Developing High-Oleic Peanut Cultivars at North Carolina State University

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An economically important crop in the Virginia-Carolina area ("VC" area, Virginia and North and South Carolina), virginia-type peanut generally is consumed by people directly as in-shell peanuts after roasting or with minimal processing after shelling and roasting. Because it is consumed by humans, consumer-related aspects of quality are more important for this crop than they might be for a feed grain or a highly processed human food. For example, even though no one should eat peanut hulls, "good" pod aesthetics are an objective of the peanut breeding program here as is improvement of roasted seed flavor. Another trait that we feel must be a part of any new cultivar release is the "high-oleic" trait patented by the University of Florida (US Patent Nos. 5,922,390, 6,063,984, and 6,121,472).

Peanut seed oil contains eight main species of fatty acids: palmitic ("16:0" or a16-carbon chain with no double bonds between carbons), stearic (18:0), oleic (18:1), linoleic (18:2), arachidic (20:0), gadoleic (20:1), behenic (22:0), and lignoceric (24:0) fatty acids. In "normal" peanut oil, the two main fatty acid types are oleic and linoleic acids in roughly a 2:1 ratio; together they make up about 80-85% of the fatty acids. In high-oleic types, that ratio could be 10:1 to 30:1, and there is a slight increase in the total of the two concomitant with a decrease in palmitic acid. . Genetically, peanuts with the high-oleic trait lack functional fatty acid dehydrogenase genes that encode the enzyme that converts oleic to linoleic acid. Because peanut is an allotetraploid species, there are actually two such homeologous gene sequences in the two progenitor species' genomes, but one of the non-functional sequences is common in virginia- and runner-type peanuts in the USA, so in crosses within those market types the trait acts as if it is controlled only by the second and rarer gene, *i.e.*, as a trait controlled by a single gene pair[1]. This gene pair is called variously "Ol_2-ol_2" or "*+-ahFAD2B*."

In commercial channels, the trait greatly reduces the oxidation to which linoleic acid is prone, oxidation that produces the aldehydes hexanal and octanal and a noticeable rancid flavor. R. Walton "Walt" Mozingo, formerly at Virginia Tech's Tidewater Agricultural Research and Extension Center at Suffolk, VA, evaluated peroxide value, an indicator of rancidity, in normal and high-oleic peanuts roasted in the shell either with or without salt brining of the pods[2] (Figs. 1, 2). The peanuts were roasted then stored for 36 weeks with sampling for peroxide value determination every two weeks. A peroxide value of 20 or greater indicates rancidity. For the unsalted in-shells, the high-oleic peanuts did not reach a peroxide value near 20 until Week 32 while the normal peanuts did so at Week 4. The effect of the high-oleic trait was even more profound when the in-shells were salted: the high-oleic peanuts did not reach a peroxide value of 20 for the duration of the study while the normal-oleic peanuts reached a value of 84 at the first sampling. Clearly the high-oleic trait confers a great advantage in shelf life over normal-oleic in-shell peanuts.

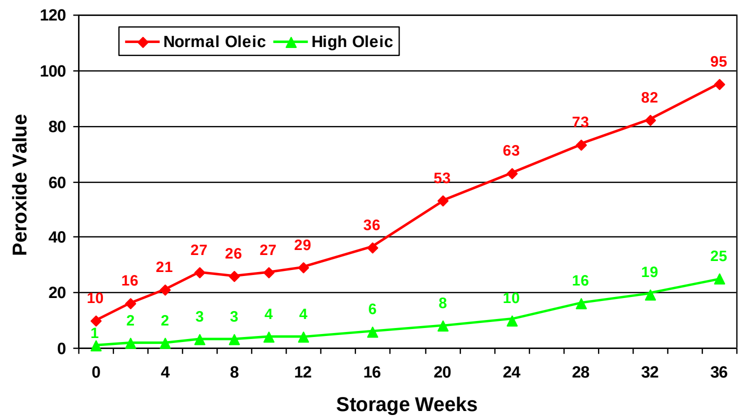

Figure 1. Shelf Life of Roasted Inshell Normal vs. High Oleic Peanuts

1 Isleib, T.G., R.F. Wilson, and W.P. Novitzky. 2006. Partial dominance, pleiotropism, and epistasis in the inheritance of the high-oleate trait in peanut. Crop Sci. 46: 1331-1335. [doi: 10.2135/cropsci2005.09-0313]

2 Mozingo, R.W., S.F. O'Keefe, T.H. Sanders, and K.W. Hendrix. 2004. Improving shelf life of roasted and salted in-shell peanuts using high-oleic fatty acid chemistry. Peanut Sci. 31: 40-45. [doi: 10.3146/pnut.31.1.0009]

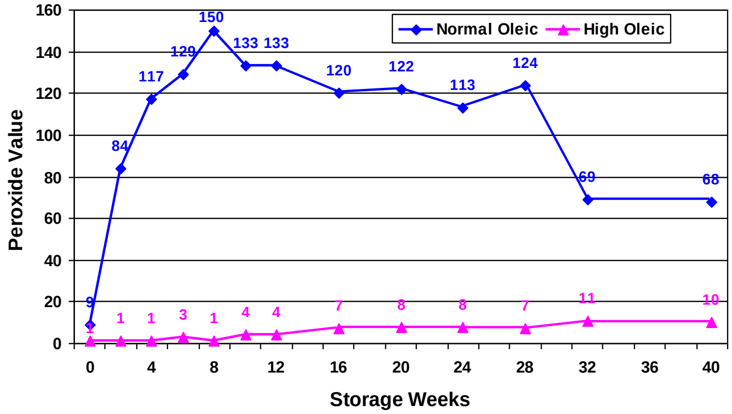

Figure 2. Shelf Life of Salted Inshell Normal vs. High Oleic Peanuts

We adopted development of high-oleic cultivars as a breeding objective in 1990. The trait was first reported by researchers at the Univ. of Florida in the late 1980s, first published by Norden *et al.*[1] in 1987, its inheritance deduced and published by Moore *et al.*[2] in 1989, a follow-up article in 1993[3] with further publications as the molecular nature of the mutation was deduced[4] and new ways of characterizing plants genetically were developed, allowing definitive ascription of specific values to the various possible genotypes[5].

The first high-oleic cultivar, runner-type 'SunOleic 95R'[6] was released in 1995. Unfortunately, SunOleic 95R was derived by backcrossing the high-oleic trait into Univ. of Florida release 'SunRunner'[7], a cultivar that is extremely susceptible to tomato spotted wilt (TSW), a viral disease caused by the *Tomato spotted wilt tospovirus* and vectored by thrips (*Frankliniella fusca* Hinds in the VC area). Release of SunOleic 95R coincided with emergence of TSW as a major problem in the Southeastern US production area (Georgia, Florida, and Alabama), so SunOleic 95R and its sister release derived from additional backcrossing, 'SunOleic 97R'[8], both failed in the seed marketplace. It is not uncommon today to hear a peanut industry worker assert that high-oleic cultivars suffer from susceptibility to TSW even though the susceptibility of SunOleic 95R and SunOleic 97R was due to the susceptibility of the recurrent parent used to make them, not to the high-oleic trait itself. If limited to a description of SunOleic 95R and SunOleic 97R, then the statement is correct: they were extremely susceptible to TSW.

In 1990, we initiated a program of backcrossing the trait into the array of cultivars that dominated production in the state: 'NC 7'[9], 'NC 9'[10], 'NC 10C'[11], and 'NC-V 11'[12]. The initial crosses were made using

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[1] Norden, A.J., D.W. Gorbet, D.A. Knauft, and C.T. Young. 1987. Variability in oil quality among peanut genotypes in the Florida breeding program. Peanut Sci. 14: 7-11. [doi: 10.3146/i0095-3679-14-1-3]

[2] Moore, K.M., and D.A. Knauft. 1989. The inheritance of high oleic acid in peanut. J. Hered. 80: 252-253.

[3] Knauft, D.A., K.M. Moore, and D.W. Gorbet. 1993. Further studies on the inheritance of fatty acid composition in peanut. Peanut Sci. 20: 74-76. [doi: 10.3146/i0095-3679-20-2-2]

[4] Chu, Y., C.C. Holbrook, and P. Ozias-Akins. 2009. Two alleles of *ahFAD2B* control the high oleic acid trait in cultivated peanut. Crop Sci. 49: 2029-2036. [doi: 10.2135/cropsci2009.01.0021]

[5] Barkley, N.A., T.G. Isleib, M.L. Wang, and R.N. Pittman. 2013. Genotypic effect of ahFAD2 on fatty acid profiles in six segregating peanut (*Arachis hypogaea* L.) populations. BMC Genetics 2013, 14: 62. [doi:10.1186/1471-2156-14-62]

[6] Gorbet, D.W., and D.A. Knauft. 1997. Registration of 'SunOleic 95R' peanut. Crop Sci. 37: 1392. [doi: 10.2135/cropsci1997.0011183X003700040081x]

[7] Norden, A.J., D.W, Gorbet, and D.A, Knauft. 1985. Registration of 'Sunrunner' peanut. Crop Sci. 25: 1126. [doi: 10.2135/cropsci1985.0011183X002500060061x]

[8] Gorbet, D.W., and D.A. Knauft. 2000. Registration of 'SunOleic 97R' peanut. Crop Sci. 40: 1190. [doi: 10.2135/cropsci2000.0032rcv]

[9] Wynne, J.C., R.W. Mozingo, and D.A. Emery. 1979. Registration of NC 7 peanut (Reg. No. 22). Crop Sci. 19: 563. [doi: 10.2135/cropsci1979.0011183X001900040037x]

[10] Wynne, J.C., R.W. Mozingo, and D.A. Emery. 1986. Registration of 'NC 9' peanut. Crop Sci. 26: 197. [doi: 10.2135/cropsci1986.0011183X002600010050x]

[11] Wynne, J.C., M.K. Beute, J. Bailey, and R.W. Mozingo. 1991. Registration of 'NC 10C' peanut. Crop Sci. 31: 484. [doi: 10.2135/cropsci1991.0011183X003100020061x]

[12] Wynne, J.C., T.A. Coffelt, R.W. Mozingo, and W.F. Anderson. 1991. Registration of 'NC-V11' peanut. Crop Sci. 31: 484-485. [doi: 10.2135/cropsci1991.0011183X003100020062x]

cultivars as females and Florida breeding line F435-2-3-B-2-1-b4-B-B-3-b3-b3-1-B[5], a spanish-type line that was identified with the high-oleic trait, as a male. That was the line initially identified by Dr. Norden at the Univ. of Florida as having the high-oleic trait, and it was the source of the trait in the Florida program. After we made our initial crosses, the F_1 generation was grown in a winter nursery at Juana Diaz, Puerto Rico in the winter of 1990-1991 (the "Puerto Rico Winter Nursery" or PRWN), the F_2 generation was subjected to single-seed descent in the field at the Peanut Belt Research Station (PBRS) at Lewiston in Bertie Co., NC in 1992, and the F_3 to single-seed descent in the PRWN in the winter of 1992-1993. Individual F_4 plants were harvested in the field at PBRS in 1993, and the $F_{4:5}$ progeny were analyzed for fatty acid profiles using gas chromatography of fatty acid methyl esters. $F_{4:5}$ progeny were tested to improve the probability of recovering a high-oleic family as the gas chromatography used at that stage carried a large cost, over $50 per pooled sample of several seeds per family in the laboratory of Dr. Clyde T. Young in N.C. State Univ.'s Dept. of Food Science. Subsequent assessment of individual seeds was made at trivial per-sample cost by W.P. Novitzky in of Dr. Richard F. Wilson's USDA-ARS Soybean and Biological Nitrogen Fixation research unit at Raleigh, NC, so we were able to examine the BC_nF_2 progeny of individual BC_nF_1 plants. In the summer of 1994, remnant seed of high-oleic $F_{4:5}$ progenies were crossed as males to the cultivars to make the first backcross. The BC_1F_1 plants were grown in the greenhouse in the winter of 1994-1995, and individual BC_1F_2 seeds were analyzed for fatty acid profile using the protocol of Zeile *et al.*[1] in Dr. Wilson's lab. In the summer of 1995, high-oleic BC_1F_2 seeds were planted in the greenhouse at NCSU to be used as females with cultivars as males in the second backcross. The BC_2F_1 plants were grown in the greenhouse in the winter of 1995-1996, and individual BC_2F_2 seeds were analyzed for fatty acid profile. In the summer of 1996, high-oleic BC_2F_2 seeds were planted in the greenhouse at NCSU to be used as females with cultivars as males in the third backcross. Heterozygous BC_3F_1 plants were grown in the greenhouse in the winter of 1996-1997 and crossed as females to cultivars in the fourth backcross. Individual BC_4F_1 seeds were analyzed for fatty acid profile, the heterozygotes carrying the partially recessive high-oleic gene identified, and those seeds planted in the greenhouse in the summer of 1997. Individual BC_4F_2 seeds were analyzed for fatty acid profile, and the high-oleic seeds were grown in the PRWN in the winter of 1998-1999. $BC_4F_{2:3}$ families were grown in a replicated yield test (the High-Oleic Preliminary Yield Test) at PBRS in 1999. Families were numbered with "N" numbers upon entry into the NCSU Advanced Yield Test. We continued to test them as their performance warranted.

As new cultivars came on line, we also started backcrossing the trait into them including 'VA-C 92R'[2], 'NC 12C'[3], 'Gregory'[4], and 'Perry'[5]. Because of the poor crossing success rate common in the greenhouse in the winter, we typically made crosses in the summer when success rates are higher, then allowed the hybrid plants to self-fertilize in the winter greenhouse and tested the individual F_2 seeds nondestructively for the high oleic trait using Zeile *et al.*'s method. Most of the high-oleic backcross derivatives were not better agronomically than their recurrent parents. Their testing coincided with the growers' realization that although they were making grants for development of high-oleic cultivars, the Univ. of Florida patent would require them to pay 2.6¢ per pound of seed (or more as Florida demands that 2.6¢ lb^{-1} be returned to them; it is customary for the collection agency to take a small percentage of the revenue as a finder's fee). The growers angrily discontinued their funding of high-oleic development work. Between this end of funding and the end of the quota pricing system with the Food Security and Rural Investment Act of 2002, release of lines with resistance to multiple diseases appeared to be a more important objective than was release of high-oleic cultivars. We released the high-oleic line with the most promise [N00090ol (7)], the backcross derivative of NC 7 that we named 'Brantley'[6], and focused on disease resistance with the releases of 'Bailey'[1] and 'Sugg'[2]. We abandoned

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1 Zeile, W.L., D.A. Knauft, and C.B. Kelly. 1993. A rapid non-destructive technique for fatty acid determination in individual peanut seed. Peanut Sci. 20: 9-11. [doi: 10.3146/i0095-3679-20-1-3]

2 Mozingo, R.W., J.C. Wynne, D.M. Porter, T.A. Coffelt, and T.G. Isleib. 1994. Registration of 'VA-C 92R' peanut. Crop Sci. 34: 539. [doi: 10.2135/cropsci1994.0011183X003400020051x]

3 Isleib, T.G., P.W. Rice, J.E. Bailey, R.W. Mozingo, and H.E. Pattee. 1997. Registration of 'NC 12C' peanut. Crop Sci. 37: 1976. [doi: 10.2135/cropsci1997.0011183X003700060051x]

4 Isleib, T.G., P.W. Rice, R.W. Mozingo, R.W. Mozingo II, and H.E. Pattee. 1999. Registration of 'Gregory' peanut. Crop Sci. 39: 1526. [doi: 10.2135/cropsci1999.0001rcv]

5 Isleib T.G., P.W. Rice, R.W. Mozingo II, J.E. Bailey, R.W. Mozingo, and H.E. Pattee. 2003. Registration of 'Perry' peanut. Crop Sci. 43: 739-740. [doi: 10.2135/cropsci2003.7390]

6 Isleib, T.G., P.W. Rice, R.W. Mozingo II, S.C. Copeland, J.B. Graeber, W.F. Novitzky, H.E. Pattee, T.H. Sanders, R.W. Mozingo, and D.L. Coker. 2006. Registration of 'Brantley' peanut. Crop Sci. 46: 2309-2311. [doi: 10.2135/cropsci2005.12.0492]

our efforts to backcross the trait into existing cultivars and opted instead to make crosses of disease-resistant lines with agronomically superior ones, making sure that at least one parent had the trait, and checking all selections from putatively segregating progeny of heterozygous plants for the trait. Our last three releases, ‘Sullivan’, ‘Wynne’, and ‘Emery’, combine fair disease resistance and agronomic performance with the trait. Because Bailey became so commercially successful yet was normal-oleic, we did initiate a formal backcrossing program with Bailey as the recurrent parent in hopes of obtaining a line combining the high yield and disease resistance of Bailey with the high-oleic trait. Otherwise, it is customary for us to identify the most all-around disease resistant lines and a set of the “best” agronomic lines, mate them in factorial fashion in the winter greenhouse, then cross the F_1 hybrids back to the agronomically superior parent in the summer greenhouse where crossing success rate is higher. We assume that there are more genes involved in producing the agronomic superiority than there are for the various disease resistances, and a single backcross to the parent contributing a higher proportion of “good” alleles to a cross will almost never hurt one’s chances of recovering a line better than either parent[3].

Seed of putatively high-oleic cultivars frequently becomes contaminated with normal-oleic seed in commercial channels. There are many opportunities for mixture: commercial pod transfer devices, pod sorting equipment, shelling machines, and seed sorting, treating, and bagging devices may afford chances for mixture if not watched carefully. Therefore, wholesale conversion of all cultivars in an area to the high-oleic trait is a condition for maintaining purity. If all cultivars are high-oleic, then even if there is contamination of one cultivar’s seed with another’s, the seed would all be high-oleic. The transition to an all-high-oleic crop is a difficult one, made more so by the necessity of collecting and paying the royalty to Florida for the trait, and therefore it is no wonder that seed companies resist the extra work and expense required of them to make the conversion and maintain purity of the trait. They are likely to give voice to their apprehensions. If one keeps one’s ears open when peanut industry representatives convene, one still hears the most amazing statements made about high-oleic cultivars. First, a rep might repeat the canard that high-oleic cultivars are more susceptible to TSW than are normal-oleic ones. Another oft-heard statement is that the flavor of high-oleic cultivars is inferior to that of normal-oleic lines. Because of the USDA’s quality assessment program conducted as part of the Uniform Peanut Performance Test, that statement was testable and proved to be false[4].

Another statement one hears is that the lessened amount of linoleic fatty acid results in an increase in the melting point of stored lipids and membrane lipids. This is true, and one might think that the phenomenon would result in inability of seeds to germinate properly under cool conditions. When temperatures are low, seed oil and membrane lipids may not be fully fluid. Dr. Kelly Chamberlin of the USDA-ARS Wheat, Peanut and Other Field Crops Research unit at Stillwater, Okla., has observed slower germination and emergence of her high-oleic runner-type release ‘Red River Runner’[5] under cold spring temperatures, but published research on the phenomenon is rare and related the temperature of the seed production environment rather than the temperature under which germination occurred[6].

One sometimes hears that high-oleic lines are agronomically “worse” than normal-oleic lines. Again, examination of the results of the Uniform Peanut Performance Tests over time negates this suggestion. If anything, high-oleic lines exhibit some superiority compared to normal-oleic lines with respect to yield and grade, but there is variation among both types of lines. Because most peanut breeding programs in the USA have adopted development of high-oleic lines as an objective, any comparison of the two types often involves

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1 Isleib, T.G., S.R. Milla-Lewis, H.E. Pattee, S.C. Copeland, M.C. Zuleta, B.B. Shew, J.E. Hollowell, T.H. Sanders, L.O. Dean, K.W. Hendrix, M. Balota, and J.W. Chapin. 2011. Registration of ‘Bailey’ peanut. J. Plant Regist. 5: 27-39. [doi:10.3198/jpr2009.12.0742crc]

2 Isleib, T.G., S.R. Milla-Lewis, H.E. Pattee, S.C. Copeland, M.C. Zuleta, B.B. Shew, J.E. Hollowell, T.H. Sanders, L.O. Dean, K.W. Hendrix, M. Balota, J.W. Chapin, and W.S. Monfort. 2015. Registration of ‘Sugg’ peanut. J. Plant Regist. 9: 44-52. [doi:10.3198/jpr2013.09.0059crc]

3 Isleib, T.G., R.F. Wilson, and W.P. Novitzky. 2006. Partial dominance, pleiotropism, and epistasis in the inheritance of the high-oleate trait in peanut. Crop Sci. 46: 1331-1335. [doi: 10.2135/cropsci2005.09-0313]

4 Isleib, T.G., H.E. Pattee, R.S. Tubbs, T.H. Sanders, L.O. Dean, and K.W. Hendrix. 2015. Intensities of sensory attributes in high- and normal-oleic cultivars in the Uniform Peanut Performance Test. Peanut Sci. 42: 83-91. [doi: 10.3146/0095-3679-42.2.83]

5 Melouk, H.A., K. Chamberlin, C.B. Godsey, J. Damicone, M.D. Burow, M.R. Baring, C.E. Simpson, K.E. Dashiell, and M. Payton. Registration of ‘Red River Runner’ peanut. J. Plant Regist. [doi: 10.3198/jpr2012.03.0174crc]

6 Sun, M. J.F. Spears, T.G. Isleib, D.L. Jordan, B. Penny, D. Johnson, and S. Copeland. 2014. Effect of production environment on seed quality of normal and high-oleate large seeded virginia-type peanut (*Arachis hypogaea* L.). Peanut Sci. 41: 90-99. [doi: 10.3146/PS12-16.1]

older normal-oleic lines and newer high-oleic ones. Comparison is possible because of overlap of the presence of the two types in the testing program and because the same check cultivars, NC 7 and ‘Florunner’[1], were used for years. As breeders make slow improvement of yield and grade over time, it is to be expected that newer lines will on average out-perform older ones. Regional testing of backcross-derived high oleics with their normal-oleic recurrent parents is rare. Brantley and NC 7 were entered in the UPPT at the same time as were ‘Georgia-09B’[2] and ‘Georgia Green’[3], but not for long. Because we developed a number of high-oleic backcross derivatives from common virginia-type cultivars, we can make several such comparisons using means stored in our database of results from in-state trials.

We extracted means from our separate databases for agronomic performance (yield and grade factors), disease reactions, and flavor. We found no consistent significant ($P \leq 0.05$) effect of the high-oleic trait for agronomic traits (Tables 1a, 1b) except that high-oleic backcross derivatives had lower content of farmer stock fancy pods than the normal-oleic recurrent parent (72.5 vs. 76.5%, $P \leq 0.0001$) and lower content of jumbo pods (37.1 vs. 41.5%, $P \leq 0.0001$). We attribute his reduction of pod diameter to use of the small-seeded Spanish line as non-recurrent parent. There was not a corresponding reduction in weight of 100 pods suggesting that the difference more reflected pod diameter than pod weight. The high oleic lines actually exhibited small increases above their recurrent parents for total sound mature kernel content (68.9 vs. 68.3%, $P=0.0042$) and the correlated trait meat content (71.4 vs. 70.8%, $P=0.0045$). For many traits, there was interaction between background genotype and oleic acid level so that there were differences between the high-oleic line and its specific recurrent parent, but the direction of change was not consistent in most cases. This underscores the difficulty of recovering exactly the phenotype of the recurrent parent in a formal backcrossing program. With regard to disease reactions (Table 2), we again did not find consistent effect of the high-oleic trait. With regard to flavor, the high-oleic trait was associated with small increases in the intensities of three negative sensory attributes (Table 3): over-roast [1.86 vs. 1.52 flavor intensity units (fiu), $P=0.0036$], bitter aftertaste (2.52 vs. 2.33 fiu, $P=00180$), and tongue / throat burn (2.25 vs. 2.10 fiu, $P=0.0161$). The critical sensory traits roasted peanut, sweet, nutty aftertaste, and bitter were not affected.

The only important aspect of peanuts we have found that might be influenced by the high-oleic trait is that backcross-derived high oleics supported about 80% more production of aflatoxin, the acutely toxic and teratogenic mycotoxin produced by *Aspergillus flavus* and *A. parasiticus*. These fungi are ubiquitous in the soil, and virtually every peanut grown anywhere is inoculated. Fortunately, peanut is not susceptible to colonization of seeds and production of aflatoxin unless one of two things happens: (1) The plant is subjected to drought stress late in the season before harvest as the pods are filling, leading to so-called “preharvest” aflatoxin contamination. (2) Mature peanuts are stored under conditions amenable to growth of the fungi, *i.e.*, conditions with free water or high water activity leading to “post-harvest” aflatoxin contamination. The latter is the greater problem in the VC area; the former is more important in the Southeastern and Southwestern production areas of the USA. As part of her doctoral research, Dr. Huiqin Xue examined the latter problem by inoculating moistened, sectioned seeds under controlled conditions, comparing backcross-derived high-oleic lines with their normal-oleic recurrent parents[4]. The high-oleic backcross derivatives supported much more aflatoxin production underscoring the importance of storing high-oleic peanuts under conditions that militate against growth of toxigenic *Aspergillus*. We have been assured by VC area shellers that they are well aware of how to best store peanuts to avoid *Aspergillus* growth, but some peanuts are rejected for sale each year because chemical testing reveals that their aflatoxin levels exceed the allowance mandated by federal law. Whatever level of post-harvest aflatoxin contamination occurs in the current normal-oleic crop, it is likely that the problem will be worse once we have converted to an all high-oleic crop.

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[1] Norden, A.J., R.W. Lipscomb, and W.A. Carver. 1969. Registration of Florunner peanuts (Reg. No. 2). Crop Sci. 9: 850. [doi: 10.2135/cropsci1969.0011183X000900060070x]

[2] Branch, W.D. 2010. Registration of ‘Georgia-09B’ peanut. J. Plant Regist. 4: 175-178. [doi: 10.3198/jpr2009.12.0693crc]

[3] Branch, W.D. 1996. Registration of ‘Georgia Green’ peanut. Crop Sci. 36(3): 806. [doi: 10.2135/cropsci1996.0011183X003600030051x]

[4] Xue, H.Q., T.G. Isleib, G.A. Payne, R.F. Wilson, W.P. Novitzky, and G. Obrian. 2003. Comparison of aflatoxin production in normal- and high-oleic backcross-derived peanut lines. Plant Dis. 87: 1360-1365. [doi: 10.1094/PDIS.2003.87.11.1360]

Table 1a. Comparison of high- and normal-oleic lines tested in the N.C. State Univ. trials. Pod characteristics.

Base genotype, oleic acid level	Extent of testing: No. tests	Years: No.	Years: First	Years: Last	Foreign material	Loose shelled kernels	Weight of 100 pods	Farmer stock fancy pods	Weighted average hull brightness	Jumbo-to-fancy ratio	Jumbo pods: Content	Jumbo pods: Brightness	Jumbo pods: Redness	Jumbo pods: Yellowness	Fancy pods: Content	Fancy pods: Brightness	Fancy pods: Redness	Fancy pods: Yellowness
				%	*%*	*g*	*%*	*Hunter L score*		*%*	*Hunter L score*	*Hunter a score*	*Hunter b score*	*%*	*Hunter L score*	*Hunter a score*	*Hunter b score*	
All, High	**191**	**13**	**1999**	**2011**	**1.1**^{NS}	**0.6**^{NS}	**239.9**^{NS}	**72.5****	**45.1**^{NS}	**1.32**^{NS}	**37.1****	**43.6**^{NS}	**3.4****	**14.4**^{NS}	**35.4**^{NS}	**44.4**^{NS}	**3.5**†	**14.5**^{NS}
All, Normal	**453**	**16**	**1999**	**2014**	**1.1**	**0.6**	**241.7**	**76.5**	**45.1**	**1.36**	**41.5**	**45.0**	**3.6**	**14.9**	**35.0**	**44.2**	**3.6**	**14.5**
NC 7, High	56	12	2000	2011	1.0$^{cd\ NS}$	0.7$^{cde\ NS}$	267.2$^{a\ *}$	80.1$^{b\ *}$	44.8$^{def\ *}$	2.16$^{b\ *}$	53.1$^{b\ **}$	45.8$^{a\ \dagger}$	3.6$^{def\ NS}$	15.2$^{a\ *}$	27.2$^{f\ NS}$	42.2$^{g\ NS}$	3.5$^{a\ NS}$	13.7$^{ef\ NS}$
NC 7, Normal	74	16	1999	2014	1.0^{bc}	0.8^{de}	260.1^{b}	77.5^{cd}	44.4^{g}	1.85^{c}	48.9^{c}	45.1^{abc}	3.7^{f}	14.9^{bc}	28.7^{f}	42.3^{g}	3.5^{ab}	13.8^{e}
NC 9, High	34	10	1999	2008	0.8$^{ab\ NS}$	0.5$^{abc\ NS}$	224.1$^{f\ *}$	70.1$^{f\ **}$	46.1$^{a\ NS}$	0.48$^{f\ **}$	24.1$^{j\ **}$	42.9$^{e\ **}$	3.4$^{bc\ NS}$	14.1$^{d\ **}$	45.8$^{a\ **}$	47.3$^{a\ **}$	3.6$^{ab\ NS}$	15.5$^{a\ **}$
NC 9, Normal	27	6	1999	2004	1.0^{a-d}	0.5^{abc}	234.5^{de}	77.9^{bcd}	46.0^{ab}	1.08^{e}	40.4^{ef}	45.8^{a}	3.5^{bcd}	15.0^{abc}	37.4^{d}	45.7^{bcd}	3.5^{ab}	14.9^{bc}
NC 10C, High	18	5	1999	2003	1.8$^{e\ **}$	0.5$^{abc\ NS}$	191.6$^{g\ **}$	47.0$^{g\ **}$	44.5$^{efg\ **}$	0.08$^{g\ *}$	6.8$^{k\ **}$	37.2$^{f\ **}$	3.0$^{a\ **}$	12.1$^{e\ **}$	40.2$^{cd\ \dagger}$	46.4$^{abc\ NS}$	3.5$^{ab\ NS}$	15.3$^{ab\ NS}$
NC 10C, Normal	23	5	1999	2003	1.1^{bcd}	0.4^{ab}	217.2^{f}	72.8^{ef}	46.2^{a}	0.56^{f}	29.8^{hi}	45.1^{abc}	3.5^{b-e}	14.9^{abc}	43.1^{abc}	46.6^{ab}	3.5^{ab}	15.4^{a}
NC-V 11, High	14	4	2002	2005	0.8$^{abc\ \dagger}$	0.3$^{a\ NS}$	228.2$^{ef\ NS}$	76.4$^{cde\ **}$	46.6$^{a\ **}$	0.88$^{ef\ NS}$	34.5$^{gh\ **}$	45.4$^{abc\ **}$	3.4$^{bcd\ NS}$	15.0$^{abc\ **}$	42.1$^{bc\ NS}$	47.0$^{a\ **}$	3.4$^{a\ *}$	15.6$^{a\ **}$
NC-V 11, Normal	72	15	1999	2013	1.1^{cd}	0.5^{abc}	226.1^{f}	71.8^{f}	45.0^{de}	0.65^{f}	27.8^{i}	43.6^{de}	3.6^{def}	14.3^{d}	43.8^{ab}	45.5^{cd}	3.6^{b}	14.9^{c}
NC 12C, High	11	3	2000	2002	1.0$^{a-d\ NS}$	1.1$^{e\ NS}$	274.7$^{a\ **}$	81.2$^{ab\ **}$	43.6$^{h\ **}$	3.09$^{a\ **}$	58.8$^{a\ **}$	44.2$^{b-e\ NS}$	3.6$^{b-f\ NS}$	14.4$^{cd\ *}$	22.3$^{g\ **}$	38.8$^{i\ **}$	3.4$^{a\ \dagger}$	12.5$^{g\ **}$
NC 12C, Normal	48	13	1999	2011	1.2^{d}	0.9^{e}	242.6^{cd}	75.4^{de}	45.2^{cd}	1.28^{de}	41.9^{de}	45.4^{ab}	3.6^{def}	15.0^{ab}	33.4^{e}	44.2^{ef}	3.6^{ab}	14.4^{d}
Gregory, High	32	9	2000	2008	0.7$^{a\ *}$	0.8$^{de\ NS}$	258.4$^{b\ \dagger}$	78.2$^{bc\ **}$	45.5$^{bc\ **}$	1.48$^{d\ **}$	45.3$^{d\ **}$	45.4$^{ab\ NS}$	3.4$^{b\ *}$	14.9$^{abc\ NS}$	33.1$^{e\ **}$	44.9$^{de\ **}$	3.4$^{a\ NS}$	14.5$^{cd\ **}$
Gregory, Normal	117	15	1999	2013	1.0^{bc}	0.7^{cd}	265.2^{ab}	82.2^{a}	44.6^{fg}	2.67^{a}	57.2^{a}	45.4^{ab}	3.5^{cde}	15.0^{ab}	24.8^{g}	41.5^{h}	3.5^{a}	13.6^{f}
Perry, High	26	7	2002	2008	1.6$^{e\ **}$	0.5$^{abc\ NS}$	234.8$^{de\ **}$	74.6$^{e\ **}$	44.6$^{efg\ NS}$	1.08$^{e\ *}$	37.5$^{fg\ **}$	44.4$^{bcd\ NS}$	3.6$^{def\ NS}$	14.8$^{abc\ NS}$	37.1$^{d\ **}$	44.2$^{ef\ NS}$	3.7$^{b\ NS}$	14.6$^{cd\ NS}$
Perry, Normal	92	15	1999	2013	1.0^{bc}	0.6^{bcd}	246.0^{c}	77.9^{bcd}	44.4^{fg}	1.47d	44.3^{d}	44.3^{cd}	3.6^{ef}	14.8^{bc}	33.5^{e}	43.7^{f}	3.6^{b}	14.4^{d}
Mean					**1.0**	**0.6**	**248.6**	**79.7**	**44.4**	**1.72**	**47.0**	**44.5**	**3.5**	**14.4**	**32.6**	**42.9**	**3.5**	**13.8**
CV (%)					**57.3**	**84.5**	**6.8**	**6.5**	**2.5**	**38.3**	**17.3**	**4.7**	**9.0**	**5.7**	**15.8**	**4.3**	**9.1**	**5.6**

a,b,c Line means followed by the same letter are not different (P≤0.05) by t-test.

NS,†,*,** Denote means for high-oleic lines that are not different from the mean for the paired normal-oleic line or different at P≤0.10, P≤0.05, and P≤0.00, respectively, by t-test.

Table 1b. Comparison of high – and normal-oleic lines tested in the N.C. State Univ. trials. Seed characteristics, pod yield, support price, and crop value.

Base genotype, Oleic acid level	Extent of testing: No. of tests	Years: No.	Years: First	Years: Last	Weight of 100 seeds	Super-extra large kernels	Extra large kernels	Sound mature kernels	Sound splits	Total sound mature kernels	Other kernels	Meat content	Support price	Pod yield	Crop value
					g	%							*¢lb*$^{-1}$	*lb A*$^{-1}$	*\$ A*$^{-1}$
All, High	**191**	**13**	**1999**	**2011**	**$86.7^{\dagger}$**	**11.6^{NS}**	**35.2^{NS}**	**$65.0^{\dagger}$**	**4.4^{NS}**	**68.9^{**}**	**2.5^{NS}**	**71.4^{**}**	**17.84^{NS}**	**2848^{NS}**	**508^{NS}**
All, Normal	**453**	**16**	**1999**	**2014**	**87.6**	**12.8**	**35.6**	**64.6**	**3.8**	**68.3**	**2.5**	**70.8**	**17.62**	**2931**	**514**
NC 7, High	56	12	2000	2011	$95.4^{ab\ *}$	$22.9^{a\ **}$	$46.3^{a\ **}$	$65.9^{ab\ NS}$	$3.7^{b\ NS}$	$69.3^{ab\ NS}$	$1.9^{a\ NS}$	$71.3^{bc\ NS}$	$18.08^{ab\ NS}$	$2982^{bcd\ NS}$	$539^{bc\ NS}$
NC 7, Normal	74	16	1999	2014	93.0^{c}	18.8^{b}	43.8^{b}	66.0^{ab}	3.6^{b}	69.3^{ab}	2.1^{ab}	71.4^{bc}	18.05^{ab}	2861^{cd}	516^{bcd}
NC 9, High	34	10	1999	2008	$82.1^{g\ **}$	$8.7^{e\ NS}$	$33.8^{e\ **}$	$65.6^{abc\ **}$	$5.0^{f\ **}$	$69.8^{a\ **}$	$2.4^{cd\ **}$	$72.3^{a\ **}$	$18.10^{ab\ **}$	$2986^{a-d\ NS}$	$541^{abc\ *}$
NC 9, Normal	27	6	1999	2004	85.6^{f}	9.7^{cde}	29.6^{f}	63.7^{e}	4.0^{bc}	67.6^{e}	2.9^{fg}	70.5^{d}	17.35^{e}	2800^{cd}	480^{de}
NC 10C, High	18	5	1999	2003	$72.3^{i\ **}$	$7.7^{cde\ NS}$	$19.3^{g\ \dagger}$	$64.7^{cde\ **}$	$5.2^{f\ **}$	$69.3^{abc\ **}$	$3.0^{gh\ \dagger}$	$72.3^{a\ **}$	$17.60^{de\ **}$	$2990^{a-d\ \dagger}$	$528^{a-d\ **}$
NC 10C, Normal	23	5	1999	2003	77.5^{h}	7.1^{de}	16.9^{g}	61.2^{f}	4.0^{bc}	65.9^{f}	3.4^{h}	69.3^{e}	16.55^{f}	2681^{d}	431^{ef}
NC-V 11, High	14	4	2002	2005	$82.0^{g\ NS}$	$6.6^{e\ NS}$	$28.8^{f\ **}$	$63.7^{e\ *}$	$5.0^{ef\ **}$	$68.1^{cde\ NS}$	$2.9^{efg\ \dagger}$	$71.0^{bcd\ NS}$	$17.55^{de\ NS}$	$2793^{bcd\ NS}$	489c$^{de\ NS}$
NC-V 11, Normal	72	15	1999	2013	84.0^{fg}	7.4^{e}	32.2^{e}	64.9^{cd}	3.7^{bc}	68.5^{cd}	2.6^{cde}	71.0^{cd}	17.63^{d}	3035^{abc}	533^{bc}
NC 12C, High	11	3	2000	2002	$97.0^{a\ **}$	--	$42.9^{b\ NS}$	$64.7^{b-e\ *}$	$4.2^{bcd\ NS}$	$68.0^{cde\ **}$	$2.0^{ab\ NS}$	$70.0^{de\ **}$	$17.86^{a-d\ \dagger}$	$2085^{e\ **}$	$364^{f\ **}$
NC 12C, Normal	48	13	1999	2011	88.3^{e}	--	43.6^{b}	66.2^{a}	4.1^{c}	69.8^{a}	2.1^{ab}	71.9^{ab}	18.20^{a}	3034^{abc}	550^{abc}
Gregory, High	32	9	2000	2008	$93.2^{bc\ NS}$	$11.5^{cd\ **}$	$38.7^{c\ **}$	$65.0^{cd\ *}$	$4.5^{de\ **}$	$68.8^{bcd\ NS}$	$2.3^{bc\ *}$	$71.1^{cd\ NS}$	$17.94^{bc\ NS}$	$2966^{bcd\ *}$	$531^{bcd\ *}$
Gregory, Normal	117	15	1999	2013	94.2^{abc}	21.7^{a}	46.1^{a}	65.9^{ab}	3.2^{a}	69.0^{bc}	2.0^{ab}	71.0^{cd}	17.96^{bc}	3202^{a}	578^{a}
Perry, High	26	7	2002	2008	$84.5^{fg\ **}$	$12.3^{c\ NS}$	$36.4^{d\ NS}$	$65.3^{a-d\ \dagger}$	$3.5^{ab\ NS}$	$68.7^{bcd\ NS}$	$2.8^{efg\ NS}$	$71.5^{abc\ \dagger}$	$17.77^{cd\ NS}$	$3133^{ab\ \dagger}$	$561^{ab\ \dagger}$
Perry, Normal	92	15	1999	2013	90.5^{d}	12.3^{c}	37.0^{d}	64.5^{de}	3.7^{b}	68.2^{de}	2.7^{def}	70.9^{cd}	17.62^{d}	2906^{bcd}	512^{bcd}
Mean					88.2	15.6	38.9	66.2	3.6	69.4	2.2	71.6	18.00	3260	588
CV (%)					5.5	25.4	10.3	2.9	25.1	2.5	26.4	2.3	2.7	17.0	18.1

a,b,c Line means followed by the same letter are not different (P≤0.05) by t-test.

NS,†,*,** Denote means for high-oleic lines that are not different from the mean for the paired normal-oleic line or different at P≤0.10, P≤0.05, and P≤0.01, respectively, by t-test.

Table 2. Comparison of high – and normal-oleic lines tested in the N.C. State Univ. trials. Disease incidence.

	Leaf spots[§]							Cylindrocladiumblack rot[§§]					Sclerotinia blight[§§§]					Tomato spotted wilt[§§§§]				
	Extent of testing						Pod yield	Extent of testing					Extent of testing					Extent of testing				
Base genotype,	No. of	Years			Defol-	No.of	without	No. of	Years			Inci-	No. of	Years			Inci-	No. of	Years			Inci-
oleic acid level	tests	No.	First	Last	iation	tests	spray	tests	No.	First	Last	dence	tests	No.	First	Last	Sminor	tests	No.	First	Last	dence
					%		*lb A⁻¹*					*%*					*%*					*%*
All, high	**49**	**13**	**2000**	**2014**	**59.7^{NS}**	**46**	**2537^{NS}**	**36**	**9**	**2003**	**2014**	**67.4^{NS}**	**27**	**7**	**2003**	**2014**	**-5.9^{NS}**	**67**	**13**	**2000**	**2014**	**-6.9^{NS}**
All, normal	**134**	**13**	**2000**	**2012**	**61.8**	**107**	**2468**	**72**	**8**	**2003**	**2011**	**68.1**	**61**	**7**	**2003**	**2012**	**-6.6**	**203**	**13**	**2000**	**2012**	**-6.9**
NC 7, high	16	12	2001	2014	$62.0^{\text{cde NS}}$	13	$2584^{\text{abc NS}}$	13	9	2003	2014	$76.2^{\text{ns NS}}$	10	7	2003	2014	$-7.0^{\text{bc NS}}$	23	12	2001	2014	$-6.4^{\text{d NS}}$
NC 7, normal	13	9	2000	2008	$59.7^{\text{a-d}}$	12	2411^{abc}	8	6	2003	2008	62.7^{ns}	5	4	2003	2008	-7.4^{ab}	19	9	2000	2008	-6.8^{cd}
NC 9, high	9	9	2000	2008	$59.0^{\text{a-d *}}$	9	$2924^{\text{a *}}$	6	6	2003	2008	$68.4^{\text{ns NS}}$	4	4	2003	2008	$-6.7^{\text{a-d NS}}$	13	9	2000	2008	$-7.4^{\text{abc *}}$
NC 9, normal	5	4	2000	2007	67.5^{e}	4	2058^{c}	3	3	2003	2007	76.0^{ns}	2	2	2003	2004	-5.4^{bcd}	15	5	2000	2007	-6.1^{d}
NC 10C, high	4	4	2000	2003	$64.4^{\text{b-e NS}}$	4	$2455^{\text{abc NS}}$	1	1	2003	2003	$63.7^{\text{ns NS}}$	1	1	2003	2003	$-3.3^{\text{cd *}}$	4	3	2000	2003	$-5.5^{\text{d NS}}$
NC 10C, normal	4	3	2000	2002	65.9^{de}	4	2143^{bc}	2	2	2003	2004	65.4^{ns}	2	2	2003	2004	-3.9^{d}	7	4	2000	2004	-6.5^{cd}
NC-V 11, high	3	3	2003	2005	$63.6^{\text{b-e NS}}$	3	$2121^{\text{abc NS}}$	3	3	2003	2005	$67.7^{\text{ns NS}}$	2	2	2003	2004	$-4.9^{\text{bcd *}}$	4	3	2003	2005	$-8.0^{\text{abc NS}}$
NC-V 11, normal	26	13	2000	2012	63.3^{de}	20	2601^{abc}	17	8	2003	2011	73.2^{ns}	16	7	2003	2012	-7.2^{b}	38	13	2000	2012	-7.6^{bc}
NC 12C, high	2	2	2001	2002	$49.4^{\text{a NS}}$	2	$2452^{\text{abc NS}}$	--	--	--	--	--	--	--	--	--	--	3	2	2001	2002	$-5.2^{\text{d NS}}$
NC 12C, normal	24	12	2000	2011	57.1^{ab}	21	2800^{ab}	--	--	--	--	--	--	--	--	--	--	31	12	2000	2011	-6.5^{cd}
Gregory, high	8	8	2001	2008	$67.0^{\text{e †}}$	8	$2484^{\text{abc NS}}$	6	6	2003	2008	$66.8^{\text{ns NS}}$	4	4	2003	2008	$-6.6^{\text{a-d NS}}$	11	8	2001	2008	$-8.1^{\text{ab NS}}$
Gregory, normal	29	13	2000	2012	61.4^{cde}	21	2592^{abc}	20	8	2003	2011	64.0^{ns}	17	7	2003	2012	-7.6^{ab}	46	13	2000	2012	-8.2^{a}
Perry, high	7	6	2003	2008	$52.8^{\text{a NS}}$	7	$2739^{\text{abc NS}}$	7	6	2003	2008	$61.8^{\text{ns **}}$	6	4	2003	2008	$-6.9^{\text{abc **}}$	9	6	2003	2008	$-7.6^{\text{abc *}}$
Perry, normal	33	13	2000	2012	57.8^{abc}	25	2671^{abc}	22	8	2003	2011	67.0^{ns}	19	7	2003	2012	-8.4^{a}	47	13	2000	2012	-6.3^{d}
Mean					61.1		2637					59.5					-8.5					-6.6
CV (%)					9.5		22.0					25.2					41.6					22.9

§ Leaf spots caused by foliar fungi *Cercospora arachidicola* and *Cercosporidium personatum* causes defoliation and yield reduction. Defoliation and yield were measured in two-rep trials of cultivars and breeding lines grown without fungicidal spray protection at the Peanut Belt Research Station (PBRS) at Lewiston, NC.

§§ Incidence of CBR caused by soil-borne fungus *Cylindrocladium parasiticum* measured in two- or three-rep trials on infested soil at the Upper Coastal Plain Research Station (UCPRS) at Rocky Mount, NC, without fumigation with metam sodium. Incidence measured as the fraction of emerged plants composed of symptomatic ones.

§§§ Incidence of Sclerotinia blight caused by soil-borne fungus *S. minor* measured infested soil at UCPRS or various sites in Bertie, Chowan and Northampton Counties, NC, without foliar protectant sprays fluazinam (Omega® 500F) or boscalid (Endura®).

§§§§ Incidence of tomato spotted wilt caused by thrips-borne foliar *Tomato spotted wilt tospovirus* measured in two- or three-rep trials using 20-inch seed spacing with no use of insecticides to control tobacco thrips (*Frankliniella fusca*), the vector of TSW in the Virginia-Carolina area.

ns F-tests for variation between oleic acid levels, among background genotypes, and their interaction was not significant (P≤0.05).

a,b,c Line means followed by the same letter are not different (P≤0.05) by t-test.

NS,†,*,** Denote means for high-oleic lines that are not different from the mean for the paired normal-oleic line or different at P≤0.10, P≤0.05, and P≤0.01, respectively, by t-test.

Table 3. Comparison of high- and normal-oleic lines tested in the N.C. State Univ. trials. Flavor.

Base genotype, oleic acid level	Extent of testing: Samples	No. tests	Years: No.	First	Last	Roast color	Sensory attribute: Over-roast	Under roast	Roasted peanut§	Sweet	Nutty after-taste	Bitter§	Bitter after-taste	Wood / hulls / skins	Astrin-gent	Tongue / throat burn	Stale / card-board	Fruity / fer mented	Painty	Moldy
						CIELAB L score*	*flavor intensity units (fiu), 1=not perceptible to 14=most intense*													
All, high	**49**	**22**	**8**	**2000**	**2009**	**57.68^{NS}**	**1.86****	**2.10^{NS}**	**4.46^{NS}**	**3.49^{NS}**	**3.46^{NS}**	**2.46†**	**2.52***	**3.30^{NS}**	**2.98***	**2.25***	**1.54^{NS}**	**1.23^{NS}**	**1.00^{NS}**	**1.05^{NS}**
All, normal	**113**	**59**	**15**	**2000**	**2014**	**58.13**	**1.52**	**2.19**	**4.46**	**3.59**	**3.45**	**2.30**	**2.33**	**3.30**	**2.83**	**2.10**	**1.56**	**1.33**	**1.00**	**1.05**
NC 7, High	26	19	7	2000	2009	58.05$^{a-d\ NS}$	1.73$^{b\ NS}$	2.22$^{ab\ NS}$	4.41$^{ns\ NS}$	3.51$^{ns\ NS}$	3.44$^{ns\ NS}$	2.38$^{ns\ NS}$	2.42$^{bc\ NS}$	3.32$^{ns\ NS}$	2.95$^{c\ *}$	2.23$^{c\ NS}$	1.49$^{ns\ NS}$	1.34$^{ns\ NS}$	0.99$^{ns\ NS}$	1.04$^{ns\ NS}$
NC 7, Normal	35	29	12	2000	2014	57.98^{a-d}	1.55^{ab}	2.25^{b}	4.41^{ns}	3.58^{ns}	3.39^{ns}	2.34^{ns}	2.41^{c}	3.31^{ns}	2.83^{ab}	2.15^{bc}	1.54^{ns}	1.38^{ns}	1.00^{ns}	1.05^{ns}
NC 9, High	9	8	3	2004	2007	57.27$^{de\ NS}$	1.74$^{b\ NS}$	1.78$^{a\ *}$	4.45$^{ns\ NS}$	3.81$^{ns\ †}$	3.37$^{ns\ NS}$	2.36$^{ns\ NS}$	2.43$^{a-d\ NS}$	3.15$^{ns\ NS}$	2.99$^{bc\ NS}$	2.17$^{bc\ NS}$	1.56$^{ns\ NS}$	1.45$^{ns\ NS}$	1.03$^{ns\ NS}$	1.06$^{ns\ NS}$
NC 9, Normal	8	3	2	2000	2001	57.24^{cde}	1.67^{ab}	2.38^{bc}	4.19^{ns}	3.42^{ns}	3.43^{ns}	2.45^{ns}	2.57^{cd}	3.44^{ns}	2.89^{abc}	2.29^{bc}	1.71^{ns}	1.47^{ns}	1.02^{ns}	1.06^{ns}
NC-V 11, High	3	3	1	2003	2003	58.97$^{a\ NS}$	1.45$^{ab\ NS}$	2.91$^{c\ *}$	4.35$^{ns\ NS}$	3.39$^{ns\ NS}$	3.33$^{ns\ NS}$	2.48$^{ns\ NS}$	2.47$^{a-d\ NS}$	3.51$^{ns\ NS}$	2.85$^{abc\ NS}$	2.36$^{bc\ **}$	1.68$^{ns\ NS}$	1.04$^{ns\ NS}$	0.98$^{ns\ NS}$	1.03$^{ns\ NS}$
NC-V 11, Normal	6	5	2	2007	2009	58.55^{ab}	1.50^{ab}	2.07^{ab}	4.53^{ns}	3.64^{ns}	3.43^{ns}	2.11^{ns}	2.14^{a}	3.32^{ns}	2.74^{a}	1.84^{a}	1.56^{ns}	1.22^{ns}	1.00^{ns}	1.05^{ns}
Gregory, High	6	6	3	2003	2007	57.31$^{b-e\ *}$	1.82$^{b\ *}$	1.84$^{ab\ NS}$	4.37$^{ns\ NS}$	3.46$^{ns\ †}$	3.51$^{ns\ NS}$	2.35$^{ns\ NS}$	2.51$^{bcd\ †}$	3.11$^{ns\ NS}$	2.95$^{abc\ NS}$	2.19$^{bc\ NS}$	1.45$^{ns\ NS}$	1.11$^{ns\ NS}$	1.01$^{ns\ NS}$	1.08$^{ns\ NS}$
Gregory, Normal	52	44	10	2003	2013	58.48^{ab}	1.37^{a}	2.17^{ab}	4.56^{ns}	3.75^{ns}	3.48^{ns}	2.26^{ns}	2.26^{ab}	3.21^{ns}	2.82^{ab}	2.17^{bc}	1.55^{ns}	1.27^{ns}	1.00^{ns}	1.04^{ns}
Perry, High	5	5	2	2003	2004	56.78$^{e\ *}$	2.55$^{c\ **}$	1.76$^{a\ NS}$	4.71$^{ns\ NS}$	3.27$^{ns\ NS}$	3.66$^{ns\ NS}$	2.72$^{ns\ *}$	2.76$^{d\ **}$	3.43$^{ns\ NS}$	3.14$^{c\ †}$	2.32$^{bc\ †}$	1.53$^{ns\ NS}$	1.21$^{ns\ NS}$	0.97$^{ns\ NS}$	1.06$^{ns\ NS}$
Perry, Normal	12	10	3	2007	2011	58.39^{abc}	1.53^{ab}	2.09^{ab}	4.60^{ns}	3.54^{ns}	3.52^{ns}	2.32^{ns}	2.28^{abc}	3.22^{ns}	2.88^{abc}	2.04^{ab}	1.45^{ns}	1.28^{ns}	1.00^{ns}	1.06^{ns}
Mean						58.27	1.51	2.15	4.42	3.58	3.41	2.32	2.32	3.17	2.84	2.16	1.49	1.28	1.02	1.04
CV (%)						1.7	25.8	20.4	8.3	9.3	9.4	13.1	11.8	10.1	7.5	10.3	16.3	22.5	4.9	8.7

§ Roasted peanut sensory attribute analyzed and means adjusted using fruity / fermented intensity and roast color (linear effects) as covariates; bitter using roast color (linear) only.

ns F-tests for variation between oleic acid levels, among background genotypes, and their interaction was not significant ($P \leq 0.05$).

a,b,c Line means followed by the same letter are not different ($P \leq 0.05$) by t-test.

NS,†,*,**Denote means for high-oleic lines that are not different from the mean for the paired normal-oleic line or different at $P \leq 0.10$, $P \leq 0.05$, and $P \leq 0.01$, respectively, by t-test.