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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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REPORT:

Crossing. We identified the ten lines with the widest array of disease resistances from our databases on resistance updated with the means from the 2016 season (wild-species-derived lines HTS 16-02, HTS 16-03, HTS 16-04, and HTS 16-05, and NCSU breeding lines N14039olLSmT, N15060olLSm, N15065olLSmT, N16036olSmT, N16039olLT, and N16040olLT). The disease-resistant parents were mated as males in a factorial fashion with a set of five agronomically "good" and as-disease-resistant-as-possible parents (N13048+ol, N14004olJ, N14009olJ, N14017olJ, and N15052ol) in the winter of 2016-2017. In the summer of 2017 we crossed the 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 2016 crossing program were planted in the 2016-2017 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 2017, and their 97 $BC_1F_{1:2}$ progeny were planted in a selection nursery at the NCDA Peanut Belt Research Station (PBRS) at Lewiston, NC, in May. In October 2017, we practiced selection among BC_1F_2 plants, shelled the selections, tested them for fatty acid genotypes, and sent 100 selected $BC_1F_{2:3}$ progeny of F_2 selections representing 17 crosses and carrying the high oleic gene to the 2017-2018 PRWN.

At maturity in Puerto Rico (April 2017), we harvested pods twice from the $BC_1F_{2:3}$ plots planted there in November 2016 (crosses made in 2015; these were also backcrosses), once taking a single pod from each plant, then again harvesting all pods. We planted a single $BC_1F_{2:4}$ seed (one from each $BC_1F_{2:3}$ plant at the PRWN) in a selection nursery at PBRS in May 2017 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 NCDA 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 105 $BC_1F_{2:4}$ 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 with no insecticide applied to control tobacco thrips, the primary 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 nor did Sclerotinia blight develop in a field known to be infested), we identified the $BC_1F_{2:4}$ families with the best resistance to leaf spots and TSW, and selected within the best families in the nursery planted for that purpose at PBRS. Sixty-one selected $BC_1F_{4:5}$ progeny representing 17 crosses harvested in October 2017 were sent to the

2017-2018 PRWN after first checking their fatty acid genotypes. At harvest there we will again harvest a single pod per $BC_1F_{4:5}$ plant followed by a bulk harvest of the $BC_1F_{4:5}$ plots.

We planted a single $F_{4:6}$ seed (one from each $F_{4:5}$ plant at the 2016-2017 PRWN from crosses made in 2014, these were again backcrosses) in a selection nursery at PBRS in May 2017 and used the bulk-harvested seed in the DST series along with the $BC_1F_{2:4}$ 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. Forty-three selected $F_{6:7}$ progeny representing 10 crosses were planted at the 2017-2018 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 39 $F_{6:8}$ lines (representing 4 crosses made in 2013, these were not backcrosses) from the 2016-2017 PRWN were included in the DST and also planted in replicated yield trials at PBRS and UCPRS in May 2017. 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. These plots received all disease-preventive treatments recommended by the station superintendent.

$BC_1F_{6:9}$ lines with superior disease resistance based on measurements from the 2016 DST were advanced or "graduated" to the 2017 "Disease Advanced Line Test" (DAT) series, our testing program for the most disease-resistant lines. There were only four such lines in addition to the 37 lines held over as multiply disease-resistant from previous years. Twelve $BC_1F_{6:9}$ lines with superior yield and grade in the 2016 DPT were graduated to the 2017 "Advanced Yield Test" (AYT) series with yield trials again grown as two-rep tests in incomplete block designs (10x10 simple square lattices) with two 24-foot rows per plot, but this time at three locations: PBRS, UCPRS, and the NCDA Border Belt Tobacco Research Station (BBTRS) at Whiteville, NC. After three 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 14 such lines in the 2017 PVQE test series. 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.

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 2017 in chemically protected replicated yield trials at multiple locations and years. There were 139 breeding lines and cultivars tested for disease reactions and yield at least one year as of 2017. Figure 1 plots pod yield versus mean disease resistance for that group of 139 lines.

Note the position of the current varieties on the graph: they were not particularly resistant within the group, even Sullivan, Bailey, and Bailey II, nor were they particularly high yielding. Every breeder has lines he or she is watching closely. The four lines of interest appear to be N14040olLSmT, N15064olLT, N15066olLSmT, and N15068olLSmT. All four of them have data on all four diseases, and all four came out in the best ten among those tested, even those tested for only two diseases. N15066olLSmT and its sister line N15065olLSmT are lines we have already used as parents and which could conceivably find their way to release. Several of the most disease-resistant lines were higher yielding than the current 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 in 2017 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. However, ‘Sullivan’ and ‘Wynne’, released in 2013, did as did ‘Bailey II’, released in 2017.

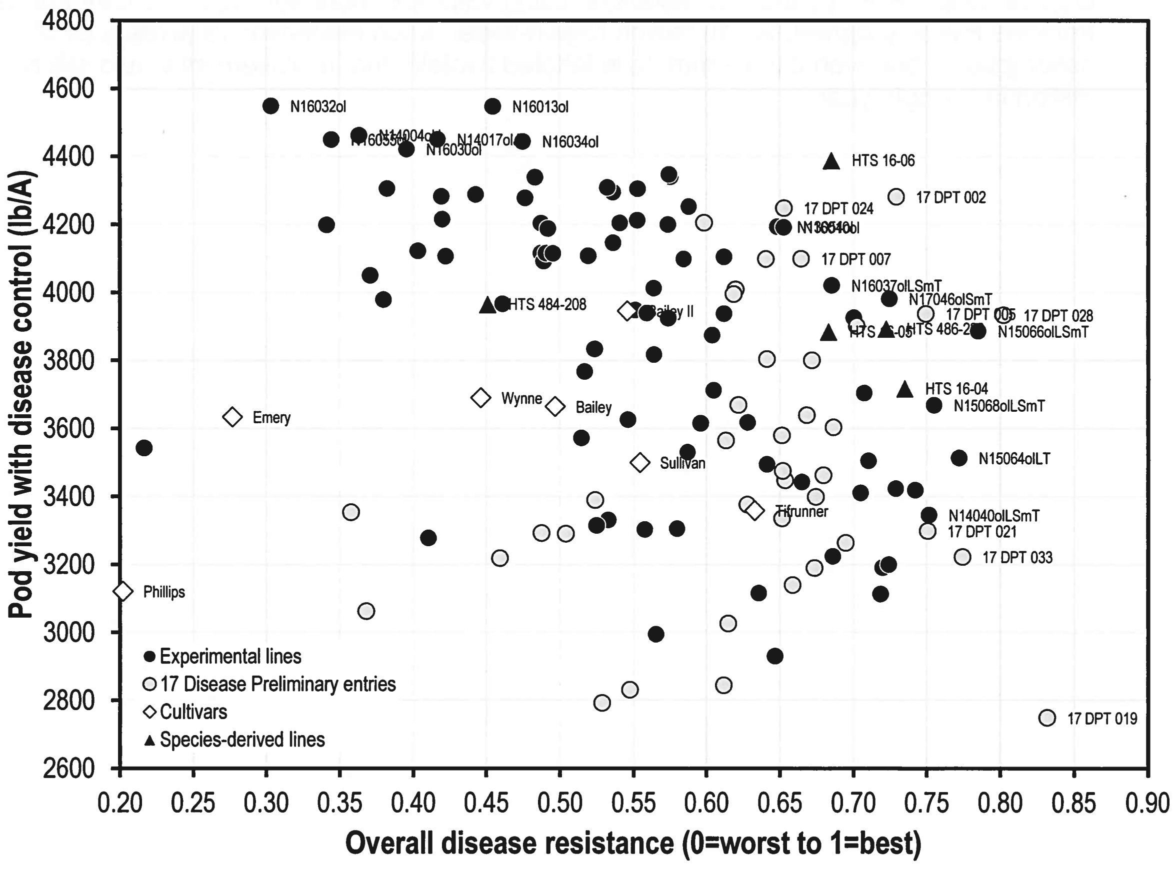

Figure 1. Pod yield versus mean disease resistance.

IMPACT STATEMENT

This is the project from which five of our last six cultivar releases came: Bailey in 2008, Sugg in 2009, and high-oleic cultivars Sullivan and Wynne in the spring of 2013 and Bailey II in 2017. Foundation seed of Bailey II was grown in 2017, 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, it will not be widely available until the spring of 2020. 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 2016 certified seed production figures as estimates of cultivar use in 2017, North Carolina releases were grown on 72% of peanut acreage in North Carolina and 76% of acreage in the VC area. 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.