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ANNUAL PROGRESS REPORT
TO
NORTH CAROLINA PEANUT GROWERS ASSOCIATION, INC.

TITLE: **Breeding Peanuts for Multiple Disease Resistance**

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DEPARTMENT(S): **Crop and Soil Sciences**

REPORT:

Crossing. We identified the five lines with the widest array of disease resistances from our databases on resistance updated with the means from the 2015 season (N14035olSmT, N14043olLSmT, N15066olLSmT, N15076olLSmT, and wild-species-derived line SPT 13-05ol). The disease-resistant parents were mated as males in a factorial fashion with a set of eight agronomically "good" and as-disease-resistant-as-possible parents (N12008olCLSmT, N12009olCLT, N14007ol, N14017olJ, N15018olJ, N15039ol, N15043ol, and N15052ol) in the winter of 2015-2016. In the summer of 2016 we crossed the 21 F_1 hybrids we were able to produce back to the "agronomic" parent in a single first backcross that produced "BC_1F_1" seeds.

Inbreeding using the winter nursery and simultaneous testing for disease resistance. The BC_1F_1 seeds from the 2015 crossing program were planted in the 2015-2016 winter seed nursery at the Illinois Crop Improvement Association's facility at Juana Diaz, PR, the "Puerto Rico Winter Nursery" or "PRWN." Those plants in the PRWN were harvested individually in April 2016, and their 127 $BC_1F_{1:2}$ progeny were planted in a selection nursery at the Peanut Belt Research Station (PBRS) at Lewiston, NC, in May. In October 2016, we practiced selection among BC_1F_2 plants, shelled the selections, tested them for fatty acid genotypes, and sent 105 selected $BC_1F_{2:3}$ progeny of F_2 selections representing 27 crosses and carrying the high oleic gene to the 2016-2017 PRWN.

At maturity in Puerto Rico (April 2016), we harvested pods twice from the $F_{2:3}$ plots planted there in November 2015 (crosses made in 2014; these were also backcrosses), once taking a single pod from each plant, then again harvesting all pods. We planted a single $F_{2:4}$ seed (one from each $F_{2:3}$ plant at the PRWN) in a selection nursery at PBRS in May 2016 and used the bulk-harvested seed to plant replicated trials for the four diseases: leaf spot and tomato spotted wilt (TSW) at PBRS, Sclerotinia blight and Cylindrocladium black rot (CBR) at the Upper Coastal Plain Research Station (UCPRS) at Rocky Mount, NC. We used incomplete block designs (15x14 double rectangular lattices) with one-row plots, 12 or 24 feet long depending on the trial. There were 98 $BC_1F_{2:4}$ families in the test series. We included cultivars and lines with outstanding disease resistance or susceptibility as checks in the trials. Recommended practices including irrigation were used with the following exceptions: For leaf spot, we did not apply any foliar fungicide to control the disease. For CBR, the trial was planted without first fumigating the soil with metam sodium for CBR control. For Sclerotinia blight, we did not apply of fluazinam or boscalid protectant spray. For TSW, seeds were planted 20 inches apart, and no insecticide was applied to control tobacco thrips, the insect vector of TSW in this area. This was called the "Disease Selection Test (DST)" series. Using the results of three DST trials (CBR did not develop in the test at UCPRS in spite of the field harboring the fungus and managing the plots to foster CBR), we identified the $BC_1F_{2:4}$ families with the best all-around disease resistance, and

selected within the best families in the nursery planted for that purpose at PBRS. Sixty-two selected $F_{4:5}$ progeny representing 13 crosses harvested in October 2016 were sent to the 2016-2017 PRWN after first checking their fatty acid genotypes. At harvest there we will again harvest a single pod per $F_{4:5}$ plant followed by a bulk harvest of the $F_{4:5}$ plots.

We planted a single $F_{4:6}$ seed (one from each $F_{4:5}$ plant at the 2015-2016 PRWN from crosses made in 2013, these were not backcrosses) in a selection nursery at PBRS in May 2016 and use the bulk-harvested seed in the DST series along with the $F_{2:4}$ plots from the following cycle. Using the results of the DST trials, we identified the $F_{4:6}$ families with the best all-around disease resistance, and selected within the best families in the nursery planted for that purpose at PBRS. Thirty-nine selected $BC_1F_{6:7}$ progeny representing 4 crosses will be planted at the 2016-2017 PRWN, and at harvest we will make only a bulk harvest of the $F_{6:7}$ plots. We consider the $F_{6:8}$ families to be genetically stable breeding lines.

The 41 $F_{6:8}$ lines (representing 10 crosses made in 2012, again these were not backcrosses) from the 2015-2016 PRWN were included in the DST and also planted in replicated yield trials at PBRS and UCPRS in May 2016. We had sufficient seed to plant this "Disease Preliminary Line Test" (DPT) as two-rep tests in incomplete block designs (7x7 simple square lattices) with two 24-foot rows per plot.

$BC_1F_{6:9}$ lines with superior disease resistance based on measurements from the 2015 DST were advanced or "graduated" to the 2016 "Disease Advanced Line Test" (DAT) series, our testing program for the most disease-resistant lines. There were 19 such lines in addition to the 19 lines held over as multiply disease-resistant from previous years. Seven $BC_1F_{6:9}$ lines with superior yield and grade in the 2015 DPT were graduated to the 2016 "Advanced Yield Test" (AYT) series with yield trials again grown as two-rep tests in incomplete block designs (10x9 double rectangular lattices) with two 24-foot rows per plot, but this time at three locations: PBRS, UCPRS, and the Border Belt Tobacco Research Station (BBTRS) at Whiteville, NC. After two years in the AYT, a line can graduate to the Peanut Variety and Quality Evaluation (PVQE) program conducted at five sites across the Virginia-Carolina (VC) region and coordinated by Dr. Maria Balota of Virginia Polytechnic Institute and State University's Tidewater Agricultural Research and Extension Center (TAREC) at Suffolk, VA. There were ten such lines in the 2016 PVQE test series including seven high-oleic backcross derivatives of Bailey. If a line performs well for three years in the PVQE program, it is considered a candidate for release the spring following the third year of PVQE testing. The high-oleic Bailey lines are at that stage. We anticipate releasing one of those lines as a variety in the spring of 2017.

Disease data from the DST series, the DAT series, and a third series in which the disease reactions are monitored for lines retained for testing because of superior yield and grade under chemically protected conditions (the "Advanced Line Disease" or "ALD" series) were analyzed, put into databases maintained by the breeding program, and summarized for each disease. The means for disease reactions were converted to a proportional zero-to-one scale with zero representing the worst line in the summary and one the best. In order to have a single number indicating the mean level of disease resistance in a line, the zero-to-one values for the individual disease reactions were averaged arithmetically across diseases. A similar summary was made for pod yields measured through 2016 in chemically protected replicated yield trials at multiple locations and years. There were 149 breeding lines and cultivars tested for disease reactions and yield at least one year as of 2016. Figure 1 plots pod yield versus mean disease resistance for that group of 149 lines.

Note the position of the current varieties on the graph: they were not particularly resistant within the group, even Bailey and Sullivan, nor were they particularly high yielding. Every breeder has lines he or she is watching closely. Current fair-haired children include the seven N12 lines that are candidates to be released as the high-oleic version of Bailey (here called 'Bailey II' although that name may or may not be used in the end), and N13048+ol, none of which was particularly resistant although they were better yielding than the current varieties. The most disease-resistant line was N15065olSmT. Sister-line N15066olLSmT was last year's most resistant line and is a line we have already used as a parent and which could conceivably find its way to release. Several of the most disease-resistant lines were higher yielding than the current

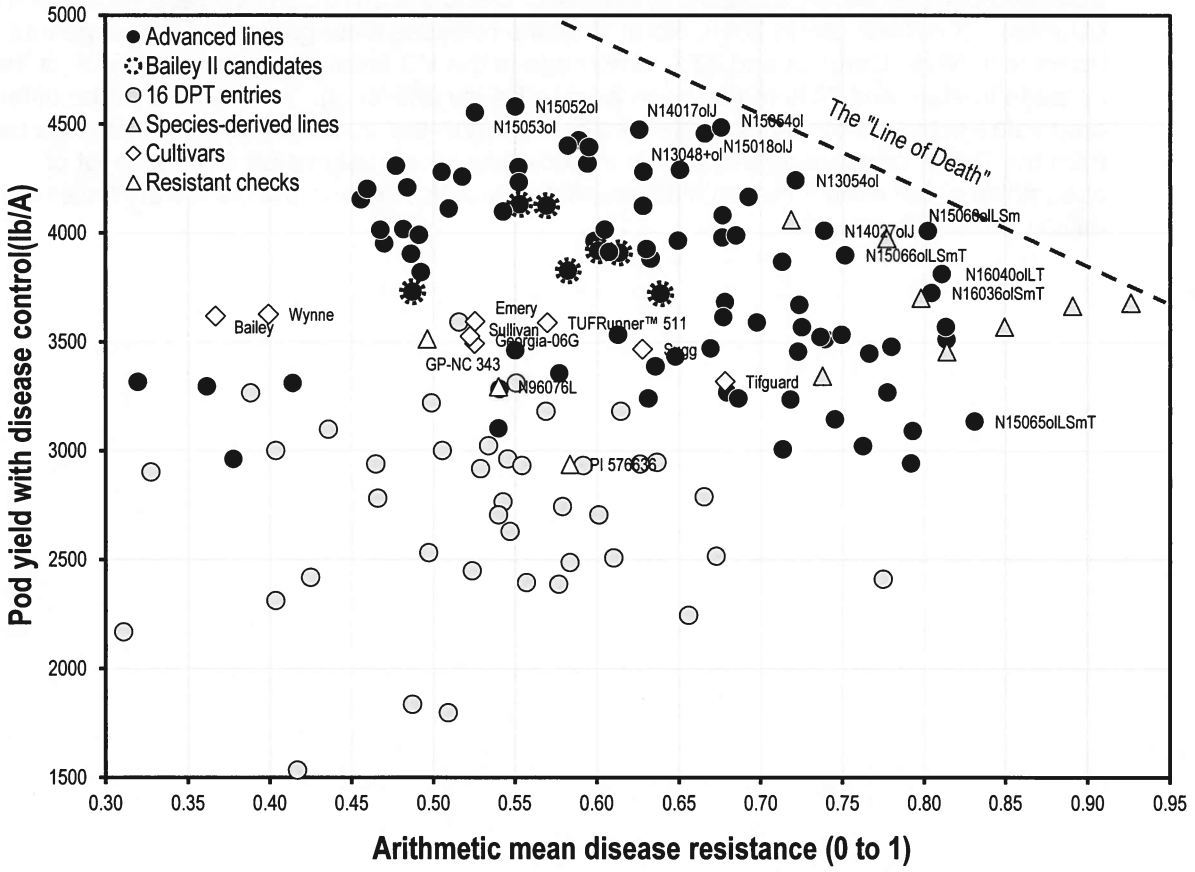

Figure 1. Pod yield versus mean disease resistance.

varieties although not necessarily the highest yielding. The highest yielding lines were not the most disease-resistant although they were similar to existing cultivars in that regard. There were a few species-derived lines tested for a first year in 2016 that appeared to be highly disease-resistant and on a par with existing cultivars vis-à-vis pod yield. We desire lines with high resistance and high yield and did not find any with both, *i.e.*, in the upper right corner of the graph. We even have a euphemistic term for the upper right edge of the scattering of points, the "Line of Death," because it is extremely difficult to cross.

We released the 'Emery' cultivar in spring of 2015, but it did not originate in the accelerated disease resistance breeding program. 'Sullivan' and 'Wynne', released in 2013, did.

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IMPACT STATEMENT

This is the project from which four of our last five cultivar releases came: Bailey in 2008, Sugg in 2009, and high-oleic cultivars Sullivan and Wynne in the spring of 2013. Foundation seed of those two releases was grown in 2013, but because there is a lag in availability of seed following release, necessary to allow for multiplication of seed to a commercial scale in the North Carolina seed chain, they will not be widely available until the spring of 2017. The Bailey and Sugg cultivars were released in 2008 and 2009, and the 2012 season was the first in which that seed became widely available to growers. Using the 2015 certified seed production as estimates of cultivar use in 2016, North Carolina releases were grown on 94% of peanut acreage in North Carolina and 87% of acreage in the VC area. Approximately 81% of the acreage in-state and 74% region-wide were in Bailey and Sugg. An estimate of the difference in crop value achieved by the new releases, using value-per-acre figures at the loan rate taken from the PVQE program, is $10 million region-wide. Such estimation requires a lot of assumptions, but even if the estimate is inflated twofold, the improvement would still be $5 million in a single year.