A COMPARATIVE ANALYSIS OF THE REPRODUCTIVE EFFICIENCY OF 14 VIRGINIA MARKET TYPE PEANUT CULTIVARS (ARACHIS HYPOGAEA L.)

by

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INTRODUCTION

Yield increases in peanut (*Arachis hypogaea* L.) have resulted from a combination of factors, including improved cultivars, agronomic practices and disease control. Pattee and Young (34) claim that plant breeding and genetics have contributed 25 to 30% of the peanut yield increases during the past four decades. Significant yield increases have occurred since the release of the early cultivars although yields are not rising as rapidly as they did earlier (30). In Florida, a comparison of the state's first and most recently released cultivars indicates that varietal improvements were responsible for an increase of greater than 100% in yield potential (13). Cultivars developed for the North Carolina-Virginia peanut growing area have shown yield increases of approximately 15% each five-year period from 1947 to 1976. Since 1976 yields have remained steady, except for 1980 when a severe drought caused a 66 % reduction in yields.

In their evaluation of the physiological changes in peanut cultivars released during the past 40 years, Duncan et al. (13) concluded that there were three physiological processes that explained most of the yield variation. These were: (1) the partioning of assimilate between vegetative and reproductive structures, (2) the length of the pod filling period and (3) the rate of fruit establishment. Estimates of the partioning of assimilate to fruit production ranged from 40% for 'Dixie Runner', the first cultivar released, to 98% for 'Early Bunch' a more recently released cultivar.

An important factor that determines the level of efficiency of these physiological processes and also yield is the reproductive efficiency of the peanut plant. Many researchers believe that higher yields will result when a greater percentage of the flowers produce mature pods. Duncan et al. (13) concluded that selection for yield increase has led to the development of peanut cultivars that partition a greater portion of their daily assimilate to pod. However, the question remains as to whether the ratio of flowers to pods is significantly greater in the more recently released cultivars than in the earlier cultivars.

Several methods have been used to estimate reproductive efficiency. Smith (40) compared the total number of flowers and pods with the total number of seeds and the number of flowers to the number of pods. Emery et al. (16) estimated reproductive efficiency as the ratio of mature fruit weight to plant weight or Harvest Index. Another estimation method is to compare the dry weight of the fruit with that of the seed.

This study was conducted to investigate the comparative reproductive efficiency of 14 virginia market type cultivars developed from 1944-1981. Five methods of estimation of reproductive efficiency were compared including Harvest Index and the proportion of flowers giving rise to fruiting structures (pods and pegs), mature plus immature pods, and mature pods alone. Additional objectives of the study were to determine the relationships existing between the various components of reproductive efficiency and both the release dates and method of cultivar development for the 14 cultivars. The components of reproductive efficiency studied were the first and peak flowering dates; flower, peg, pod, and seed number; and pod, seed, and plant weight.

LITERATURE REVIEW

Morphology of Reproductive Structures

Arachis hypogaea L. produces flowers in the axils of leaves on very short inflorescences. First, the reproductive branch develops in the axils of the foliage leaves. Flowers are then produced in the axils of scale-like leaves found on the reproductive branch (39). There are two distinct botanical groups based on the branching habit. These are the alternately branching cultivars (*A. hypogaea* subsp. *hypogaea* var. *hypogaea*) and the sequentially branching cultivars (*A. hypogaea* subsp. *fastigiata* var. *fastigiata* and *A. hypogaea* subsp. *fastigiata* var. *vulgaris*). Buds on the main stems of alternately branching cultivars produce no reproductive branches but give rise either to vegetative branches or remain dormant (39). Inflorescences are produced on the primary branches from the main stem, then on secondary and higher order branches (36, 38, 39). The sequentially branching cultivars produce inflorescences on some of the higher nodes on the main stem as well as those on the lateral branches (38, 39).

The peanut is a member of the family Leguminosae and subfamily Papilionaceae. Its flowers are papilionate, yellow, sessile, zygomorphic and are borne in groups of three to five on the condensed spikes, but develop and open in succession at intervals of 1 to several days (39). In the subsp. hypogaea var. hypogaea, cultivars produce buds that are long and narrow, while buds are short and thick in cultivars of the subsp. fastigiata. Also, the corolla is larger in the subsp. fastigiata than in the subsp. hypogaea var. hypogaea cultivars (36). The unusually long, tubular hypanthium bears the calyx, corolla and a fleshy staminal column at its top. Within the hypanthium, lies the style with its club-shaped stigma.

The androecium consists of ten monodelphous stamens two of which are sterile (36, 39). Four of the filaments bear adnate, oblong anthers which alternate with four filaments that bear dorsifixed, globose anthers (36, 39). The dry pollen grains are oblong and assume a spherical shape when moistened. The gynoecium is comprised of a sessile, superior, monocarpellate ovary containing two to five ovules and a stigma (39). The ovules develop alternately along the ventral suture of the carpel, the apical ovules developing first (39).

The day before anthesis the flower bud expands slowly and the hypanthium elongates. This growth process accelerates during the night allowing anthesis and pollination to occur shortly after sunrise (36, 39). Peanut is normally self pollinated; and the closed keel, which securely encloses the stamens and style, is a major obstacle to cross-pollination. However, natural hybridization does occur in a high enough frequency (0.01 to 0.55% (11), 0.73-2.56% (22)) that it should be taken into consideration when maintaining cultivar purity. On warm, sunny days the corolla, calyx, hypanthium and style wither in 4 to 6 hours; in cool weather, withering is delayed. However, the ovary and base of the style remain turgid. Rapid pollen tube growth after pollination results in syngamy within 4 hours of pollination (39).

After syngamy, the fruit appears first as a pointed, stalk-like structure (called a peg) which elongates by means of an intercalary meristem at the base of the ovary just below the ovarian cavity (39). Being positively geotropic, the peg extends downward into the soil. Here, its apex enlarges and pod development follows. Peg formation and elongation is the transition between the aerial flower and the subterranean fruit (39). The peg is visible in 5 to 7 days and grows to varying lengths depending on its position on the lateral branches and whether the plant is a spreading or erect type. The peg is conical with a firm, sharp apex facilitating its penetration of the soil. It is usually purple initially and contains minute hairs which are deciduous and fall off in a few days (36).

After penetrating the soil, the peg develops into a pod at depths of 2 to 6 cm. At the commencement of pod enlargement, peg elongation ends (39). The pod develops in a horizontal position, ventral suture uppermost, due to unequal growth in the proximal region (39). It enlarges from the base to the apex to form a segmented pod with constrictions between segments, even though it is uniloculate in the cultivated species. The dry pod does not dehisce but the pericarp can be ruptured along the longitudinal ventral sutures mechanically. The dry shell is reticulate and consists of an outer spongy layer, a middle fibrous layer, a woody layer and an internal papery layer lining the pod. Seeds vary from one to five within the species but are normally two in *A. hypogaea* subsp. *hypogaea* var *hypogaea*.

Reproductive Efficiency in *A. hypogaea L*.

Arachis hypogaea normally produces an abundance of flowers over an extended period lasting until late in the growing season. This is a result of the indeterminate nature of the species. Consequently, at harvest there are pods at various stages of development and maturity. The peanut is very inefficient in converting the majority of flowers into pods and even more inefficient in converting them into mature pods (40). As many as 20 times more flowers than pods may be produced (40). Shibuya (38) and Smith (40) reported that only 16.3 and 13.5%, respectively, of the flowers form mature pods. Even though all the flowers are fertile, a significant portion of them fail to continue development after pollination, resuting in a substantial reduction in the yield potential as represented by the number of flowers (42). There was some earlier thought that many of the flowers were sterile, but Umen (42) and Smith (39) determined that all flowers are hermaphroditic, fertile and capable of fertilization. Many of the pegs fail to reach the soil surface and do not form pods. Smith (40) found that 40% of the flowers failed to initiate fruit development and another 40% produced pegs which aborted before pod enlargement occured. Those reproductive structures that fail to mature do not abscise as in many legumes but remain attached to the plant until time of harvest (40).

Normally, once flowering has begun, flowers are produced daily, particularly if there is adequate soil moisture (36). Smith (40) found that erect (subsp. _fastigiata_ var. _vulgaris_) cultivars produced two-thirds of their flowers during the 4 week period beginning 6 weeks after planting, while the spreading (subsp. _hypogaea_ var. _hypogaea_) cultivars produced four-fifths of their flowers during the third month after planting. Therefore, flowering appears more concentrated earlier in the erect cultivars than in the spreading types.

Shibuya (38), Bolhuis (3, 4), Smith (40) and Umen (42) examined the normal flower production pattern in _Arachis_ cultivars and observed a distinct cyclic periodicity. The daily number of flowers fluctuated from a minimum to a maximum over 2 to 5 day intervals. This phenomenon is characteristic of peanuts as it has been observed in at least three of the four major botanical varieties - _A_. _hypogaea_ subsp. _hypogaea_ var. _hypogaea_, subsp. _fastigiata_ var. _fastigiata_, and subsp. _fastigiata_ var. _vulgaris_. Variety _hypogaea_ is represented commercially in the U.S. by both runner and virginia market types and spreading and erect growth habit. Variety _fastigiata_ is represented commercially in the U.S. by the valencia market type and erect habit. Variety _vulgaris_ is represented in the U.S. by the spanish market type and erect habit.

Smith (38) and Bolhuis (3, 4), having determined that flowering periodicity is independent of the variation in day length and climatic conditions, concluded that cyclic flowering is controlled by an internal rhythm associated with the developmental processes of the peanut plant. Cultivars of A. hypogaea subsp. hypogaea var. hypogaea began flowering at a gradual rate 5 weeks after planting (40). The rate increased 3 weeks later, and peak production occurred 5 to 6 weeks after the initial flowers (40). This frequency was suddenly interrupted at regular intervals by the cyclic fluctuations in flower number. The seasonal distribution of flowers followed essentially a normal curve, with late flowering decreasing at approximately the same rate as the early season increase (40).

The flowers that give rise to the heaviest yield of seeds are formed long before peak flower production is reached (37). The low reproductive efficiency level may be due in part to the indeterminate growth habit of the peanut, since the late-season flowers produced do not have time to develop into mature pods before harvest (14). About 2 months are required from fertilization to pod maturity (20). Other reasons suggested for failure of late developed pegs to mature include unavailaility of sufficient macronutrients (2) and other inherent factors (37, 40). These findings support the conclusion that the date and position of the flowers and date of peg placement in the soil are factors that significantly influence the reproductive efficiency of peanuts.

Most of the fruits of A. hypogaea subsp. hypogaea var. hypogaea are produced from flowers at the lower nodes of the lateral branches, which are the most important area of pod formation (38). Gupton et al. (21) reported that pegs form initially on the first inflorescence of the cotyledonary lateral and that successive pegging extends outward and upward in concentric circles from the first inflorescence on the lateral. Gupton et al. (21) identified three well defined pegging groups by their order of appearance on the lateral; these were designated as early, intermediate and late pegging. Therefore, the mature peanut plant includes a multiple of maturity groups derived from fruit set over an extended period.

Various studies on the ontogeny and ecology of flowering in A. hypogaea have shown that adverse climatic conditions do significantly affect growth, flowering and pod set (21, 31, 35, 42). Low temperature and low rainfall either stop flowering completely or slow the process and also keep the styles recessed. Bolhuis and DeGroot (5) observed that temperatures less than 24°C completely inhibited flowering in three erect cultivars. At a constant temperature of 33°C there was increased vegetative growth but without an increase in pod number. Fortanier (18) inhibited flower opening by subjecting plants to 40°C daytime and 35°C nighttime temperatures. Fortanier (18) also reported that flower elongation and opening were light-dependent and that the time of flower opening was regulated by a light stimulus received by the flower bud 3 days earlier.

Moisture is critical for pod formation. In dry soil the fertilized ovary does not develop into a pod (42). Billaz and Ochs (1) reported that a water deficit 50 to 80 days after planting reduced flowering and pegging and that this caused a greater reduction in yield than water stress at any other growth period. In 1958, Il'ina (24) reported that flower initiation was delayed 7 days when the soil was kept at or drier than 35% of field capacity. However, others have reported that the peanut plant has a tendency to compensate for reduced flower production due to drought by producing a flush of flowers and pods when the water deficit is over-come (6) or by maturing a higher percentage of fruits (43).

Soil moisture deficit during peg formation and pod development reduces pod number but does not significantly affect weight per pod (33, 43). Underwood et al. (41) and Ono et al. (32) reported that during drought the transition from pegs to pods is an important factor in reducing pod numbers. If the soil surface is dry, many pegs fail to penetrate, thereby preventing pod development. Also, the lack of adequate moisture in the pod formation zone prevents effective uptake of calcium which results in a higher percent of unfilled pods, more single-seeded pods, and a lower calcium concentration in hulls and seeds (10, 37).

These are some of the factors that influence the reproductive efficiency of peanuts. However, neither all the factors nor the sequence of events following flowering which prevent pod development or maturation are fully understood. Inherent genetic factors are likely responsible. The many intermediate physiological steps from flower initiation to pod maturity must involve complex genotypic-environmental interactions (16). Gregory et al. (20) concluded that no direct relationship existed between the progression of flowering and ultimate pod production. Shear and Miller (37) reported that the peanut quickly restores the number of pods it will bear if pods are artificially removed. Gregory et al. (20) suggested that the over-production of flowers may be related to a survival mechanism from pre-cultivation times rather than represent a great potential for yield.

MATERIALS AND METHODS

Fourteen cultivars of the U.S. virginia market type peanut were selected for this study (Table 1). They comprised five cultivars released from Virginia (VA B46-2, VA 56R, VA 61R, VA 72R, VA 81B); six from North Carolina (NC 4, NC 2, NC 5, NC 17, NC 6, NC 7); one from Georgia (GA 119-20), one from Florida (Florigiant), and one commercially released cultivar (GK 3). Four pure line selection cultivars and ten cultivars selected from crossing programs are represented. The growth habit of the cultivars is either spreading or erect and their maturities range from early to late.

The experimental design was a randomized complete block (RCB) with four replications and 14 plots per replication. Plots consisted of two rows 0.9 m wide by 6.09 m long. Two randomly chosen plants were selected for each cultivar per replication giving a total of 112 samples (eight plants per cultivar). The experiment was conducted in the field in 1983 and 1984 at the Tidewater Research Center in Suffolk, Virginia. Field plantings were made on 16 May 1983 and on 10 May 1984. The soil type in 1983 was an Eunola loamy fine

Table 1. The maturity, release dates, growth habit and breeding methods of 14 U.S. virginia market type peanut cultivars

Entry No.	Cultivar	Maturity	Release Date	Growth Habit	Breeding Method
1	NC 4	Medium	1944[1]	Erect	Pure line
2	VA B	Medium	1952	Erect	Pure line
3	NC 2	Medium early	1952	Erect	Hybrid
4	GA 119-20	Medium early	1954	Erect	Hybrid
5	VA 56R	Medium late	1956	Spreading	Pure line
6	FLORIGIANT	Medium	1961	Spreading	Hybrid
7	VA 61R	Medium late	1961	Spreading	Pure line
8	NC 5	Late	1964	Spreading	Hybrid
9	NC 17	Early	1969	Erect	Hybrid
10	VA 72R	Late	1971	Spreading	Hybrid
11	NC 6	Medium late	1976	Semi-spreading	Hybrid
12	GK 3	Late	1976	Spreading	Hybrid
13	NC 7	Early	1978	Semi-erect	Hybrid
14	VA 81B	Early	1981	Erect	Hybrid

[1]Never officially released; first selection made in 1929 and final selection made in 1944 by North Carolina Agricultural Reserach Service.

sand (fine-loamy, siliceous, thermic aquic Hapludult), and in 1984 a Nansemond fine sandy loam (coarse-loamy, siliceous, thermic Aquic Hapludult).

The number of flowers that had opened by 0800 h each morning were counted and recorded for each selected plant. Observations were made as to whether flowers were located on the lateral branches or on the main stem of the plants. Attempts made during the 1983 and 1984 field experiments to tag the pegs weekly were discontinued because spreading cultivar pegs had to be removed from the soil, and it was felt that this practice would have significantly affected the peg's re-entrance in the soil and potentially reduce normal yield. During 1984, a plant adjacent to the observed plant within each plot was harvested at 11 weeks after planting and the number of pegs and pods recorded. At 15 weeks after planting the next adjacent plant was removed and the number of pegs and pods recorded as well. Plants used for flower counts were harvested during the second week of October at which time the number of pegs and pods were counted. Plants were oven-dried for 48 hours and the total plant and pod dry weights recorded. Mature pods were separated from immature pods which were identified by their shrivelled seeds. The total number of mature pods and mature seeds and immature pods and immature seeds were counted and weighed.

Recommended agronomic and disease control practices were implemented for both experiments. The weekly accumulated rainfall, average daily temperature and average daily radiation were recorded at the research station. Radiance was measured in Langley units (SR) which is a unit of energy per unit area, equal to one gram-calorie cm^{-2}. A cloudy day averages about 200 SR and a sunny day between 400 to 700 SR at Suffolk Virginia (Dr. J. L. Steele, Tidewater Research Center).

Data were analyzed by an analysis of variance (ANOVA) (27). Means of significant treatments were ranked using Duncans Multiple Range Test (27, 29). Bonferroni contrasts were used to determine significant differences among groups of cultivars (28). Linear and multiple regression analyses and correlation coefficients were determined between certain traits (27, 29). 'Z' test of binomial proportions were used to detect any significant differences between the proportions relating to Reproductive Efficiency (RE) (29).

Relationships between the following characters were examined:

a) The first and peak flowering dates and yields of each cultivar;

b) The total number of flowers and the number of pegs plus pods;

c) The total number of flowers and the number of pods;

d) The total number of flowers and the number of mature pods, and

e) The number of flowers, pegs and pods produced and the release dates and mode of development of cultivar.

Five methods of estimating RE in peanut cultivars were used. The formulae are:

1. $$RE = \frac{\text{mature pod dry weight}}{\text{plant dry weight}} = \text{Harvest Index (HI)}$$

2. $$RE = \frac{\text{mature pod total}}{\text{flower total}}$$

3. $$RE = \frac{\text{pod total}}{\text{flower total}}$$

4. $$RE = \frac{\text{peg total + pod total}}{\text{flower total}}$$

5. $$RE = \frac{\text{mature seed total}}{\text{2(flower total)}}$$

RE methods 1 and 2 were calculated using data from 1983, 1984, and both years combined. RE methods 3 and 4 were calculated using 1984 data. RE method 5 was calculated using 1983 and 1984 combined data.

RESULTS

In 1983, there were highly significant (P = 0.01) differences among the 14 cultivars for flower total (FT), mature pod total (MPT), seed total (ST), plant dry weight (PLDW), mature pod dry weight (MPDW), vine dry weight (VW) and seed dry weight (SW) (Table 2). Highly significant or significant (P = 0.05) differences were also observed for all of these plant traits in 1984 except MPDW and SW. In addition, differences among the 14 cultivars for peg total (PGT), immature pod total (IMPT), and pod total (PT) were highly significant in 1984, the only year these parameters were studied.

Flower Total (FT)

In 1983, NC 5 and Florigiant flowered the most prolifically, while VA B46-2 and NC 17 produced the fewest (Table 3). Earliest anthesis was observed for VA 81B and NC 17 at 37 days after planting. The order of flowering for the remaining cultivars was NC 7, Florigiant and VA B46-2 (39 days); GK 3 and VA 56R (40 days); NC 4, NC 5, VA 72R, and NC 6 (41 days); and VA 61R, GA 119-20, and NC 2 (42 days). The

Table 2. ANOVA for 10 traits[1] of 14 peanut cultivars studied in 1983 and 1984.

Source of Variation	FT 1983 MS	FT 1983 PR[2] > F	FT 1984 MS	FT 1984 PR > F	PGT 1984 MS	PGT 1984 PR > F	PT 1984 MS	PT 1984 PR > F	MPT 1983 MS	MPT 1983 PR > F	MPT 1984 MS	MPT 1984 PR > F
CV[3]	130527.5	0.0001**	57868.9	0.0001**	4335.4	0.0001**	3735.1	0.0035**	2653.0	0.0001**	1155.2	0.0164*
BLOCK	37841.9	0.0120*	26845.5	0.0837	7748.9	0.0001	2685.7	0.1333	294.3	0.7180	1186.9	0.0880
ERROR	11164.3		11809.9		910.5		1414.2		646.7			
	PLDW 1983		PLDW 1984		MPDW 1983		MPDW 1984		VW 1983		VW 1984	
CV	33622.0	0.0006**	17768.1	0.0006**	8103.5	0.0001**	2241.6	0.0773	10325.9	0.0001**	8779.2	0.0001**
BLOCK	8615.6	0.2451	8027.9	0.2395	3650.9	0.1356	1824.9	0.2562	1996.5	0.3230	3460.4	0.1696
ERROR	6132.1		5637.6		1936.0		1333.6		1697.2		2029.8	
	ST 1983		ST 1984		SW 1983		SW 1984		IMPT 1983		IMPT 1984	
CV	10316.9	0.0001**	4382.9	0.0140*	9338.4	0.0001**	1075.5	0.1021	--	--	1202.6	0.0002**
BLOCK	3053.2	0.7302	4405.4	0.0880	895.1	0.5878	898.7	0.2697	--	--	327.5	0.4248
ERROR	2325.5		1972.7		1374.1		677.7		--	--	347.3	

[1] FT = flower total
PGT = peg total
PT = pod total
MPT = mature pod total
PLDW = plant dry weight
MPDW = mature pod dry weight
VW = vine dry weight
ST = seed total
SW = seed weight
IMPT = immature pod total

[2] PR = probability

[3] CV = cultivars

*Significant at the 0.05 level
**Significant at the 0.01 level

Table 3. Duncan's Multiple-Range Test of mean flower total (FT) for 14 peanut cultivars (1983, 1984, and 1983-84).

Cultivars	Mean Flower Total		
	1983	1984	1983-84
NC 5	616a[1]	353ab	485a
Florigiant	583ab	292abc	437ab
NC 6	471bcd	372a	422abc
VA 72R	444cd	353ab	399bc
VA 56R	436cd	232ab	380bc
VA 61R	435cd	312ab	374bc
NC 7	497bc	235bcd	366bc
GK 3	504bc	175cd	340c
GA 119-20	296ef	228bcd	262d
NC 4	266ef	238bcd	252d
VA 81B	360de	139d	240d
NC 2	300ef	180cd	240de
VA B46-2	230f	181cd	206de
NC 17	219f	113d	166e
Mean	404	250	327

[1]Means in column followed by same letter are not significantly different at the .05 level of probability.

peak flowering period for the two earliest flowering cultivars occurred during the fifth week of flowering, 1 week prior to most of the other cultivars (Table 4). Flowering of NC 5, considered a late maturing cultivar, peaked 2 weeks after the earliest cultivars.

There were significantly fewer flowers produced by cultivars developed from pure line selections (341) than by those selected from hybrid selections (429) (Table 5). Cultivars released prior to 1970 produced significantly fewer flowers (376) than those released after 1970 (455). The five cultivars released prior to 1960 produced significantly fewer flowers (306) than those released during the 1960's (463), but there were no significant differences between cultivars released in the 1960's compared to those released after 1970. Significant differences existed between cultivars of the 1950's and those of the 1970's (306 vs 455) and also between the erect and spreading cultivars (310 vs 498).

In 1984, all cultivars produced significantly fewer flowers than in 1983 as indicated by the highly significant year effects (Table 6). NC 6, NC 5 and VA 72R produced the largest FT's whereas, NC 17, VA 81B and VA B46-2 produced the smallest FT's (Table 3).

In 1984, all cultivars flowered within 5 days of each other. The peak flowering period was 1 to 2 weeks later for

Table 4. No. of weeks after first flower produced by the earliest flower-producing cultivar, VA 81B, to peak flowering periods for 14 peanut cultivars in 1983 and 1984.

Cultivars	1983	1984
NC 4	6	8
VA B46-2	6	6, 8[1]
NC 2	6	6
GA 119-20	6	8
VA 56R	6	8
Florigiant	6	6
VA 61R	6	6, 8[1]
NC 5	7	8
NC 17	5	6
VA 72R	6	8
NC 6	6, 7	8
GK 3	6	6
NC 7	5, 6	6, 8[1]
VA 81B	5	5

[1]Two peak periods

Table 5. F values for Bonferroni contrasts of flower totals (FT), peg totals (PGT), pod totals (PT), immature pod totals (IMPT), seed totals (ST), plant dry weights (PLDW), mature pod dry weights (MPDW), vine weights (VW), and seed weights (SW) data of 14 peanut cultivars for 1983 and 1984.

Contrasts	FT		PGT		PT		MPT		IMPT	
	1983	1984	1983	1984	1983	1984	1983	1984	1983	1984
Pure line cvs Vs. Hybrid cvs	15.56*	0.72	--	1.00	--	0.39	4.26	0.82	--	0.03
Older[2] cvs Vs. Recent[3] cvs	14.59*	0.15	--	0.03	--	0.18	7.18*	0.00	--	0.70
1950's[4] cvs Vs. 1960's cvs	39.65*	2.09	--	1.06	--	1.17	5.69	0.28	--	2.36
1960's cvs Vs. 1970's cvs	0.10	0.23	--	0.08	--	0.06	0.81	0.10	--	0.02
1950's cvs Vs. 1970's[5] cvs	40.16*	1.05	--	0.00	--	0.78	12.16*	0.05	--	2.14
Erect[6] cvs Vs. Spreading[7] cvs[8]	89.54*	36.26*	--	16.96*	--	17.69*	29.92*	7.45*	--	26.07*

Contrasts	VW		SW		ST		PLDW		MPDW	
	1983	1984	1983	1984	1983	1984	1983	1984	1983	1984
Pure line cvs Vs. Hybrid cvs	3.73	0.47	30.17*	0.20	6.59	0.25	9.27*	0.44	12.65*	0.13
Older cvs Vs. Recent cvs	4.63	0.03	25.36*	0.86	7.94*	0.00	10.77*	0.23	14.35*	1.00
1950's cvs Vs. 1960's cvs	7.41*	0.02	4.19	0.96	7.98*	0.69	8.64	0.15	6.91	0.97
1960's cvs Vs. 1970's cvs	0.08	0.05	9.31*	0.05	0.60	0.18	1.20	0.03	2.85	0.08
1950's cvs Vs. 1970's cvs	10.12*	0.01	29.22*	1.64	14.56*	0.19	18.31*	0.36	20.98*	1.81
Erect cvs Vs. Spreading cvs	46.17*	18.73*	10.66*	2.12	26.52*	5.95	36.95*	11.61*	19.97*	3.75

*Significant at the 0.05 Bonferroni critical value (Bonferroni .05, 6, 95 = 7.156).

1 F value for contrasts
2 Older = cultivars developed before 1970
3 Recent = cultivars developed after 1970
4 1950's cvs includes NC4 released in 1929
5 1970's cvs includes VA 81B released in 1981
6 Erect includes NC 7 a semi-erect cv
7 Spreading includes NC 6 a semi-spreading cv
8 cvs = cultivars

Table 6. ANOVA of combined 1983-84 data for flower totals (FT), mature pod totals (MPT), seed totals (ST), plant dry weights (PLDW), mature pod dry weights (MPDW), vine weights (VW), and seed weights (SW) of 14 peanut cultivars.

Source of Variation	FT		MPT		ST		PLDW		MPDW	
	MS	PR[1] > F	MS	PR > F	MS	PR > F	MS	PR > F	MS	PR > F
CV[2]	149942.31	0.0001**	2744.57	0.0001**	10722.41	0.0001**	38382.72	0.0001**	6942.53	0.0001**
BLOCKS	43932.64	0.0116**	500.39	0.4755	1734.92	0.4990	5474.31	0.4353	3087.91	0.1333
YEAR	1335189.45	0.0001**	31968.64	0.0001**	115706.61	0.0001**	77562.01	0.0004**	128319.36	0.0001**
CV * YEAR	38454.10	0.0002**	1063.70	0.0472*	3977.33	0.0408*	13007.46	0.0018*	3402.59	0.0178*

	VW		SW	
	MS	PR > F	MS	PR > F
CV	15426.76	0.0001**	5956.97	0.0001**
BLOCKS	2298.36	0.3033	759.91	0.5323
YEAR	7907.57	0.0418*	157378.20	0.0001**
CV * YEAR	3678.41	0.0267*	4456.93	0.0001**

*Significant differences at 0.05 level of probability
**Significant differences at 0.01 level of probability
[1]PR = probability
[2]CV = cultivar

most cultivars in 1984 than 1983 (Table 4). VA 81B again produced most of its flowers 5 weeks after flower initiation while NC 5 and VA 72R, regarded as late maturing cultivars, peaked at 8 weeks after they began flowering.

The Bonferroni contrasts of the 1984 FT data showed trends very different from those seen in 1983 (Table 5). Only erect cultivars produced significantly smaller FT (188) than spreading cultivars (312). All other contrasts indicated no significant differences in FT.

The combined analysis of the 1983-84 data showed highly significant differences in FT among the 14 cultivars and also a highly significant interaction between cultivars and year (Table 6). NC 5, Florigiant and NC 6 were the most prolific flower-producing cultivars (Table 3). NC 5, released in 1964, produced 485 flowers which was significantly more than 11 other cultivars. VA B46-2 and NC 17 produced the fewest flowers averaging 206 and 166 respectively, which was much less than the mean over all cultivars (327).

The reduction in FT in 1984 was not uniform across cultivars (Table 3). Florigiant produced about 150 flowers more than VA 56R in 1983, but in 1984 VA 56R produced 30 flowers more than Florigiant. VA 61R also produced more flowers than Florigiant in 1984 while the opposite occurred in 1983. The reduction in FT in 1984 for NC 2, Florigiant, NC 5, NC 17, NC 7, GK 3 and VA 81B was much more severe (> 40%) than for NC 4, NC 17, VA B46-2, GA 119-20, VA 72R, and NC 6 (<25%).

Bonferroni contrasts of the combined data provide an overall comparison for the various categories of cultivars. There were no significant differences in FT's between pure line cultivars (303) and hybrid cultivars (337) and between cultivars released in the 1960's (366) and the more recent cultivars of the 1970's (355). However, the cultivars released prior to 1970 produced significantly fewer flowers (311) than those released after 1970 (355). The five cultivars released prior to 1960 produced an average of 268 flowers per plant which was significantly fewer than the 366 produced by the four cultivars released during the 1960's and the 355 produced by cultivars since 1970. The erect cultivars produced a significantly smaller FT than the spreading cultivars (249 vs 407) (Table 7).

Mature Pod Total (MPT)

In 1983, NC 5, GK 3, VA 61R and NC 6 produced the largest number of mature pods per plant, while NC 4, NC 17 and VA B46-2 had the fewest (Table 8). The mean MPT across all cultivars was 85.

Table 7. Bonferroni contrasts of flower totals (FT), mature pod totals (MPT), seed totals (ST), plant dry weights (PLDW), vine weights (VW), mature pod dry weights (MPDW), and seed weights (SW) of 14 cultivars using 1983-84 combined data.

Contrasts			FT	MPT	ST	PLDW	VW	MPDW	SW
Pure line Cvs[2]	vs.	Hybrid Cvs	4.54[1]	0.84	2.37	2.99	0.63	6.25	17.98*
Older Cvs	vs.	Recent Cvs	8.55*	3.81	4.37	7.17*	1.72	12.53*	21.66*
1950's Cvs	vs.	1960's Cvs	29.07*	4.44	6.88	5.62	3.72	6.99*	5.01
1960's Cvs	vs.	1970's Cvs	0.32	0.20	0.08	0.83	0.00	2.18	6.90
1950's Cvs	vs.	1970's Cvs	26.22*	7.37*	9.50*	12.10*	4.27	19.08*	26.62*
Erect Cvs	vs.	Spreading Cvs	117.63*	34.29*	29.28*	44.87*	59.87*	21.70*	12.31*

*Significant at the 0.05 Bonferroni critical value (Bonferroni .05, 6, 193 = 6.922)

[1]F value for contrasts

[2]Cvs = cultivars

Table 8. Duncan's Multiple-Range Test of mature pod totals (MPT) for 14 peanut cultivars (1983, 1984, and 1983-84).

Cultivars	Mean Mature Pod Total		
	1983	1984	1983-84
VA 61R	103a[1]	77ab	90a
VA 72R	93ab	83a	88a
NC 6	102a	73abc	88a
NC 5	107a	63abcd	85ab
NC 7	96ab	62abcd	79abc
VA 56R	90ab	64abcd	78abc
GK 3	103a	48cd	76abc
NC 2	86abc	63abcd	74abc
Florigiant	86abc	59abcd	72abc
GA 119-20	78abcd	57abcd	67bcde
NC 4	58cd	66abcd	62cde
VA 81B	72bcd	38d	55de
NC 17	56d	51bcd	53de
VA B46-2	56d	49cd	53e
Mean	85	61	73

[1]Means in column followed by same letter are not significantly different at the 0.05 level of probability.

No significant differences were observed in the number of mature pods produced by pure lines (77) versus hybrid cultivars (85) in 1983 (Table 5). In addition, no significant differences were observed between cultivars released prior to 1960 and those of the 1960's (74 vs 88), and between those released in the 1960's and cultivars released after 1970 (88 vs 93). However, there were significant differences in the MPT produced by cultivars released prior to 1970 and those released after 1970 (80 vs 93), between those released prior to 1960 and those released after 1970 (74 vs 93), and between erect and spreading cultivars (74 vs 95).

In 1984 the highest MPT's were produced by VA 72R, VA 61R and NC 6; the lowest by VA 81B, GK 3 and VA B46-2 (Table 8). The mean MPT over all cultivars was 61, about 24 mature pods per plant less than in 1983. As for FT, the reduction in MPT in 1984 compared with 1983 was not uniform across all 14 cultivars (Table 8), hence the significant interaction between the environment and cultivars (Table 6). Only the erect cultivars differed significantly from the spreading cultivars in 1984 (55 vs 67). The Bonferroni contrasts of the remaining categories were not significant (Table 5).

The combined analysis on MPT indicates that VA 61R, VA 72R and NC 6 had the highest MPT's, although there were no significant differences among the top nine cultivars (Table

8). VA B46-2, NC 17 and VA 81B yielded the fewest mature pods. The mean MPT over all cultivars for both years was 73, ranging from VA 61R with a mean of 90 to NC 17 and VA B46-2 with a mean of 53 mature pods per plant.

The contrasts for the combined data show that there were no significant differences in MPT's for pure line (71) vs hybrid (74) cultivars, older (70) vs more recent (77) cultivars, 1950's (67) vs 1960's (75) cultivars or for 1960's (75) vs 1970's (77) cultivars (Table 7). The individual cultivar performance is quite dissimilar to the performance of cultivars as a group. For example, VA 61R which yielded the most mature pods, was released in 1961 as a pure line selection, whereas VA 81B, which produced an average 35 mature pods fewer than VA 61R, is the most recently released cultivar and came out of a hybridization program.

The only significant differences in combined year MPT were found between cultivars released before 1960 and those released after 1970 (67 vs 77), and between erect and spreading cultivars (63 vs 82). Although significant differences in MPT were observed between the five oldest and the five most recent cultivars, the absence of a consistent linear trend over the four decades of breeding effort is indicative of the difficulty in selecting for this trait.

Seed Total (ST)

In 1983, the cultivars producing the highest ST's were NC 5, GK 3, VA 61R and NC 7, whereas NC 4, NC 17 and VA B46-2 produced the fewest (Table 9). Bonferroni contrasts of ST's showed no significant differences between pure line cultivars (143) and hybrids (169), nor between cultivars released in the 1960's (170) versus those of the 1970's (178) (Table 5). There were significant differences between cultivars released prior to 1970 (151) and those released after 1970 (171); between cultivars released prior to 1960 (141) and those of the 1960's (171); between cultivars released prior to 1960 (141) and those released after 1970 (178); and between erect (138) and spreading cultivars (185).

In 1984, lower ST's were produced than in 1983 following the pattern seen with FT and MPT (Table 9). The cultivars producing the largest number of seeds from mature pods were VA 72R and VA 61R. VA 81B, VA B46-2 and GK 3 yielded the smallest ST's. The most drastic reduction in ST was observed for GK 3 which produced over 50% fewer seeds in 1984 than in 1983 (Table 9). The 1984 reduction in ST was not uniform across cultivars and a significant cultivar x environment interaction was observed (Table 2). Bonferroni contrasts revealed no significant differences for ST's among any of the categories of cultivars in 1984 (Table 5).

Table 9. Duncan's Multiple-Range Test of mean seed totals(ST) for 14 peanut cultivars (1983, 1984, and 1983-84).

Cultivars	Mean Seed Total		
	1983	1984	1983-84
VA 61R	196ab[1]	147ab	172a
VA 72R	179abc	159a	169a
NC 5	212a	125abc	168a
NC 7	195ab	125abc	160ab
NC 6	184abc	132abc	158ab
GK 3	197ab	92cd	145abc
NC 2	164abcd	121abcd	143abc
VA 56R	163abcd	116abcd	140abcd
Florigiant	161abcd	111abcd	136abcd
GA 119-20	148cde	108abcd	128bcde
NC 4	112de	126abc	119cde
VA 81B	127de	72d	104de
NC 17	110de	99bcd	104de
VA B46-2	100e	87cd	92e
Mean	161	116	139

[1]Means in column followed by same letter are not significantly different at the .05 level of probability.

The combined analysis for ST's shows that VA 61R, VA 72R and NC 5 produced the most seeds/plant, although there were no significant differences among the top nine cultivars (Table 9). VA 81B, NC 17 and VA B46-2 produced significantly fewer fewest seeds/plant than the mean ST. The overall cultivar means were 161 in 1983 and 116 in 1984.

There were significant differences in the mean ST's between cultivars released prior to 1960 (125) and those released after 1970 (147), and between erect cultivars (120) and spreading cultivars (155) (Table 7). No significant differences among the other categories of cultivars were observed.

Plant Dry Weight (PLDW)

In 1983 the highest PLDW's were produced by GK 3, NC 6, NC 7, VA 72R, NC 6 and VA 61R (Table 10). NC 17, VA 81B and VA B46-2 produced the lowest PLDW's.

There were significant differences in PLDW's among all but one of the categories of cultivars in 1983 (Table 5). Pure line cultivars produced significantly less PLDW than hybrids (248.1 vs 298.0 g). There were significant differences between cultivars released prior to 1970 (239.1 g) and those released after 1970 (316.3 g); between those released prior to 1960 (241.4 g) and those of the 1960's (310.5 g);

between cultivars of the 1950's (241.4g) and those released after 1970 (316.3 g); and between erect (238.7 g) and spreading cultivars (328.7 g). There were no signifcant differences between those cultivars released during the 1960's and those of the 1970's (310.5 g vs 316.3g) (Table 5).

In 1984 the largest PLDW's were produced by NC 6, VA 72R and VA 61R, whereas VA 81B, VA B46-2 and NC 17 produced the smallest PLDW's (Table 10). None of the three cultivars that produced the largest PLDW's in 1983 did so in 1984. The three cultivars lowest in PLDW were the same for both years. Bonferroni contrasts of categories of cultivars indicated a significant difference only between erect (222.49) and spreading cultivars (270.7g) (Table 5).

The combined analysis of the PLDW's of the 14 cultivars indicates that NC 6 (328.99 g) and VA 72R (316.93 g) produced the highest PLDW, while VA B46-2 (198.4 g) and VA 81B (168.74 g) produced the lowest. The mean PLDW was 283.7 g in 1983, 246.5 g for 1984 and 265.1 g over both years.

The combined contrasts show that the more recent cultivars produced significantly more PLDW as a group than those of the 1950's (284 vs 241 g) (Table 7). Erect cultivars averaged 231 g compared to 300 g for spreading cultivars. The cultivars released since 1970 averaged significantly higher

Table 10. Duncan's Multiple-Range Test of mean plant dry weights (PLDW) for 14 cultivars (1983, 1984, and 1983-84).

Cultivars	Mean Plant Dry Weight (g)		
	1983	1984	1983-84
NC 6	324.6abc[1]	333.4a	329.0a
VA 72R	331.5abc	302.4ab	316.9ab
GK 3	390.7a	224.0bc	307.4abc
NC 5	368.8ab	245.8bc	307.2abc
VA 61R	315.9abc	296.8ab	306.4abc
NC 7	335.4abc	257.4abc	296.4abc
VA 56R	272.4cde	259.5abc	265.9bcd
Florigiant	297.2bcd	233.1bc	265.2bcd
GA 119-20	264.1cde	262.1abc	258.1bcde
NC 2	266.1cde	233.9bc	250.0cde
NC 4	212.1de	254.6abc	233.4de
NC 17	202.1e	215.5bcd	208.8def
VA B46-2	192.1e	204.9cd	198.5ef
VA 81B	199.4e	138.1d	158.7f
Mean	283.7	246.5	265.1

[1]Means in column followed by same letter are not significantly different at the .05 level of probability.

PLDW than the cultivars released prior to 1970 (Table 7). None of the remaining categories differed significantly in their PLDW's.

Mature Pod Dry Weight (MPDW)

In 1983, the cultivars with the heaviest crop of MPDW's were NC 7 and GK 3, while VA B46-2 and NC 4 had the lightest MPDW's (Table 11). The mean MPDW for the 14 cultivars was 149.6 g.

The Bonferroni contrasts show that there were no significant differences in MPDW's between cultivars released prior to 1960 and those released during the 1960's, and also none between those of the 1960's and cultivars released after 1970. There were significant differences between all other categories of cultivars (Table 5).

MPDW's were significantly less in 1984 than in 1983. NC 6, VA 61R, NC 7 and VA 72R yielded the highest MPDW's (Table 11). NC 4 and VA B46-2 again produced one of the lowest MPDWs along with VA 81B, NC 2 and GA 119-20. Bonferroni contrast analysis revealed no significant differences between any of the categories of cultivars (Table 5).

The combined analysis indicates cultivars having the heaviest MPDW's were NC 7 and NC 6 although there were no significant differences between the seven cultivars heaviest

Table 11. Duncan's Multiple-Range Test of mean mature pod dry weights (MPDW) for 14 peanut cultivars (1983, 1984, and 1983-84).

Cultivars	Mean[1] Mature Pod Dry Weight (g) 1983	1984	1983-84
NC 7	196.6a[1]	119.3ab	157.9a
NC 6	174.6ab	127.5a	151.5ab
GK 3	196.0a	91.8abc	143.9abc
VA 72R	163.1abc	120.6ab	141.9abc
VA 61R	156.5abc	125.6ab	141.0abc
NC 5	181.7ab	92.2abc	136.9abcd
Florigiant	160.7abc	95.0abc	127.8abcde
VA 56R	144.0bcd	104.6abc	124.3bcde
GA 119-20	138.9cd	71.2c	120.9bcde
NC 2	141.5bcd	84.1bc	112.8cde
NC 17	113.2cd	102.5abc	107.8de
NC 4	101.1d	95.0abc	98.1e
VA 81B	122.9cd	71.2c	97.0e
VA B46-2	102.9d	89.2abc	96.0e
Mean	149.6	99.3	125.6

[1]Means in column followed by same letter are not significantly different at the 0.05 level of probability.

in MPDW's (Table 11). NC 4, VA 81B and VA B46-2 produced the lowest MPDW yields, which were about 38% lower than NC 7.

There were significant differences in MPDW's between cultivars released prior to 1970 (118.49 g) and cultivars released since 1970 (138.5 g) (Table 7). Significant differences were also found between cultivars of the 1950's (110.4 g) and those of the 1960's (128.4 g), between those released during the 1950's and those of the 1970's (138.5 g) and between erect (112.9 g) and spreading cultivars (138.0g) (Table 7). There were no significant differences between pureline cultivars (114.9 g) and hybrids (129.9 g) or between cultivars released during the 1960's (128.4 g) and those released after 1970 (138.5 g).

Vine Dry Weight (VW)

In 1983 GK 3 and NC 5 produced the most VW weight, whereas VA B46-2, NC 17 and VA 81B produced the least (Table 12). The top two cultivars were significantly different from nine other cultivars. There were significant differences between 1950's and 1960's cultivars (115.8 vs 142.4 g), between 1950's and 1970's cultivars (115.8 vs 145.1 g) and between erect (107.4 g) and spreading cultivars (160.2 g). No significant differences occurred between the remaining groupings of cultivars.

Table 12. Duncan's Mulitple-Range Test of mean vine dry weights (VW) for 14 peanut cultivars (1983, 1984, and 1983-84).

Cultivars	Mean Vine Weight (g)		
	1983	1984	1983-84
NC 6	150.1abc[1]	204.9a	177.5a
VA 72R	168.4ab	181.8ab	175.1ab
NC 5	184.8a	153.6bc	169.2abc
VA 61R	159.4ab	171.3ab	165.4abc
GK 3	194.8a	132.2bc	163.5abc
Florigiant	136.6bc	150.6bc	143.6abc
VA 56R	128.4bcd	154.9bc	141.6bc
NC 7	138.8bc	137.9bc	138.3c
GA 119-20	125.8bcd	148.7bc	137.2c
NC 2	124.7bcd	149.6bc	137.1c
NC 4	111.0cde	159.7abc	135.3c
VA B46-2	89.2de	115.6c	102.4d
NC 17	89.0de	113.0c	101.0d
VA 81B	73.6e	66.9d	70.3e
Mean	133.8	145.8	139.8

[1] Means in column followed by same letter are not significantly different at the 0.05level of probability.

NC 6, VA 72R and VA 61R produced the heaviest VW's in 1984 (Table 13). The cultivars lowest in VW's were VA B46-2, NC 17 and VA 81B. Erect cultivars produced significantly less VW's compared to the spreading cultivars (125.9 g vs 165.7 g) (Table 5). Differences among all other categories of cultivars were non-significant.

The 1983-84 combined analysis shows that NC 6 and VA 72R produced the largest VW's, whereas NC 17 and VA 81B produced the lightest VW's. The mean VW over both years was 139.8 g. Only the erect vs spreading cultivars showed any significant differences (117.4 vs 162.2) (Table 7).

Seed Weight (SW)

In 1983, SW's of NC 7 and GK 3 were the highest of the 14 cultivars tested, while SW's of VA B46-2 and NC 4 were the lowest (Table 13). These rankings are similar to those for MPDW (Table 11). There were significant differences in SW's for all but one of the Bonferroni contrasts analyzed, cultivars released during the 1950's vs those released during the 1960's (Table 5). Seeds from pure line cultivars weighed significantly less (92.6 g) than those from hybrids (135.2 g); those from early cultivars weighed significantly less (109.9 g) than the more recent cultivars of the 1970's and 1980's (146.7 g); cultivars of the 1960's (119.9 g) dif-

Table 13. Duncan's Multiple-Range Test of mean seed weights (SW) for 14 peanut cultivars (1983, 1984, and 1983-84).

Cultivars	Mean Seed Weight		
	1983	1984	1983-84
NC 7	194.4a[1]	84.4a	139.4a
NC 6	146.7bc	89.9a	118.3ab
GK 3	168.5ab	61.5ab	115.0b
NC 5	150.0b	62.1ab	106.1bc
VA 72R	121.4cdef	79.1ab	100.3bcd
Florigiant	135.8bcd	63.8ab	99.8bcd
VA 61R	104.0defg	86.3a	95.1bcde
VA 56R	114.7cdef	72.3ab	93.5bcdef
NC 2	126.6cde	59.3ab	92.9bcdef
GA 119-20	116.4cdef	68.1ab	92.4bcdef
NC 17	89.7efg	74.5ab	82.1cdef
VA 81B	102.2defg	50.4b	76.4def
VA B46-2	81.6fg	60.5ab	71.1ef
NC 4	70.1g	67.8ab	68.9f
Mean	123.0	70.0	96.5

[1]Means in columns followed by same letter are not significantly different at the 0.05 level of probability.

fered significantly from those released after 1970 (146.7 g); SW of 1950's cultivars (101.9 g) were also significantly different from those of the 1970's (146.7 g) and erect cultivars (111.6 g) produced significantly less SW than spreading cultivars (158.5 g).

In 1984, NC 6, NC 7 and VA 61R produced the highest SW's while VA 81B produced the lowest SW's (Table 13). Unlike 1983, there were very few significant differences in SW between any of the individual cultivars in 1984. There were no significant differences between any of the Bonferroni contrast categories (Table 5).

Highest SW's for combined years were observed for NC 7 and NC 6, while the lowest SW's were observed for VA B46-2 and NC 4 (Table 13). The mean over all cultivars for both years was 96.5 g.

Bonferroni contrasts of combined 1983-1984 data indicated significant differences in SW's between pure line cultivars (82.2 g) and hybrids (102.2 g); between early (89.1 g) and more recent cultivars (109.9 g); between cultivars of the 1950's (83.7 g) and those since 1970 (109.9 g); and between erect (88.9 g) and spreading cultivars (104.0 g) (Table 7). There were no significant differences in SW between cultivars of the 1950's and those of the 1960's or between cultivars released during the 1960's and those released after 1970.

Peg Total (PGT)

No data were collected on (PGT) in 1983, but in 1984 NC 5, VA 72R and NC 6 produced the most pegs (Table 14). VA 81B and NC 17 produced the fewest pegs, while the overall mean PGT was 55 (Table 14). No significant differences were observed among the top seven cultivars or the bottom seven cultivars. There were no significant differences in PGT for five of the six Bonferroni contrast categories of cultivars (Table 5). Only erect cultivars differed significantly from spreading cultivars (43 vs 67).

Immature Pod Total (IMPT)

In 1984, NC 6 produced the highest IMPT of the cultivars studied, whereas NC 4 and NC 2 produced the lowest IMPT's (Table 14). There were no significant differences for five of the six Bonferroni contrast categories of cultivars (Table 5). Erect cultivars differed significantly from spreading cultivars (16 vs 36).

Pod Total (PT)

In 1984, NC 6 produced the most pods, while NC 17, GK 3, VA B46-2 and VA 81B produced the fewest (Table 14). There were no significant differences in PT among the top 8 cultivars. NC 4, NC 17 and NC 2 produced 86, 80 and 90% of their total pods as mature pods respectively (Table 14). All cultivars were above 60% MPT, except NC 6. Erect cultivars had a significantly lower PT than spreading cultivars (73 vs 102) (Table 5). The other Bonferroni contrast categories showed no significant differences (Table 5).

Regression Analyses of Traits

A simple linear regression analysis of the 1983 data revealed significant regression slopes indicating the existance of a linear relationship between the dependent and independent plant traits (Table 15). About 70% of the total variability in MPT and ST produced by the 14 cultivars is explained by the number of flowers developed. The multiple regression model containing the MPT explains most of the variation in ST among cultivars (97%) and is the best one-variable model (Table 16).

In 1984, regression analyses gave results similar to those observed in 1983 (Tables 17 and 18). Regression slopes were significant for all sets of simple linear models. Sixty three percent of the variability in MPT and about 57% of the variability in ST were explained by the FT of cultivars. In the multiple regression model, the best one-variable model was again that containing MPT, explaining 97% of the variability in ST seen among the 14 cultivars.

Table 14. Duncan's Multiple-Range Test of mean peg totals (PGT), immature pod totals (IMPDT), and mean pod totals (PDT) for 14 peanut cultivars (1984).

Cultivars	Mean Peg Total	Mean Immature Pod Total	Mean Pod Total	% Mature Pods
NC 5	92a[1]	35abc	98abcde	64
NC 6	90a	53a	126a	58
VA 72R	76a	34abc	118ab	71
VA 61R	72ab	37ab	115abc	68
GA 119-20	70abc	31bcd	88abcde	65
NC 4	65abc	11d	79bcde	86
VA 56R	59abcd	39ab	103abcde	62
Florigiant	40bcde	33abc	82abcde	60
NC 7	40bcde	21bcd	83abcde	75
VA B46-2	40bcde	15bcd	70de	79
NC 2	37cde	7d	73cde	90
GK 3	35cde	21bcd	70de	70
VA 81B	29de	13cd	54e	76
NC 17	19e	13cd	64de	80
Mean	55	26	88	

[1]Means in column followed by same letter are not significantly different at the 0.05 level of probability.

Table 15. Simple Linear Regression of traits measured on 14 peanut cultivars during 1983.

Dependent trait	Parameter	Estimate	$PR^1>F$	R^2
Mature pod total	Intercept	36.50	0.0023	0.704
	flower total	0.12	0.0002**	
Mature pod weight	Intercept	13.58	0.4603	0.835
	mature pod total	7.80	0.0001**	
Mature pod weight	Intercept	63.62	0.0019	0.724
	flower total	0.21	0.0001**	
Seed total	Intercept	65.95	0.0037	0.709
	flower total	0.24	0.0002**	
Seed weight	Intercept	0.05	0.9985	0.638
	seed total	0.76	0.0006**	
Seed weight	Intercept	1.64	0.9577	0.583
	mature pod total	1.43	0.0015**	
Seed weight	Intercept	-27.14	0.1190	0.882
	mature pod weight	1.00	0.0001**	

** = significant at the 0.01 level of probability.

[1]PR = probability

Table 16. Stepwise Regression of data collected on 14 peanut cultivars during 1983 using model: ST = MPDW+MPDT+FT+SW

Models		Estimate	PR[1]>F	R^2
Best 1 variable	Intercept	-2.82		
	mature pod total	1.93	0.0001	0.970
Best 2 variable	Intercept	-5.93		
	mature pod weight	0.23	0.0947	0.977
	mature pod total	1.57	0.001	
Best 3 variable	Intercept	-6.81		
	mature pod weight	0.30	0.3979	0.977
	mature pod total	1.52	0.0007	
	seed weight	-0.04	0.8272	
Best 4 variable	Intercept	-7.19		
	mature pod weight	0.31	0.4337	0.977
	mature pod total	1.52	0.0014	
	seed weight	-0.002	0.9329	
	flower total	-0.05	0.8265	

[1]PR = probability

Table 17. Simple Linear Regression of traits measured on 14 peanut cultivars in 1984.

Dependent variable	Parameter	Estimate	PR[1] > F	R^2
Peg total	Intercept	-4.65	0.6601	0.7531
	flower total	0.24	0.0001**	
Pod total	Intercept	25.19	0.0081	0.8561
	flower total	0.26	0.0001**	
Mature pod total	Intercept	21.70	0.0104	0.7281
	pod total	0.44	0.0001**	
Mature pod total	Intercept	32.59	0.0003	0.634
	flower total	0.11	0.0007**	
Mature pod weight	Intercept	35.58	0.0418	0.608
	mature pod total	1.08	0.0018**	
Mature pod weight	Intercept	70.84	0.0001	0.387
	flower total	0.12	0.0175*	
Seed total	Intercept	63.88	0.0005	0.573
	flower total	0.21	0.0017**	
Seed total	Intercept	78.29	0.0001	0.467
	peg total	0.69	0.0070**	
Seed total	Intercept	45.84	0.0150	0.624
	pod total	0.79	0.0080**	
Seed weight	Intercept	39.78	0.182	0.292
	seed total	0.27	0.0046**	
Seed weight	Intercept	38.63	0.0213	0.306
	mature pod total	0.54	0.0403*	
Seed weight	Intercept	9.20	0.3841	0.762
	mature pod weight	0.61	0.0001**	

*,**Significant at 0.05 and 0.01 levels of probability, respectively.

[1]PR = probability.

Table 18. Stepwise Regression of data collected on 14 peanut cultivars during 1984 using model: ST = MPDW+MPDT+PDT+FT+PGT+SW.

Models	Parameter	Estimate	PR[1]>F	R^2
Best 1 variable	Intercept	0.23		0.971
	mature pod total	1.89	0.0001	
Best 2 variable	Intercept	-1.93		
	mature pod total	2.20	0.0001	0.980
	pod total	-0.19	0.0414	
Best 3 variable	Intercept	-0.14		
	mature pod total	2.20	0.0001	0.983
	pod total	-0.30	0.0405	
	FT	0.03	0.2825	
Best 4 variable	Intercept	-6.48		
	MPDW	0.21	0.1127	0.987
	MPDT	2.10	0.0001	
	PDT	-0.50	0.0132	
	FT	0.07	0.0696	
Best 5 variable	Intercept	-6.61		
	MPDW	0.23	0.0983	0.988
	MPDT	2.08	0.0001	
	PDT	-0.53	0.0141	
	FT	0.06	0.1308	
	PGT	0.07	0.4359	
Best 6 variable	Intercept	-7.40		
	MPDW	0.16	0.4288	0.988
	MPDT	2.10	0.0001	
	PDT	-0.53	0.0204	
	FT	0.06	0.1466	
	PGT	0.07	0.4477	
	SW	0.09	0.6476	

[1]PR = probability

Reproductive Efficiency (RE)

Methods 1, Harvest Index (HI), and 2 (MPT/FT) gave very different estimates of RE. For example, VA 81B, which was ranked eighth in RE by Method 2, was the most efficient of the 14 cultivars by Method 1 (Tables 19 and 20). Similarly, Florigiant had a higher (HI) than nine other cultivars. NC 4 had the lowest HI. The HI rankings were very similar for 1983, 1984 and the combined analysis.

Calculations of RE using Method 2 indicate that hybrids NC 17 and NC 2, released in 1969 and 1952 respectively, converted the highest proportion of their flowers into mature pods whereas NC 5 and Florigiant, also developed from hybrid selections, converted the lowest proportion (Table 20). Cultivars released prior to 1970 converted an average 46.6% of their biological output (PLDW) into reproductive yield (MPDW), whereas those cultivars released after 1970, all hybrids, converted 49.7%, an increase of 3%. Although this is an accurate indication of the HI increase as a group, individual comparisons are more striking. For example, VA 81B, a hybrid released in 1981, converted 15.5% more of its PLDW into MPDW than NC 4, a pure line released in 1944. NC 7, a hybrid released in 1978, converted more of its PLDW into MPDW than any cultivar released before it, and more than any cultivar of the pure line selections. As a group, hybrids had higher HI's than pure lines (48.5 vs 45.8%). Erect cultivars averaged 49.2% while spreading cultivars averaged 46.2% conversion of biological yield into reproductive yield.

Using Method 3 (PT/FT) of RE estimation, NC 17 had the highest and NC 5 the lowest RE with a difference of almost 30% (Table 21). RE of Florigiant is low by both Method 3 and Method 2 estimation while VA 81B is ranked higher (fourth) by Method 3 than by Method 1. As in most of the traits discussed previously in this study, there is no increasing trend in performance of cultivars according to the year of release. Hence, some early cultivars are more reproductively efficient than recently released ones. For example, NC 2 released in 1952 converted 40.6% of its flowers into pods compared to NC 6, released in 1976, which converted only 33.9%.

Rankings of cultivars by Method 4 (PGT+PT/FT) were somewhat different than those by Method 3. For example, GA 119-20 jumped from sixth position to second. Although NC 17 (0.735) maintained first position, NC 5 was ranked more efficient than Florigiant, VA 56R or NC 7 (Table 21).

The mean RE of Methods 2 and 5 were virtually equal (0.233 and 0.221). NC 17 and NC 2 ranked highest in RE by using Method 5. NC 5 and Florigiant were ranked lowest.

Table 19. Reproductive efficiency estimated by Method 1 (RE = Harvest Index $= \frac{MPDW}{PLDW}$) for 14 peanut cultivars.

Cultivars	1983	1984	1983-84
VA 81B	0.612	0.515	0.575
NC 7	0.586	0.463	0.533
NC 17	0.560	0.476	0.516
VA B46-2	0.536	0.435	0.484
Florigiant	0.540	0.408	0.482
GA 119-20	0.524	0.410	0.468
GK 3	0.502	0.410	0.468
VA 56R	0.529	0.403	0.467
NC 6	0.538	0.385	0.461
VA 61R	0.496	0.423	0.460
NC 2	0.532	0.360	0.451
VA 72R	0.492	0.399	0.448
NC 5	0.493	0.375	0.446
NC 4	0.477	0.373	0.420
Mean	0.530	0.417	0.477

Table 20. Reproductive efficiency measured by Method 2 $(RE = \frac{MPT}{FT})$.

Cultivars	1983	1984	1983-84
NC 17	0.258	0.451	0.319
NC 2	0.287	0.350	0.308
VA B46-2	0.244	0.271	0.257
GA 119-20	0.263	0.250	0.256
NC 4	0.219	0.277	0.246
VA 61R	0.237	0.247	0.241
GK 3	0.206	0.273	0.224
VA 81B	0.201	0.273	0.221
VA 72R	0.210	0.235	0.221
NC 7	0.193	0.264	0.216
NC 6	0.217	0.196	0.209
VA 56R	0.207	0.198	0.205
NC 5	0.174	0.178	0.175
Florigiant	0.147	0.202	0.165
Mean	0.219	0.262	0.233

Results in 1984 indicate that some cultivars formed pegs and pods at a faster rate than others between 11 and 15 weeks after planting, or 4 to 8 weeks after flowering (Table 22). VA B46-2 and VA 56R, for example, had a much larger percentage increase in pegs plus pods (125 and 103%, respectively) than NC 7 (22%) and NC 6 (25%). VA 81B, with the largest HI, had a larger percentage increase in pegs plus pods than NC 17, the cultivar with the highest RE by estimation Method 2.

Table 21. Additional methods[1] of estimation of reproductive efficiency for 14 peanut cultivars.

Cultivar	1984 Method 3	1984 Method 4	1983-84 Method 5
NC 17	0.566	0.735	0.313
NC 2	0.406	0.611	0.268
GK 3	0.398	0.597	0.232
VA 81B	0.389	0.597	0.186
VA B46-2	0.387	0.608	0.252
GA 119-20	0.386	0.693	0.260
VA 61R	0.369	0.599	0.214
NC 7	0.353	0.523	0.191
NC 6	0.339	0.581	0.204
VA 72R	0.334	0.550	0.212
NC 4	0.332	0.605	0.236
VA 56R	0.319	0.502	0.188
Florigiant	0.315	0.452	0.166
NC 5	0.278	0.538	0.173
Mean	0.369	0.585	0.221

[1]Method 3 $RE = \frac{PT}{FT}$

Method 4 $RE = \frac{PGT+PT}{FT}$

Method 5 $RE = \frac{ST}{2(FT)}$

Table 22. Comparative increase in yield of 14 peanut cultivars as estimated by number of pegs and pods formed over a 4-week period.

Cultivar	11 weeks Mean Pegs + Pods	15 weeks Mean Pegs + Pods	% Increase Pegs + Pods
NC 4	43	52	21
VA B46-2	32	72	125
NC 2	45	65	44
GA 119-20	36	60	67
VA 56R	33	67	103
Florigiant	48	71	48
VA 61R	44	71	61
NC 5	35	59	69
NC 17	34	47	38
VA 72R	45	70	56
NC 6	75	94	25
GK 3	43	57	33
NC 7	46	56	22
VA 81B	42	67	60

Table 23. Rainfall, temperature, and radiation recorded during period of peanut flowering for 1983 and 1984.

Date		Time Period		Weekly Rainfall (cm)		Mean temp. (C)		Mean daily radiation (SR)[1]	
1983	1984	1983	1984	1983	1984	1983	1984	1983	1984
6/22	6/18	Week 1	Week 1	8.68	0.00	23.6	25.5	588.9	641.8
6/29	6/25	Week 2	Week 2	0.73	0.82	24.1	24.6	694.6	618.3
7/6	7/2	Week 3	Week 3	2.38	1.35	25.4	23.5	610.5	630.6
7/13	7/9	Week 4	Week 4	0.00	4.25	22.6	24.9	728.4	635.9
7/20	7/16	Week 5	Week 5	1.47	0.80	27.4	24.5	643.7	508.9
7/27	7/23	Week 6	Week 6	1.14	4.60	25.9	23.1	574.0	407.6
8/3	7/30	Week 7	Week 7	0.00	5.71	25.3	23.3	625.8	427.2
8/10	8/6	Week 8	Week 8	2.58	2.33	25.8	24.6	540.7	532.1
8/17	8/13	Week 9	Week 9	0.23	2.75	22.3	25.4	567.7	515.1
8/24	8/20	Week 10	Week 10	1.13	3.52	26.9	24.5	551.1	502.5
8/31	8/27	Week 11	Week 11	4.47	0.03	23.6	21.3	584.4	576.6
			Total/mean[2]	22.81	26.16	24.8	24.1	610.0	545.1

[1]SR = LANGLEY

[2]Total rainfall for flowering period, mean weekly temperature and mean daily radiation.

DISCUSSION

Flowering

Peanut cultivars regarded as late or medium-late maturing produced more flowers than cultivars considered early maturing (Tables 3 and 5). This appears consistent with the fact that late maturing cultivars have a longer flowering period than early maturing cultivars (Table 4). Cultivars producing the greatest number of flowers also have a spreading growth habit in contrast to the erect growth habit of the lowest flower producing cultivars (Table 5). This, too, is consistent with the observation that the late or medium-late maturing cultivars have a spreading growth habit whereas the early maturing cultivars are erect. Smith (40) reported similar results in an earlier study. The results from the present study indicate that some of the genes for maturity, flower number, flowering period and growth habit may be closely linked.

The nonsignificant difference in number of flowers produced by pure line and hybrid cultivars (Table 5) suggests that either there was not a great deal of genetic variation released for this particular trait by the hybridization of the parents involved or that selection for increased flower production -- if a specific objective -- was more successful in pure line than in hybridization programs. Only four of the 14 cultivars were pure line selections and they were released in 1944, 1952, 1956, and 1962. Examination of this data on an individual basis indicates that six of the ten hybrid cultivars produced significantly more flowes than two of the four pure line selections, and that one hybrid cultivar, NC 17, produced fewer flowers than each of the four pure line cultivars (Table 3). Apparently more progress was made in the selection for increased flower production in certain hybrid cultivars than in others.

Observations made during this study on the position of flowers on the plant generally supported the proposal in earlier studies (36,38,39) that cultivars of Arachis hypogaea subsp. hypogaea var. hypogaea (virginia type) give rise to inflorescences in the axils of leaves only on branches and not on the main stem as found for spanish (A hypogaea subsp. fastigiata var. vulgaris), and valencia cultivars (A hypogaea subsp. fastigiata var. fastigiata). However, although the 14 cultivars used in this study are classified commercially as virginia type cultivars, two cultivars (Florigiant and VA 81B) were observed with flowers and pegs on the main stems of several plants. Florigiant and Va 81B were selected from crossing programs with *A. hypogaea* subsp. *fastigiata* parents. These cultivars may have homozygous recessive genes at both *J* loci or both *K* loci or all four loci, the genetic conditions which determine flowering in the main stem axils (23,45). They could have received either two or all four genes from spanish or valencia parents used in the crosses (8,9).

Other Traits

Results from this 2-year comparative analysis of various aspects of the reproductive efficiency of 14 virginia-type peanut cultivars showed significant differences among cultivars for peg total (PGT), pod total (PT), mature pod total (MPT), immature pod total (IMPT), seed total (ST), plant dry weight (PLDW), mature pod dry weight (MPDW), vine weight (VW) and seed weight (SW). The breeding methods used to develop these cultivars did not significantly affect any trait, except SW (Table 7). However, it is somewhat misleading to examine the pure line versus hybrid contrast in isolation, because there were significant differences between the 1950's cultivars and those of the 1970's for MPT, ST, PLDW, MPDW and SW (Table 7). Since three of the four 1950's cultivars were pure lines and all of the 1970's cultivars were hybrids, it would be more correct to say that five hybrid cultivars produced more for these five traits than 75% of the pure line cultivars.

Release data had more of an effect on PLDW, MPDW and SW than on MPT, St, VW, PGT, PT, IMPT and WV (Tables 5 and 7). The increase in PLDW of the five cultivars released in the 1970's over the five older cultivars, reflects an increase in reproductive rather than vegetative production. This is confirmed by the significantly larger MPDW of these same five cultivars over the five oldest cultivars (Table 11). With respect to the increase in MPDW, peanut breeders made more progress in the 1960's than the 1970's. The four cultivars released during the 1960's produced more MPDW than the older cultivars and as much as the five newer cultivars.

The growth habit of the 14 cultivars was an important determining factor for differences among several traits (Tables 5 and 7). Erect cultivars produced significantly fewer FT, MPT and ST, and significantly lower PLDW, MPDW, VW and SW than the spreading cultivars. If yield is expressed as kg/hectare = no. pods/plant x no. plants/hectare x wt./pod, then these differences may not be as meaningful, since erect cultivars can be planted at higher densities to compensate for fewer flowers, pods and seeds per plant and lower plant, pod and seed weight.

The significant positive correlation found between SW and MPDW, between ST and SW, and between MPT and MPDW were similar to those found by Coffelt and Hammons in a previous study (44). The implications of these correlations is that selection for any of these traits should also result in selection for an increase in the remaining traits as well.

Reproductive Efficiency

Using Method 1 (MPDW/PLDW) or HI, VA 81B and NC 7, the newest cultivars studied, were 15.5% and 11.3% more efficient in converting more of their photosynthate into pod yield than vine yield than NC 4, the oldest cultivar studied (Table 19). These results are not unexpected for VA 81B, since it has very little vine growth compared to other cultivars (9). Emery and Wynne (15) reported a similar relationship for RE using this method among the four cultivars NC 17, Florigiant, NC 5 and NC 2. The results presented by Emery et al. (16) for the same data are not directly comparable to this study because the HI's were calculated as the ratio of pod dry weight to plant green weight.

When reproductive efficiency is estimated suing Method 2 (MPT/FT), NC 17 shows about a 15% advantage over Florigiant, the most widely grown cultivar in Virginia and North Carolina (Table 20). NC 2 also showed a high Re and NC 5 a low RE using Method 2. These estimates are all higher than that reported by Smith (40) of 13.5% and Shibuya (38) of 16.3%. This difference may be due to several factors, such as changes in cultural practices and the use of different cultivars in each study.

Since all cultivars were harvested at the same time, it might be an unfair evaluation of some cultivars to count only mature pods. Thus in 1984, two methods (Method 3 and Method 4) were used to compensate for maturity differences in pods. In Method 3, RE was estimated using PT/FT. However, although actual estimates of RE were higher, the rankings were similar with NC 17 and NC 2 the highest and NC 5 and Florigiant the lowest (Table 21). Using Method 4 (PGt + PT/FT), actual estimates of RE were even higher (Table 21). However, NC 17 again had the highest RE and Florigiant the lowest. Methods 3 and 4 do give an indication of how much peanut yield could be increased if all pods matured at harvest or if all pegs produced harvestable pods. These results indicate that peanut yields could be doubled, if one of these conditions were possible.

Using Method 1, there was about a 4% increase in RE for more recent cultivars compared to older cultivars. In contrast, using Methods 2, 3, 4 and 5 there was a slight decrease in RE for more recent cultivars compared to older cultivars. When data are averaged over all cultivars within maturity classes, about a 5-10% higher RE is seen for earlier maturing cultivars than for later maturing cultivars using all methods of estimating RE. Averaging the data over all cultivars within growth habit types indicates that erect types had only a slight (3%) advantage using Method 1, but a 6% advantage using the other methods. A comparison of RE method x breeding methodology interaction means revealed that hybrids were 3% more efficient than inbreds according to Method 1, while the other RE methods did not differentiate breeding methodologies.

Methods 2 and 5 can be used in conjunction to determine whether a cultivar has a tendency to produce more one-seeded or three-seeded pods. Cultivars with a higher efficiency rating by Method 2 than by Method 5 produce more one-seeded than three-seeded pods, and vice versa. By this comparison it was found that NC 2 and VA 81B produce more one-seeded than three-seeded pods (Tables 20 and 21).

RE, by itself, may not always be a good predictor of peanut cultivar performance. For example: Florigiant has a low RE by all methods but is the dominant variety in the Virginia-North Carolina production area. This is apparently due to the fact that RE does not take into account total number of flowers. Florigiant ranked second in flower production, significantly higher than seven other cultivars (Table 3).

Yield expressed as ST is greatly dependent on MPT as indicated by the very high proportion of the variation in ST that is explained by MPT (Tables 15, 16, 17, 18, 20). Similarly, the T produced by cultivars appears to be an important determinant of economic yield since Ft accounts for 70% of the variability in MPT and St. However, this does not seem to be borne out in terms of RE expressed as the ratio of MPT to fT (Table 20). Others (13, 26, 40, 45) have also suggested that the FT is probably not closely related to MPT because of the small proportion of flowers that result in-pods, and because flower number per day fluctuates widely, while pod initiation appears nearly constant until a maximum is reached.

The HI of a cultivar may be the best single indicator of RE, as it reflects the percentage of biological yield represented by economic yield. Cultivars with the highest HI are, therefore, more biologically efficient in producing that part of the plant of economic interest -- the pods and seeds. On the other hand, it is probably best to consider the rankings of cultivars by at least several methods of RE estimation in order to obtain an overall composite picture of cultivar efficiency for this trait. A choice of parents to be used in a hybridization program that is based solely on one criterion for estimating RE would decrease the likelihood of being able to pool all the genes associated with a higher RE. It may not be necessary to breed for increased FT considering the peanut already produces an abundance of flowers, but breeding to increase the ratio of MPT to FT is important. This higher proportion must also go beyond the higher proportion usually observed when fewer flowers are produced due to environmental conditions. Thus, at least one other method besides HI should also be used for obtaining maximum information on the RE of a cultivar.

Environmental Factors

One reason for the reduction in flower production in 1984 and the interaction between cultivars and the environment may be that rainfall distribution differed between 1983 and 1984 (Table 23). In 1983, periods of rainfall were followed by a period of very little or no rain creating a cycle of wet and dry conditions that did not occur in 1984. In 1984, it was continuously wet during the flowering period. It is common in peanut plants for bursts of flowering to occur after rain, particularly following a dry period. Low flower frequency has been observed during cloudy, wet periods as well as in the absence of these conditions.

Results of this study suggest that excessive rainfall may promote vegetative growth at the expense of reproductive development. Although VW of 11 cultivars were greater in 1984 (a wet year) than in 1983 (a dry year) (Table 6 and 12), biological yields (PLDW) were reduce (Table 10). Evidently, for these 11 cultivars, there was more partitioning of assimilates to vegetative growth than reproductive growth during the wetter year. Hence, even though a reduction in flower production does not necessarily lead to a decrease in yield, since the peanut plant produces excessive flowers, changes in the ratio of the partitioning of assimilates can reduce yield.

Temperature, photoperiod, and total radiation are also factors that affect the relative amounts of vegetative and reproductive growth as well as the rate at which flowers are formed (18, 19, 25, 44). Ketring (25) found that at low irradiance the number of flowers, pegs, pods and seeds were smaller, but leaf area and stem height increased. Also, De Beer (12) showed that at higher temperatures more flowers were produced but a smaller percentage formed pods; conversely, at lower temperatures fewer flowers were formed but a higher percentage of these developed pods. Results from this study confirm all of these observations. im summary im bib contents

CONCLUSIONS

Results from this 2-year comparative analysis of various aspects of the reproductive efficiency of 14 virginia-type peanut cultivars led to the following conclusions.

1. Some of the genes for maturity, flower number, flowering period, and growth habit may be closely linked.
2. More progress was made in the selection for increased flower production in certain cultivars than in others.
3. A reduction in flower production per se does not necessarily lead to a decrease in yield, since the peanut plant produces excessive flowers. However, a reduction in flower production accompanied by a change in the partitioning of assimilates between vegetative and reproductive growth reduce yield.
4. The observation of flowers on the main stems of Florigiant and VA 81B (virginia market-type peanuts) indicates that they received the genes controlling this trait from either the spanish or valencia type parents involved in their crosses and should not be classified as _A_. _hypogaea_ subsp. _hypogaea_ var. _hypogaea_.

5. The breeding methods used in developing the 14 peanut cultivars studied (pure line vs. hybridization) did not significantly affect any of the vegetative and reproductive traits except seed weight and FT.
6. Improvement in total plant dry weight of the five more recent cultivars over the five oldest cultivars reflects an increase in reproductive rather than vegetative production.
7. The growth habit of the 14 cultivars was the most significant factor affecting differences observed among all traits.
8. Although the best single measure of reproductive efficiency is Harvest Index, it alone may not be adequate for choosing the most biological efficient cultivars.
9. The ideal genotype appears to be an early maturing, erect type with a high HI and high RE by at least one other method.
10. Plant breeders have apparently increased yield in peanuts by (a) increasing the total number of flowers, (b) increasing the HI and/or (c) increasing RE by increasing the proportion of flowers that form mature pods. Any further increase in yield would have to occur through improvement in a combination of

these methods and also any other yield limiting factors such as photosynthesis.

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A COMPARATIVE ANALYSIS OF THE REPRODUCTIVE EFFICIENCY OF 14 VIRGINIA MARKET TYPE PEANUT CULTIVARS (ARACHIS HYPOGAEA L.)

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(ABSTRACT)

There is inadequate basic information available on the reproductive efficiency of peanut (Arachis hypogaea L.) cultivars and a need to determine the sources of yield improvement made in peanut over the past four decades. Therefore, a study of the reproductive efficiency (RE) of 14 virginia market-type peanut cultivars was conducted using field experiments at the Tidewater Research Center, Suffolk, Virginia, in 1983 and 1984.

The 14 cultivars vary in maturity from early to late, in release dates from 1944-1981, in breeding method of development from selection within an existing cultivar to hybridization followed by selection, and in growth habit from erect to spreading. The traits studied included flower total (FT), mature pod total (MPT), seed total (ST), pod total (PDT), peg total (PGT), immature pod total (IMPDT), mature pod dry weight (MPDW), plant dry weight (PLDW), vine weight (VW) and seed weight (SW). The five methods used to measure RE were (1) MPDW/PLDW (Harvest Index), (2) MPT/FT, (3) PDT/FT, (4) PGT + PDT/FT and (5) ST/(2*FT).

The results indicate that the five most recently released cultivars produced more plowers, 10% more mature pods, 9.7% more mature seeds, and 11% more plant dry weight than the nine previously released cultivars. Using Harvest Index (HI) there was a 4% increase in RE for more recent vs. older cultivars, and about an 8% higher RE for early maturing vs. later maturing cultivars. Also, there was a 3% increase in RE for erect vs. spreading cultivars and a similar advantage for hybrids vs. pure lines. A slight decrease in RE for cultivars released since 1970 vs. those released earlier was observed using Methods 2, 3, 4 and 5. In addition, there was a 4-10% advantage in RE for the two earlier maturing classes over the medium or late classes using the same methods and also a 6% increase in RE for erect vs. spreading cultivars. The growth habit of the 14 cultivars was a very important determining factor for all trait differences. HI appears to be the single best measure of RE in peanuts; however, at least one other method should also be used for obtaining the truest estimate of the RE of a cultivar. It appears that the total peanut cultivar is early maturing and erect with a high RE.

This study shows that plant breeders have apparently increased yield in peanuts by (a) increasing the total number of flowers, (b) increasing the HI and (c) increasing reproductive efficiency by increasing the proportion of flowers that form mature pods. Any further increase in yield must combine these three methods of increasing yield as well as overcoming any limiting factors, such as photosynthetic capacity, in order to surpass the present yield plateau.