Breeding for physiological drought and heat tolerance in Georgia peanut: from cell to whole plant

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Rational and Significance of Research. Peanut (*Arachis hypogaea* L.) is a relatively drought tolerant crop; however, more frequent and intense drought episodes coupled with high temperatures caused by climate change are impairing growth and productivity of peanuts grown in Georgia. Breeding for drought resistance is quite challenging as drought and heat conditions in the field are difficult to replicate from year to year and resistance to drought and heat involves multiple traits. Identifying individual physiological and metabolic traits that contribute to resistance can be used as more reliable screens for drought and heat resistance. Combining several traits from many parental genotypes or cultivars requires large population sizes and the ability to evaluate large numbers quickly and accurately. Therefore, having a more accurate, repeatable, and detailed screen could accelerate genetic improvement for drought and heat resistance in peanut.

Objective. Our objectives with this research are to identify physiological processes that contribute to drought and heat resistance and further develop more accurate and detailed screening methods to accelerate genetic improvement for drought and heat resistance in peanut.

Procedures. Nine peanut genotypes were planted on May 1, 2025 under field conditions at UGA, Tifton Campus. Fully irrigated and drought-stress blocks were planted on the same day in the same field. Rainout shelters were used to cover approximately 5.5 m (18 ft) of the dry plots when forecast predicts a rain event from 70 to 112 days after planting (DAP). During sunny days, drought blocks were not covered with the shelters. The untreated control received irrigation as needed throughout the season. Other field management practices followed UGA Extension recommendations. Measurements were taken from all plots at five different timings: 1) a day prior to the onset of the drought stress, 2) one week of drought stress, 3) two weeks of drought stress, 4) three weeks of drought stress, and 5) one week after the end of drought stress. Physiological measurements included gas exchange and fluorescence. Metabolic measurements included amino acid accumulation, activity of enzymes involved in the cellular defense pathway, and reactive oxygen species. Yield and grade data were collected from the plots at the end of the season.

Results. Preliminary results indicate differential responses in net photosynthesis among genotypes under contrasting water regimes during the stress period. Breeding line NB-4 exhibited a reduction in net photosynthesis beginning in the first week of drought, whereas GA-14N showed a decline only after three weeks of stress. Drought stress reduced biomass production in some genotypes. Harvest index was affected by drought only in GA-14N, while the remaining genotypes exhibited similar harvest index values across irrigation treatments. Yield was negatively impacted by drought; however, genotypes such as GA-14N and C76-16 demonstrated greater yield stability across water regimes. Biochemical analyses are currently underway in the laboratory. Additional studies are needed to further elucidate the complex traits associated with drought tolerance in peanut, and this research will be repeated in 2026.