

**ANNUAL PROGRESS REPORT  
TO  
NORTH CAROLINA PEANUT GROWERS ASSOCIATION**

**TITLE:** Improvement of Sensory Quality and Composition of virginia-type Peanuts

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**REPORT:**

This project monitors the flavor intensity of breeding lines under consideration for cultivar release by the breeding program at NCSU. All potential new releases are subjected to a more or less long-term evaluation of flavor. We find that in order to obtain reliable mean sensory panel values for a line, one must have samples from at least three crop years, so the mean values for lines tested for a first or second year in a given year must be viewed as preliminary ones subject to change as more data is accumulated. Our ultimate objective is to make sure that the lines we do release for use as cultivars are superior in terms of flavor or at least do not have less intense "positive" flavor or more intense "negative" flavor compared with standard cultivars.

For submission to the sensory panel or "flavoring" in 2017, we chose 136 samples from the 2016 NCSU variety trials including 20 virginia-type breeding lines based on their agronomic performance and disease reactions. For purposes of comparison we included as checks in the set samples of five virginia-type cultivars (Bailey, Bailey II, Emery, Sullivan, and Wynne) and four runner-type cultivars (Florida-07, Florun™ '157', Georgia-06G, and Georgia-09B). The runner-type cultivars were, are, or may become the dominating cultivars in the Southeastern production area and are therefore included as flavor checks. Lines tested included 120 SMK samples representing these lines (16 samples were re-roasted to achieve a more nearly optimum roast color), 28 grown in the 2015 crop season (8 were re-roasted) and 5 in 2014 (none re-roasted) but still stored in the cooler where we keep samples prior to processing. The older samples include previous years' samples of lines that we opted to taste due to their agronomic and/or disease performance as of the 2016 season. We may not have tasted samples of those lines earlier but still had samples in storage. The 20 experimental lines tested included all 19 submitted to the regional performance testing program, the Peanut Variety and Quality Evaluation (PVQE) program, high-oleic backcross derivatives of the poplar 'Bailey' cultivar, as well as very large-seeded line N11020oIJ. Having made the list of lines to be flavored, we pulled any remnant samples of those lines from the 2015 and 2014 seasons, samples that had been held in cool storage.

Each sample was manually cleaned so as not to present moldy or otherwise "dirty" samples to the panel. The sample was then divided into 16 subsamples of roughly equal weight (approximately 40 g). A set of eight subsamples was distributed in a Blue M Power-O-Matic 60 laboratory oven (SPX Thermal Product Solutions, White Deer, PA) and roasted at a temperature of 160°C (320°F) for approximately 12 min or to as near an ideal color as possible (note that the seed coats are still on the seeds at the time of roasting, that there is no window into the oven, and that the seeds continue to cook in their own oil once they have heated – evaluating color is done after the fact). Duration of the roast was recorded. The seeds were air-cooled, manually

blanched (seed coats removed), and ground to paste in an Old Tyme tabletop peanut butter mill (Old Tyme Food Products, E. Long Meadow, MA). Once the paste cooled to room temperature, its color was measured using a Minolta Chroma light meter, a CIELAB L\* score of 58.3 being considered ideal to elicit roasted peanut flavor. If the roast color was outside the range from 55.5 to 60.0, either too light (higher score) or too dark (lower score), then the second set of eight subsamples was roasted, adjusting the roast duration upward or downward as indicated.

A total of 178 roasted ground SMK samples from 19 graded field experiments (136 samples from 10 tests in the 2016 crop year, 36 samples from 4 tests in the 2015 crop year, and 6 samples from 5 tests in the 2014 season), representing 20 different breeding lines and 9 cultivars, were submitted to the sensory panel in the Department of Food, Bioprocessing, and Nutritional Sciences at NCSU under the direction of Dr. MaryAnne Drake. The 178 samples were assigned to 17 sensory panel sessions of 10 or 11 samples each. Two additional sessions were used at the outset of flavoring to calibrate the panelists using commercial peanut butter samples. Assignment was performed to minimize the standard error of a difference between two breeding line means. All of the panelists tasted each roasted paste sample independently and assigned a whole-number score to it for intensities of a number of sensory attributes or "flavor notes:" roast peanut, over-roast (also called "dark roast"), under-roast (also called "raw beany"), sweet, woody / hulls / skins, fruity / fermented, painty / rancid, stale / cardboard, moldy, petroleum, bitter, tongue / throat burn, astringent mouth feel, nutty aftertaste, and bitter aftertaste. All intensities were expressed on a 14-point scale from 1 (not perceptible) to 14 (most intense) for each panelist. The sample values were averaged across panelists; the averages were then added to the data base of NCSU flavor data. We performed multiple-year analysis for those lines and cultivars tasted in 2017. The data in hand was statistically analyzed using "fruity/fermented" intensity score and the linear and quadratic effects of roast color covariates (if appropriate) for roasted peanut, sweet, and bitter attribute intensities.

Data on the samples most recently submitted to the sensory panel have not yet been returned. In the absence of that data, it is possible only to summarize the database as last modified in 2016. Experimental line N09042oIF had the greatest roasted peanut intensity among lines tested at least three years (Table 1), but there were 17 other lines whose roasted peanut scores fell into the "a," *i.e.*, "best," group not statistically separable from the best line tested. Considering all the important flavor notes, "positive" sensory traits (roast peanut, sweet, nutty aftertaste) and the negative trait bitter, only one experimental line, N12014ol, fell into the "a" group for all four as did runner check Georgia-09B. Based on flavor alone measured in this small number of runner-type cultivars, Georgia-09B, a high-oleic single-backcross derivative of Georgia Green, should be the preferred one to use in the Virginia-Carolina area. Georgia-09B had the greatest value for sweet score and Georgia-06G, currently the most popular runner-type cultivar and therefore the peanut most commonly used in the manufacture of peanut butter, the second greatest sweet value, so if the requirement for large sweet score is relaxed so that lines with sweet scores in the "b" group are included, then there were only two additional virginia-type lines in the "best" group, N12007ol and N12015ol. If the requirement is further reduced to include the "d" group, then there are six lines in the best group, five of them experimental virginia-type lines: N09042oIF, N12007ol, N12014ol, N12015ol, and N13048+ol. N12007ol and N12010ol are high-oleic backcross derivatives of Bailey.

**Table 1. Adjusted mean sensory attribute intensities (flavor “notes”) for sound mature kernel (SMK) samples from NCSU breeding lines, current virginia-type cultivars, and dominating runner-type cultivars. Means for lines tested in the field in 2015 and for at least three years and for runner-type sensory checks, adjusted to a common level of environment (year and location).**

Type / line	Extent of testing					Sensory attribute intensity									
	No. of		First	Last	Roast	Over-	Under-	Roast	Nutty	Astrin-	Fruity /	Stale /	Fer-	Card-	
	Reps	Tests													Yrs
	CIELAB					flavor intensity units (fiu), 1=none to 14=most intense									
	L*														
<b>NCSU lines</b>	<b>271</b>	<b>37</b>	<b>6</b>	<b>2010</b>	<b>2015</b>	<b>57.93<sup>a</sup></b>	<b>1.75<sup>a</sup></b>	<b>1.58<sup>a</sup></b>	<b>4.89<sup>ns</sup></b>	<b>3.79<sup>β</sup></b>	<b>3.74<sup>α</sup></b>	<b>2.26<sup>β</sup></b>	<b>2.89<sup>β</sup></b>	<b>1.52<sup>α</sup></b>	<b>1.58<sup>α</sup></b>
N09042olF	26	22	6	2010	2015	57.07 <sup>hij</sup>	2.11 <sup>d</sup>	1.33 <sup>ab</sup>	5.15 <sup>a</sup>	3.94 <sup>cde</sup>	3.90 <sup>a-d</sup>	2.32 <sup>d-g</sup>	3.02 <sup>gh</sup>	1.68 <sup>c-h</sup>	1.65 <sup>f-i</sup>
N11020olJ	18	17	5	2011	2015	58.52 <sup>abc</sup>	1.81 <sup>abc</sup>	1.66 <sup>c-g</sup>	4.96 <sup>a-d</sup>	3.68 <sup>ghi</sup>	3.66 <sup>a-h</sup>	2.42 <sup>a-h</sup>	2.98 <sup>c-h</sup>	1.62 <sup>b-h</sup>	1.80 <sup>g-j</sup>
N11028ol	19	16	5	2011	2015	58.56 <sup>ab</sup>	1.69 <sup>abc</sup>	1.65 <sup>c-f</sup>	5.01 <sup>abc</sup>	3.92 <sup>c-g</sup>	3.77 <sup>c-g</sup>	2.27 <sup>b-e</sup>	2.91 <sup>a-f</sup>	1.43 <sup>a-e</sup>	1.49 <sup>b-f</sup>
N11055B	12	9	3	2013	2015	58.77 <sup>a</sup>	1.63 <sup>ab</sup>	2.02 <sup>hij</sup>	4.68 <sup>def</sup>	3.47 <sup>i</sup>	3.45 <sup>hi</sup>	2.64 <sup>h</sup>	2.99 <sup>c-h</sup>	1.72 <sup>c-h</sup>	1.98 <sup>jk</sup>
N11063B	8	7	3	2013	2015	58.07 <sup>a-g</sup>	1.69 <sup>abc</sup>	2.16 <sup>ij</sup>	4.51 <sup>ef</sup>	3.53 <sup>hi</sup>	3.41 <sup>hi</sup>	2.43 <sup>d-h</sup>	3.03 <sup>d-h</sup>	1.68 <sup>a-h</sup>	1.92 <sup>ijk</sup>
N12006ol	13	10	4	2012	2015	57.58 <sup>d-j</sup>	1.69 <sup>abc</sup>	1.55 <sup>b-e</sup>	4.83 <sup>b-f</sup>	3.72 <sup>e-i</sup>	3.70 <sup>c-h</sup>	2.29 <sup>f</sup>	2.97 <sup>b-h</sup>	1.57 <sup>a-g</sup>	1.62 <sup>c-h</sup>
N12007ol	13	13	4	2012	2015	57.72 <sup>c-i</sup>	1.79 <sup>abc</sup>	1.52 <sup>bcd</sup>	5.02 <sup>abc</sup>	3.98 <sup>b-e</sup>	3.81 <sup>a-f</sup>	2.19 <sup>a-d</sup>	2.90 <sup>a-f</sup>	1.60 <sup>a-h</sup>	1.43 <sup>a-e</sup>
N12008olCLSmT21	17	4	2012	2015	57.91 <sup>b-g</sup>	1.71 <sup>abc</sup>	1.58 <sup>b-e</sup>	4.81 <sup>c-f</sup>	3.71 <sup>e-i</sup>	3.75 <sup>c-g</sup>	2.21 <sup>bcd</sup>	2.90 <sup>a-f</sup>	1.66 <sup>c-h</sup>	1.59 <sup>c-g</sup>	
N12009olCLT	19	17	4	2012	2015	57.78 <sup>c-g</sup>	1.70 <sup>abc</sup>	1.60 <sup>b-e</sup>	4.88 <sup>b-e</sup>	3.94 <sup>c-f</sup>	3.80 <sup>b-g</sup>	2.18 <sup>a-d</sup>	2.87 <sup>a-f</sup>	1.69 <sup>c-h</sup>	1.55 <sup>c-f</sup>
N12010ol	17	14	4	2012	2015	57.93 <sup>a-g</sup>	1.65 <sup>ab</sup>	1.74 <sup>d-h</sup>	4.95 <sup>a-d</sup>	3.91 <sup>c-g</sup>	3.70 <sup>d-h</sup>	2.11 <sup>abc</sup>	2.82 <sup>abc</sup>	1.74 <sup>e-h</sup>	1.53 <sup>c-f</sup>
N12014ol	14	13	4	2012	2015	57.08 <sup>g-j</sup>	1.80 <sup>abc</sup>	1.10 <sup>a</sup>	5.06 <sup>abc</sup>	4.14 <sup>abc</sup>	4.08 <sup>a</sup>	2.01 <sup>a</sup>	2.82 <sup>ab</sup>	1.33 <sup>ab</sup>	1.24 <sup>a</sup>
N12015ol	15	13	4	2012	2015	57.72 <sup>c-i</sup>	1.87 <sup>a-d</sup>	1.53 <sup>bcd</sup>	5.05 <sup>abc</sup>	4.01 <sup>bcd</sup>	3.96 <sup>abc</sup>	2.22 <sup>bcd</sup>	2.84 <sup>a-e</sup>	1.54 <sup>a-g</sup>	1.51 <sup>b-f</sup>
N13003olF	9	8	3	2013	2015	58.24 <sup>a-e</sup>	1.68 <sup>abc</sup>	1.53 <sup>bcd</sup>	4.98 <sup>a-d</sup>	3.66 <sup>e-i</sup>	3.78 <sup>a-g</sup>	2.29 <sup>b-g</sup>	2.83 <sup>a-d</sup>	1.26 <sup>a</sup>	1.39 <sup>abc</sup>
N13006ol	8	8	3	2013	2015	57.72 <sup>a-i</sup>	1.89 <sup>a-d</sup>	1.39 <sup>a-d</sup>	4.83 <sup>a-f</sup>	3.80 <sup>d-i</sup>	3.74 <sup>b-h</sup>	2.17 <sup>a-d</sup>	2.84 <sup>a-e</sup>	1.33 <sup>abc</sup>	1.65 <sup>c-i</sup>
N13007ol	8	7	3	2013	2015	58.26 <sup>a-e</sup>	1.51 <sup>a</sup>	1.95 <sup>f-j</sup>	4.64 <sup>def</sup>	3.68 <sup>d-i</sup>	3.50 <sup>i</sup>	2.33 <sup>c-g</sup>	2.86 <sup>a-f</sup>	1.60 <sup>a-h</sup>	1.70 <sup>d-j</sup>
N13048+ol	9	8	3	2013	2015	58.11 <sup>a-f</sup>	1.63 <sup>ab</sup>	1.35 <sup>abc</sup>	4.89 <sup>a-e</sup>	3.78 <sup>d-i</sup>	3.85 <sup>a-e</sup>	2.18 <sup>a-d</sup>	2.84 <sup>a-e</sup>	1.36 <sup>abc</sup>	1.45 <sup>a-f</sup>
N13049olJ	10	8	3	2013	2015	57.60 <sup>d-j</sup>	1.76 <sup>abc</sup>	1.34 <sup>abc</sup>	4.85 <sup>a-f</sup>	3.82 <sup>d-h</sup>	3.76 <sup>b-g</sup>	2.22 <sup>a-e</sup>	2.82 <sup>abc</sup>	1.37 <sup>a-d</sup>	1.51 <sup>b-f</sup>
N13054ol	8	8	3	2013	2015	57.73 <sup>a-i</sup>	1.88 <sup>a-d</sup>	1.54 <sup>b-e</sup>	4.87 <sup>a-f</sup>	3.54 <sup>hi</sup>	3.80 <sup>a-g</sup>	2.40 <sup>b-h</sup>	2.92 <sup>g</sup>	1.38 <sup>a-e</sup>	1.65 <sup>c-i</sup>
N13057olL	13	11	3	2013	2015	58.09 <sup>a-f</sup>	1.74 <sup>abc</sup>	1.50 <sup>bcd</sup>	4.96 <sup>a-d</sup>	3.78 <sup>d-i</sup>	3.77 <sup>b-g</sup>	2.22 <sup>a-e</sup>	2.79 <sup>a</sup>	1.34 <sup>abc</sup>	1.44 <sup>a-f</sup>
N13058olSm	11	10	3	2013	2015	58.14 <sup>a-e</sup>	1.65 <sup>ab</sup>	1.51 <sup>bcd</sup>	4.87 <sup>a-e</sup>	3.75 <sup>d-i</sup>	3.63 <sup>e-i</sup>	2.07 <sup>ab</sup>	2.77 <sup>a</sup>	1.46 <sup>a-f</sup>	1.41 <sup>a-d</sup>
<b>Cultivars</b>	<b>307</b>	<b>96</b>	<b>13</b>	<b>2003</b>	<b>2015</b>	<b>57.47<sup>β</sup></b>	<b>1.86<sup>β</sup></b>	<b>1.67<sup>β</sup></b>	<b>4.81<sup>ns</sup></b>	<b>3.74<sup>β</sup></b>	<b>3.72<sup>αβ</sup></b>	<b>2.38<sup>γ</sup></b>	<b>3.04<sup>α</sup></b>	<b>1.72<sup>β</sup></b>	<b>1.68<sup>β</sup></b>
Bailey	94	87	13	2003	2015	57.55 <sup>e-j</sup>	1.79 <sup>abc</sup>	1.87 <sup>ghi</sup>	4.59 <sup>f</sup>	3.62 <sup>hi</sup>	3.55 <sup>ghi</sup>	2.40 <sup>e-h</sup>	3.01 <sup>gh</sup>	1.85 <sup>h</sup>	1.83 <sup>ij</sup>
Emery	35	32	5	2011	2015	57.32 <sup>f-j</sup>	1.86 <sup>bcd</sup>	1.52 <sup>bcd</sup>	4.95 <sup>a-d</sup>	3.88 <sup>d-g</sup>	3.82 <sup>b-e</sup>	2.28 <sup>de</sup>	3.05 <sup>gh</sup>	1.69 <sup>d-h</sup>	1.55 <sup>c-f</sup>
Sugg	70	64	13	2003	2015	57.10 <sup>j</sup>	1.80 <sup>abc</sup>	1.85 <sup>e-h</sup>	4.60 <sup>ef</sup>	3.69 <sup>hi</sup>	3.56 <sup>ghi</sup>	2.37 <sup>d-g</sup>	2.99 <sup>e-h</sup>	1.78 <sup>gh</sup>	1.78 <sup>hij</sup>
Sullivan	53	47	9	2007	2015	58.27 <sup>a-d</sup>	1.91 <sup>bcd</sup>	1.58 <sup>b-e</sup>	5.02 <sup>abc</sup>	3.73 <sup>ghi</sup>	3.85 <sup>b-e</sup>	2.47 <sup>gh</sup>	3.04 <sup>gh</sup>	1.57 <sup>a-g</sup>	1.63 <sup>e-h</sup>
Wynne	55	48	8	2008	2015	57.11 <sup>j</sup>	1.96 <sup>cd</sup>	1.54 <sup>b-e</sup>	4.89 <sup>bcd</sup>	3.78 <sup>e-i</sup>	3.82 <sup>b-e</sup>	2.37 <sup>d-g</sup>	3.09 <sup>h</sup>	1.72 <sup>gh</sup>	1.61 <sup>c-h</sup>
<b>Sensory cks</b>	<b>140</b>	<b>66</b>	<b>25</b>	<b>1985</b>	<b>2015</b>	<b>57.40<sup>β</sup></b>	<b>1.71<sup>α</sup></b>	<b>1.83<sup>γ</sup></b>	<b>4.79<sup>ns</sup></b>	<b>4.13<sup>α</sup></b>	<b>3.63<sup>β</sup></b>	<b>2.17<sup>α</sup></b>	<b>2.87<sup>β</sup></b>	<b>1.70<sup>β</sup></b>	<b>1.68<sup>β</sup></b>
Florunner	71	34	21	1985	2014	57.75 <sup>c-h</sup>	1.82 <sup>abc</sup>	2.11 <sup>j</sup>	4.54 <sup>f</sup>	3.69 <sup>i</sup>	3.38 <sup>i</sup>	2.46 <sup>gh</sup>	2.95 <sup>b-g</sup>	1.78 <sup>gh</sup>	2.07 <sup>k</sup>
Georgia Green	43	33	10	1998	2015	57.22 <sup>f-j</sup>	1.52 <sup>a</sup>	1.89 <sup>fi</sup>	4.55 <sup>f</sup>	4.17 <sup>ab</sup>	3.41 <sup>i</sup>	2.13 <sup>abc</sup>	2.87 <sup>a-f</sup>	1.93 <sup>h</sup>	1.76 <sup>g-j</sup>
Georgia-06G	16	12	3	2013	2015	58.04 <sup>a-g</sup>	1.64 <sup>ab</sup>	2.03 <sup>hij</sup>	4.95 <sup>a-d</sup>	4.31 <sup>a</sup>	3.68 <sup>d-h</sup>	2.11 <sup>abc</sup>	2.88 <sup>a-f</sup>	1.59 <sup>a-g</sup>	1.61 <sup>c-h</sup>
Georgia-09B	10	8	3	2013	2015	56.57 <sup>i</sup>	1.84 <sup>a-d</sup>	1.31 <sup>ab</sup>	5.13 <sup>ab</sup>	4.37 <sup>a</sup>	4.06 <sup>ab</sup>	1.99 <sup>a</sup>	2.80 <sup>ab</sup>	1.50 <sup>a-g</sup>	1.27 <sup>ab</sup>
Mean						57.79	1.53	1.82	4.61	4.14	3.63	1.94	2.63	1.46	1.70
CV (%)						2.0	28.0	22.9	8.9	9.4	10.1	14.3	8.3	30.3	18.8

‡ Fruity attribute intensity and roast color (linear and quadratic) were used as covariates for roaster peanut intensity, fruity for sweet intensity, and fruity and roast color (linear) for bitter intensity.  
 ol, B "ol" denotes lines with the high oleic fatty acid trait in the seed oil; "B" denotes lines with black pods.  
 α,β Type means followed by the same Greek letter are not different (P<0.05) by t-test.  
 a,b,c Type means followed by the same Roman letter are not different (P<0.05) by t-test.  
 ns Denotes means for traits for which the F-test of types or lines was not significant (P<0.05).

## **IMPACT STATEMENT**

This program provides the sensory data that is included among the criteria considered when a cultivar release is contemplated. The result is the release of lines with superior flavor profiles, or at least not diminished profiles. It is not possible to ascribe improved price or sales to improvement of flavor, nor is it possible to assert that the release of cultivars with superior flavor results in greater market share for virginia-type peanuts, but processors of peanuts insist that flavor is their overriding concern. As long as we can obtain funds to continue the program, we will do so.