Photogrammetry Enables Indirect Selection and Increase Genetic Gains for Leaf Spot Tolerance in Peanut Breeding Program in Ghana.

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Early and late leaf spot diseases are part of the major destructive peanut diseases. Peanut genotypes that are tolerant or resistant to leaf spot diseases are important to increase peanut production. A comprehensive breeding approach along with accurate phenotyping and genotyping are needed to increase yield and crop tolerance to biotic and abiotic factors in order to guarantee sustainable food production and security. This work reports on the effectiveness of photogrammetry as a high-throughput phenotyping tool to increase precision in the assessment of peanut for leaf spot tolerance in a breeding program in Ghana. A replicated experiment arranged in a lattice design was conducted during the 2020 rainy season using a set of 60 genotypes as the training population and 192 genotypes as the validation population for the development of indirect selection models for leaf spot tolerance using red-green-blue (RGB) color space indices. Florida 1 to 10 visual rating scale where 1 indicate no disease (0% defoliation) and 10 indicate plants killed by leaf spot disease (100% defoliation) was used to assess early leaf spot (ELS) disease caused by *Cercospora arahidicola* and late leaf spot (LLS) disease caused by *Cercosporidium personatum.* Visual ratings were done at 70, 80, 85 and 95 days after planting (DAP). Samsung Galaxy NX300 RGB camera that captures 20.3 million effective pixels was used to take plot pictures at the same time with the visual disease evaluations. The indices derived from the RGB image were green area (GA), greener area (GGA), Hue and crop senescence index (CSI). ANOVA was performed on the raw data using R statistical package version 4.0.2. Adjusted means from the ANOVA were used for Multiple linear regression, Principal component analysis and Pearson correlation. The highest scores for ELS for the training population were seen at 85 DAP and ranged from 3 to 6. However, the highest scores for LLS for the training population was at 95 DAP and ranged from 3 to 7. In particular, green area (GA), greener area (GGA) and Hue exhibited negative significant associations ($p < 0.000$) with both ELS and LLS. Crop senescence index (CSI) on the other hand showed significant positive association ($p < 0.001$) with both ELS and LLS. The eleven important traits were grouped into two principal components and explained 73.7 % of the total variation. The principal component analysis shows that GA, GGA, Hue, Pods/plant and pod weight/plant are important key traits for the exploitation of genetic variability in the peanut breeding program in Ghana. Biplot of the genotype groupings from the PCA further indicates that geographical origin did not influence the principal components demonstrating it is not a measure of genetic diversity in this study. The RGB indices exhibited comparable or better broad sense heritability to the visual score indicating that they can be used in the breeding programs to increase genetic gain in selecting for leaf spot tolerance.