Early-Generation Yield Trials of Peanuts[1]

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ABSTRACT

In 1969, a large number of F_2 lines developed from reciprocal infraspecific crosses between the varieties 'Argentine' and 'Early Runner' was available for use in the peanut (**Arachis hypogaea**) breeding program at Tifton, Georgia. These lines were used to make preliminary observations on the possible use of early-generation yield trials in developing superior peanut varieties.

High yielding F_2 lines were tested consecutively in F_3, F_4, F_5 and F_6 yield trials. Lines not outyielding the parental cultivars were discarded after each test. Lines were placed in F_5 and F_6 Spanish and Runner yield trials on the basis of seed weight/100 seed. Eight commercial checks were used in the F_5 yield trials and five in the F_6 yield trials. Yield and shelling grade data from the F_5 and F_6 yield trials were evaluated statistically.

Nine of the twelve breeding lines in the F_5 yield trials outyielded the parents. Seven yielded more than the highest yielding commercial check. Two of the five breeding lines in the F_6 yield trials did not yield significantly less than the highest yielding commercial check. The remaining three did not yield significantly less than the parental cultivars. Based on these results, early testing in yield trials may be an acceptable breeding procedure for evaluation and selection of peanut varieties.

Additional index words: **Arachis hypogaea**, Infraspecific hybridization.

The main objective in peanut breeding is the development of varieties that are more satisfactory to the grower, processor, and consumer. Primary breeding methods for peanuts are those used for other self-pollinated crops.

The improvement of self-pollinated crops usually follows a similar pattern: 1) introduction of varieties, 2) selection within the varieties and finally, when this form of selection is no longer effective 3) hybridization and selection (2). According to Norden (7), peanut breeding has advanced to stage 3 in the United States.

An extensive review of breeding methods of the cultivated peanut *(Arachias hypogaea)* has been made by Norden (7). Earlier reviews of peanut breeding methods have also been made (4, 8, 9). The most common types of selection methods are the mass and pedigree methods (7).

Selection indices and their relationship to plant breeding were reviewed by Hammons (6) and Norden (7). Selection for yield was usually as effective as selection for other characters in isolating desirable high yielding lines. However, Badwal and Gupta (1) found that selection on the basis of yield only is generally less efficient than selections based on a number of yield components.

Boerma (2) has recently reviewed the literature on the use of early - generation yield trials in breeding several self-pollinated crops. Advantages of the early-generation procedure are the early elimination of undesirable material, increased efficiency in identifying high yielding lines, and earlier release of a new variety (2, 10). Boerma (2) concluded from previous studies that yield genes stabilize in an early generation. He found in his own research with soybeans that pure lines developed by early - generation testing did not yield significantly different from those developed by late testing in pedigree selection or single seed descent procedures.

The objectives of this experiment were to make preliminary observations on the possible use of early-generation yield trials in developing superior peanut varieties. This method has not been feasible previously, because of the limited seed produced by early-generation hybrids. However, recent observations of early generation populations in the breeding program at Tifton, Georgia indicate small populations are no longer necessarily a limitation in peanut breeding.

Materials and Methods

Reciprocal infraspecific crosses were made in 1967 between the two most widely grown and adapted cultivars in the United States at that time, 'Argentine' and 'Early Runner'. Argentine is classified commercially as a Spanish type (subsp. **fastigiata**, var. **vulgaris**). Early Runner is marketed as a commercial Runner type (subsp. **hypogaea**, var. **hypogaea**). These cultivars differ in several morphological traits described previously by Coffelt and Hammons (3) and Hammons (5).

The cross, Argentine (♀) x Early Runner (♂), was designated as C200 and the reciprocal cross, Early Runner (♀) x Argentine (♂), as C201. In 1968, 22 F_1 plants from the C200 cross and 19 F_1 plants from the C201 cross were grown in field nurseries at Tifton, Georgia. Seed from the 41 F_1 plants were space planted in non-replicated field nurseries in 1969.

At harvest 20 plants were randomly selected from each of the 41 F_2 plots, and 50 plants were randomly selected from each of the parental plots. This gave a total of 820 individual plant observations for the F_2 population, and 100 individual plant observations for the parental cultivars. Pod type and yield components were recorded for each individual plant selection. Spanish and Runner pod types yielding more than Argentine and Early Runner, respectively, were placed in an F_3 yield test.

Individual plant selections were made in high-yielding F_3 plots. Plants yielding more seed/plant than the highest yielding parent were placed in a replicated F_4 yield trial in a radomized-complete-block design. All yield trials were grown in standard-size plots used in the U.S.D.A. breeding program at Tifton, Georgia.

Yield and shelling grade data were recorded for each entry in the F_4 yield trial. Lines with a higher pod weight/plant were advanced to replicated F_5 yield trials. The five highest yielding lines in the F_4 were advanced

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one generation in a winter nursery in Puerto Rico, and placed in replicated F_6 yield trials. Selected lines with a seed weight of less than 45 grams/100 seed were placed in F_5 and F_6 Spanish-type yield trials. Selected lines with a seed weight of more than 45 grams/100 seed were placed in F_5 and F_6 Runner-type yield trials. Randomized-complete-block designs with four replications were used in all F_5 and F_6 yield trials.

Four commercial varieties were used as checks in each of the F_5 yield trials. 'Tifspan', 'Spancross', Argentine, and 'Comet' were used in the Spanish yield trial, and 'Florunner', Early Runner, 'Florigiant', and 'Virginia Bunch 67' in the Runner yield trial. Three commercial checks, Tifspan, Spancross, and Argentine, were used in the F_6 Spanish yield trial. Two commercial checks, Florunner and Early Runner, were utilized in the F_6 Runner experiment.

Yield and shelling data from the F_5 and F_6 yield trials were evaluated by analysis of variance and Duncan's multiple range test. These results were used to determine the effectiveness of early testing as a breeding procedure for peanuts to develop lines that are equivalent or superior to the parental varieties and/or present commercial varieties.

Results and Discussion

The highly productive, well adapted, widely grown cultivars, Argentine and Early Runner, were crossed reciprocally by controlled artificial pollinations. Hybrid vigor was marked for F_1 plant diameter, but not for seed/plant and other characters. The highest yielding F_1 plant from the reciprocal crosses produced 622 pods, weighing 693 g, and shelling out a record 1156 seed. The C200F_1 plants averaged 719 seed/plant, while the C201 F_1 plants averaged 575 seed/plant for an overall average of 652 seed/plant. The average number of seed/plant for the parental cultivars was 427 for Argentine and 648 for Early Runner.

Approximately 4%, or 34 F_2 plants, were selected from the 820 F_2 plants. These plants yielded equal to or better than the minimum of the parental cultivars. Six F_2 Spanish lines were selected that exceeded the minimum Argentine yield of 152 pods/plant. Three lines exceeded the maximum Argentine yield of 167 pods/plant. The range in yield for the six lines was 154 - 201 pods/plant, and for the top three lines was 170 - 201 pods/plant. Twenty-eight F Runner lines were selected that equalled or exceeded the minimum Early Runner yield of 120 pods/plant. Eighteen lines exceeded the maximum Early Runner yield of 132 pods/plant. The ranges in yield for the 28 lines and the 18 lines were 120 - 172 pods/plant and 133 - 172 pods/plant, respectively. Pod weight/plant, seed weight/plant, and number of seed/plant were also considered in making selections, as was suggested by Badwal and Gupta (1).

Due to the extent of segregation for macromutants in the F test, mass selection on a plot basis was considered impractical. Therefore, individual-plant selections were made in high yielding plots. From these individual plant selections, 36 F_3 plants were selected that yielded more seed/plant than the highest yielding parent, Argentine. The range in yield of seed/plant was 161 - 336 seed/plant, compared to 159 seed/plant for Argentine. The number of pods/plant, pod weight/plant, and seed weight/plant were also considered in making selections.

The results from the F_2 and F_3 segregating generations of the infraspecific cross (intraspecific cross between subspecies) indicate that mass selection is not feasible until the F_4 generation. However, recent results with different crosses in the breeding nurseries at Tifton, Georgia show that mass selection in yield trials can be practiced in the F_2 and F_3 generations of intraspecific crosses within subspecies (Hammons, personal communication). These results indicate that early-generation yield trials may be of more value in populations from crosses within rather than between subspecies. More data are needed to confirm this proposal.

The eleven highest yielding, non-segregating lines and the highest yielding segregating line were selected from the F_4 yield trial to be advanced to the F_5 yield trials. These lines outyielded Early Runner (2259 kg/ha) with a range in yield from 2342 kg/ha to 3965 kg/ha. The four highest yielding lines also outyielded Argentine (3040 kg/ha.). Weight of 100 seed for the 12 selected lines ranged from 27.5 grams to 51.0 grams (Argentine = 33.5 grams/100 seed and Early Runner = 50.5 grams/100 seed). Six selections had values below the 45 grams/100 seed level, and six selections had values above this level. Shelling and grade data were acceptable for the selections in most cases. Two selections had an undesirably high percentage of "other kernels".

Results from the F_5 and F_6 yield trials are presented in Tables 1 - 4. No significant differences occurred in the F_5 Spanish yield trial, although five of the six selections outyielded the highest yielding commercial check (Spancross). The remaining selection outyielded the Argentine parent. Analysis of variance gave a nonsignificant F value at the 5% level of probability.

Table 1. Growth habit, yield, and shelling grade characteristics for F_5 Spanish progenies and standard cultivars.

Entry	Growth Habit	Testa Color	Yield kg/ha	% Meat*	Seed Quality % Ride
Tifspan	Bunch	Flesh	2797 b**	77.7 bc	70.8ab
Spancross	Bunch	Flesh	3740a	78.1abc	72.3a
Argentine (P_1)	Bunch	Flesh	3207ab	78.8ab	71.6a
Comet	Bunch	Flesh	3727a	76.2 c	67.8 bc
C201-72-1	Bunch	Pink	3870a	78.4abc	60.9 d
C201-76-3	Bunch	Flesh	3805a	79.1ab	70.6ab
C201-65-2	Bunch	Pink	3630ab	80.4a	67.8 bc
C201-67-4	Spreading	Flesh	3155ab	79.7ab	70.5ab
C201-52-5	Bunch	Pink	3740a	77.6 bc	66.5 c
C201-67-1	Bunch	Flesh	3285ab	78.0abc	70.3ab

Table 1. Continued

Seed Quality					
% OK	% SS	% DK	% SMK	% TSK	g/100 Seed
5.4 f	3.9 cd	2.5 b	66.0a	69.8a	36.2 e
5.5 f	4.2 cd	2.7 b	65.8a	70.0a	36.1 e
6.5 ef	3.7 cd	2.9 b	65.7a	69.4ab	35.7 e
7.8 de	4.1 cd	3.4 b	60.9 b	65.1 bc	37.6 de
17.0a	5.6 bc	1.9 b	54.0 d	59.6 d	30.4 f
7.9 de	6.1 b	5.9a	59.2 bc	65.3 bc	43.0 b
12.5 b	8.8a	2.7 b	56.6 cd	65.3 bc	39.4 cd
8.8 cd	6.8 b	3.1 b	61.0 b	67.8abc	40.3 c
10.5 bc	2.2 d	2.6 b	62.3ab	64.5 c	48.4a
7.1 def	7.3ab	3.7 b	59.9 bc	67.2abc	40.7 c

*Abbreviations are defined in Table 4. Values are means expressed as a percentage for 1000 gram fruit samples from 4 replicates.

**Values followed by the same letter are not significantly different at the .05 level of probability.

Four of the Runner selections outyielded the highest yielding commercial check (Early Runner) in the F_5 Runner yield trial, but not significantly. Only one selection was significantly outyielded by Early Runner. The Virginia Bunch 67 check was significantly outyielded by all entries, except the lowest yielding selection. Analysis of variance gave a highly significant F_5 value ($P > .01$).

Table 2. Growth habit, yield, and shelling grade characteristics for F_5 Runner progenies and standard cultivars.

Entry	Growth Habit	Testa Color	Yield kg/ha	% Meat*	Seed Quality % Ride
Florunner	Spreading	Pink	4846 bcd**	82.3a	79.0a
Early Runner (P_2)	Spreading	Pink	5171abc	80.0 bcd	75.7 bcd
Florigiant	Spreading	Pink	5028abcd	75.9 e	72.2 e
Va. Bunch 67	Bunch	Pink	3890 e	74.8 ef	69.1 f
C201-68-2	Bunch	Flesh	5594ab	81.3ab	76.6 b
C201-68-3	Spreading	Flesh	5659a	79.0 d	73.6 cde
C201-62-4	Bunch	Flesh	5302abc	80.4 bcd	73.1 de
C200-58-3	Bunch	Pink	4684 cd	74.0 f	68.4 f
C200-52-7	Bunch	Pink	4391 de	79.5 cd	74.5 bcde
C200-52-3	Bunch	Pink	5757a	80.7abc	75.9 bc

Table 2. Continued

Seed Quality					
% OK	% SS	% DK	% SMK	% TSK	g/100 Seed
3.0 c	10.9a	5.2a	63.4abc	74.2ab	63.3 b
3.8 bc	8.8ab	2.0 b	65.5a	74.3ab	58.5 def
3.2 c	4.8 cd	4.5a	63.6abc	68.3 cd	94.1a
5.2ab	2.7 d	2.6 b	64.5ab	67.1 d	61.9 bc
4.4 bc	10.9a	2.0 b	64.0ab	74.9a	56.5 ef
4.8 bc	11.6a	2.4 b	60.2 c	71.8ab	58.9 de
6.9a	10.2a	2.3 b	60.9 bc	71.2 bc	55.8 f
5.2ab	6.2 bc	2.8 b	59.9 c	66.1 d	48.8 g
4.6 bc	6.3 bc	2.1 b	66.6a	72.8ab	57.0 def
4.5 bc	6.6 bc	2.7 b	67.0a	73.6ab	59.9 cd

*Abbreviations are defined in Table 4. Values are means expressed as a percentage for 1000 gram fruit samples from each of 4 replicates.
**Values followed by the same letter are not significantly different at the .05 level of probability.

Table 3. Growth habit, yield, and shelling grade characteristics for F_6 Spanish-type progenies and standard cultivars.

Entry	Growth Habit	Testa Color	Yield kg/ha	% Meat*	Seed Quality % Ride
Tifspan	Bunch	Flesh	4736a**	79.6ab	72.8a
Spancross	Bunch	Flesh	4651ab	78.6 bc	72.7a
Argentine (P_1)	Bunch	Flesh	4378 bc	78.9 b	73.2a
C201-72-1	Bunch	Pink	4378 bc	80.3ab	61.9 c
C201-76-3	Bunch	Flesh	4150 bc	77.0 c	68.3 b
C201-65-2	Bunch	Pink	3838 c	80.7a	68.9 b

Table 3. Continued

Seed Quality					
% OK	% SS	% DK	% SMK	% TSK	g/100 Seed
6.3 d	4.4 b	5.0a	63.9a	68.3a	37.5 c
5.3 d	5.1 b	5.0a	63.3a	68.4a	36.8 c
5.3 d	5.0 b	5.4a	63.3a	68.2a	36.7 c
18.0a	5.5 b	1.5 b	55.4 b	60.9 c	30.4 d
8.3 c	6.0 b	5.6a	57.2 b	63.2 bc	42.4a
11.6 b	8.2a	3.8a	57.2 b	65.4ab	39.5 b

*Abbreviations are defined in Table 4. Values are means (percent) for 1000 gram fruit samples from 4 replicates.
**Values followed by the same letter are not significantly different at the .05 level of probability.

Table 4. Growth habit, yield, and shelling grade characteristics for F_6 Runner-type progenies and standard cultivars.

Entry	Growth Habit	Testa Color	Yield kg/ha	% Meat*	Seed Quality % Ride
Florunner	Spreading	Pink	5171a**	82.7a	79.9a
Early Runner (P_2)	Spreading	Pink	4996a	80.1 c	76.7 c
C201-68-2	Bunch	Flesh	4749a	81.2 b	78.3 b
C201-68-3	Spreading	Flesh	5061a	78.6 d	74.9 d

Table 4. Continued

Seed Quality					
% OK	% SS	% DK	% SMK	% TSK	g/100 Seed
2.2 b	12.6ab	6.3a	61.5ab	74.2a	63.9a
3.1a	8.7 b	2.2a	66.1a	74.9a	58.5 b
2.7ab	13.6a	5.4a	59.6 b	73.2a	58.4 b
3.3a	8.8 b	6.0a	60.6ab	69.3a	55.8 c

*Value are means (percent) for 1000 gram fruit samples from 4 replicates.
% Meat = all kernels in shelling sample including sound mature kernels, sound splits, other kernels, and damaged kernels.
% Ride = kernels which ride a 5.95 x 19.05 mm (15/64- x 3/4-inch) screen in Spanish and a 6.35 x 19.05 mm (16/64- x 3/4-inch) screen in Runner tests.
% Other Kernels (OK) = kernels which pass through the above screens.
% Sound Splits (SS) = split or broken kernels which are not damaged.
% Damaged Kernels (DK) = any kernels which are moldy or decayed or have been affected by insects, weather conditions, or skin and flesh discoloration.
% Sound Mature Kernels (SMK) = the whole kernels which ride the appropriate screen (see % Ride).
% Total Sound Kernels (TSK) = sound splits plus sound mature kernels.
**Values followed by the same letter are not significantly different at the .05 level of probability.

All entries in the F_6 Spanish yield trial were outyielded significantly by Tifspan, except Spancross. However, the three selections were not outyielded significantly by Argentine. Analysis of variance gave a significant F value ($P > .05$).

Analyses of variance were nonsignificant ($P < .05$) for differences between the two selections, their Early Runner parent and the commercial cultivar Florunner in the F_6 Runner yield test.

Shelling grade data are presented in Tables 1, 2, 3, and 4 for the F_5 Spanish, F_5 Runner, F_6 Spanish, and F_6 Runner tests, respectively. These results indicate that the selections generally met acceptable standards of seed quality. It is interesting to note that selections were obtained in the Spanish tests with pink testa color and in the Runner tests with flesh testa color. This is the opposite of what is observed in all present commercial cultivars of these types. Results also show that desirable characters in each parent were transferred to breeding lines of the opposite commercial type without any selection pressure for these qualities.

One of the most important bonuses was the transfer of the spreading habit of growth into a Spanish cultivar. Growers are presently demanding the spreading type of growth habit in cultivars to be used with new types of harvesting equipment. This selection (C201-67-4) should be of value to breeders either as a new variety or as a source of germplasm in their breeding programs. Some of the other desirable traits segregating in these lines were maturity, dormancy, and pod constriction.

From these results, it was concluded that the procedure of utilizing early generations for yield trials may be acceptable for peanuts. Critical evaluation of this breeding procedure by comparison of pure lines developed by early testing and the other methods currently being used by peanut breeders remains to be done. Results from these studies are needed to compare the relative efficiency of each breeding procedure.

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