985. Comparison of conventional and no-tillage peanut production practices in central Georgia. Proc. South. Region No-Till Conf., Griffin, GA, 16-17 July 1985.
Chin Choy, E.W., J. F. Stone, R.S. Matlock, and G.M. McCauley. 1982. Plant population and irrigation effects on spanish peanuts (*Arachis hypogaea* L.) Peanut Sci. 9:73-76.
Coffelt, T. A., D. M. Porter, and R. W. Mozingo. 1994. Registration of 'VA 93B' peanut. Crop Sci. 34:1126.
Colvin, D.L., and B.J. Brecke. 1988. Peanut cultivar response to tillage systems. Peanut Sci. 15:21-24.
Colvin, D.L., B.J. Brecke, and E.B. Whitty. 1988. Tillage variables for peanut production. Peanut Sci. 15:94-97.
Colvin, D.L., R.H. Walker, M.G. Patterson, G. Wehtje, and J.A. McGuire. 1985. Row pattern and weed management effects on peanut production. Peanut Sci. 12:22-27.
Colvin, D.L., G.R. Wehtje, M. Patterson, and R.H. Walker. 1985. Weed management in minimum-tillage peanuts (*Arachis hypogaea*) as influenced by cultivar, row spacing, and herbicides. Weed Sci. 33:233-237.
Fink, R.J., and D. Wesley. 1974. Corn yield as affected by fertilization and tillage system. Agron. J. 66:70-71.
Garren, K.H. 1959. The stem rot of peanuts and its control. Virginia. Agric. Exp. Stn. Tech. Bull. 144.
Garren, K.H., and G.B. Duke. 1958. The effects of deep covering of organic matter and non-dirting weed control on peanut stem rot. Plant Dis. Rep. 42:629-636.
Gorbet, D.W., and D.A. Knauft. 1995. Registration of 'Andru 93' peanut. Crop Sci. 35:(in press).
Gorbet, D.W., D.A. Knauft, and A.J. Norden. 1992. Registration of 'Marc I' peanut. Crop Sci. 32:279.
Gorbet, D.W., A.J. Norden, F.M Shokes, and D.A. Knauft. 1987. Registration of 'Southern Runner' peanut. Crop Sci. 27:817.
Grichar, W.J., and T.E. Boswell. 1987. Comparison of no-tillage, minimum, and full tillage cultural practices on peanuts. Peanut Sci. 14:101-103.
Grichar, W.J., and O.D. Smith. 1992. Interaction of tillage and cultivars in peanut production systems. Peanut Sci. 19:95-98.
Hallock, D.L. 1975. Effect of plowing date and certain crop rotations on peanut productivity. Peanut Sci. 2:81-83.
Hartzog, D.L., and J.E. Adams. 1989. Reduced tillage for peanut production. Soil Tillage Res. 14:85-90.
Hauser, E.W., and G.A. Buchanan. 1981. Influence of row spacing, seeding rates, and herbicide systems on competitiveness and yield of peanuts. Peanut Sci.8:74-81.
Hauser, E.W., G.A. Buchanan, R. L. Nichols, and R.M. Patterson. 1982. Effects of Florida beggarweed (*Desmodium tortuosum*) and sickle pod (*Cassia obtusifolia*) on peanut (*Arachis hypogaea*) yield. Weed Sci. 30:602-604.
Heichel, G.H. 1987. Legumes as a source of nitrogen in conservation tillage systems, pp.29-35 *In* J.F. Power (ed.) The Role of Legumes in Conservation Tillage Systems. Soil Cons. Soc. of Amer., Ankeny, IA.

Hewitt, T.D., and D.W. Gorbet. 1985. Economic analysis of producing peanuts using a skip-row pattern. Proc. Amer. Peanut Res. Educ. Soc. 17:36 (Abstr.).

Jaaffar, Z., and F.P. Gardner. 1988. Canopy development, yield, and market quality in peanut as affected by genotype and planting pattern. Crop Sci. 28:299-305.

Johnson, W.C. III. 1991. Weed management in peanut as affected by weed management in rotation crops. Proc. Amer. Peanut Res. Educ. Soc. 23:56 (Abstr.).

Kirby, J.S., D.J. Banks and J.R. Sholar. 1989. Registration of 'Spanco' peanut. Crop Sci. 29:1573-1574.

Kirby, J.S., and C. Kitbamroong. 1986. Peanut cultivar response to row spacing and plant density. Proc. Amer. Peanut Res. Educ. Soc. 18:48 (Abstr.).

Knauft, D.A., A.J. Norden, and N.F. Beninati. 1981. Effects of intra-row spacing on yield and market quality of peanut (*Arachis hypogaea* L.) genotypes. Peanut Sci. 8:110-112.

Knauft, D.A., A.J. Norden, and D. W. Gorbet. 1986. The effect of three digging dates on oil quality, yield, and grade of five peanut genotypes grown without leafspot control. Peanut Sci. 13:82-86.

Kvien, C.S., and C.L. Bergmark. 1987. Growth and development of the Florunner peanut cultivar as influenced by population, planting date, and water availability. Peanut Sci. 14:11-16.

Lamb, M.C., J.I. Davidson, and C.L. Butts. 1993. Peanut yield decline in the Southeast and economically feasible solutions. Peanut Sci. 20:36-40.

Linker, H.M., and H.D. Coble. 1990. Effect of weed management strategy and planting date on herbicide use in peanuts (*Arachis hypogaea*). Weed Tech. 4:20-25.

Melville, D.R., and J.L. Rabb. 1976. Studies with no-till soybean production. Louisiana Agric. 20:3, 16.

Minton, N.A. 1985. Influence of tillage, nematicide, and fungicide-insecticide treatments on double-cropped peanut in wheat stubble. Proc. Amer. Peanut Res. Educ. Soc. 17:39 (Abstr.).

Minton, N.A., A.S. Csinos, R.E. Lynch, and T.B. Brenneman. 1990. Effects of tillage and double-cropping with wheat on pest management in peanut. Proc. Amer. Peanut Res. Educ. Soc. 22:46 (Abstr.).

Minton, N.A., A.S. Csinos, R.E. Lynch, and T.B. Brenneman. 1991. Effects of two cropping and two tillage systems and pesticides on peanut pest management. Peanut Sci. 18:41-46.

Mixon, A.C. 1963. Effects of deep turning and non-dirting weed control on peanut stem rot. Alabama Exp. Stn. Bull. 344.

Mixon, A.C., and W.D. Branch. 1985. Agronomic performance of a spanish and runner cultivar harvested at six different digging intervals. Peanut Sci. 12:50-54.

Mixon, A.C., and C.C. Dowler. 1984. Potential peanut performance in double-cropping systems. Peanut Sci. 11:27-31.

Mozingo, R.W. 1984. Skip-row planting and row pattern effects on virginia-type peanut cultivars. Agron. J. 76:660-662.

Mozingo, R.W., and T.A. Coffelt. 1984. Row pattern and seeding rate effects on value of virginia-type peanut. Agron. J. 76:460-462.

Mozingo, R.W., T.A. Coffelt, and F.S. Wright. 1991. The influence of planting and digging dates on yield, value, and grade of four virginia-type peanut cultivars. Peanut Sci. 18:55-62.

Mozingo, R.W., T.A. Coffelt, and J.C. Wynne. 1987. Characteristics of virginia-type peanut varieties released from 1944-1985. South. Coop. Ser. Bull. No. 326.

Mozingo, R.W., D.M. Porter, and T.A. Coffelt. 1986. Cultivar and planting date effects on peanut diseases and plant deterioration. Proc. Amer. Peanut Res. Educ. Soc. 18:47 (Abstr.).

Mozingo, R.W., and J.L. Steele. 1989. Intrarow seed spacing effects on morphological characteristics, yield, grade, and net value of five peanut cultivars. Peanut Sci. 16:95-99.

Mozingo, R.W., and F.S. Wright. 1994. Diamond-shaped seeding of six peanut cultivars. Peanut Sci. 21:5-9.

Mozingo, R.W., J.C. Wynne, D.M. Porter, T.A. Coffelt, and T.G. Isleib. 1993. VA-C 92R A new high-yielding peanut variety. Virginia Agric. Exp. Stn. Bull. 93-1.

Mozingo, R.W., J.C. Wynne, D.M. Porter, T.A. Coffelt, and T.G. Isleib. 1994. Registration of 'VA-C 92R' peanut. Crop Sci. 34:539-540.

Musick, J.T., A.F. Weise, and R.R. Allen. 1975. Limited and no-tillage systems for bed-furrow irrigated soil. Paper No. 75-2538. Amer. Soc. Agric. Eng., St. Joseph, MI.

Nelson, L.R., R.N, Gallaher, R.R. Bruce, and M.R. Holmes. 1977. Production of corn and sorghum grain in double-cropping systems. Agron. J. 69:41-45.
Norden, A.J., D.W. Gorbet, and D.A. Knauft. 1985. Registration of 'Sunrunner' peanut. Crop Sci. 25:1126.
Norden, A.J., R.W.Lipscomb, and W.A. Carver. 1969. Registration of 'Florunner' peanut. Crop Sci. 9:850.
Phipps, P.M. 1987. Effect of planting date, seeding rate, growth regulator, and fungicide on Sclerotinia blight of peanut. Proc. Amer. Peanut Res. Educ. Soc. 19:26 (Abstr.).
Porter, D.M., R.W. Mozingo, and K.P. Burnham. 1988. The effect of planting date on severity of leafspot and Sclerotinia blight of peanuts. Proc. Amer. Peanut Res. Educ. Soc. 20:28 (Abstr.).
Porter, D.M., and F.S. Wright. 1991. Early leafspot of peanuts: Effect of conservational tillage practices on disease development. Peanut Sci. 18:76-79.
Rodriquez-Kabana, R., and H. Ivey. 1986. Crop rotation systems for the management of *Meloidogyne arenaria* in peanut. Nematropica 16:53-63.
Rodriquez-Kabana, R., H. Ivey, and P. A. Backman. 1987. Peanut-cotton rotations for the management of *Meloidogyne arenaria*. J. Nematol. 19:484-487.
Rodriguez-Kabana, R., D.G. Robertson, C.F. Weaver, and L. Wells. 1991a. Rotations of bahiagrass and castorbean with peanut for the management of *Meloidogyne arenaria*. J. Nematol. 23:658-661.
Rodriguez-Kabana, R., D.G. Robertson, L. Wells, P.S. King, and C.F. Weaver. 1989. Crops uncommon to Alabama for the management of *Meloidogyne arenaria* in peanut. J. Nematol. 21:712-716.
Rodriguez-Kabana, R., D.G. Robertson, L. Wells, C.F. Weaver, and P.S. King. 1991b. Cotton as a rotation crop for the management of *Meloidogyne arenaria* and *Sclerotium rolfsii* in peanut. J. Nematol. 23:652-657.
Rodriquez-Kabana, R., and J.T. Touchton. 1984. Corn and sorghum rotational crops for management of *Meloidogyne arenaria* in peanut. Nematropica 14:26-36.
Samples, L.E. 1987. Land preparation, pp. 4/1-4/2. *In* Georgia Peanut Production Guide. Georgia Coop. Ext. Serv., Athens.
Sanders, T. H., A. M. Schubert, and H. E. Pattee. 1982. Maturity methodology and postharvest physiology, pp. 624-654. *In* H. E. Pattee and C. T. Young (eds.) Peanut Science and Technology. Amer. Peanut Res. Educ. Soc. Inc., Yoakum, TX.
Sanford, J.O., D.L. Myhre, and N.C. Merwine. 1973. Double cropping systems involving no-tillage and conventional tillage. Agron. J. 65:978-982.
Schubert, A.M., C.L. Pohler, and D.H. Smith. 1983. Skip-row peanuts in south central Texas. Texas Agric. Exp. Stn. Prog. Rep. 4058.
Sholar, J.R., J.P. Damicone, B.S. Landgraf, J.L. Baker, and J.S. Kirby. 1993. Comparison of peanut tillage practices in Oklahoma. Proc. Amer. Peanut Res. Educ. Soc. 25:71 (Abstr.).
Sholar, J.R., and K.E. Jackson. 1990. Cultivar and harvest date effects on peanut yield and Sclerotinia blight incidence. Proc. Amer. Peanut Res. Educ. Soc. 22:61 (Abstr.).
Smith, O.D., and C.E. Simpson. 1989. Registration of 'Tamrun 88' peanut. Crop Sci. 29:238.
Smith, O.D., C.E. Simpson, W.J. Grichar, and H.A. Melouk. 1991. Registration of 'Tamspan 90' peanut. Crop Sci. 31:1711.
Soundara Rajan, M.S., K. Ramakumar Reddy, M.S. Venkateswariu, and G.H. Sankara Reddi. 1981. Effect of zero tillage on weed control and yield of rainfed groundnut. Pesticides 15:17-18.
Sturkie, D.G., and G.A. Buchanan. 1973. Cultural practices, pp. 299-326. *In* Peanut Culture and Uses. Amer. Peanut Res. Educ. Assoc., Yoakum, TX.
Sullivan, G.A. 1991. Cultivar response to twin row planting. Proc. Amer. Peanut Res. Educ. Soc. 23:36 (Abstr.).
Trivedi, P.C., and K.R. Barker. 1986. Management of nematodes by cultural practices. Nematropica 16:213-216.
Unger, P.W., A.W. Weise, and R.R. Allen. 1977. Conservation tillage in the southern plains. J. Soil Water Cons. 32:43-48.
Varnell, R.J., H. Mwandemere, W.K. Robertson, and K.J. Boote. 1976. Peanut yields affected by soil water, no-till, and gypsum. Proc. Soil Crop Sci. Soc. Florida 35:56-59.
Wehtje, G., R.H. Walere, M.G. Patterson, and J.A. McGuire. 1984. Influence of twin rows on yield and weed control in peanuts. Peanut Sci. 11:89-91.
Wells, L., R. Weeks, and G. Wehtje. 1992. Performance of peanuts (*Arachis hypogaea* L.) as

influenced by seeding rate and planter. Proc. Amer. Peanut Res. Educ. Soc. 24:60 (Abstr.).

Wilcut, J.W., G.R. Wehtje, D.L. Colvin, and M.G. Patterson. 1987. Economic assessment of herbicide systems for minimum-tillage peanuts. Peanut Sci. 14:83-86.

Williams, E.J., and J.S. Drexler. 1981. A non-destructive method for determining peanut pod maturity. Peanut Sci. 8:134-141.

Wright, F.S. 1991. Alternate tillage practices for peanut production in Virginia. Peanut Sci. 18:9-11.

Wright, F.S., and D.M. Porter. 1982. Underrow ripping of peanuts in Virginia. Peanut Sci. 9:62-65.

Wright, F.S., and D.M. Porter. 1991. Digging date and conservational tillage influence on peanut production. Peanut Sci. 18:72-75.

Wright, F.S., D.M. Porter, N.L. Powell, and B.B. Ross. 1986. Irrigation and tillage effects on peanut yield in Virginia. Peanut Sci. 13:89-92.

Wynne, J.C., and M.K. Beute. 1983. Registration of 'NC 8C' peanut. Crop Sci. 23:183-184.

Wynne, J.C., M.K. Beute, J. Bailey, and R.W. Mozingo. 1991a. Registration of 'NC 10C' peanut. Crop Sci. 31:484.

Wynne, J.C., T.A. Coffelt, R.W. Mozingo, and W.F. Anderson. 1991b. Registration of 'NC-V11' peanut. Crop Sci. 31:484-485.

Wynne, J. C., R. W. Mozingo, and D.A. Emery. 1979. Registration of 'NC 7' peanut. Crop Sci. 19:563.

Wynne, J. C., R. W. Mozingo, and D.A. Emery. 1986. Registration of 'NC 9' peanut. Crop Sci. 26:197.