

PROGRESS REPORT
to
NORTH CAROLINA PEANUT GROWERS ASSOCIATION, INC.

Project Title: Offsetting the cost of breeding plots at the Peanut Belt Research Station

Project Investigator(s): Thomas G. Isleib
Department of Crop Science
North Carolina State University, Raleigh, NC

Summary: The North Carolina Department of Agriculture & Consumer Services' (NCDA&CS) Peanut Belt Research Station (PBRS) is our primary research site where we grow replicates of all our yield trials in addition to trials of about 300 lines and families conducted with and without chemical control of leaf spots and trials conducted under conditions that promote tomato spotted wilt (TSW). We also grow the multi-state cooperative Uniform Peanut Performance Test of runner- and virginia-type breeding lines that is usually a last step before release of a new cultivar. We also use PBRS to grow nurseries of early generation breeding plots where we make our selections of individual plants leading to line development as well as the seed multiplication nurseries for all the lines and cultivars that come out of that process. We grow about 30 acres of plots at PBRS.

Researchers provide at least 50% of the input costs incurred by the research stations as they plant and tend our plots. NCPGA provided those funds for PBRS only. I used other funds for UCPRS and/or BBTRS. At my request, PBRS superintendent Tommy Corbett estimated his variable cost per acre of plots at \$1,000, excluding station labor, fuel, and irrigation. We have been asked to cover 50% of variable costs plus 12.5% of non-standard labor cost.

In 2012, we grew 9135 plots at PBRS including 6853 "entries," either breeding lines entered in trials of some sort (yield and grade or resistance to leaf spot or TSW), seed multiplication plots of entries, or early generation plant selection plots. There were 876 yield plots (444 entries), 1114 plots of seed increases of which 633 were combined leaving 481 from which two to four small mesh bags full of pods were hand-picked to preserve seed purity, and 1976 plots subjected to single-plant selection. There were 2136 plots (1068 entries) left unsprayed with leaf spot control fungicide and similarly 984 plots (432 entries) planted at wide (20 inch) seed spacing left untreated with insecticide to promote development of thrips-vectored TSW. We hand harvested a single pod from each plant in 161 plots. We harvested about 300 individual plants for line purification, 1050 plots for development of recombinant inbred lines, and 115 plots of accessions from the national germplasm collection.

REPORT

Project Title: Offsetting the cost of breeding plots at the Peanut Belt Research Station

Project Investigator(s): Thomas G. Isleib
Department of Crop Science
North Carolina State University, Raleigh, NC

Objectives: Provide 50% of the variable input cost and 12.5% of hand-labor cost for breeding plots grown at the Peanut Belt Research Station.

Procedures: The NCDA&CS Peanut Belt Research Station (PBRS) is our primary research site where we grow replicates of all our yield trials in addition to trials of the 300 breeding lines and families conducted with and without chemical control of leaf spots and trials conducted under conditions that promote tomato spotted wilt (TSW). We also grow the multi-state cooperative Uniform Peanut Performance Test of runner- and virginia-type breeding lines that is usually a last step before release of a new cultivar. We also use PBRS to grow nurseries of early generation breeding plots where we make our selections of individual plants leading to line development as well as the seed multiplication nurseries for all the lines and cultivars that come out of that process. We grow about 30 acres of plots at PBRS.

Researchers provide at least 50% of the input costs incurred by the research stations as they plant and tend our plots. NCPGA provided those funds for PBRS only. I used other funds for UCPRS and/or BBTRS. At my request, PBRS superintendent Tommy Corbett estimated his variable cost per acre of plots at \$1000, excluding station labor, fuel, and irrigation. We have been asked to cover 50% of variable costs plus 12.5% of non-standard labor cost.

Cultivar development is complex but can be summarized by dividing it into three main parts:

(1) Create genetic variability by crossing diverse parents that complement each other with respect to the traits they carry. This part of the project is accomplished at the greenhouse on NCSU's Raleigh campus. We use agronomically elite virginia-type parents that we have developed as well disease-resistant parents that may include NCSU lines, introductions from other US market types or other countries, and highly disease resistant tetraploid lines derived from wild species here at NCSU by Dr. Tallury. Dr. Tallury gets this resistance from diploid wild peanut species from South America. Because of the difference in ploidy between the cultivated and wild peanuts, transfer of genetic traits is difficult. We often make a "backcross," a cross of the F₁ hybrid back to the agronomically elite parent, especially if the other parent has pod or seed type quite different from that required for the virginia market type. We do very little "formal" backcrossing, *i.e.*, making a series of backcrosses to a given parent to try to move a single trait into that parent. That said, we do have a high oleic version of the Bailey cultivar in the early stages of testing now. Although the parents may be genetically diverse, the F₁ hybrid plants are uniform if genetically unstable. There is a burst of genetic variation in the F₂ or second "filial" self-pollinated generation following the cross or among the backcross progeny should we make one.

(2) Inbreed the ensuing populations to reach a genetically stable “true-breeding” level, selecting for desirable traits along the way. This part of the project is performed entirely at PBRs. Because this process entails quite a bit of post-harvest handling (hand shelling, packaging seeds for planting, and gas chromatography to measure fatty acids in the seed oil), several months are taken up with the processing and most populations are limited to a single generation per year. In a companion proposal, an “accelerated” method that uses a winter seed nursery to achieve two generations per year and also uses early generation testing for disease reactions in a few select populations is outlined. We generally make our last single-plant selection in the F_6 or sixth generation following the cross, and the $F_{6;7}$ or later generation progeny of the F_6 plant are considered to be a genetically stable breeding line.

(3) Test the breeding lines in trials replicated within a location as well as across locations and years. This part of the project is performed at PBRs and other research stations. We must also multiply the seed of tested lines so they could be tested again at need in the following year. This seed multiplication is done entirely at PBRs. The trials are usually conducted as incomplete block designs with two or three replicates in a single trial. They include tests of yield and grade and also tests of reactions of the lines to the four diseases that commonly produce an economic effect in North Carolina: early leaf spot (ELS) caused by *Cercospora arachidicola*, *Cylindrocladium* black rot (CBR) caused by *C. parasiticum*, *Sclerotinia* blight (SB) caused by *S. minor*, and tomato spotted wilt (TSW) caused by *Tomato spotted wilt tospovirus*. Yield and grade testing is hierarchical with an in-state level conducted on the three North Carolina research stations including PBRs, a regional level, the Peanut Variety and Quality Evaluation (PVQE) program conducted at five sites across the VC region and coordinated by Dr. Maria L. Balota of Virginia Polytechnic Institute and State University’s Tidewater Agricultural Research and Extension Center (TAREC) at Suffolk, VA, and a national Uniform Peanut Performance Test (UPPT) conducted at nine sites across the US peanut-producing states and coordinated by Dr. William D. Branch of the University of Georgia’s Coastal Plain Experiment Station (CPES) at Tifton, GA. We conduct disease and flavor testing on advanced lines from our in-state program. Composition and flavor of lines entered in the UPPT is assessed by USDA-ARS personnel located at Raleigh, NC.

Generally, we consider release of a breeding line as a cultivar only after it has performed well for at least three years of testing in the PVQE, our “official variety test” for peanuts in the VC area. This includes at least five years in our in-state trials, two or more at the Clemson University’s Edisto AREC at Blackville, SC, and at least one year at all locations of the UPPT. We may truncate the testing for a line derived from a formal backcross program, *i.e.*, one that results from a series of three to five backcrosses and that should be very similar genetically to the “recurrent” parent. We consider agronomic performance as well as hull color, disease reactions, and flavor in making release decisions.

For virginia-type peanuts, the data collected include pod yield, content of foreign material and loose shelled kernels, pod size (percent jumbo and fancy pods as well as weight of 100 pods), brightness and hue of jumbo and fancy pods eligible for sale as in-shell peanuts, seed size and distribution (weight of 100 kernels and contents of super-extra large, extra large, sound mature or “SMK,” and “other” kernels), meat content, price per pound of shelled goods, and dollar value per acre. We rate the proportion of the canopy of each yield plot showing symptoms of disease in the field and use nuclear magnetic resonance to measure oil content in an SMK sample from each plot. These data are subjected to statistical analysis using the appropriate linear model, then the genotypic means from each test are added to a data base that goes back to 1990. Multiple-location or multiple-year analyses are performed by extracting the desired means from the data base, assessing macro-environmental and genotypic effects, and calculating the means for genotypes adjusted to a common environmental effect. There are separate data bases for severity of ELS, pod yield in the presence of ELS, and incidence of CBR, SB, and TSW from which multiple-year summaries may be extracted. After each year we identify lines to be advanced or “graduated” to the next phase of testing.

Results and Discussion: In 2012, we grew 9135 plots at PBRs including 6853 "entries," either breeding lines entered in trials of some sort (yield and grade or resistance to leaf spot or TSW), seed multiplication plots of entries, or early generation plant selection plots. There were 876 yield plots (444 entries), 1114 plots of seed increases of which 633 were combined leaving 481 from which two to four small mesh bags full of pods were hand-picked to preserve seed purity, and 1976 plots subjected to single-plant selection. There were 2136 plots (1068 entries) left unsprayed with leaf spot control fungicide and similarly 984 plots (432 entries) planted at wide (20 inch) seed spacing left untreated with insecticide to promote development of thrips-vectored TSW. We hand harvested a single pod from each plant in 161 plots. We harvested about 300 individual plants for line purification, 1050 plots for development of recombinant inbred lines, and 115 plots of accessions from the national germplasm collection.

Lay Interpretation of Results

Offsetting the Cost of Breeding Plots at the Peanut Belt Research Station

Researchers provide at least 50% of the input costs incurred by the research stations as they plant and tend our plots. The NCDA&CS Peanut Belt Research Station (PBRS) is our primary research site where we grow replicates of all our yield trials in addition to trials of about 300 breeding lines and families conducted with and without chemical control of leaf spots and trials conducted under conditions that promote tomato spotted wilt (TSW). We also grow the multi-state cooperative Uniform Peanut Performance Test of runner- and virginia-type breeding lines that is usually a last step before release of a new cultivar. We also use PBRS to grow nurseries of early generation breeding plots where we make our selections of individual plants leading to line development as well as the seed multiplication nurseries for all the lines and cultivars that come out of that process. In 2012, we grew 9135 plots at PBRS including 6853 "entries," either breeding lines entered in trials of some sort (yield and grade or resistance to leaf spot or TSW), seed multiplication plots of entries, or early generation plant selection plots.