# Use of Plant Introductions in Peanut Cultivar Development

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**ABSTRACT**

The genetic base of peanut (*Arachis hypogaea* L.) in the U.S.A. has at times been extremely narrow, particularly in specific production areas where a single cultivar may be grown in near-monoculture. Because peanut is not a native North American species, all U.S. cultivars necessarily trace their ancestry to plant introductions (PIs), but most of the genetic base of current cultivars rests on selections from farmer-stock peanuts of obscure origin. The objectives of this study were to (a) summarize and document the use of introduced genetic resources in cultivar development and (b) estimate the resulting economic impact. Different PIs were used as parents in early breeding programs. B.B. Higgins used Gambian line Basse as a parent of the GA 207 cross that gave rise to selections used in Georgia, Florida, and North Carolina as the basis for further improvement. PI 121067 was one of seven parents used by W.C. Gregory to initiate the program in North Carolina. A different set of PIs including PI 121070, PI 161317, PI 168661, and *A. monticola* Krapov. & Rigoni were used in the Texas and Oklahoma programs. Recycling of lines as parents and exchange of germplasm among breeding programs proliferated these PIs in the pedigrees of cultivars released since 1960. Over the past 20 yr, there have been concerted efforts to incorporate additional germplasm into U.S. breeding populations, usually with the purpose of improving resistance to diseases or pests, but also with the objective of broadening the genetic base. These efforts have had a significant economic impact on U.S. peanut farmers, the largest from the development of cultivars with resistance to Sclerotinia blight (*Sclerotinia minor* Jagger), root-knot nematodes (*Meloidogyne* spp.), and tomato spotted wilt virus. Use of these resistant cultivars has an economic impact of more than $200 million annually for U.S. peanut producers. In the runner and virginia market types, the average PI ancestry of all cultivars was 17.9%. There are several examples of successful cultivars with up to 25% ancestry from a single PI, including Georgia Green and NC-V11. In the spanish market type, most successful cultivars have derived 50% or more of their ancestry from PIs. Several recent or impending releases incorporate PI germplasm but have not yet been proven in the U.S. seed market.

Key Words: *Arachis hypogaea* L., coancestry, disease resistance, genetic vulnerability, genetic resources.

As of July 2000, 119 peanut (*Arachis hypogaea* L.) cultivars had been released in the U.S. (Table 1), 53 released prior to 1961 when the Crop Science Society of America (CSSA) began to register crop cultivars and germplasm (Isleib and Wynne, 1992) and 66 registered with the CSSA after 1960 (registered cultivars, germplasm lines, parental lines, and genetic stocks can be obtained from the National Plant Germplasm System web site at www.ars-grin.gov/npgs) or with the Plant Variety Protection Office. Forty-eight were protected under Plant Variety Protection certificates, 24 of them current, eight expired, and 16 pending. One hundred twenty-eight additional lines have been released as germplasm, parental lines, or genetic stocks (Table 2).

In spite of the large number of cultivars available to growers, the U.S. peanut crop has been characterized as being genetically vulnerable to diseases and insect pests (Hammons, 1972, 1976; Knauft and Gorbet, 1989). This has been due to the commercial success of specific cultivars grown in particular production areas. For example, the runner-type cultivar Florunner dominated production in the southeastern U.S. (Georgia, Florida, and Alabama) from 1972 to 1993, occupying over 60% of the acreage in those years, over 80% from 1974 through 1987, and over 95% from 1976 through 1984. Currently, southeastern production is dominated by the cultivar Georgia Green. The Virginia-Carolina (VC) production area has had less tendency toward monoculture. The most dominant cultivar of the past 40 yr in the VC area was Florigiant which averaged over 60% of the area's acreage from 1974 through 1985, and with a maximum of over 80% in 1979. Since the decline of Florigiant, no cultivar in the VC area has occupied more than 50% of the acreage in a given year. In the southwestern (SW) production area (Texas and Oklahoma) where spanish-type cultivars were the main type produced through the 1970s, there was near-monoculture of Starr in the late 1960s and early 1970s. Over the past 20 yr, there has

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**Table 1. Cultivars released or registered in the United States.**

| Name | Market type | CSSA no. | NPGS no. | PVP cert. no. | Yr of release | Releasing agency | Reference |
|---|---|---|---|---|---|---|---|
| AD-1 | virginia | | | 8600030 | 1986 | J. Ashley Darden | |
| AgraTech 1-1 | runner | | | 200000134* | 2000 | AgraTech Seeds Inc. | K. Moore[a], 2000 |
| AgraTech AT 108 | runner | | | 9600322 | 1997 | AgraTech Seeds Inc. | K. Moore[a], 2000 |
| AgraTech AT 120 | runner | | | 9700275 | 1997 | AgraTech Seeds Inc. | K. Moore[a], 2000 |
| AgraTech AT 127 | runner | | | 9200066 | 1996 | AgraTech Seeds Inc. | K. Moore[a], 2000 |
| AgraTech AT 201 | runner | | | 200000135* | 2000 | AgraTech Seeds Inc. | K. Moore[a], 2000 |
| AgraTech AT 225 High Oleic | runner | | | 9700010 | 1997 | AgraTech Seeds Inc. | K. Moore[a], 2000 |
| AgraTech GK 3 | virginia | | | 7300094** | 1976 | Gold Kist Peanut Co. | E. Harvey[a], 1990/D.A. Knauft[a], 1990 |
| AgraTech GK 7 | runner | | | 8200141* | 1982 | Gold Kist Peanut Co. | E. Harvey[a], 1990 |
| AgraTech GK 7 High Oleic | runner | | | 9800019* | 1997 | AgraTech Seeds Inc. | K. Moore[a], 2000 |
| AgraTech GK 19 | runner | | | 7300005** | 1973 | Gold Kist Peanut Co. | E. Harvey[a], 1990 |
| AgraTech VC-1 | virginia | | | 9200014 | | AgraTech Seeds Inc. | K. Moore[a], 2000 |
| AgraTech VC-2 | virginia | | | 200000136* | 2000 | AgraTech Seeds Inc. | K. Moore[a], 2000 |
| AgraTech ViruGard® | runner | | | 9800022* | 1997 | AgraTech Seeds Inc. | K. Moore[a], 2000 |
| ALR 2 | spanish | CV-61 | PI 599975 | | 1994 | ICRISAT; Tamil Nadu Agric. Univ. | Varman *et al.*, 1998 |
| Altika | runner | CV-18 | PI 565453 | | 1972 | Guyana Min. Agric., FLAES | Norden & Gorbet, 1974 |
| Andru 93 | runner | CV-53 | PI 566905 | 9300153 | 1993 | FLAES | Gorbet & Knauft, 1995 |
| Argentine | spanish | | PI 300585 | | 1951 | OKAES | McGill, 1963 |
| Avoca 11 | virginia | | | 7100110** | 1976 | R.J. Reynolds Co. | Mozingo *et al.*, 1987 |
| C-99R | runner | | | 200000182* | 1999 | FLAES | Gorbet *et al.*, 1999 |
| COAN | runner | | | 9900338* | 1999 | TXAES | C.E. Simpson[a], 2000 |
| Comet | spanish | | | | 1970 | OK & GA AES | J.S. Kirby[a], 1990 |
| David | virginia | | | 9500120 | 1996 | Israel Agric. Res. Org. | I. Wallerstein[a], 1999 |
| Dixie Runner | runner | | | | 1943 | FLAES | Carver & Hull, 1950 |
| Dixie Spanish | spanish | | | | 1950 | GAAES | Higgins & Bailey, 1955 |
| Early Bunch | virginia | CV-21 | PI 565458 | | 1977 | FL & GAAES, USDA-ARS | Norden *et al.*, 1978 |
| Early Runner | runner | | | | 1952 | FLAES | Carver *et al.*, 1952 |
| Flavorunner 458 | runner | | | 9600242 | 1997 | Mycogen | |
| Florida MDR 98 | runner | | | 9900212* | 1998 | FLAES | D.W. Gorbet[a], 2000 |
| Florigiant | virginia | CV-01 | PI 565445 | | 1961 | FLAES | Carver, 1969 |
| Florispan Runner | spanish | | | | 1953 | GAAES | Carver, 1953 |
| Florunner | runner | CV-02 | PI 565448 | | 1969 | FLAES | Norden *et al.*, 1969 |
| Georgia 119-20 | virginia | CV-12 | PI 565440 | | 1954 | GAAES & USDA-ARS | Hammons, 1971 |
| Georgia Bold | runner | CV-60 | PI 601980 | 9800041* | 1997 | GAAES | Branch, 1998 |
| Georgia Browne | runner | CV-52 | PI 574450 | 9400043 | 1993 | GAAES | Branch, 1994 |
| Georgia Green | runner | CV-55 | PI 587093 | 9500165 | 1995 | GAAES | Branch, 1996 |
| Georgia Red | valencia | CV-33 | PI 508278 | | 1986 | GAAES & USDA-ARS | Branch & Hammons, 1987 |
| Georgia Runner | runner | CV-41 | PI 542960 | 9200029 | 1990 | GAAES | Branch, 1991 |
| GFA Spanish | spanish | | | | 1941 | GAAES | Higgins & Bailey, 1955 |
| Goldin I | spanish | | | 7100035** | 1976 | Wilson Co. Peanut Co. | R.O. Hammons[a], n.d. |
| Gregory | virginia | CV-62 | PI 608666 | 9900337* | 1997 | NCARS | Isleib *et al.*, 1999 |
| H&W Valencia 101 | valencia | | | 9700337* | | H&W GENETEX, Inc. | |
| H&W Valencia 102 | valencia | | | 9700336* | | H&W GENETEX, Inc. | |
| Holland Jumbo | virginia | | | | 1945 | VAAES | Batten, 1945 |
| Holland Va. Runner | virginia | | | | 1943 | VAAES | Batten, 1945 |
| Hughes Runner | runner | | | 200000203* | 2000 | Kenneth E. Hughes | |
| ICGS 1 | spanish | CV-43 | PI 478780 | | 1990 | ICRISAT | Nigam *et al.*, 1991b |
| ICGS 11 | spanish | CV-38 | PI 478788 | | 1986 | ICRISAT | Nigam *et al.*, 1990a |
| ICGV 86325 | spanish[b] | CV-54 | PI 590879 | | 1994 | ICRISAT | Dwivedi *et al.*, 1996a |
| ICGV 86590 | valencia | CV-49 | PI 562530 | | 1991 | ICRISAT | Reddy *et al.*, 1993 |
| ICGV 87128 | spanish | CV-37 | PI 537112 | | 1988 | ICRISAT | Nigam *et al.*, 1990b |
| ICGV 87141 | spanish[b] | CV-42 | PI 546372 | | 1989 | ICRISAT | Nigam *et al.*, 1990c |
| ICGV 87160 | spanish | CV-47 | PI 478787 | | 1990 | ICRISAT | Reddy *et al.*, 1992 |
| ICGV 87187 | spanish | CV-45 | PI 550930 | | 1990 | ICRISAT | Nigam *et al.*, 1992b |
| Improved Spanish 2B | spanish | | | | | GAAES | Beattie *et al.*, 1954 |
| Jeokwangtangkong | spanish | CV-63 | PI 607913 | | 1997 | ICRISAT | Oh *et al.*, 2000 |
| Keel 29 | virginia | | | 8000155* | 1974 | Keel Peanut Seed Co. | Mozingo *et al.*, 1987 |
| Keel 76 | virginia | | | | | James T. Keel | |
| KH20 | runner | | | 8700094 | | Kenneth E. Hughes | |
| Langley | runner | CV-31 | PI 506237 | | 1986 | TXAES | Simpson *et al.*, 1987 |
| MARC 1 | runner | CV-46 | PI 552555 | 9200115 | 1990 | FLAES | Gorbet *et al.*, 1992 |
| McRan | valencia | | | 7300066** | 1973 | Borden Peanut Seed Co. | R.O. Hammons[a], n.d. |
| NC 1 | virginia | | | | 1952 | NCAES | W.C. Gregory[a], n.d. |

**Table 1 (Continued)**

| Name | Market type | CSSA no. | NPGS no. | PVP cert. no. | Yr of release | Releasing agency | Reference |
|---|---|---|---|---|---|---|---|
| NC 2 | virginia | CV-05 | PI 565446 | | 1952 | NCAES | Gregory, 1970 |
| NC 4 | virginia | | | | 1944 | NCAES | W.C. Gregory[a], n.d. |
| NC 4X | virginia | | | | 1959 | NCAES | Gregory, 1960 |
| NC 5 | virginia | CV-06 | PI 565447 | | 1964 | NCAES | Emery & Gregory, 1970 |
| NC 6 | virginia | CV-20 | PI 565456 | 7605011** | 1976 | NCARS | Campbell *et al.*, 1977 |
| NC 7 | virginia | CV-22 | PI 565459 | 7900104** | 1978 | NCARS | Wynne *et al.*, 1979 |
| NC 8C | virginia | CV-27 | PI 565476 | | 1982 | NCARS | Wynne & Beute, 1983 |
| NC 9 | virginia | CV-30 | PI 565484 | 8500201 | 1985 | NCARS | Wynne *et al.*, 1986 |
| NC 10C | virginia | CV-39 | PI 540460 | 8900116 | 1988 | NCARS | Wynne *et al.*, 1991a |
| NC-V11 | virginia | CV-40 | PI 540461 | | 1989 | NCARS | Wynne et al., 1991b |
| NC 12C | virginia | CV-57 | PI 596406 | 9700074 | 1996 | NCARS | Isleib *et al.*, 1997 |
| NC-Fla 14 | virginia | CV-17 | PI 565466 | | 1973 | NCAES & FLAES | Emery *et al.*, 1974 |
| NC 17 | virginia | CV-07 | PI 565451 | | 1969 | NCARS | Emery, 1970 |
| New Mexico Valencia A | valencia | CV-14 | PI 565452 | | 1971 | NMAES | Hsi & Finkner, 1972 |
| New Mexico Valencia C | valencia | CV-24 | PI 565461 | | 1979 | NMAES | Hsi, 1980 |
| Okrun | runner | CV-36 | PI 531499 | | 1986 | USDA-ARS & OKAES | Banks *et al.*, 1989 |
| Perry | virginia | | | 20000022[5] | 2000 | NCARS | T.S. Isleib[a], 2000 |
| Pronto | spanish | CV-28 | PI 565475 | | 1980 | USDA-ARS, OK & GAAES | Banks & Kirby, 1983 |
| Shosh | virginia | | | 9400123 | | Israel Agric. Res. Org. | I. Wallerstein[a], 1997 |
| Shulamith | virginia | | PI 372572 | | 1968 | Israel Agric. Res. Org. & GAAES | Goldin, 1970 |
| Sinkarzei (ICGS 114) | spanish | CV-48 | PI 561673 | | 1989 | ICRISAT | Nigam *et al.*, 1993b |
| Southeastern Runner 56-15 | runner | CV-09 | PI 565439 | | 1947 | GAAES & USDA-ARS | Hammons, 1970a |
| Southern Runner | runner | CV-32 | PI 506419 | 8700093 | 1984 | FLAES | Gorbet *et al.*, 1987 |
| Southwest Runner | runner | CV-58 | PI 599178 | | 1995 | OKAES & USDA-ARS | Kirby *et al.*, 1998 |
| Spanco | spanish | CV-35 | PI 531500 | | 1981 | OKAES & USDA-ARS | Kirby *et al.*, 1989 |
| Spancross | spanish | CV-03 | PI 565449 | | 1970 | GAAES, USDA-ARS, & OKAES | Hammons, 1970b |
| Spanette | spanish | | | | 1959 | GAAES | NAS, 1972 |
| Spanhoma | spanish | | | | 1969 | OKAES & GAAES | NAS, 1972 |
| Spanish 18-38 | spanish | | | | | GAAES | Gregory *et al.*, 1951 |
| Spanish No. 146 | spanish | | | | | | Higgins & Bailey, 1955 |
| Spantex | spanish | CV-15 | PI 565442 | | 1948 | TXAES | Simpson, 1972a |
| Starr | spanish | CV-16 | PI 565443 | | 1961 | TXAES | Simpson, 1972b |
| Sunbelt Runner | runner | CV-26 | PI 565473 | | 1982 | USDA-ARS & GAAES | Mixon, 1982 |
| SunOleic 95R | runner | CV-56 | PI 578304 | 9400148 | 1995 | FLAES | Gorbet & Knauft, 1997 |
| SunOleic 97R | runner | CV-65 | PI 596800 | 9700182 | 1997 | FLAES | Gorbet & Knauft, 2000 |
| Sunrunner | runner | CV-29 | PI 565433 | | 1982 | FLAES | Norden *et al.*, 1985 |
| Tamnut 74 | spanish | CV-19 | PI 564855 | | 1974 | TXAES, OKAES, & GAAES | Simpson & Smith, 1975 |
| Tamrun 88 | runner | CV-34 | PI 520600 | | 1988 | TXAES | Smith & Simpson, 1989 |
| Tamrun 96 | runner | CV-59 | PI 601819 | 9800338* | 1996 | TXAES | Smith *et al.*, 1998 |
| Tamrun 98 | runner | CV-64 | PI 608737 | 9900189* | 1998 | TXAES | Simpson *et al.*, 2000 |
| Tamspan 90 | spanish | CV-44 | PI 550721 | | 1990 | TXAES & USDA-ARS | Smith *et al.*, 1991 |
| Tennessee Red | valencia | | | | | | Handy, 1896 |
| Tifrun | runner | | | | 1977 | GAAES & USDA-ARS | R.O. Hammons[a], 1977; D.A. Knauft[a], 1990 |
| Tifspan | spanish | CV-04 | PI 565450 | | 1964 | GAAES, USDA-ARS, & OKAES | Hammons, 1970c |
| Toalson | spanish | CV-23 | NSL 102066 | | 1979 | TXAES | Simpson *et al.*, 1979 |
| VA-C 92R | virginia | CV-50 | PI 561566 | 9200252 | 1992 | VAAES, NCARS, & USDA-ARS | Mozingo *et al.*, 1994 |
| VA 93B | virginia | CV-51 | PI 561568 | | 1993 | VAAES & USDA-ARS | Coffelt *et al.*, 1994b |
| VA 98R | virginia | CV-66 | PI 607566 | 9900419* | 1998 | VAAES & USDA-ARS | Mozingo *et al.*, 2000 |
| Virginia 56R | virginia | CV-10 | PI 565441 | | 1956 | VAAES | Alexander & Allison, 1970a |
| Virginia 61R | virginia | CV-11 | PI 565444 | | 1961 | VAAES | Alexander & Allison, 1970b |
| Virginia 72R | virginia | CV-13 | PI 565454 | | 1972 | VAAES | Alexander & Allison, 1972 |
| Virginia 81 Bunch | virginia | CV-25 | PI 565474 | | 1981 | VAAES & USDA-ARS | Coffelt *et al.*, 1982 |
| Virginia Bunch 46-2 | virginia | | | | 1952 | VAAES & USDA | Beattie & Batten, 1953 |
| Virginia Bunch 67 | runner | CV-08 | PI 565438 | | 1945 | GAAES | Hammons, 1970d |
| Virginia Bunch G2 | virginia | | | | 1952 | GAAES | Higgins & Bailey, 1955 |
| Virginia Bunch G26 | virginia | | | | 1952 | GAAES | Higgins & Bailey, 1955 |

*,**Plant variety protection certificate pending or expired, respectively.

[a]Denotes personal communication.

[b]Denotes lines with spanish-type seeds but botanically classified as var. *hypogaea*.

**Table 2. Germplasm lines, parental lines, and genetic stocks registered with the Crop Science Society of America (CSSA).**

| Line | CSSA reg. no. | NPGS no. | Year of release | Releasing agency | Reference |
|---|---|---|---|---|---|
| AR-1 | GP-35 | PI 565480 | 1983 | USDA-ARS & GAAES | Mixon, 1983a |
| AR-2 | GP-36 | PI 565481 | 1983 | USDA-ARS & GAAES | Mixon, 1983a |
| AR-3 | GP-37 | PI 565482 | 1983 | USDA-ARS & GAAES | Mixon, 1983a |
| AR-4 | GP-38 | PI 565483 | 1983 | USDA-ARS & GAAES | Mixon, 1983a |
| CBR-R1 | GP-12 | PI 565470 | 1981 | USDA-ARS | Hammons, 1981 |
| CBR-R2 | GP-13 | PI 565469 | 1981 | USDA-ARS | Hammons, 1981 |
| CBR-R3 | GP-14 | PI 565468 | 1981 | USDA-ARS | Hammons, 1981 |
| CBR-R4 | GP-15 | PI 565471 | 1981 | USDA-ARS | Hammons, 1981 |
| CBR-R5 | GP-16 | PI 565467 | 1981 | USDA-ARS | Hammons, 1981 |
| CBR-R6 | GP-17 | PI 565472 | 1981 | USDA-ARS | Hammons, 1981 |
| Chico | GP-02 | PI 565455 | 1974 | USDA-ARS, GA, VA, & OKAES | Bailey & Hammons, 1975 |
| CPES population | GP-55 | PI 542961 | 1990 | GAAES & USDA-ARS | Branch & Holbrook, 1991 |
| F334A-B-14 | GP-32 | PI 565477 | 1983 | USDA-ARS, FL & GAAES | Hammons *et al.*, 1983 |
| GFA-1 | GP-33 | PI 565478 | 1983 | USDA-ARS & GAAES | Mixon, 1983b |
| GFA-2 | GP-34 | PI 565479 | 1983 | USDA-ARS & GAAES | Mixon, 1983b |
| NC-GP 343 | GP-01 | PI 565465 | 1952 | NCARS | Campbell *et al.*, 1971 |
| NC-GP WS 1 | GP-59 | PI 564844 | 1992 | NCARS | Stalker & Beute, 1993 |
| NC-GP WS 2 | GP-60 | PI 564845 | 1992 | NCARS | Stalker & Beute, 1993 |
| NC-GP WS 3 | GP-61 | PI 564846 | 1992 | NCARS | Stalker & Beute, 1993 |
| NC-GP WS 4 | GP-62 | PI 564847 | 1992 | NCARS | Stalker & Beute, 1993 |
| NC-GP WS 5 | GP-103 | PI 619169 | 1998 | NCARS | Stalker *et al.*, 2002a |
| NC-GP WS 6 | GP-104 | PI 619170 | 1998 | NCARS | Stalker *et al.*, 2002a |
| NC-GP WS 7 | GP-105 | PI 619171 | 1998 | NCARS | Stalker & Lynch, 2002 |
| NC-GP WS 8 | GP-106 | PI 619172 | 1998 | NCARS | Stalker & Lynch, 2002 |
| NC-GP WS 9 | GP-107 | PI 619173 | 1998 | NCARS | Stalker & Lynch, 2002 |
| NC-GP WS 10 | GP-108 | PI 619174 | 1998 | NCARS | Stalker & Lynch, 2002 |
| NC-GP WS 11 | GP-109 | PI 619175 | 1998 | NCARS | Stalker *et al.*, 2002b |
| NC-GP WS 12 | GP-110 | PI 619176 | 1998 | NCARS | Stalker *et al.*, 2002b |
| NC-GP WS 13 | GP-111 | PI 619177 | 1998 | NCARS | Stalker *et al.*, 2002b |
| NC-GP WS 14 | GP-112 | PI 619178 | 1998 | NCARS | Stalker *et al.*, 2002b |
| NC-GP WS 15 | GP-113 | PI 619179 | 1998 | NCARS | Stalker *et al.*, 2002b |
| ICGL 1 | GP-50 | PI 544348 | 1989 | ICRISAT | Nigam *et al.*, 1991a |
| ICGL 2 | GP-51 | PI 544349 | 1989 | ICRISAT | Nigam *et al.*, 1991a |
| ICGL 3 | GP-52 | PI 544350 | 1989 | ICRISAT | Nigam *et al.*, 1991a |
| ICGL 4 | GP-53 | PI 544351 | 1989 | ICRISAT | Nigam *et al.*, 1991a |
| ICGL 5 | GP-54 | PI 544352 | 1989 | ICRISAT | Nigam *et al.*, 1991a |
| ICGS 35 | GP-67 | PI 577819 | 1981/1986 | ICRISAT | Nigam *et al.*, 1994 |
| ICGV-SM 83305 | GP-91 | PI 598135 | 1995 | ICRISAT | Nigam *et al.*, 1998b |
| ICGV-SM 83708 | GP-68 | PI 585000 | 1990 | ICRISAT | Nigam *et al.*, 1995a |
| ICGV-SM 85048 | GP-90 | PI 598134 | 1992 | ICRISAT | Nigam *et al.*, 1998a |
| ICGV-SM 86715 | GP-89 | PI 598133 | 1992 | ICRISAT | Moss *et al.*, 1998 |
| ICGV 86015 | GP-73 | PI 585005 | 1993 | ICRISAT | Nigam *et al.*, 1995b |
| ICGV 86031 | GP-58 | PI 561917 | 1991 | ICRISAT | Dwivedi *et al.*, 1993 |
| ICGV 86143 | GP-87 | PI 596359 | 1994 | ICRISAT | Upadhaya *et al.*, 1997b |
| ICGV 86155 | GP-79 | PI 594969 | 1995 | ICRISAT | Upadhaya *et al.*, 1997a |
| ICGV 86156 | GP-80 | PI 594970 | 1995 | ICRISAT | Upadhaya *et al.*, 1997a |
| ICGV 86158 | GP-81 | PI 594971 | 1995 | ICRISAT | Upadhaya *et al.*, 1997a |
| ICGV 86252 | GP-69 | PI 585001 | 1993 | ICRISAT | Dwivedi *et al.*, 1995 |
| ICGV 86388 | GP-77 | PI 593239 | 1995 | ICRISAT | Dwivedi *et al.*, 1996b |
| ICGV 86393 | GP-70 | PI 585002 | 1993 | ICRISAT | Dwivedi *et al.*, 1995 |
| ICGV 86455 | PI-71 | PI 585003 | 1993 | ICRISAT | Dwivedi *et al.*, 1995 |
| ICGV 86462 | GP-72 | PI 585004 | 1993 | ICRISAT | Dwivedi *et al.*, 1995 |
| ICGV 86564 | GP-65 | PI 573007 | 1992 | ICRISAT | Dwivedi *et al.*, 1994 |
| ICGV 86699 | GP-76 | PI 591815 | 1994 | ICRISAT | Reddy *et al.*, 1996 |
| ICGV 87121 | GP-57 | PI 478784 | 1989 | ICRISAT | Nigam *et al.*, 1992a |
| ICGV 87157 | GP-56 | PI 556992 | 1990 | ICRISAT | Nigam *et al.*, 1992b |
| ICGV 87165 | GP-78 | PI 594923 | 1994 | ICRISAT | Moss *et al.*, 1997 |
| ICGV 87378 | GP-82 | PI 594972 | 1995 | ICRISAT | Upadhyaya *et al.*, 1997a |
| ICGV 87921 | GP-83 | PI 594973 | 1995 | ICRISAT | Upadhyaya *et al.*, 1997a |
| ICGV 88145 | GP-74 | PI 585006 | 1993 | ICRISAT | Rao *et al.*, 1995 |
| ICGV 88438 | GP-84 | PI 596514 | 1995 | ICRISAT | Hadjichristodoulou *et al.*, 1997 |
| ICGV 89104 | GP-75 | PI 585007 | 1993 | ICRISAT | Rao *et al.*, 1995 |
| ICGV 89214 | GP-85 | PI 596515 | 1995 | ICRISAT | Hadjichristodoulou *et al.*, 1997 |
| ICGV 91098 | GP-86 | PI 596516 | 1995 | ICRISAT | Hadjichristodoulou *et al.*, 1997 |
| ICGV 92196 | GP-92 | PI 599344 | 1996 | ICRISAT | Upadhaya *et al.*, 1998 |
| ICGV 92206 | GP-93 | PI 599345 | 1996 | ICRISAT | Upadhaya *et al.*, 1998 |
| ICGV 92234 | GP-94 | PI 599346 | 1996 | ICRISAT | Upadhaya *et al.*, 1998 |
| ICGV 92243 | GP-95 | PI 599347 | 1996 | ICRISAT | Upadhaya *et al.*, 1998 |

**Table 2 (Continued)**

| Line | CSSA reg. no. | NPGS no. | Year of release | Releasing agency | Reference |
|---|---|---|---|---|---|
| NC 10247 | GP-05 | PI 565434 | 1975 | NCARS | Campbell *et al.*, 1975 |
| NC 10272 | GP-06 | PI 565435 | 1975 | NCARS | Campbell *et al.*, 1975 |
| NC 15729 | GP-07 | PI 565436 | 1975 | NCARS | Campbell *et al.*, 1975 |
| NC 15745 | GP-08 | PI 565437 | 1975 | NCARS | Campbell *et al.*, 1975 |
| NC 3033 (ICG 5816) | GP-09 | PI 565460 | 1974 | NCARS | Beute *et al.*, 1976 |
| PI 109839 (Mani) | GP-10 | PI 109839 | 1979 | GAAES & USDA-ARS | Hammons *et al.*, 1980 |
| PI 337394F | GP-03 | PI 337394F | 1974 | USDA-ARS, AL, & GAAES | Mixon & Rogers, 1975 |
| PI 337409 (Rosado) | GP-04 | PI 337409 | 1974 | USDA-ARS, AL, & GAAES | Mixon & Rogers, 1975 |
| Tifrust-1 | GP-18 | PI 561676 | 1981 | USDA-ARS, GAAES, & ICRISAT | Hammons *et al.*, 1982d |
| Tifrust-10 (ICG 7890) | GP-27 | PI 561685 | 1981 | USDA-ARS, GAAES, & ICRISAT | Hammons *et al.*, 1982c |
| Tifrust-11 (ICG 7893) | GP-28 | PI 561686 | 1981 | USDA-ARS, GAAES, & ICRISAT | Hammons *et al.*, 1982c |
| Tifrust-12 (ICG 7891) | GP-29 | PI 561687 | 1981 | USDA-ARS, GAAES, & ICRISAT | Hammons *et al.*, 1982c |
| Tifrust-13 (ICG 7883) | GP-30 | PI 561688 | 1981 | USDA-ARS, GAAES, ICRISAT & Israel Agric. Res. Org. | Hammons *et al.*, 1982b |
| Tifrust-14 (ICG 7882) | GP-31 | PI 561689 | 1982 | USDA-ARS, GAAES, & ICRISAT | Hammons *et al.*, 1982a |
| Tifrust-2 (ICG 7886) | GP-19 | PI 561677 | 1981 | USDA-ARS, GAAES, & ICRISAT | Hammons *et al.*, 1982d |
| Tifrust-3 (ICG 7887) | GP-20 | PI 561678 | 1981 | USDA-ARS, GAAES, & ICRISAT | Hammons *et al.*, 1982d |
| Tifrust-4 (ICG 7898) | GP-21 | PI 561679 | 1981 | USDA-ARS, GAAES, & ICRISAT | Hammons *et al.*, 1982d |
| Tifrust-5 (ICG 7894) | GP-22 | PI 561680 | 1981 | USDA-ARS, GAAES, & ICRISAT | Hammons *et al.*, 1982c |
| Tifrust-6 (ICG 7895) | GP-23 | PI 561681 | 1981 | USDA-ARS, GAAES, & ICRISAT | Hammons *et al.*, 1982c |
| Tifrust-7 (ICG 7896) | GP-24 | PI 561682 | 1981 | USDA-ARS, GAAES, & ICRISAT | Hammons *et al.*, 1982c |
| Tifrust-8 (ICG 7888) | GP-25 | PI 561683 | 1981 | USDA-ARS, GAAES, & ICRISAT | Hammons *et al.*, 1982c |
| Tifrust-9 (ICG 7889) | GP-26 | PI 561684 | 1981 | USDA-ARS, GAAES, & ICRISAT | Hammons *et al.*, 1982c |
| Tifton-8 | GP-39 | PI 565463 | 1985 | USDA-ARS, VAAES, & GAAES | Coffelt *et al.*, 1985 |
| TxAG-1 | GP-40 | NSL 199440 | 1985 | TXAES | Simpson & Smith, 1986 |
| TxAG-2 | GP-41 | NSL 199441 | 1985 | TXAES | Simpson & Smith, 1986 |
| TxAG-4 | GP-48 | PI 535816 | 1990 | TXAES, USDA-ARS, & OKAES | Smith *et al.*, 1990 |
| TxAG-5 | GP-49 | PI 535817 | 1990 | TXAES, USDA-ARS, & OKAES | Smith *et al.*, 1990 |
| TxAG-6 | GP-63 | PI 565287 | 1992 | TXAES | Simpson *et al.*, 1993 |
| TxAG-7 | GP-64 | PI 565288 | 1992 | TXAES | Simpson *et al.*, 1993 |
| VGP 1 | GP-11 | PI 565462 | 1979 | USDA-ARS & VAAES | Coffelt, 1980 |
| VGP 10 | GP-88 | PI 584772 | 1997 | USDA-ARS & VAAES | Coffelt & Mozingo, 1998 |
| VGP 11 | GP-96 | PI 584773 | 1997 | USDA-ARS & VAAES | Coffelt *et al.*, 1998 |
| VGP 2 | GP-42 | PI 509536 | 1986 | USDA-ARS & VAAES | Coffelt *et al.*, 1987 |
| VGP 3 | GP-43 | PI 509537 | 1986 | USDA-ARS & VAAES | Coffelt *et al.*, 1987 |
| VGP 4 | GP-44 | PI 509538 | 1986 | USDA-ARS & VAAES | Coffelt *et al.*, 1987 |
| VGP 5 | GP-45 | PI 509539 | 1986 | USDA-ARS & VAAES | Coffelt *et al.*, 1987 |
| VGP 6 | GP-46 | PI 509540 | 1986 | USDA-ARS & VAAES | Coffelt *et al.*, 1987 |
| VGP 7 | GP-47 | PI 509541 | 1986 | USDA-ARS & VAAES | Coffelt *et al.*, 1987 |
| VGP 9 | GP-66 | PI 561567 | 1993 | USDA-ARS & VAAES | Coffelt *et al.*, 1994a |
| GA 207-3-4 | PL-02 | PI 565464 | 1984 | GAAES & USDA-ARS | Branch & Hammons, 1984 |
| Jenkins Jumbo | PL-01 | PI 565457 | 1978 | GA & FLAES & USDA-ARS | Hammons & Norden, 1979 |
| Curly-leaf | GS-03 | PI 578012 | 1993 | GAAES | Branch, 1995 |
| Georgia Non-Nod | GS-06 | PI 595385 | 1994 | GAAES | Branch, 1997 |
| ICGL 6 | GS-01 | PI 561916 | 1991 | ICRISAT | Nigam *et al.*, 1993a |
| Krinkle-leaf[a] | | | | | USDA-ARS Hammons, 1964 |
| Rusty-Leaf | GS-07 | PI 608669 | 1998 | GAAES | Branch, 1999a |
| Variegated-Leaf | GS-02 | PI 561736 | 1992 | GAAES | Branch, 1993 |
| VGS 1 | GS-04 | PI 584770 | 1994 | USDA-ARS & VAAES | Coffelt, 1995 |
| VGS 2 | GS-05 | PI 584771 | 1994 | USDA-ARS & VAAES | Coffelt, 1995 |
| White-Spot Testa | GS-08 | PI 608670 | 1998 | GAAES | Branch, 1999b |

[a]A genetic stock whose description was published in Crop Science, but not registered with the Crop Science Society of America.

been an influx of runner-type cultivars into the SW area, resulting in relatively great genetic diversity among the cultivars grown there.

One of the ways that plant breeders can increase the genetic diversity of a crop is to incorporate diverse germplasm into the breeding populations from which cultivars derive. *Arachis hypogaea* is a genetically diverse species with two subspecies and six botanical varieties. The first peanut introduction of the modern era was PI 4253, collected by B. Lathrop and D.G. Fairchild in 1899 and identified as the prize-winning peanut from the 1898 exposition of the Khedival Agricultural Society of Cairo, Egypt (USDA, 1900, 1901). There have been thousands of accessions of *A. hypogaea* introduced and numbered by the USDA since that time. Many were donated by U.S. diplomats, missionaries, and travelers in foreign countries. Others were provided by foreign governments and agricultural research institutions as part of germplasm exchanges with U.S. institutions. Still others were collected as part of a coordinated effort by the USDA and international agencies to collect and preserve natural genetic diversity before it erodes through the displacement of farmer-held seed stocks by improved cultivars. The current USDA collection contains over 8000 *A. hypogaea* accessions. Many of these are duplicated within the collection as a result of wholesale exchange of germplasm with collections in other countries. In the early years of the national plant germplasm system, breeding lines from U.S. programs were often cataloged, and accessions were sometimes renumbered each time seed was produced. Many exotic accessions have been lost from the U.S. collection because early introductions of minor crops were often increased only once or not at all, then distributed to the agricultural experiment stations in states where the crop was grown. Some accessions without obvious value were discarded by recipients after cursory observation. No doubt some lines were lost due to special requirements or characteristics that made them unadapted to the prevailing conditions in the southern U.S. Some accessions were used as parents in peanut breeding programs, and some have descendants among released cultivars and germplasm lines. The objectives of this study were to (a) summarize and document the use of genetic resources in cultivar development and (b) estimate the resulting economic impact.

## Materials and Methods

The importance of ancestors of current runner, virginia, and spanish cultivars was assessed by pedigree analysis of improved cultivars (Tables 3-5; Figs. 1-3). The parentage of each cultivar was traced back to ancestors for which no further information could be found. Pedigree information was gathered from published registration articles, release notices, internal documents of the North Carolina and Florida breeding projects, and by personal communication with breeders in other states.

Each cultivar was assigned to a breeding cycle based on the number of cycles of crossing and selection it was removed from the founding ancestors. In this system, ancestors were assigned to Cycle 0, selections from Cycle 0 ancestors or progeny from crosses between Cycle 0 lines were assigned to Cycle 1, and so on. Each line was assigned to a cycle one higher than the higher of its parents. Coefficients of coancestry (Malécot, 1948) of the cultivars with each of the ancestors were then calculated. Each such coancestry value represents the proportion of the genome of the cultivar that should trace to the ancestor. Coancestries were totaled across PI ancestors to indicate the proportion of the cultivar's genome attributable to PIs.

The coancestry between lines X and Y, $(\theta_{XY} = \theta_{XC} + \theta_{XD})/2 = (\theta_{AY} + \theta_{BY})/2 = (\theta_{AC} + \theta_{AD} + \theta_{BC} + \theta_{BD})/4$. The expressions are expanded back until they intersect at a common ancestor, W, at which point they include a term $\theta_{WW}$, the coancestry of a line with itself which is $\theta_{WW} = (1 + F_W)/2$, where $F_W$ is the coefficient of inbreeding or the probability that the two genes carried by W are identical by descent. For purposes of this study, all lines were assumed to be completely inbred (F = 1). These rules were developed for outcrossing species, but can be adapted for use in self-pollinated species. If one assumes that the probability of fixation under self-pollination of the gene derived from either parent of a cross is 0.5 (St. Martin, 1982), then the computational rules for self-pollinators are identical to those for cross-pollinators. Additional rules are required to determine the coancestry of lines derived by self-fertilization from the same cross (Cockerham, 1983). For lines derived by selection within an existing line, either with or without mutagenesis, it was assumed that the coancestry of the parental and selected lines was 0.99.

Averages and ranges were calculated for the coancestries of cultivars from different breeding cycles and market types to assess the contributions of the ancestors to particular groups. These averages were not weighted by the acreage planted to each cultivar. The total ancestry derived from plant introductions was summed for each cultivar, and distributions were calculated in increments of 12.5%. Distributions were compared through the use of contingency tables and chi-square testing.

The economic impact from the use of genetic resources in cultivars was assessed through surveys of peanut breeders, pathologists, and extension specialists. Estimates were based on the yield advantage of new cultivars in comparison to older ones, land area occupied by new cultivars, and any reduction in pesticide usage that may have occurred because of the release of new cultivars.

## Results and Discussion

***Use of Genetic Resources in Cultivar Development.*** Because peanuts as a crop were introduced to what is now the U.S.A., all U.S. peanut cultivars necessarily trace back to plant introductions. However, much of the genetic base of current cultivars traces back to ancestors that were developed by mass selection from farmer stock peanuts in the various production areas (Isleib and Wynne, 1992). Much of the base of improved runner and virginia cultivars rests on four ancestors used as parents in the early years of peanut improvement in the U.S., including var. *hypogaea* lines Dixie Giant and Basse and var. *vulgaris* Harz lines Small White Spanish and Spanish 18-38. Of these, only Basse is known to have been introduced in the modern era of plant collection. The initial cross of Small White Spanish by Dixie Giant was made by W.A. Carver at the Univ. of Florida in the early to mid-1930s, and the cross, numbered F230 in the Florida system, eventually gave rise to the successful runner-type cultivar Early Runner and numerous sibling lines derived from $F_2$ plant selection F230-118. Meanwhile, B.B. Higgins at the Univ. of Georgia crossed Basse by Spanish 18-38, giving rise to several selections in the GA 207 series. Most current runner- and virginia-type cultivars trace their ancestry back to these two crosses through Florispan and its close siblings, derived from a cross between GA 207-3 and F230-118-2-2, and their immediate descendants Florunner and Florigiant.

In addition to the four primary ancestors of runner-type cultivars, the early virginia market-type cultivars had additional infusion of ancestry from farmer stock selection Jenkins Jumbo, a large-seeded selection from farmer stock used as a parent in the Florida program, a group of five lines (NC 4, NC Bunch, White's Runner, Improved

**Table 3. Improved runner cultivars released in the U.S.A., their origin, breeding cycle, and coancestry with 13 introduced ancestors.**

| Cycle | Name | Origin | Basse | PI 203 396 | PI 109 839 | Goldin I | PI 331 334 | TxAG-6 | PI 121 070 | PI 161 317 | PI 259 785 | PI 475 871 | F21 | PI 121 067 | PI 221 057 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Southeastern Runner | Selection from farmer stock | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| 1 | Dixie Runner | Small White Spanish 3x-1 / Dixie Giant | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| 1 | Early Runner | Small White Spanish 3x-2 / Dixie Giant | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| 1 | Georgia Runner | Krinkle-leaf / PI 331334 | .000 | .000 | .000 | .000 | .500 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .500 |
| 1 | Southeastern Runner 56-15 | Selection from 'Southeastern Runner' | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| 1 | Virginia Bunch 67 | Selection from 'Virginia Bunch' | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| 1 | Virginia Bunch G2 | Selection from 'Virginia Bunch' | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| 1 | Virginia Bunch G26 | Selection from 'Virginia Bunch' | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| 2 | Florispan | Basse / Spanish 18-38, GA 207-3 // F230-118-2, Small White Spanish 3x-2 / Dixie Giant | .250 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .250 |
| 3 | Florunner | F334A-3-14 (Florispan sib) / F230-118-B-8-1 (Early Runner sib) | .125 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .125 |
| 4 | COAN | TxAG 6 / 6*Florunner | .123 | .000 | .000 | .000 | .000 | .016 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .139 |
| 4 | Flavorunner | High-oleic mutant in Florunner | .124 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .124 |
| 4 | GK 123 | F439-16-10-3-1 (Florunner component) / GK 17-2-6-5-5 | .125 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .125 |
| 4 | GK 19 | F334A-3-5-5-1 (Florispan deriv.) / Jenkins Jumbo, F393-6 // F334A-9 (Florispan sib) | .188 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .188 |
| 4 | Langley | Florunner / PI 109839 | .063 | .000 | .500 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .563 |
| 4 | Okrun | Florunner / Spanhoma | .063 | .000 | .000 | .000 | .000 | .000 | .490 | .000 | .000 | .000 | .000 | .000 | .000 | .553 |
| 4 | Southern Runner | PI 203396 / Florunner | .063 | .500 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .563 |
| 4 | Southwest Runner | Comet / Florunner | .063 | .000 | .000 | .000 | .000 | .000 | .000 | .248 | .000 | .000 | .000 | .000 | .000 | .310 |
| 4 | Sunrunner | F439-16-10-1-1 (Florunner component) // F393-7-1 (NC-Fla 14 sib), F334A-3-5-5-1 (Florispan derivative) / Jenkins Jumbo | .125 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .125 |
| 4 | Tamrun 88 | Goldin I / Florunner | .063 | .000 | .000 | .500 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .563 |
| 4 | Tifrun | Florida Small Spanish / Dixie Giant, F231-51 / 4 / F385-1-7-2, Pearl (F228) // F68-74 S3-1-2, McSpan (F13, Small White Spanish) / Virginia Jumbo F416) Runner (F14), F249-42-3-1 / 3 / Jenkins Jumbo, T1645 (selection from F416) / T1861 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| 5 | AT 127 | GK 1A / GK 123 | .125 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .125 |
| 5 | GK 3 | Florida Small Spanish / Dixie Giant, F231-51 / 4 / F385-1-7-1, Pearl (F228) // F68-74 S3-1-2, McSpan (F13, Small White Spanish) / Virginia Jumbo Runner (F14), F249-42-3-1 / 3 / Jenkins Jumbo, F416-2 / 5 / F392 (Florigiant sib) | .063 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .063 |
| 5 | GK 7 | F334A-3-5-5-1 (Florispan derivative) / Jenkins Jumbo, F393-2 // GK 19 | .156 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .156 |
| 5 | Sunbelt Runner | F392-12-B-28 (Florigiant sib) / VA Bunch 67, A4-4 // Florunner | .094 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .094 |
| 5 | SunOleic 95R | Sunrunner*4 / F435-2-3-B-2-1-b4-B-3-b3-1-B | .117 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .117 |
| 5 | Tamrun 96 | Langley // TX 833841, Florunner / PI 475871 | .063 | .000 | .250 | .000 | .000 | .000 | .000 | .000 | .000 | .250 | .000 | .000 | .000 | .563 |
| 5 | Tamrun 98 | TxAG-5 // TP 107-11, Florunner / PI 109839 | .031 | .000 | .250 | .000 | .000 | .000 | .000 | ..063 | .000 | .000 | .000 | .000 | .063 | .406 |
| 5 | ViruGard | NC 7 / Florunner | .094 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .063 | .000 | .156 |
| 6 | Andru 93 | Early Runner / Florispan, F439-17-2-1-1 (Florunner sib) // F459B-3-2-4-6-2-2-1 (Early Bunch component) | .078 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .078 |
| 6 | AT 108 | GK 7 / GK 3 | .109 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .109 |
| 6 | AT 120 | GK 3 / AT 193B | .109 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .063 | .000 | .000 | .172 |

Table 3 (Continued)

| Cycle | Name | Origin | Basse | PI 203 396 | PI 109 839 | Goldin I | PI 331 334 | TxAG-6 | PI 121 070 | PI 161 317 | PI 259 785 | PI 475 871 | F21 | PI 121 067 | PI 221 057 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | C-99R | PI 203396 / F427B-3-1-7-4 (Altika sib), UF81206-1 // 72x32B-13-1-3, PI 259785 / Florigiant | .047 | .250 | .000 | .000 | .000 | .000 | .000 | .000 | .250 | .000 | .000 | .000 | .000 | .547 |
| 6 | Georgia Browne | Southern Runner / Sunbelt Runner | .078 | .250 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .328 |
| 6 | Georgia Green | Southern Runner / Sunbelt Runner | .078 | .250 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .328 |
| 6 | GK 193 | GK 3 / Early Bunch | .047 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .047 |
| 6 | MARC I | Early Runner / Florispan, F439-17-2-1-1 (Florunner sib) // F459B-3-2-4-6-2-2-1 (Early Bunch component) | .078 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .078 |
| 6 | SunOleic 97R | SunOleic 95R / Sunrunner | .121 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .121 |
| 7 | Georgia Bold | Southern Runner / Sunbelt Runner, Georgia Bold Parent 1 / Sunbelt | .086 | .125 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .211 |
| 8 | Florida MDR 98 | Southern Runner / 3 / Florida MDR parent 2, F439-17-2-1-1 (Florunner sib) / F459B-3-2-4-6-2-2-1 (Early Bunch sib), UF79308 // UF81206-1, PI 203396 / F427B-3-1-7-4 (Altika sib) | .059 | .375 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .434 |
| | Number of descendants among 41 cultivars | | 32 | 6 | 3 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 33 |
| | Mean coancestry with introduction | | .076 | .043 | .024 | .012 | .012 | .012 | .012 | .008 | .006 | .006 | .002 | .002 | .002 | .216 |
| | Mean of nonzero coancestries | | .097 | .292 | .333 | .500 | .500 | .500 | .490 | .155 | .250 | .250 | .063 | .063 | .063 | .268 |

[a]Current cultivar, i.e., cultivar in use in the 2000 season.

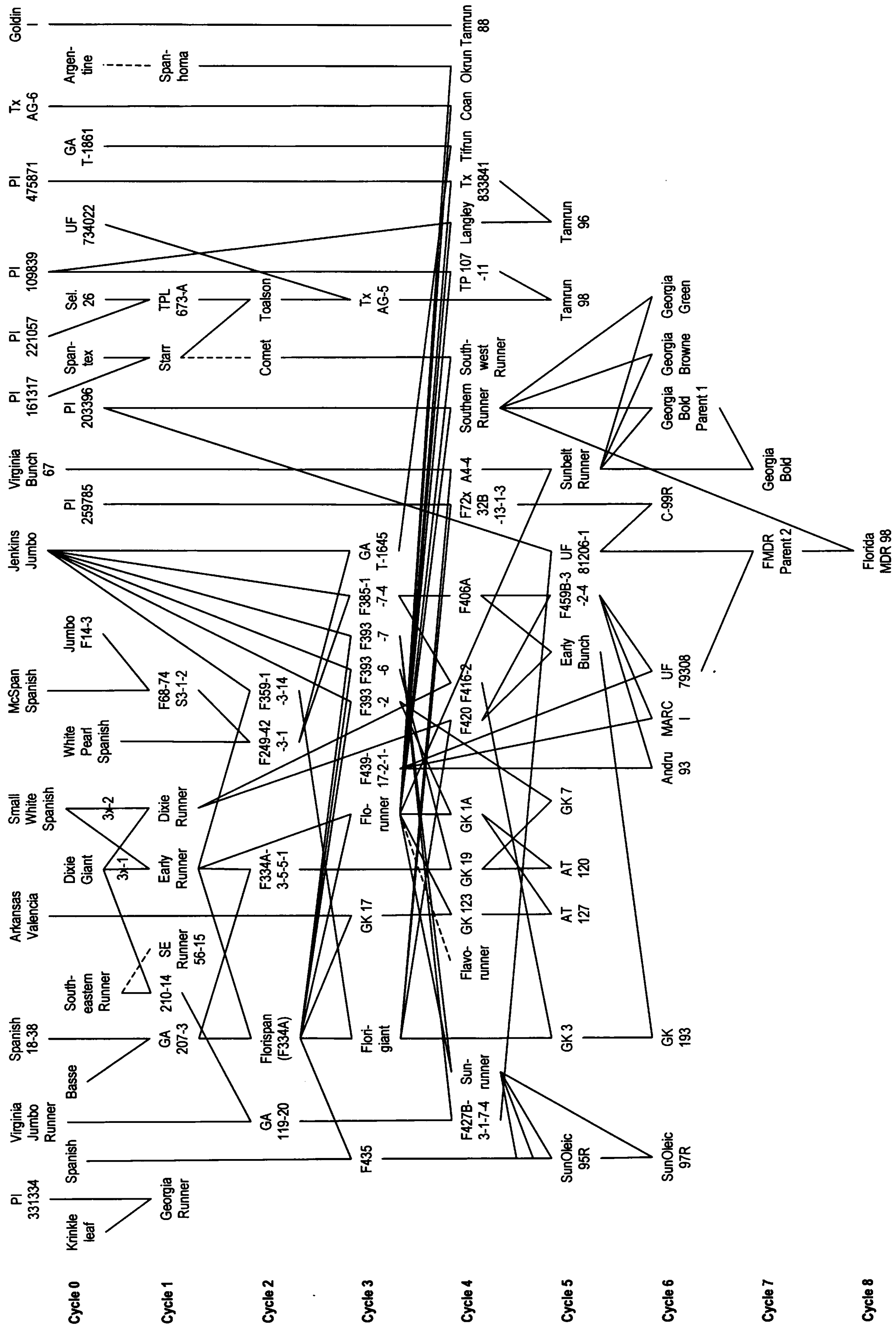


**Fig. 1. Parentage of runner-type cultivars. Solid lines indicate parents and progeny of crosses; dashed lines indicate selections from existing lines with or without mutation.**

Spanish 2B, and PI 121067) among seven used by W.C. Gregory to initiate the breeding program at N. C. State Univ., and Atkins Runner, an ancestor used by the USDA breeding program in Virginia. Of these additional early ancestors of the virginia market type, only PI 121067 is a modern plant introduction. A different set of introductions including PI 121070, PI 161317, PI 268661, and *A. monticola* Krapov. & Rigoni were used as parents in the Texas and Oklahoma breeding programs.

Thirteen plant introductions occur in the pedigrees of runner-type cultivars (Table 3; Fig. 1):

- **Basse** is by far the most common introduction in the pedigrees of cultivars of the runner and virginia market types, appearing in the pedigrees of 32 of 41 improved runner-type cultivars. Basse has been identified as an introduction from Gambia, and the specimen in the collection in North Carolina is a runner-type line, but the exact source of the original introduction has become obscure. Several lines identified as Basse or selections from Basse have been reintroduced to the U.S.A. There were other early peanut introductions from Gambia [PI 5358 (USDA, 1902), PI 15785 (USDA, 1907), PI 21198 ("'Nkate or Nbatie'," received from the Gold Coast in 1907) (USDA, 1908)], but Basse is likely PI 24114 which was sent to the USDA in 1908 by R.P. Skinner, U.S. consul general at Marseille, France, at the request of W.R. Beattie and C.S. Scofield and was identified as having originated in Gambia. Beattie is quoted in the Plant Inventory (USDA, 1909) as regarding the line as "exceptionally valuable for use in the manufacture of candy and other products where shelled nuts are required."
- **PI 203396**, A.A. Beetle Col. No. 2201, collected in a market at Porto Alegre, Brazil in 1952 (USDA, 1957), was used as a parent in the Univ. of Florida breeding program in the 1970s and 1980s. It was a source of resistance to late leaf spot [*Cercosporidium personatum* (Berk. & Curt.) Deighton], southern stem rot (*Sclerotium rolfsii* Sacc.), and tomato spotted wilt virus. PI 203396 appears in the pedigrees of six runner-type cultivars through its use as a parent of the multiple disease-resistant cultivar Southern Runner and sibling line UF81206-1. Through Southern Runner, PI 203396 is a grandparent of Georgia Browne and Georgia Green and a great-grandparent of Georgia Bold. Georgia Green is currently the most extensively grown runner cultivar in the U.S.A., particularly in the southeastern production area where tomato spotted wilt virus is the primary constraint to production. Through UF81206-1, PI 203396 is a grandparent of disease-resistant Florida releases Florida MDR 98 and C-99R.
- **PI 109839**, W.A. Archer Col. No. 2971, identified locally as "Mani," ("peanut") collected at a market in Caracas, Venezuela in 1935 (USDA, 1939), is a source of resistance to early leaf spot (*Cercospora arachidicola* Hori). It was used in the 1980s as a parent in the Texas A&M Univ. breeding program and appears in the pedigrees of the Texas cultivars Langley, Tamrun 96, and Tamrun 98. PI 109839 has been used also as a parent in the N.C. State Univ. program but, due to its small seed size, its progeny have not been suited to the virginia-type market.
- **PI 259785**, "U/A 29-S 185" presented by the Agric. Res. Sta., Lilongwe, Nyasaland (Malawi) in 1959 (USDA, 1966), is a grandparent of C-99R, a disease-resistant release from the Univ. of Florida.
- **PI 331334,** R.O. Hammons & W.R. Langford Col. No. 169, known as "Criollo" ("local") at its original site of collection in Bolivia, was obtained from the INTA collection at Manfredi, Argentina in 1968 (USDA, 1970) and is a parent of Georgia Runner.
- **PI 475871**, GKSPSc Col. No. 223, collected from a farmer at Guajara-Mirim, Bolivia in 1979 (USDA, 1984), is a grandparent of Tamrun 96.
- **F21** is an introduction with no known PI number but identified in Florida records as "Rasteiro," obtained by W.A. Carver and used in the Florida breeding program in the early to mid-1930s. Two Brazilian lines named Rasteiro are listed in the USDA Plant Inventory as having been introduced in 1935 (USDA, 1940); PI 111885 donated by the Inst. Agronomico at Campinas, Saô Paulo, and PI 111965 presented by the Estação Exp. de Cana de Assucar e Plantas Oleaginosas, Piracicaba, Saô Paulo. F21 provided 6.25% of the ancestry of AgraTech release AT 120.
- **Goldin I**, obtained from E. Goldin (Faculty of Agric., Hebrew Univ. of Jerusalem, Rehovot, Israel) by the Wilson Peanut Co. of Pleasanton, TX is probably derived at least in part from U.S. breeding materials transported to Israel. No records are extant to permit determination of the relationship between Goldin I and U.S. germplasm. Goldin I is a parent of Tamrun 88.
- **TxAG-6** is a synthetic allotetraploid created by C.E. Simpson by making a three-way cross among diploid ($2n = 2x = 20$) wild peanut species PI 298639 (*A. batizocoi* Krapov. and W.C. Gregory, K 9484) // PI 262141 (*A. cardenasii* Krapov. and W.C. Gregory, GKP 10017) / PI 276235 (*A. diogoi* Hoehne, GKP 10602) (USDA, 1966, 1967b, 1968) and treating the hybrid with colchicine to induce tetraploidy. TxAG-6 is a parent of COAN, a runner-type cultivar that derives its resistance to root-knot nematodes [*Meloidogyne arenaria* (Neal) Chitwood] from the interspecific hybrid.

The remaining five introductions that appear in the pedigrees of runner-type cultivars (PI 121067, PI 121070, PI 616317, PI 259785, and PI 221057) do so through crosses of runner-type parents with virginia-type and spanish-type parents. Their descriptions are included below in the sections for those market types. Only three plant introductions appear in the pedigrees of improved virginia-type cultivars (Table 4; Fig. 2): Basse, PI 121067, and PI 337396.

- **Basse** was described earlier; its genetic contribution is present in 24 of 33 improved virginia-type cultivars, including all that are currently grown. Al-

**Table 4. Improved virginia-type cultivars released in the U.S.A., their origin, breeding cycle, and coancestry with three introduced ancestors.**

| Cycle | Name | Origin | Basse | PI 121067 | PI 337396 | Total |
|---|---|---|---|---|---|---|
| 1 | NC 1 | NC 4 / Improved Spanish 2B | .000 | .000 | .000 | .000 |
| 1 | NC 4X | Selection from irradiated 'NC 4' | .000 | .000 | .000 | .000 |
| 1 | VA 56R | Selection from 'Atkins Runner' | .000 | .000 | .000 | .000 |
| 1 | VA 61R | Selection from 'Atkins Runner' | .000 | .000 | .000 | .000 |
| 1 | Virginia Bunch 46-2 | Selection from 'Virginia Bunch Large' | .000 | .000 | .000 | .000 |
| 2 | GA 119-20 | Southeastern Runner / Dixie Giant, 210-4 // Virginia Runner | .000 | .000 | .000 | .000 |
| 2 | NC 2 | Basse / Spanish 18-38, GA 207-2 // White's Runner | .000 | .000 | .000 | .000 |
| 2 | NC 5 | NC 4 / Improved Spanish 2B, NC 1 // C12, PI 121067 / NC Bunch | .000 | .250 | .000 | .250 |
| 2 | NC 6[a] | NC Bunch / PI 121067, C12 // C37 (same as C12), GP-NC 343 (selection from NC Ac 4508) // VA 61R | .000 | .500 | .000 | .500 |
| 2 | VA 72R | VA 61R / VA A89-15 (selection from farmers stocks, perhaps Atkins Runner) | .000 | .000 | .000 | .000 |
| 3 | Avoca 11 | Selection from 'NC 2' | .248 | .000 | .000 | .248 |
| 3 | Florigiant | Basse / Spanish 18-38, GA 207-3 // F230-118-2-2 (same as F230), F334A-5-5-1 / 3 / F359-1-3-14, Jenkins Jumbo // F230-118-5-1, Dixie Giant / Small White Spanish 3x-2 | .125 | .000 | .000 | .125 |
| 3 | NC-Fla 14 | Jenkins Jumbo / F334A-3-5-5-1 (Florispan derivative) | .125 | .000 | .000 | .125 |
| 3 | NC 17 | F334A-3-5-5-1 / Jenkins Jumbo | .125 | .000 | .000 | .125 |
| 4 | Altika | F393-7-1 (NC-Fla 14 sib) / 3 / GA 119-20, Southeastern Runner / Dixie Giant, 210-14 // Virginia Runner | .063 | .000 | .000 | .063 |
| 4 | GK 25 | Florigiant / GA 186-28 | .063 | .000 | .000 | .063 |
| 4 | Keel 29 | Selection from 'Florigiant' | .124 | .000 | .000 | .124 |
| 4 | NC 7[a] | NC 5 // F393, F334-3-5-5-1 (Florispan derivative) / Jenkins Jumbo | .063 | .125 | .000 | .188 |
| 4 | NC 8C | NC 2 // A48, NC 4 / Spanish 2B, NC Ac 3139 / 3 / Florigiant | .125 | .000 | .000 | .125 |
| 4 | NC 9[a] | NC 2 / Florigiant | .188 | .000 | .000 | .188 |
| 4 | Shulamith | Florigiant / F334A-B-17-1 (Florispan derivative) | .188 | .000 | .000 | .188 |
| 4 | VA 81B | F392-8 (Florigiant sib) / 3 / GA 119-20, Southeastern Runner / Dixie Giant, 210-14 // Virginia Runner | .063 | .000 | .000 | .063 |
| 5 | Early Bunch | Virginia Station Jumbo / 4 / F385-1-7-4, Pearl (F228) // F68-74 S3-1-2, McSpan (F13, Small White Spanish) / Virginia Jumbo Runner (F14), F249-42-3-1 / 3 / Jenkins Jumbo, F406A / 5 / F420, F231-51 (Dixie Runner sib) / F392-12-1-7 (Florigiant sib) | .031 | .000 | .000 | .031 |
| 5 | Gregory[a] | NC 7 / NC 9 | .125 | .063 | .000 | .188 |
| 5 | NC 10C[a] | NC 8C / Florigiant | .125 | .000 | .000 | .125 |
| 5 | NC-V11[a] | Florigiant / NC 5 // Florigiant / PI 337396 | .063 | .063 | .250 | .375 |
| 5 | NC 12C[a] | NC 7 / NC 9 | .125 | .063 | .000 | .188 |
| 5 | VA-C 92R[a] | Florigiant / F393-7-47-1-7-1, NC Ac 17213 // NC 7 | .094 | .063 | .000 | .156 |
| 6 | Perry[a] | | .125 | .000 | .000 | .125 |
| 6 | VA 93B[a] | VA 81B / 3 / VA 78039 (NC-V11 sib), Florigiant / NC 5, NC Ac 17257 // NC Ac 17922, Florigiant / PI 337396 | .063 | .031 | .125 | .219 |
| 6 | VA 98R[a] | VA 81B / 3 / VA 78039 (NC-V11 sib), Florigiant / NC 5, NC Ac 17257 // NC Ac 17922, Florigiant / PI 337396 | .063 | .031 | .125 | .219 |
| 6 | AgraTech VC-1 | GA 207-3 / F230-118-2-2, F334A-3-5-5-1 // Jenkins Jumbo, F393-2-1-1-2 / 4 / Florunner, GK 1A / 5 / AgraTech VC1 Parent 2, Florigiant / 3 / GA 186-28, Virginia Runner / Pearl // Dixie Giant / Carolina Runner, GK 25 / 4 / Florunner | .109 | .000 | .000 | .109 |
| 7 | AgraTech VC-2[a] | F435-2-3-B-2-1-b4-B-3-b3-1-B / 3*GK 193 | .086 | .000 | .000 | .086 |
| | Number of descendants among 33 | | 24 | 9 | 3 | 26 |
| | Mean coancestry with introduction | | .084 | .036 | .015 | .135 |
| | Mean of nonzero coancestries | | .115 | .132 | .167 | .171 |

[a]Current cultivar, i.e., cultivar in use in the 2000 season.

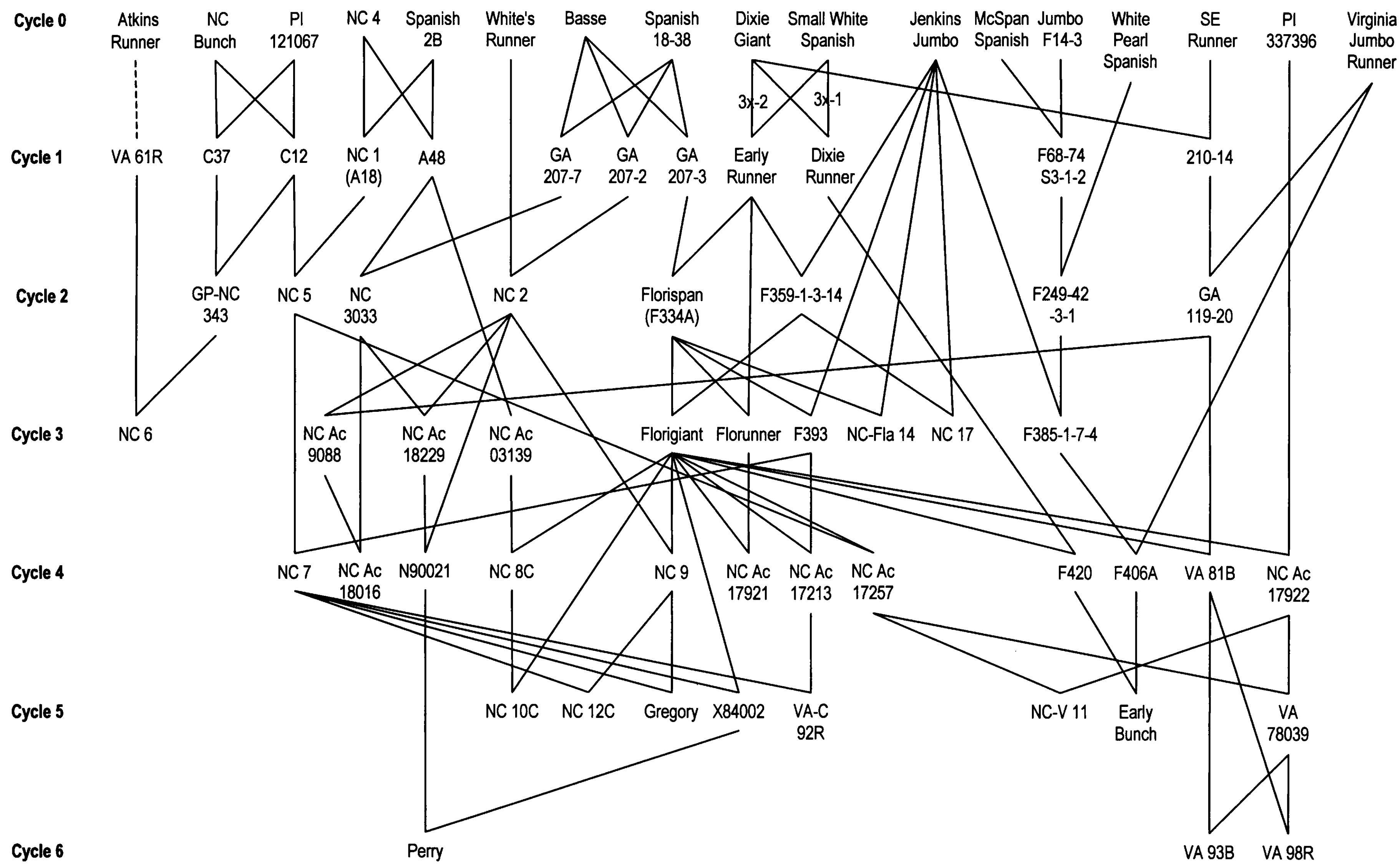


**Fig. 2.** Parentage of virginia-type cultivars. Solid lines indicate parents and progeny of crosses; dashed lines indicate selections from existing lines with or without mutation.

**Table 5. Spanish-type cultivars released in the USA, their origins, breeding cycle, and coancestry with seven introduced ancestors.**

| Cycle | Name | Origin | PI 161317 | PI 121070 | Chico | PI 221057 | Spanish No. 146 | PI 405933 | *A. monticola* | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | Spantex | Selection from farmers□ Spanish stocks | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| 1 | Argentine | Selection from PI 121070 | .000 | .990 | .000 | .000 | .000 | .000 | .000 | .990 |
| 1 | Dixie Spanish | Selection from Spanish introduction (Coll. No. 146) | .000 | .000 | .000 | .000 | .990 | .000 | .000 | .990 |
| 1 | Spanette | Selection from Spanish 18-38 | .000 | .000 | .000 | .000 | .000 | .000 | .000 | .000 |
| 1 | Starr | Spantex / PI 161317 | .500 | .000 | .000 | .000 | .000 | .000 | .000 | .500 |
| 2 | Comet | Selection from Starr | .495 | .000 | .000 | .000 | .000 | .000 | .000 | .495 |
| 2 | Spancross | Argentine (PI 121070-1) / PI 405933 | .000 | .495 | .000 | .000 | .000 | .500 | .000 | .995 |
| 2 | Spanhoma | Selection from □Argentine□ | .000 | .980 | .000 | .000 | .000 | .000 | .000 | .980 |
| 2 | Tamnut 74 | Starr // TPL 647-2-5, Spantex / *A. monticola* | .250 | .000 | .000 | .000 | .000 | .000 | .250 | .500 |
| 2 | Tifspan | Argentine (PI 121070-1) / Spanette | .000 | .495 | .000 | .000 | .000 | .000 | .000 | .495 |
| 2 | Toalson | PI 221057 / Selection 26 (Spantex sib), TPL 673-A // Starr | .250 | .000 | .000 | .250 | .000 | .000 | .000 | .500 |
| 3 | Pronto | Chico / Comet | .248 | .000 | .500 | .000 | .000 | .000 | .000 | .748 |
| 3 | Spanco | Chico / Comet | .248 | .000 | .500 | .000 | .000 | .000 | .000 | .748 |
| 4 | Tamspan 90[a] | Selection in TxAG-5 (Toalson / UF 734022) | .124 | .000 | .000 | .124 | .000 | .000 | .000 | .248 |
| Number of descendants among 14 | | | 7 | 4 | 2 | 2 | 1 | 1 | 1 | 12 |
| Mean coancestry with introduction | | | .151 | .211 | .071 | .027 | .071 | .036 | .018 | .585 |
| Mean of nonzero coancestries | | | .302 | .740 | .500 | .187 | .990 | .500 | .250 | .682 |

[a]Current cultivar, *i.e.*, cultivar in use in the 2000 season.

though Basse ancestry is common across most virginia-type cultivars, it accounts for only about 10% of the total ancestry.

- **PI 121067**, W.A. Archer Col. No. 4998; "Indio" (A.H. 1119-A) from Misiones, Argentina; presented by Sr. Clos of the Min. de Agric., Buenos Aires, Argentina in 1937 (USDA, 1942), was one of the seven parents used by W.C. Gregory to initiate the peanut breeding program at N.C. State Univ. It has partial resistance to *C. arachidicola* and southern corn rootworm (*Diabrotica undecimpunctata* Howardi Barber) and is an ancestor of many of the North Carolina breeding populations and releases including insect-resistant germplasm line GP-NC 343 and seven cultivars—NC 5, insect-resistant NC 6, NC 7, NC-V 11, Cylindrocladium black rot-resistant NC 12C, Gregory, and VA-C 92R. Through NC 5, PI 121067 is also an ancestor of Virginia releases VA 93B and VA 98R. Through NC 7, it is an ancestor of runner-type cultivar Virugard.
- **PI 337396,** R.O. Hammons & W.R. Langford Col. No. 250. "FAV 70," a valencia-type line obtained from the INTA collection at Manfredi, Misiones, Argentina in 1968 (USDA, 1970), is a grandparent of NC-V 11 and a sibling line that was a parent of VA 93B and VA 98R.

Most runner- and virginia-type cultivars are characterized as having had some introgression of genes from subsp. *fastigiata* Waldron, mostly from var. *vulgaris* but to some extent from var. *fastigiata*. Spanish-type cultivars are more varietally pure than other market types for the most part. Seven introductions appear in the pedigrees of spanish-type cultivars; most are spanish-type (var. *vulgaris*) lines themselves. Two are accessions of *A. monticola*, an alternate-branching tetraploid ($2n = 4x = 40$) species that crosses readily with *A. hypogaea*.

- **PI 161317**, J.L. Stephens & W. Hartley Col. No. 31-A; a spanish-type line collected in Salto, Uruguay in 1947 (USDA, 1954), appears in the pedigrees of seven spanish-type cultivars—Starr, Comet, Tamnut 74, Toalson, Pronto, Spanco, and Tamspan 90.
- **PI 121070**, W.A. Archer Col. No. 5001; spanish-type Strain A.H. 1131-1 collected at Chiarí, Entre Rios, Argentina in 1937 (USDA, 1942), is ancestral to four spanish-type cultivars. It was the source from which Argentine was selected. Argentine was used in the Oklahoma breeding program and is a parent of Spanhoma and the source from which the cultivar Spanhoma was selected. Argentine is also a parent of Tifspan, developed by the USDA program at Tifton, GA.
- **Chico**, a selection from spanish-type PI 268661; "APAXUC 70" ["*Arachis* 70"] from the USSR; presented by the Mount Makulu Res. Sta., Chilanga, Rhodesia (Zambia) in 1960 (USDA, 1967a), is a very early maturing line. Chico has been used as a parent in several programs in attempts to shorten maturity; it is a parent of Pronto and Spanco.
- **PI 221057**, spanish type line "J.B.M. 19/3" presented by the Inst. Agronomiço at Campinas, Saô Paulo, Brazil in 1954 (USDA, 1960), is a grandparent of Toalson and a great-grandparent of Tamspan 90.
- **Spanish No. 146**, a spanish-type introduction (Col. No. 146) obtained from India by Tom Huston Peanut Co., was used in the Georgia breeding program where it was the source from which Dixie Spanish was selected.
- **PI 405933**, *A. monticola* T-1119 collected in Yala,

Jujuy, Argentina in 1950; presented to the USDA by V.A. Rigoni, Estacion Exp. Agropecuaria, Manfredi, Misiones, Argentina (USDA, 1978), was a parent of Spancross in the USDA program at Stillwater, OK.

- ***A. monticola***, an accession not identified by PI number, is a grandparent of Tamnut 74 in the Texas A&M Univ. program. As the number of *A. monticola* accessions in the national collection is limited, and common accessions are generally held by several breeding programs, it is possible that this is also PI 405933.

When the distribution of lines with different proportions of PI ancestry (Table 6) were compared for the runner, virginia, and spanish market types, there were marked differences overall ($\chi^2$ = 39.07 with 14 df, P < 0.001), but most of the difference was between the spanish type and the two alternate-branching types (runner and virginia). The distribution of PI ancestry in improved cultivars was similar for the runner and virginia market types ($\chi^2$ = 5.65 with 5 df, P < 0.35) while the distribution of the pooled runner and virginia types were very different from the spanish group ($\chi^2$ = 33.53 with 7 df, P < 0.001). In the runner and virginia groups, the average PI ancestry of all improved cultivars was 17.9% with a range of 0 to 56.2%. Due to the proliferation of ancestry derived from early PI ancestors, later breeding cycles had no lines without PI ancestry, and after the fourth cycle there remained a slight trend toward increased PI ancestry in later cycles. Overall, 28 of 41 runner-type cultivars and 31 of 33 virginia-type cultivars derived 25% or less of their ancestry from plant introductions. Only seven of the 74 total cultivars derived more than half of their ancestry from PIs, and in all cases that total was due to the contributions of more than one PI in the pedigree of the cultivar. No single introduction contributed more than half the ancestry of any cultivar.

Many crosses involving plant introductions as parents are made with the objective of transferring some desirable trait from the PI into an adapted breeding population. Because most improved cultivars contain between

**Table 6. Distribution of ancestry derived from plant introductions for improved US peanut cultivars by market-types and breeding cycles.**

| Market-type | No. of lines | $\theta_{total}$ = 0 | 0< $\theta_{total}$ ≤ 0.125 | 0.125< $\theta_{total}$ ≤ 0.25 | 0.25< $\theta_{total}$ ≤ 0.375 | 0.375< $\theta_{total}$ ≤ 0.5 | 0.5< $\theta_{total}$ ≤ 0.625 | 0.625< $\theta_{total}$ ≤ 0.75 | 0.75< $\theta_{total}$ ≤ 0.875 | 0.875< $\theta_{total}$ ≤ 1 | Mean $\theta_{total}$ | Minimum $\theta_{total}$ | Maximum $\theta_{total}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Runner | | | | | | | | | | | | | |
| Cycle 0 | 1 | 1 | — | — | — | — | — | — | — | — | .000 | .000 | .000 |
| Cycle 1 | 7 | 6 | — | — | — | 1 | — | — | — | — | .071 | .000 | .500 |
| Cycle 2 | 1 | — | — | 1 | — | — | — | — | — | — | .250 | .250 | .250 |
| Cycle 3 | 1 | — | 1 | — | — | — | — | — | — | — | .125 | .125 | .125 |
| Cycle 4 | 11 | 1 | 3 | 1 | 1 | — | 5 | — | — | — | .334 | .000 | .562 |
| Cycle 5 | 8 | — | 4 | 2 | — | 1 | 1 | — | — | — | .211 | .062 | .562 |
| Cycle 6 | 10 | — | 5 | 2 | 2 | — | 1 | — | — | — | .195 | .047 | .547 |
| Cycle 7 | 1 | — | — | 1 | — | — | — | — | — | — | .211 | .211 | .211 |
| Cycle 8 | 1 | — | — | — | — | 1 | — | — | — | — | .434 | .434 | .434 |
| All cycles | 41 | 8 | 13 | 7 | 3 | 3 | 7 | — | — | — | .216 | .000 | .562 |
| Virginia | | | | | | | | | | | | | |
| Cycle 1 | 5 | 5 | — | — | — | — | — | — | — | — | .000 | .000 | .000 |
| Cycle 2 | 5 | 2 | — | 2 | — | 1 | — | — | — | — | .200 | .000 | .500 |
| Cycle 3 | 4 | — | 3 | 1 | — | — | — | — | — | — | .156 | .125 | .248 |
| Cycle 4 | 8 | — | 5 | 3 | — | — | — | — | — | — | .125 | .062 | .188 |
| Cycle 5 | 6 | — | 2 | 3 | 1 | — | — | — | — | — | .177 | .031 | .375 |
| Cycle 6 | 4 | — | 2 | 2 | — | — | — | — | — | — | .168 | .109 | .219 |
| Cycle 7 | 1 | — | 1 | — | — | — | — | — | — | — | .086 | .086 | .086 |
| All cycles | 33 | 7 | 13 | 11 | 1 | 1 | — | — | — | — | .135 | .000 | .500 |
| Pooled runner and virginia | | | | | | | | | | | | | |
| Cycle 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .000 | .000 | .000 |
| Cycle 1 | 12 | 11 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | .042 | .000 | .500 |
| Cycle 2 | 6 | 2 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | .208 | .000 | .500 |
| Cycle 3 | 5 | 0 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | .150 | .125 | .248 |
| Cycle 4 | 19 | 1 | 8 | 4 | 1 | 0 | 5 | 0 | 0 | 0 | .246 | .000 | .562 |
| Cycle 5 | 14 | 0 | 6 | 5 | 1 | 1 | 1 | 0 | 0 | 0 | .196 | .031 | .562 |
| Cycle 6 | 14 | 0 | 7 | 4 | 2 | 0 | 1 | 0 | 0 | 0 | .188 | .047 | .547 |
| Cycle 7 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | .148 | .086 | .211 |
| Cycle 8 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | .434 | .434 | .434 |
| All cycles | 74 | 15 | 26 | 18 | 4 | 4 | 7 | 0 | 0 | 0 | .179 | .000 | .562 |
| Spanish | | | | | | | | | | | | | |
| Cycle 0 | 1 | 1 | — | — | — | — | — | — | — | — | .000 | .000 | .000 |
| Cycle 1 | 4 | 1 | — | — | — | 1 | — | — | — | 2 | .620 | .000 | .990 |
| Cycle 2 | 6 | — | — | — | — | 4 | — | — | — | 2 | .661 | .495 | .995 |
| Cycle 3 | 2 | — | — | — | — | — | — | 2 | — | — | .748 | .748 | .748 |
| Cycle 4 | 1 | — | — | 1 | — | — | — | — | — | — | .248 | .248 | .248 |
| All cycles | 14 | 2 | — | 1 | — | 5 | — | 2 | — | 4 | .585 | .000 | .995 |

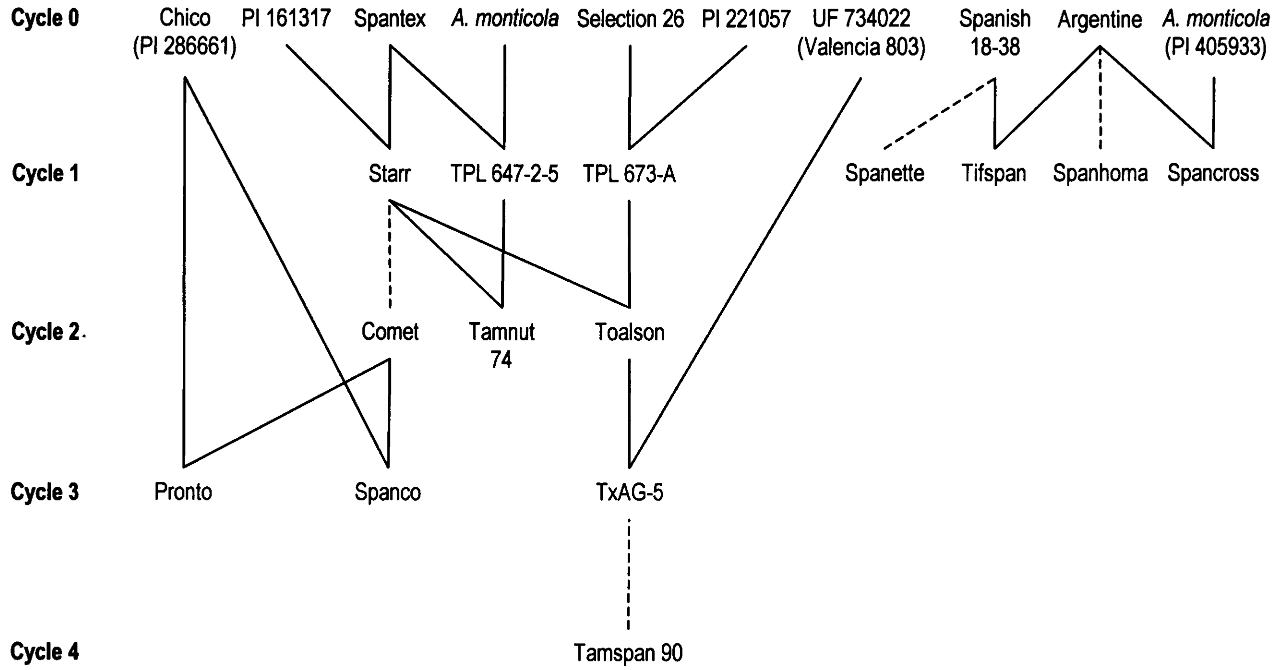


**Fig. 3. Parentage of spanish-type cultivars. Solid lines indicate parents and progeny of crosses; dashed lines indicate selections from existing lines with or without mutation.**

12.5 and 25% PI ancestry, it would appear that successful incorporation of PI ancestry into adapted cultivars is best achieved through some form of backcrossing. This might be achieved in the classical way by testing for the trait under transfer from the exotic parent at the $F_1$ or $F_2$ generation following a given backcross, or it might be performed in a less conventional way with selection of lines from later generations of the initial cross to the PI followed by backcrossing to the adapted parent as was the case in the development of lines derived from PI 203396.

***Economic Impact of Genetic Resources.*** The genetic variability contributed to breeding populations by the introgression of genes from introductions has no doubt contributed to genetic gain in the development of cultivars that possess no salient disease resistance or other introduction-derived trait. However, the economic impact of such introgression is difficult if not impossible to measure. Genetic resources have been particularly useful in adding disease resistance to peanut cultivars. This has had significant economic impact on U.S. peanut farmers, the largest from the development of cultivars with resistance to Sclerotinia blight, root-knot nematode, and tomato spotted wilt virus.

PI 221057 served as a source of resistance to Sclerotinia blight in the development of the spanish-type cultivar Tamspan 90 and, more recently, in the runner-type cultivar Tamrun 98. There are approximately 16,200 ha (40,000 acres) of Sclerotinia-infested land in the southwestern peanut production area, and fungicide treatments for the control of this disease are costly. Use of Sclerotinia-resistant cultivars increases yield and reduces fungicide costs. The estimated impact from the use of these resistant cultivars is $5 million annually.

COAN, a nematode-resistant runner-type cultivar, was developed by introgressing resistance from wild diploid peanut species. Approximately 29,000 ha (72,000 acres) of peanut land in the Southwest is infested with *M. arenaria* race 1. A nematode-resistant cultivar would save southwestern peanut growers an estimated $6.5 million annually in increased yields and reduced nematicide costs. Unfortunately, COAN is susceptible to TSWV and is therefore not adapted to the southeastern peanut production area. Breeders are attempting to combine resistance to root-knot nematode with field resistance to TSWV.

The use of PIs has had its largest economic impact through the development of runner-type cultivars with resistance to TSWV. In the Southeastern U.S., TSWV was detected in peanut in 1987, and its incidence has increased substantially in the ensuing years (Culbreath *et al.*, 1992). PI 203396 was an ancestor to many breeding populations in the Southeast due to its resistance to late leaf spot. Fortunately, PI 203396 also has resistance to TSWV which was transmitted to resistant runner-type cultivars Southern Runner, Georgia Green, Florida MDR 98, and C-99R. Under severe TSWV pressure, the additional economic return from growing these cultivars in comparison to previous susceptible cultivars is in excess of $500 per acre. Assuming that half of the peanut acreage in the Southeast has severe TSWV pressure, the economic impact of this resistance is more than $200 million annually.

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