Peanut Cultivars Developed at North Carolina State University

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The peanut breeding project at North Carolina State University is responsible for the development of high-yielding virginia-type cultivars ("cultivated varieties") for use by the peanut growers of the Virginia-Carolina production area. The project has released numerous cultivars over the years, beginning with 'NC 4' in the 1940s and ending with 'Emery' in 2015 (Table 1).

The success of an individual cultivar in the seed market is a function of its appeal to seedsmen, growers, shellers, and processors of peanuts. New cultivars often are developed and released in response to the occurrence of new diseases or insect pests, or to address shortcomings of earlier releases as communicated to the breeder by the concerned parties. The breeder must collect extensive performance and quality data on candidates for release, but it is the first year or two a new cultivar is in the hands of the seedsmen that are critical. Being producers themselves, seedsmen must be satisfied as to the agronomic performance of new cultivars before they will risk putting their resources into producing large amounts of seed. As a new release progresses through the seed chain (breeder, foundation, registered, and certified seed production), the seedsmen look at it critically in comparison to the relatively small number of cultivars with which it will compete, often with an eye toward subtle traits that the breeder may have overlooked. Because the seed must be shelled, shellers also get an early look at new releases in shelling plants during this time. The short lifetimes of several released cultivars in the seed market reflect shortcomings that became evident only when they reach the hands of growers and shellers in quantity (Tables 2 and 3). The history and impact of the peanut cultivars released by NCSU are described below.

NC 4[1] was the first peanut cultivar released by North Carolina State University. It was selected by Mr. P.H. Kime from among 100 plant selections he made in farmer stock peanuts collected from various peanut-growing counties in the state in 1929. The seed lines derived from the 100 selections were tested from 1936 through 1944, and Line 4 was identified as a typical Virginia bunch type. NC 4 was never formally released, but seed was distributed to growers on an informal basis. This method of plant breeding, called "mass selection" or "pure-line selection," was common in the early part of the 20th century when most cultivars of crops still had substantial genetic variability within them. Pure lines contain very little residual genetic variation; the vast majority of the variation is between rather than within lines. Once pure line cultivars proliferated, there was little additional progress to be made by selecting within them. Although some breeding projects continued to release cultivars selected as "sports" or mutants occurring naturally within existing cultivars, any substantial progress had to come from hybridization and selection with the hybrid populations.

In the late 1930s and early 1940s, Drs. P.H. Harvey and G.K. Middleton assembled a collection of peanut germplasm at NCSU, including lines selected from North Carolina growers, introductions from other states, and exotic lines collected in South America by W.A. Archer of the USDA's Bureau of Plant Industry. They began to evaluate their collection, seeking superior lines to use as parents, but their attention was divided between crops: Dr. Harvey was responsible for the corn breeding project and Dr. Middleton the small grains project, so progress in peanuts was slow. In 1944, the peanut program was assigned to W.C. Gregory, the first full-time peanut breeder at NCSU.

Gregory continued the program initiated by Harvey and Middleton. He identified ten lines in the NCSU collection to be used as parents, crossing them in all pairwise combinations, a mating design called a "diallel cross." This first hybridization program led to the release of two lines: 'NC 1' in 1951

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[1] Early history of the NCSU peanut breeding project taken from Gregory, W.C., and J.C. Wynne. 1978. Peanuts. *In* G.K. Middleton and F.W. McLaughlin (eds.) Seeds of Time - A History of the North Carolina Crop Improvement Association, 1929-1977. N.C. Crop Imp. Assoc., N.C. Agric. Exp. Sta., N.C. State Univ., Raleigh.

and 'NC 2'[2] in 1952. NC 1, selected from the cross of NC 4 / Spanish 2B made as part of Gregory's ten-parent diallel cross and tested as A18, was not formally released, but certified seed was produced from 1953 through 1956. NC 2, selected from another of Gregory's original crosses (Ga 207-7 / White's Runner), was formally released in 1952 and became very successful, occupying as much as 75% of the peanut acreage in North Carolina[3]. NC 2 had a bunch growth habit and was resistant to Southern stem rot (*Sclerotium rolfsii* Sacc.) or "white mold." This cultivar was dominant in the state until the advent of 'Florigiant[4]'. Certified seed of NC 2 was produced as late as 1985.

While conducting selection within the hybrid populations he had created, Gregory also tried to increase the genetic diversity he had on hand to use as the building blocks of superior peanut cultivars. Dr. Gregory was deeply interested in the diversity of cultivated and wild peanuts. Numbers of exotic peanut lines had been introduced into the U.S.A. by 1944, but in the absence of USDA funding for maintenance of the collection, introduced seeds were sent to different breeding projects in the peanut-producing states where they were evaluated for their potential as direct releases or for use as parents for hybridization. Because exotic lines, especially those from the tropics, often are not well adapted to the temperate U.S.A., most lines did not perform well or exhibit traits useful for breeding, so many lines ultimately were lost. Dr. Gregory proposed to the USDA that they should fund additional plant-collecting trips to South America, and they eventually sent plant explorers J.L. Stephens and William Hartley to South America in 1946. In the meantime, Gregory sought to create new genetic variation by embarking on a program of mutation breeding, an eminently fundable field in the wake of the atomic bombing Hiroshima and Nagasaki in 1945. He maintained both the mutation breeding program and the conventional program of hybridization and selection program as potential sources of new cultivars.

In 1949, Gregory sent 100 lb of NC 4 seed to the Oak Ridge National Laboratory where they were exposed to nuclear radiation. This "X_1" seed was grown in the field, individual plants were harvested, then X_2 progeny rows were planted the following year. Out of over 84,000 $X_{1:2}$ plants examined, some 11,000 bore visible mutations. These "macromutations" included a number of leaf-shape mutants that were named for their appearance: "Cup," "Flop," "Corduroy," and "Ilex" for example. There also were plants with altered growth habit, maturity, flower color, and other traits. Gregory crossed some of the macromutants to develop lines carrying "double" mutations. A number of normal-looking plants also were selected and their progenies compared with NC 4 to see if there had been "micromutations" in the genes affecting agronomic performance. This program of selection among the "normal" plants led to the release in 1959 of 'NC 4X', the so-called "atomic peanut." NC 4X was grown in the seed certification program for a few years, but it never occupied a large acreage and must be viewed as a curiosity or novelty cultivar.

Also in 1949, Gregory made the second cycle of crosses among selections from his original diallel mating. This set of crosses led to the selection and release of the cultivar 'NC 5'[5] in 1964[6]. NC 5 was selected from the cross NC 1 / C12, C12 in turn being a selection from NC Bunch / PI 121067. PI 121067 is a late-maturing introduction from Argentina; it carries resistance to early leafspot (*Cercospora arachidicola* Hori) and to several insect pests common in North Carolina, especially Southern corn rootworm (*Diabrotica undecimpunctata howardi* Barber). NC 5 was a late-maturing cultivar that generally graded poorly as a result of its late maturity. It had some resistance to early leafspot, but its release coincided with the advent of effective leaf spot fungicides that took some of the pressure off the grower to plant resistant cultivars. It also coincided with the advent of the cultivar Florigiant from the breeding program at the University of Florida.

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2 Gregory, W.C. 1970. Registration of NC 2 peanuts (Reg. No. 5). Crop Sci. 10:459-460.

3 Gregory, W.C. 1960. The peanut NC 4X - a milestone in crop breeding. Crops and Soils 12(8).

4 Carver, W.A. 1969. Registration of Florigiant peanuts (Reg. No. 1). Crop Sci. 9:849-850.

5 Emery, D.A., A.J. Norden, J.C. Wynne, and R.W. Mozingo. 1974. Registration of NC-Fla 14 peanuts (Reg. No. 17). Crop Sci. 14:494.

6 Emery, D.A., and W.C. Gregory. 1970. Registration of NC 5 peanuts (Reg. No. 6). Crop Sci. 10:460.

Florigiant's superior grade made it popular with growers, and its bright, shapely pods made it popular with shellers. Florigiant quickly became the dominant cultivar in the Virginia-Carolina production area. From 1968 to 1986, Florigiant occupied more certified acreage than any other cultivar; in 1969 and throughout 1972-1985, Florigiant was grown on more than half the certified acres, culminating in 1978 when it was grown on 87% of the certified peanut acreage. There usually were several other Virginia-type cultivars on the market, but it was not until growers gained access to 'NC 7[7]' after its release in 1978 that Florigiant's dominance in the seed market was seriously challenged. The popularity of Florigiant resulted in its widespread use as a parent in the breeding program. Several cultivar releases made in the 1980's and 1990's were direct descendants of Florigiant.

In 1958, D.A. Emery joined the peanut breeding project at NCSU, assuming the cultivar development duties while Dr. Gregory focused on germplasm collection and the taxonomy of wild South American peanuts. Dr. Emery released two cultivars during the Florigiant era: 'NC 17'[8] in 1969 and 'NC-Fla 14'[9] in 1973. Both lines were selections out of the University of Florida cross F393, a mating between a selection from the 'Florispan Runner[10]' cultivar and 'Jenkins Jumbo', a very large-seeded line obtained from a farmer in Georgia[11]. The cross and early-generation selections were made by W.A. Carver at the University of Florida, and late-generation selections by Carver's successor, A.J. Norden. Norden shared these lines with Emery, conducting cooperative performance trials in Florida and North Carolina. In the NCSU program, NC 17 was numbered NC Ac 15717 before its release. Breeding project and extension personnel and growers involved in cooperative testing came to refer to the line as "17," hence its out-of-sequence name. The same rationale was used in naming NC-Fla 14. NC 17 had large pods and seeds, early maturity, and a tight bunch growth habit that permitted mid-season cultivation for weed control. It was used in experiments with narrow rows and the growth regulator Kylar™.

NC-Fla 14 was a joint release by NCSU and the University of Florida. It was tested in North Carolina under the experimental number NC 15714 and in Florida as F393-2-1-2-4-3. The push to release the line came from Florida where it performed well in central part of the state. In North Carolina, its value per acre was superior to Florigiant and NC 5, but like NC 17, it did not compete with Florigiant in the seed market.

Several disease- and insect-resistant lines were released as germplasm lines during and after Dr. Emery's tenure as project leader. These lines were developed in collaboration with entomologist W.V. Campbell and plant pathologist M.K. Beute. 'GP-NC 343[12]', a parent of 'NC 6[13]' and descended from the cross NC Bunch / PI 121067, has resistance to Southern corn rootworm as well as other pests in the North Carolina insect complex. Four other germplasm lines were released for their resistance to leafhoppers (*Empoasca fabae* Harris)[14]. 'NC 10247' and 'NC 10272' were selected from a cross of GP-NC 343 with its sister line NC Ac 00317, while 'NC 15729' and 'NC 15745' were selected from an irradiated population from the cross NC 1 / C12, C12 being a direct parent of GP-NC 343. These lines have been used widely as parents in the NCSU breeding program among others. Disease-resistant

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7 Wynne, J.C., R.W. Mozingo, and D.A. Emery. 1979. Registration of NC 7 peanut (Reg. No. 22). Crop Sci. 19:563.

8 Emery, D.A. 1970. Registration of NC 17 peanuts (Reg. No. 7). Crop Sci. 10:460.

9 Emery, D.A., A.J. Norden, J.C. Wynne, and R.W. Mozingo. 1974. Registration of NC-Fla 14 peanuts (Reg. No. 17). Crop Sci. 14:494.

10 Carver W.A. 1953. The Florispan Runner peanut variety. Florida Agric. Exp. Sta. Circ. S-62, 4 p.

11 Hammons, R.O., and A.J. Norden. 1979. Registration of Jenkins Jumbo peanut (Reg. No. PL-1). Crop Sci. 19:132.

12 Campbell, W.V., D.A. Emery, and W.C. Gregory. 1971. Registration of GP-NC 343 peanut germplasm (Reg. No. GP 1). Crop Sci. 11-605.

13 Campbell, W.V., J.C. Wynne, D.A. Emery, and R.W. Mozingo. 1977. Registration of NC 6 peanuts (Reg. No. 20). Crop Sci. 17:346.

14 Campbell, W.V., D.A. Emery, and J.C. Wynne. 1975. Registration of four germplasm lines of peanuts (Reg. Nos. GP 5 to GP 8). Crop Sci. 15:738-739.

germplasm line 'NC 3033[15]' was released in 1976, selected from a cross of Ga 207-7 / A48, A48 being from NC 4 / 'Spanish 2B'. NC 3033 was identified as resistant to Southern stem rot, and it was later found to be highly resistant to Cylindrocladium black rot (CBR, *Cylindrocladium parasiticum* Crous, Wingfield & Alfenas).

Johnny C. Wynne joined the peanut program as a graduate student in 1968, obtained his doctorate under Dr. Emery, and eventually became project leader in 1974. Dr. Wynne's first release was made in 1976: NC 6, an insect-resistant cultivar that performed well on finer textured or "heavier" peanut soils. NC 6's main resistance was to Southern corn rootworm, derived from its parent GP-NC 343, but it also had resistance to corn earworm (*Helicoverpa zea* Boddie) and lesser cornstalk borer (*Elasmopalpus lignosellus* Zeller) and some resistance to early leaf spot. Although NC 6 occupied on average only 7% of the certified peanut acreage in the Virginia-Carolina area, it had a loyal following among growers and continued in the seed certification program until 1997. Until the advent of tomato spotted wilt virus (TSWV, *Tomato spotted wilt tospovirus*), it continued to perform well relative to later releases in performance trials where it was included as a check cultivar.

The first serious challenge to the dominance of Florigiant in the seed market came with the release of NC 7 in 1978. Project lore has it that NC 7 was passed over for release because its extremely large, rather poorly shaped pods made it undesirable to area shellers who were asked to evaluate the line as part of the Peanut Variety and Quality Evaluation (PVQE) program[16]. Later, demand for a very large-seeded peanut resulted in NC 7 being pulled "off the shelf." The impetus to release NC 7 came from then Director of Research Durward Bateman, who was familiar with peanut production. NC 7's high meat content and high ELK premium made it a high-value cultivar to the grower. Although it has a very high percentage of jumbo pods and extra large kernels, the shape of its pods and kernels are somewhat irregular or "blocky," making the cultivar less desirable to area shellers. NC 7 became the dominant cultivar in Virginia-Carolina area in 1987 and remained so until 1996 although it never exceeded 37% of the total certified seed production in any year. NC 7 became popular not only in the Virginia-Carolina area, but also in west Texas and Oklahoma where it was grown as contract additional peanuts for the export market. The cultivar also was popular in Australia. One of the shortcomings of NC 7 was that, like Florigiant, it is susceptible to almost all of the diseases and insects that attack peanuts in the area. Growers of NC 7 were forced to continue the reliance on chemical controls of diseases and pests that they developed in the Florigiant era.

Cylindrocladium black rot appeared in North Carolina in the early 1970s. Because there was no effective method of control and no resistant cultivar, this soil-borne disease threatened to ruin peanut production in the counties where it appeared. Drs. Emery and Wynne began a crash program of breeding for resistance, screening large numbers of cultivars, breeding lines and introductions for resistance, and finding a few sources including NC 3033 and NC Ac 03139. Although NC 3033 had superior resistance, it turned out to be a very poor parent, transferring to its progeny its irregular pod and seed shape as well as thickened stems and leaves that dried slowly after digging. NC Ac 03139 proved to be a better parent. 'NC 8C'[17], selected from Florigiant / NC Ac 03139 and released in 1982, was the first in the series of CBR-resistant cultivars developed at NCSU. NC 8C had good resistance to CBR and very high SMK and meat content. It immediately became popular with growers, but it presented problems to area shellers. The "tight" hull associated with high meat made it difficult to shell without splitting the seeds, and it occasionally failed to make the 40% minimum fancy pod content necessary to be graded as a virginia-type peanut. These shortcomings resulted in the removal of NC 8C from the seed certification

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15 Beute, M.K., J.C. Wynne, and D.A. Emery. 1976. Registration of NC 3033 peanut germplasm (Reg. No. GP 9). Crop Sci. 16: 887.

16 Balota, M. W.S. Monfort, T.G. Isleib, and S.Tallury. 2013. Peanut Variety and Quality Evaluation results, 2013. I. Agronomic and grade data. Va. Polytechnic Inst. & State Univ., Va. Agric. Exp. Stn., Tidewater Agric. Res. Ext. Ctr. Inf. Ser. No. 504, 77p.

17 Wynne, J.C., and M.K. Beute. 1983. Registration of NC 8C peanut (Reg. No. 27). Crop Sci. 23:184.

program when its descendant NC 10C was released. Because of its good CBR resistance, NC 8C was maintained without certification by farmers for several years after its removal from the program.

'NC 9'[18] was released in 1985 in response to shellers' concerns over the large blocky pods of NC 7 and the too-small pods of NC 8C. Selected from the cross NC 2 / Florigiant, NC 9 has bright, shapely pods, pink seed coats, and uniform, elliptical seeds that are preferred by shellers. Growers in CBR-infested areas liked NC 9 because it had slight resistance which enabled them to make better yields than they could achieve with NC 10C, especially when use of NC 9 was coupled with application of metam sodium fumigant, a partially effective chemical control of CBR. NC 9 suffered from so-called "late-season breakdown," a degeneration of the above-ground plant parts when the leaf spot control program was discontinued in September. In the 1990s NC 9 was found to be the most susceptible of the then-extant array of cultivars to tomato spotted wilt virus (TSWV), a relatively new disease that can cause late-season wilting and death of infected plants. Although the severity of TSWV in the Virginia-Carolina area has been less than in the Georgia-Florida-Alabama area and parts of the Southwest, the disease is present. TSWV may have been a contributor to late season breakdown of NC 9. This shortcoming resulted in the growers' shying away from production of NC 9. Production of foundation seed of NC 9 was discontinued in the 1999 season, and certified seed was no longer available after 2001.

Responding to the need for a Florigiant-like pod in a cultivar with resistance to CBR, Dr. Wynne crossed NC 8C back to its parent Florigiant, selecting simultaneously for resistance and pod size and shape. The resulting cultivar with 75% Florigiant ancestry in its make-up was released as 'NC 10C'[19] in 1988. NC 10C's pods were large enough to ensure that it would regularly grade in the virginia class, and they were bright and shapely, making it a favorite cultivar of area shellers. NC 10C's maturity was somewhat late resulting in low meat contents and relatively low price for the producer. In the last few years of its lifetime as a commercial cultivar, the average pod and seed size of NC 10C fell off dramatically. The cause of this phenomenon is unknown but likely to be related to the sheller practice of "scalping," that is removing large pods before shelling or large seeds after shelling for sale as in-shell or shelled goods rather than use as seed. At any rate, the dwindling size of NC 10C dampened sheller enthusiasm for the cultivar, and it too was discontinued from the seed certification program.

The cultivar most commonly grown in the Virginia-Carolina area for a number of years was 'NC-V 11'[20], a cultivar jointly released by NCSU and Virginia Polytechnic Institute and State University (VPI&SU) in 1989. Part of the lasting popularity of NC-V 11 may have been the result of its inherent partial resistance to TSWV. It also has a compact plant type with a clearly visible mainstem that makes it easy for growers to distinguish the rows at digging time. NC-V 11 was selected from the first cycle of a recurrent selection program initiated by Dr. Wynne in 1976 by intermating 40 parents he selected for superior agronomic performance. The immediate parents of NC-V 11 were NC Ac 17257 and NC Ac 17922. NC Ac 17257 was selected from the cross Florigiant / NC 5 and NC Ac 17922 from Florigiant / PI 337396, a valencia-type peanut. Like NC 9, NC-V 11's release was in part due to shellers' desire to have more fancy-size pods with better shape and color than could be obtained from NC 7 which had become the dominant cultivar in the area.

One of the breeding lines submitted by Dr. Wynne to the PVQE program had mixed pink and tan seed coat colors. R.W. Mozingo, coordinator of the testing program, obtained permission from Dr. Wynne to separate the pink-seeded component from the mixture and continue testing it as a VPI&SU line. This joint development was released in 1992 as 'VA-C 92R'[21]. It was the first cultivar released in the area to carry a royalty or research fee on seed, generating funds to help continue the breeding and

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[18] Wynne, J.C., R.W. Mozingo, and D.A. Emery. 1986. Registration of 'NC 9' peanut. Crop Sci. 26:197.

[19] Wynne, J.C., M.K. Beute, J. Bailey, and R.W. Mozingo. 1991. Registration of 'NC 10C' peanut. Crop Sci. 31:484.

[20] Wynne, J.C., T.A. Coffelt, R.W. Mozingo, and W.F. Anderson. 1991. Registration of 'NC-V 11' peanut. Crop Sci. 31:484-485.

[21] 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: 539-540.

testing efforts at NCSU and VPI&SU. VA-C 92R was extremely productive and quickly increased in popularity in the area, becoming the second most commonly grown peanut in 1994. However, area shellers soon became concerned that VA-C 92R's pods were relatively dark, having the appearance of being diseased or burned when sold as roasted in-shell products. Acquiescing to the shellers' concerns, the extension service de-emphasized VA-C 92R in its varietal recommendations, and grower use of the cultivar declined.

In 1989, Dr. Wynne assumed new duties as Head of the Department of Crop Science, and in 1990 his former student, T.G. Isleib, was hired as leader of the peanut breeding project. 'NC 12C'[22], released in 1996, was the first cultivar released by Dr. Isleib and the third in NCSU's CBR-resistant series. It was discovered as a result of monitoring the CBR reactions of lines selected from crosses of NC 7 with NC 9 and Florigiant for early maturity and pod and seed size and shape. NC 12C came from the cross of NC 7 with NC 9 and is more resistant to CBR than NC 9, its level of resistance being comparable to that of NC 10C. NC 12C's pods resemble and grade like those of NC 7. North Carolina growers embraced NC 12C because of its CBR resistance, high meat content, and high ELK content. Growers in Virginia were less enthusiastic due to NC 12C's susceptibility to Sclerotinia blight (*Sclerotinia minor* Jagger), a disease formerly more common in Virginia than in North Carolina, but now a serious constraint to production in both states. NC 12C has very vigorous vines that create a tall, dense canopy conducive to spread of Sclerotinia blight in cool wet weather. The luxuriant shoot growth also can cause problems at digging time. Nevertheless, NC 12C represented a step forward in terms of disease resistance from its parent NC 7, the cultivar it most resembles and which is also highly susceptible to Sclerotinia blight. Shellers were concerned about the relatively thin hull of NC 12C which contributes to breakage and often darkens upon roasting, and also that its high jumbo pod content and low fancy pod content made it unlikely to replace the smaller-podded NC 10C in terms of the shellers' markets for those pod classes. The same problem of pod and seed size distribution arose with respect to the next release, Gregory.

'Gregory'[23], named in honor of Drs. W.C. and M.P. Gregory, was released in response to needs expressed by Dr. Peter Valenti of the Planters/Lifesavers division of RJR/Nabisco for more and larger ELK. In 1988, Planters funded a program at NCSU to select cultivars with very large pods and seeds to satisfy this demand. The program continued throughout the early and mid 1990's and culminated with the release of NC 12C and Gregory. Released in 1997, Gregory contains even more jumbo pods and ELK than NC 7 or NC 12C. Unfortunately, about the time of Gregory's release, the Planters/Lifesavers division underwent a reorganization in which Dr. Valenti and several other Planters personnel involved in the project left the company. The new division managers expressed little interest in the cultivar development programs in the Virginia-Carolina area. With the voice of Planters silenced, area shellers criticized Gregory as not meeting their needs for fancy pods for the domestic in-shell market. Because the in-shell market dominated the large-seeded virginia-type peanut market, Gregory was slow to find acceptance with growers and shellers. It did occupy a niche in the seed market for very large-seeded virginia types destined for the jumbo-in-shell export or boiling peanut markets. Like its sister line NC 12C and their parents NC 7 and NC 9, Gregory is very susceptible to Sclerotinia blight.

Throughout the 1980s and 1990s, NC peanut growers continued to support development of CBR-resistant cultivars. 'Perry'[24], a highly CBR-resistant selection with some resistance to Sclerotinia blight, was selected from a cross between an unnumbered selection from NC 7 / Florigiant and breeding line N90021. N90021 was selected from NC Ac 18229A / NC 2. NC Ac 18229A was selected from NC 2 / NC 3033. Therefore, Perry was the first CBR-resistant release to have been derived from NC 3033, a

[22]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.

[23]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.

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

line with excellent resistance to soil-borne diseases but with poor agronomic properties, poor properties as a parent, and a high degree of susceptibility to TSWV. The name "Perry" was chosen in honor of two men of that surname to have figured prominently in the peanut breeding program: Astor Perry, former peanut extension specialist in the Department of Crop Science, and Tommy Perry, long-time supervisor at the NCDA's Peanut Belt Research Station in Lewiston, NC where most of the cultivar selection and testing work is done. Perry has the disease resistance to help growers avoid yield losses associated with CBR and Sclerotinia, and it also has a relatively high percentage of bright fancy pods to satisfy the shellers' major markets. With the advent of heavy infestation of North Carolina peanut fields by tomato spotted wilt virus in the early 2000s, Perry proved to be very susceptible to TSWV, limiting its appeal to growers. Perry's agronomic performance also fell of subsequent to its release, perhaps due to its reaction to the commonly present TSWV.

With the discovery of the high-oleic oil trait in peanut at the University of Florida in 1987[25] and the elucidation of its simple mode of inheritance[26], most U.S. peanut breeding programs either began to backcross the recessive Florida gene into existing cultivars, or they initiated programs of mutation breeding to create their own high oleics. Because the University of Florida seemed likely to succeed in their application for a U.S. Utility Patent on the high-oleic trait, Dr. Isleib opted to backcross the trait from the Florida breeding line F435. Backcross programs were initiated using several NCSU releases as the recurrent parents. The first high-oleic large-seeded virginia-type cultivar to be released was 'Brantley,'[27] named for the late Ms. Peggy Y. Brantley, the long-time secretary to the peanut breeding and genetics projects at NCSU. Brantley is a high-oleic backcross derivative of NC 7 with four backcrosses to the recurrent parent. It was released in 2005, but it was observed shortly thereafter that the seed of Brantley had become contaminated with another line that was not high oleic. Production of certified seed of Brantley was discontinued.

Upon the release of NC 12C and Gregory, VC area shellers made it known that they would prefer cultivars with greater contents of bright fancy pods, the shellers' stock in trade in the in-shell peanut market. To respond to the shellers concerns about hull brightness, the breeding project acquired a colorimeter and incorporated measurement of hull color and hue into the standard grading process for pod samples taken from each plot in every replicated yield test. Hull brightness was included among the criteria applied to replicated yield test data to determine which lines would be retained for the following year of testing. The first cultivar released primarily because of its high yield of bright fancy pods was 'Phillips,'[28] named for the late Ms. Ida G. "Gerry" Phillips, the person responsible for more than three decades for grading all the yield test samples. Phillips proved to be susceptible to most of the area's common diseases and is no longer in commercial production.

Because there had been a series of unforeseen disease problems with newly released NCSU cultivars (NC 12C and Gregory proved to be highly susceptible to Sclerotinia blight, Perry to TSWV, and Brantley and Phillips to most diseases), a series of crosses were made in 1998 to try to incorporate resistance to all four economically important diseases into a single cultivar. The program is "accelerated," *i.e.*, it intersperses generations of field testing for the diseases and selection of individual plants from the most resistant families with use of a winter seed nursery in Puerto Rico to produce enough seed for testing and selection the following summer in North Carolina. Populations move to the genetically stable sixth filial or "F_6" generation in three calendar years following the cross rather than the six it would ordinarily require. Those three years are followed by at least five years of testing for disease

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25 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.

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

27 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.

28 Isleib, T.G., P.W. Rice, R.W. Mozingo II, S.C. Copeland, J.B. Graeber, H.E. Pattee, T.H. Sanders, R.W. Mozingo, and D.L. Coker. 2006. Registration of 'Phillips' peanut. Crop Sci. 46: 2308-2309.

resistance, yield and grade. The multiply resistant cultivar 'Bailey'[29], named in honor of late Extension Plant Pathologist Jack E. Bailey, was released in 2008. Shellers immediately expressed concern over the relatively small pod and seed sizes of Bailey. Although Bailey's sizes were as large as those of NC-V 11 and 'VA 98R'[30], each of which had in its time been the dominant cultivar in the VC area, Bailey's release was quickly followed by that of 'Sugg'[31], named in honor of Joseph W. "Joe" and Norfleet "Fleet" Sugg, two cousins who jointly served as Executive Directors of the North Carolina Peanut Growers Assoc. for over 26 years. Sugg has larger seeds and pods than Bailey, but its array of disease resistances and yield is marginally less. Sugg also has pink seed coats compared to the tan seed coats of Bailey. Both Bailey and Sugg were produced as certified seed in 2010. By 2011 they made up 47% of the certified acreage, 60% in 2012, so it appears that they will become a substantial part of the array of cultivars grown in the VC area.

It became evident that the high-oleic trait would be demanded in new peanut cultivars. Given the commercial success of Bailey and Sugg, high-oleic lines derived from those successful cultivars made sense. Sullivan, named for former peanut extension specialist, and Wynne, named for former peanut breeder Johnny C. Wynne, were released in the spring of 2013. These cultivars are just emerging from the seed chain at present, *i.e.*, there has been no or very limited production of certified seed to date. Another high-oleic cultivar, Emery, was released in the spring of 2015. Most of the 350 lb of breeder seed of Emery purified for the high-oleic trait was ruined. A small increase of breeder seed was planted in 2015, and a repeat of the two-year process of purifying additional breeder seed was initiated in 2015. In 2016, there are in the field nearly 200 progenies of individual plants checked for their high-oleic nature. We anticipate having approximately 700 lb of Breeder Seed for planting in 2017.

Several additional varieties have been released under exclusive contracts with private companies. Goliath, a very large-seeded variety tested under experimental line designation N97053J, was licensed to the Severn Peanut Company for use in the fresh-picked boiling peanut market. Similarly, lines N99080J and N99085J were sold outright to the Hardy Farms of Hawkinsville, GA, for the same use. In Australia, the Queensland Dept. of Primary Industries and the peanut Company of Australia have each licensed NCSU germplasm for use in the Australian market.

Even though the need for improved cultivars is stronger than ever, the future of peanut variety development at NCSU is less certain today than it was even just a year or two ago. Changes in the federal price support program have made peanut a less profitable crop, and acreage has dropped substantially since the 2001 season, reaching a low of 66,000 A in North Carolina in 2009. Resources for conducting research in North Carolina have dwindled as a result of the state's downturn in production. The peanut program incorporates conventional plant breeding under T.G. Isleib, utilization of wild species as sources of disease and pest resistance and molecular approaches to improvement under H.T. Stalker, disease control under B.B. Shew, insect control under R.L. Brandenburg, weed control and production practices under D.L. Jordan, and market quality under the USDA-ARS Market Quality and Handling Research Unit formerly headed by T.H. Sanders. H.E. Pattee, formerly of the USDA-ARS-MQHRU, has been engaged as a part-time NCSU employee since 2004 and continues to lead the effort to monitor flavor of advanced breeding lines. In spite of the challenges that face us in the next few years, the peanut research and extension faculty are dedicated to the continued success of peanut production in the Virginia-Carolina and will apply any genetic or management tool that can be brought to bear on the problems faced by our growers.

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[29] 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 Reg. 5: 27-39. [doi:10.3198/jpr2009.12.0742crc]

[30] Mozingo R.W., T.A. Coffelt, and T.G. Isleib. 2000. Registration of 'VA 98R' peanut. Crop Sci. 40: 1202-1203.

[31] 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. ND. Registration of 'Sugg' peanut. J. Plant Reg. (Accepted)

Table 1. Cultivars released by NCSU, their parentage, time required for development, and breeder.

Cultivar	Parentage	Year of Cross	Year of Release	Total Years	Breeder	Years Certified	Max. area†	Ave. area†
NC 4	Selection from farmer stock	1929‡	1944	15	P.H. Kime	No record	--	--
NC 1	NC 4 / Spanish 2B	1944	1953	9	W.C. Gregory	1953-1956	75.1	35.2
NC 2	GA 207-2 / White's Runner	1944	1952	8	W.C. Gregory	1953-1985	96.6	33.5
NC 4X	Selection from irradiated NC 4	1949‡	1959	10	W.C. Gregory	1959-1967	14.9	4.2
NC 5	NC 1 / C12	1949	1964	15	W.C. Gregory	1965-1979	28.5	11.0
NC 17	F334A-3-5-5-1 / Jenkins Jumbo	1951	1969	18	D.A. Emery	1970-1979	9.1	2.4
NC-Fla 14	F334A-3-5-5-1 / Jenkins Jumbo	1951	1973	22	D.A. Emery	1974	0.4	0.4
NC 6	GP-NC 343 / VA 61R	1966	1976	10	J.C. Wynne	1978-1998	21.5	7.0
NC 7	F393-7-47-1-7-1 / NC 5	1966	1978	12	J.C. Wynne	1980-2006	36.8	18.6
NC 8C	NC Ac 03139 / Florigiant	1966	1982	16	J.C. Wynne	1982-1988	6.1	3.0
NC 9	NC 2 / Florigiant	1966	1985	19	J.C. Wynne	1987-2001	24.9	15.4
NC 10C	NC 8C / Florigiant	1979	1988	9	J.C. Wynne	1988-2001	17.4	9.0
NC-V 11	NC Ac 17257 / NC Ac 17922	1975	1989	14	J.C. Wynne	1990-present	32.8	18.9
VA-C 92R	NC Ac 17213 / NC 7	1978	1992	14	J.C. Wynne	1992-2003	22.9	11.4
NC 12C	NC 7 / NC 9	1984	1996	12	T.G. Isleib	1997-2007	21.0	12.0
Gregory	NC 7 / NC 9	1984	1997	13	T.G. Isleib	1999-present	22.4	8.8
Perry	NC 7 / NC 9 selection // N90021	1989	2000	11	T.G. Isleib	2000-present	34.7	16.3
Brantley	NC 7*5 / F435	1990	2005	15	T.G. Isleib	2005-2009	4.6	2.5
Phillips	N90014E / N91024	1992	2005	13	T.G. Isleib	2005-2012	16.7	6.4
Bailey	NC 12C*2 / N96076L	1998	2008	11	T.G. Isleib	2009-present	75.5	54.5
Sugg	N90010E // Gregory / Tamrun 98	1998	2009	12	T.G. Isleib	2009-present	25.1	19.5
Sullivan	N03079FT*2 / N02059ol (Per)	2003	2013	11	T.G. Isleib	2015-present	5.4	1.9
Wynne	Bailey*2 / Brantley	2003	2013	11	T.G. Isleib	2015-present	5.9	2.1
Emery	N03079FT*2 / Brantley	2003	2015	12	T.G. Isleib	Not yet certified	--	--

† Denote the maximum and average percentage of the total virginia-type acreage certified in the Virginia-Carolina area for the years in which that cultivar was certified. Prior to 1975, substantial parts of the total peanut acreage were planted with farmer-saved seed, so certified acreage may not be indicative of actual acreage planted with specific cultivars.

‡ Denotes year of single plant selection for NC 4 and of initial irradiation of seed for NC 4X.

Table 2. History of certified seed production for North Carolina cultivars in the Virginia-Carolina production area, 1946-2014[†].

Year	NC 1	NC 2	NC 4X	NC 5	NC 17	NC-Fla 14	NC 6	NC 7	NC 8C	NC 9	NC 10C	NC-V 11	VA-C 92R	NC 12C	Greg-ory	Perry	Brant-ley	Phil-lips	Bai-ley	Sugg	Sull livan	Wynne	Total	NC lines	Flori -giant	Other lines
	acres certified																									
1946	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1947	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	287	--	--	287
1948	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	150	--	--	150
1949	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2	--	--	2
1950	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	60	--	--	60
1951	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	70	--	--	70
1952	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1953	337	112	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	449	449	--	--
1954	917	764	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1681	1681	--	--
1955	126	1502	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1628	1628	--	--
1956	35	1000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1035	1035	--	--
1957	--	1073	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1596	1073	--	523
1958	--	1122	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1498	1122	--	376
1959	--	1181	119	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1737	1300	--	437
1960	--	1811	399	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2684	2210	--	474
1961	--	2391	122	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3603	2513	--	1090
1962	--	3022	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4721	3022	--	1699
1963	--	2778	7	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4078	2785	31	1262
1964	--	2975	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	4839	2975	637	1227
1965	--	3234	2	96	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5855	3332	1471	1052
1966	--	2467	--	1628	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6144	4095	1733	316
1967	--	2756	2	1542	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7674	4300	2462	912
1968	--	2248	--	2808	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	9856	5056	3188	1612
1969	--	2687	--	1624	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10743	4311	5732	700
1970	--	2762	--	2039	23	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10816	4824	4877	1115
1971	--	2497	--	1698	1062	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	11696	5257	5733	706
1972	--	2911	--	1990	948	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	14035	5849	7218	968
1973	--	2247	--	1642	302	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	16987	4191	11602	1194
1974	--	2213	--	1060	301	56	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15689	3630	10683	1376
1975	--	1374	--	605	173	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	17546	2152	11904	3490
1976	--	1390	--	367	79	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10481	1836	7375	1270
1977	--	1190	--	278	268	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	19471	1736	16536	1199
1978	--	486	--	52	166	--	1717	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	20825	2421	18078	326
1979	--	187	--	51	90	--	2898	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	13493	3226	10030	237
1980	--	199	--	--	--	--	3548	6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	22666	3753	18562	351
1981	--	229	--	--	--	--	2199	2113	--	--	--	--	--	--	--	--	--	--	--	--	--	--	29066	4541	23999	526
1982	--	153	--	--	--	--	1367	3413	34	--	--	--	--	--	--	--	--	--	--	--	--	--	21131	4967	15908	256
1983	--	97	--	--	--	--	2064	4850	246	--	--	--	--	--	--	--	--	--	--	--	--	--	24114	7257	16395	462
1984	--	57	--	--	--	--	2457	5501	220	--	--	--	--	--	--	--	--	--	--	--	--	--	26679	8235	17411	1033
1985	--	86	--	--	--	--	2876	7450	551	--	--	--	--	--	--	--	--	--	--	--	--	--	24884	10963	13400	521
1986	--	--	--	--	--	--	2476	7261	1057	--	--	--	--	--	--	--	--	--	--	--	--	--	22407	10794	10601	1012
1987	--	--	--	--	--	--	3259	7528	1468	4637	--	--	--	--	--	--	--	--	--	--	--	--	24058	16892	6461	705
1988	--	--	--	--	--	--	3418	9530	1455	6181	6	--	--	--	--	--	--	--	--	--	--	--	25887	20590	4832	465
1989	--	--	--	--	--	--	2966	9746	--	6824	4769	--	--	--	--	--	--	--	--	--	--	--	27428	24305	2879	244
1990	--	--	--	--	--	--	2381	10524	--	5966	5037	4982	--	--	--	--	--	--	--	--	--	--	30310	28890	1313	107
1991	--	--	--	--	--	--	2637	9768	--	7598	4543	5926	--	--	--	--	--	--	--	--	--	--	31326	30472	613	241
1992	--	--	--	--	--	--	1396	11186	--	6166	4123	7607	32	--	--	--	--	--	--	--	--	--	33229	30510	30	2689
1993	--	--	--	--	--	--	2200	12322	--	6079	4349	6408	3877	--	--	--	--	--	--	--	--	--	36673	35235	--	1438

1994	--	--	--	--	--	--	837	11192	--	5480	4181	5895	8592	--	--	--	--	--	--	--	--	--	37517	36177	--	1340
1995	--	--	--	--	--	--	511	10184	--	5535	3669	5815	6681	--	--	--	--	--	--	--	--	--	33681	32395	--	1286
1996	--	--	--	--	--	--	112	8719	--	5201	3528	7988	5877	--	--	--	--	--	--	--	--	--	31829	31425	--	404
1997	--	--	--	--	--	--	46	7437	--	4381	2801	9751	5352	1307	--	--	--	--	--	--	--	--	31772	31075	--	697
1998	--	--	--	--	--	--	56	4333	--	3280	1801	10392	6835	4209	--	--	--	--	--	--	--	--	31689	30906	--	783
1999	--	--	--	--	--	--	62	1670	--	2166	850	9099	5055	6403	732	--	--	--	--	--	--	--	30548	26037	--	4511
2000	--	--	--	--	--	--	28	1014	--	1528	733	8313	2727	5296	1720	29	--	--	--	--	--	--	31031	21388	--	9643
2001	--	--	--	--	--	--	34	738	--	78	143	8819	1587	5374	2835	5188	--	--	--	--	--	--	33031	24796	--	8235
2002	--	--	--	--	--	--	--	228	--	--	--	2961	844	3588	2690	7645	--	--	--	--	--	--	22052	17956	--	4096
2003	--	--	--	--	--	--	--	41	--	--	--	5334	847	4404	5410	5289	--	--	--	--	--	--	26524	21325	--	5199
2004	--	--	--	--	--	--	--	77	--	--	--	5751	85	3659	6361	5496	--	--	--	--	--	--	28395	21429	--	6966
2005	--	--	--	--	--	--	--	72	--	--	--	4862	--	1901	4256	5120	126	187	--	--	--	--	22473	16524	--	5949
2006	--	--	--	--	--	--	--	65	--	--	--	3271	--	960	4752	4533	405	1735	--	--	--	--	21977	15721	--	6256
2007	--	--	--	--	--	--	--	--	--	--	--	4496	--	513	3254	6387	1156	2600	--	--	--	--	25345	18406	--	6939
2008	--	--	--	--	--	--	--	--	--	--	--	5121	--	--	1976	5139	467	4088	--	--	--	--	24474	16791	--	7683
2009	--	--	--	--	--	--	--	--	--	--	--	2258	--	--	1056	4203	536	1647	--	--	--	--	15606	9700	--	5906
2010	--	--	--	--	--	--	--	--	--	--	--	3334	--	--	2527	5014	--	3582	861	395	--	--	22615	15713	--	6902
2011	--	--	--	--	--	--	--	--	--	--	--	1704	--	--	1358	2865	--	1369	9114	4271	--	--	28239	20681	--	7558
2012	--	--	--	--	--	--	--	--	--	--	--	1923	--	--	276	1573	--	12	11639	6343	--	--	26836	21766	--	5070
2013	--	--	--	--	--	--	--	--	--	--	--	321	--	--	76	6	--	--	13523	5662	3	2	22564	19593	--	2971
2014	--	--	--	--	--	--	--	--	--	--	--	--	--	--	158	--	--	--	20561	5077	57	81	27241	25934	--	1307
2015	--	--	--	--	--	--	--	--	--	--	--	--	--	--	560	--	--	--	16956	2547	1246	1381	23269	22690	--	579
Total	1415	51201	651	17480	3412	56	41545	146968	5031	71100	40533	132331	48391	37614	39997	58487	2690	15220	72654	24295	1306	1464	1199995	813841	251694	134460

† Data compiled from 1946-2015 volumes of Association of Official Seed Certifying Agencies (AOSCA) publication, Acres Applied for Certification.

Table 3. History of certified seed production for North Carolirna cultivars in the Virginia-Carolina production area, 1946-2014. Production of individual cultivars expressed as a percentage of the total certified acreage for that year[†].

Year	NC 1	NC 2	NC 4X	NC 5	NC 17	NC-Fla 14	NC 6	NC 7	NC 8C	NC 9	NC 10C	NC-V 11	VA-C 92R	NC 12C	Greg-ory	Perry	Brant-ley	Phil-lips	Bai-ley	Sugg	Sul-livan	Wynne	NC lines	Flori-giant	Other lines
	% of total acres certified																								
1946	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1947	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100.0
1948	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100.0
1949	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100.0
1950	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100.0
1951	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100.0
1952	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1953	75.1	24.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100.0	--	--
1954	54.6	45.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100.0	--	--
1955	7.7	92.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100.0	--	--
1956	3.4	96.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	100.0	--	--
1957	--	67.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	67.2	--	32.8
1958	--	74.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	74.9	--	25.1
1959	--	68.0	6.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	74.8	--	25.2
1960	--	67.5	14.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	82.3	--	17.7
1961	--	66.4	3.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	69.7	--	30.3
1962	--	64.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	64.0	--	36.0
1963	--	68.1	0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	68.3	0.8	30.9
1964	--	61.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	61.5	13.2	25.4
1965	--	55.2	0.0	1.6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	56.9	25.1	18.0
1966	--	40.2	--	26.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	66.7	28.2	5.1
1967	--	35.9	0.0	20.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	56.0	32.1	11.9
1968	--	22.8	--	28.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	51.3	32.3	16.4
1969	--	25.0	--	15.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	40.1	53.4	6.5
1970	--	25.5	--	18.9	0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	44.6	45.1	10.3
1971	--	21.3	--	14.5	9.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	44.9	49.0	6.0
1972	--	20.7	--	14.2	6.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	41.7	51.4	6.9
1973	--	13.2	--	9.7	1.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	24.7	68.3	7.0
1974	--	14.1	--	6.8	1.9	0.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	23.1	68.1	8.8
1975	--	7.8	--	3.4	1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	12.3	67.8	19.9
1976	--	13.3	--	3.5	0.8	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	17.5	70.4	12.1
1977	--	6.1	--	1.4	1.4	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8.9	84.9	6.2
1978	--	2.3	--	0.2	0.8	--	8.2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	11.6	86.8	1.6
1979	--	1.4	--	0.4	0.7	--	21.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	23.9	74.3	1.8
1980	--	0.9	--	--	--	--	15.7	0.0	--	--	--	--	--	--	--	--	--	--	--	--	--	--	16.6	81.9	1.5
1981	--	0.8	--	--	--	--	7.6	7.3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	15.6	82.6	1.8
1982	--	0.7	--	--	--	--	6.5	16.2	0.2	--	--	--	--	--	--	--	--	--	--	--	--	--	23.5	75.3	1.2
1983	--	0.4	--	--	--	--	8.6	20.1	1.0	--	--	--	--	--	--	--	--	--	--	--	--	--	30.1	68.0	1.9
1984	--	0.2	--	--	--	--	9.2	20.6	0.8	--	--	--	--	--	--	--	--	--	--	--	--	--	30.9	65.3	3.9
1985	--	0.3	--	--	--	--	11.6	29.9	2.2	--	--	--	--	--	--	--	--	--	--	--	--	--	44.1	53.8	2.1
1986	--	--	--	--	--	--	11.1	32.4	4.7	--	--	--	--	--	--	--	--	--	--	--	--	--	48.2	47.3	4.5
1987	--	--	--	--	--	--	13.5	31.3	6.1	19.3	--	--	--	--	--	--	--	--	--	--	--	--	70.2	26.9	2.9
1988	--	--	--	--	--	--	13.2	36.8	5.6	23.9	0.0	--	--	--	--	--	--	--	--	--	--	--	79.5	18.7	1.8
1989	--	--	--	--	--	--	10.8	35.5	--	24.9	17.4	--	--	--	--	--	--	--	--	--	--	--	88.6	10.5	0.9
1990	--	--	--	--	--	--	7.9	34.7	--	19.7	16.6	16.4	--	--	--	--	--	--	--	--	--	--	95.3	4.3	0.4
1991	--	--	--	--	--	--	8.4	31.2	--	24.3	14.5	18.9	--	--	--	--	--	--	--	--	--	--	97.3	2.0	0.8
1992	--	--	--	--	--	--	4.2	33.7	--	18.6	12.4	22.9	0.1	--	--	--	--	--	--	--	--	--	91.8	0.1	8.1
1993	--	--	--	--	--	--	6.0	33.6	--	16.6	11.9	17.5	10.6	--	--	--	--	--	--	--	--	--	95.8	--	4.2
1994	--	--	--	--	--	--	2.2	29.8	--	14.6	11.1	15.7	22.9	--	--	--	--	--	--	--	--	--	96.4	--	3.6

1995	--	--	--	--	--	--	1.5	30.2	--	16.4	10.9	17.3	19.8	--	--	--	--	--	--	--	--	--	96.2	--	3.8
1996	--	--	--	--	--	--	0.4	27.4	--	16.3	11.1	25.1	18.5	--	--	--	--	--	--	--	--	--	98.6	--	1.4
1997	--	--	--	--	--	--	0.1	23.4	--	13.8	8.8	30.7	16.8	4.1	--	--	--	--	--	--	--	--	97.8	--	2.2
1998	--	--	--	--	--	--	0.2	13.7	--	10.4	5.7	32.8	21.6	13.3	--	--	--	--	--	--	--	--	97.6	--	2.4
1999	--	--	--	--	--	--	0.2	5.5	--	7.1	2.8	29.8	16.5	21.0	2.4	--	--	--	--	--	--	--	85.2	--	14.8
2000	--	--	--	--	--	--	0.1	3.3	--	4.9	2.4	26.8	8.8	17.1	5.5	0.1	--	--	--	--	--	--	68.9	--	31.1
2001	--	--	--	--	--	--	0.1	2.2	--	0.2	0.4	26.7	4.8	16.3	8.6	15.7	--	--	--	--	--	--	75.1	--	24.9
2002	--	--	--	--	--	--	--	1.0	--	--	--	13.4	3.8	16.3	12.2	34.7	--	--	--	--	--	--	81.4	--	18.6
2003	--	--	--	--	--	--	--	0.2	--	--	--	20.1	3.2	16.6	20.4	19.9	--	--	--	--	--	--	80.4	--	19.6
2004	--	--	--	--	--	--	--	0.3	--	--	--	20.3	0.3	12.9	22.4	19.4	--	--	--	--	--	--	75.5	--	24.5
2005	--	--	--	--	--	--	--	0.3	--	--	--	21.6	--	8.5	18.9	22.8	0.6	0.8	--	--	--	--	73.5	--	26.5
2006	--	--	--	--	--	--	--	0.3	--	--	--	14.9	--	4.4	21.6	20.6	1.8	7.9	--	--	--	--	71.6	--	28.4
2007	--	--	--	--	--	--	--	--	--	--	--	17.7	--	2.0	12.8	25.2	4.6	10.3	--	--	--	--	72.6	--	27.4
2008	--	--	--	--	--	--	--	--	--	--	--	20.9	--	--	8.1	21.0	1.9	16.7	--	--	--	--	68.6	--	31.4
2009	--	--	--	--	--	--	--	--	--	--	--	14.5	--	--	6.8	26.9	3.4	10.6	--	--	--	--	62.2	--	37.8
2010	--	--	--	--	--	--	--	--	--	--	--	6.0	--	--	4.8	10.1	--	4.8	32.3	15.1	--	--	73.2	--	26.8
2011	--	--	--	--	--	--	--	--	--	--	--	7.2	--	--	1.0	5.9	--	0.0	43.4	23.6	--	--	81.1	--	18.9
2012	--	--	--	--	--	--	--	--	--	--	--	7.2	--	--	1.0	5.9	--	0.0	43.4	23.6	--	--	81.1	--	18.9
2013	--	--	--	--	--	--	--	--	--	--	--	1.4	--	--	0.3	0.0	--	--	59.9	25.1	0.0	0.0	86.8	--	13.2
2014	--	--	--	--	--	--	--	--	--	--	--	--	--	--	0.6	--	--	--	75.5	18.6	0.2	0.3	95.2	--	4.8
2015	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.4	--	--	--	72.9	10.9	5.4	5.9	97.5	--	2.5
Total[‡]	0.1	4.3	0.1	1.5	0.3	0.0	3.5	12.2	0.4	5.9	3.4	11.0	4.0	3.1	3.3	4.9	0.2	1.3	6.1	2.0	0.1	0.1	100.0	67.8	21.0
Average[§]	35.2	33.5	4.2	11.0	2.4	0.4	7.0	18.6	3.0	15.4	9.0	18.6	11.4	12.0	8.8	16.3	2.5	6.4	54.5	19.5	1.9	2.1	65.6	46.3	20.0
Maximum[§]	75.1	96.6	14.9	28.5	9.1	0.4	21.5	36.8	6.1	24.9	17.4	32.8	22.9	21.0	22.4	34.7	4.6	16.7	75.5	25.1	5.4	5.9	100.0	86.8	100.0

† Data compiled from 1946-2015 volumes of Association of Official Seed Certifying Agencies (AOSCA) publication, Acres Applied for Certification.
‡ Percent of total acreage certified during 1946-2015.
§ Average and maximum percent of acreage certified in any year the cultivar was in certified production.