PEANUT SCIENCE

VOLUME 13 | JANUARY - JUNE, 1986 | NUMBER 1

End-of-Row Effects on Peanut Yield Tests[1]

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ABSTRACT

Peanut (*Arachis hypogaea* L.) yield test plots are often trimmed to standard row lengths early in the growing season. This might bias selection if cultivars differ in end-of-row effects. Terminal, sub-terminal, and center row sections of 2-row plots 5 m in length were harvested separately to ascertain relative end-of-row competition effects. Data were collected on two cultivars each of spanish, runner, and virginia market types from irrigated and non-irrigated yield tests at each of two locations for two years. Significant end-of-row effects were observed for all cultivars with the greater effect on the virginia and runner cultivars in non-irrigated tests. Row section x location, irrigation, and market type interactions were significant ($P = .0001$) but the cultivar within market type x row section interaction was not significant ($P = .05$) when averaged over tests. Yield component analyses from two tests indicated that higher unit area yields of terminal compared to center row segments resulted from increased pod numbers. Pod and 100-seed weight of mature, two-segmented pods from terminal row sections were less than for center-of-row sections. Disproportionate end-of-row effects among the cultivars on total row yield were not sufficient in this test to cause significant selection misclassifications, if comparisons are made within spanish and virginia botanical types.

Key Words: *Arachis hypogaea*, groundnut, competition, yield trials, end-trimming.

Effects of competition on crop performance and evaluation have been long recognized (2, 3, 6). Efficient utilization of plant aggressiveness to enhance yield or stability through mixtures and inter-cropping (4, 5), and reduction of error from competition in evaluation and selection have been major research concerns (1, 3, 7). Procedures for reducing error from competition effects include utilization of border rows, grouping genotypes of common maturity and plant size for comparative evaluations, and row end-trimming (1, 2, 3, 6, 7).

Indeterminate growth and subterranean fruit production in peanut, *Arachis hypogaea* L., makes maturity classifications more difficult than for many other crops. Successful classification of selections into maturity groups in peanut breeding programs is often delayed until early filial generations have passed and reasonable homogeneity within lines has been achieved. This results in preliminary yield evaluation in populations that are not grouped for growth duration. In addition, estimates of relative performance of peanut cultivars differing in duration of growth, market type, growth habit, and other traits are useful for management decisions.

Experimental procedures vary for the management of end-of-row effects: no row length adjustment following planting; adjustments to uniform plot length during juvenile growth stage; removal of terminal plants just prior to digging; and removal of 0.25 m or more from row ends immediately prior to digging. Row trimming at maturity is laborious and expensive, particularly when excess vines must be removed from the field to prevent contamination of genotypes or wildlife predation. Nevertheless, experimental bias that leads to erroneous decisions must be diminished insofar as practical. The purpose of this research was to 1) quantify end-of-row effects under our experimental conditions, 2) evaluate the importance of end-of-row effects as a source of error in selection within and among peanut market types in experiments with two-row plots approximately 5 m in length, and 3) ascertain whether labor costs and time demands during the harvest season can be reduced by elimination of pre-digging row length adjustment and vine removal.

Materials and Methods

Row segments were harvested from border or center rows of 4-row non-irrigated and irrigated tests near Bryan and Stephenville, Texas, respectively, in 1979 and 1981. Data were taken for six cultivars representing three market types: Florunner and Tifrun (runner), Florigiant and Early Bunch (virginia), and Starr and Tamnut 74 (spanish). Starr and Tamnut 74 are early maturing, typical spanish cultivars. Florunner, Tifrun, and Florigiant are spreading in growth habit, approximately equal in growth duration, and commonly attain maximal maturation three to four weeks later than the spanish cultivars. Early Bunch has a spreading bunch vine with maturity intermediate between the other two groups. All cultivars are adapted to the test areas and most have been grown commercially in the state. Rows in the four-replicate tests were spaced one meter apart in the Bryan test and 0.92 m at Stephenville. Alleys between ranges (tiers) of 2.4 m minimum width were fallowed throughout the growing season. Planting rates for the spanish and virginia botantical types, respectively, were 21 and 15 seeds/m for irrigated, and 17 and 15 seeds/m, for non-irrigated tests. Recommended cultural management

[1]Contribution from the Texas Agric. Exp. Stn., Texas A&M Univ., College Station, TA No. 20764. Partial support provided by the Texas Peanut Producers Board, Gorman, TX.

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practices for irrigated and non-irrigated production were followed.

Terminal (section 3) and sub-terminal (section 2) row segments each 46 cm in length, beginning at the base of the main stem of the end plant, and the remaining center row portions (sections 1) of border (at Bryan) or center rows (at Stephenville) of 4-row plots were dug and bagged separately. Vines with pods were artificially dried and threshed. Pods were processed for yield determinations. Center row section lengths varied slightly, because the Stephenville tests were pre-trimmed during the seedling stage to 4.6 m row lengths whereas the Bryan plots remained at the 5.03 m planted length until digging. All yields were mathematically adjusted to g/m of row for analyses.

Additional data were taken on two replications of the irrigated and three replications of the non-irrigated 1981 Bryan tests to ascertain the effect of end-of-row production on some components of yield. Data recorded after threshing included number of two, one, and zero-seeded ("pops") pods per 100 pods, weight of seed from two-seeded and from one-seeded pods adjusted to a weight/100 seed basis, and the weight of 100 mature two-seeded pods.

Yields were combined over location and irrigation and analyzed using the SAS Procedure ANOVA program - both by row section and combined over row sections. Total row yields were calculated by summation of pod weights for the three separate row sections divided by total row length and adjusted to a g/m² basis. Fruit characteristic data were analyzed by test because data were not collected on equal numbers of replications for the two tests. Means were compared by the Duncan's Multiple Range Test at the 5% probability level.

Results and Discussion

Individual test mean yields ranged from 251 to 493 g/m² for the irrigated and 246 to 375 g/m² for the non-irrigated. Site specific records on rainfall are not available for all tests. The 1981 non-irrigated Bryan test sustained less water stress than the other non-irrigated tests, and abundant rainfall early in the growing season caused short periods of excessive moisture in the 1981 Bryan irrigated test. Stands were good at all locations and disease control was adequate to prevent significant effect on the results. In rare situations, diseased or damaged plants at an end of a row rendered data for the end row section meaningless, so the remaining representative row segments of the plot were harvested and yield adjustments were made to provide equitable comparisons.

Mean yields are portrayed for the three market types on a g/m basis for each of the row sections (Fig. 1). Irrigation x row section and location x row section interactions were statistically significant but the interactions resulted from differences in magnitude, not reversals, of end-of-row effects. The yields shown in Fig. 1 are illustrative of mean end-of-row effects that occured over a range of environmental conditions. The spanish entries yielded less than both the runner and virginia entries for comparable row sections. Significant end-of-row effects occurred for all market classes; the most pronounced effect occurring in the terminal section (section 3) but some effect extended to the sub-terminal section (section 2). Yields of row section 3 were 68% and 58% higher than the center of row sections for the runner and spanish entries, respectively. Inability of the spanish cultivars to equal those of the runner and virginia entries in utilizing the moisture, nutrient, or other resources available at the ends of the rows for fruit production accounted for a significant (P = .0001) market type x row section interaction.

End-of-row effects for all three market types were greater in the Stephenville test than at Bryan (Table 1).

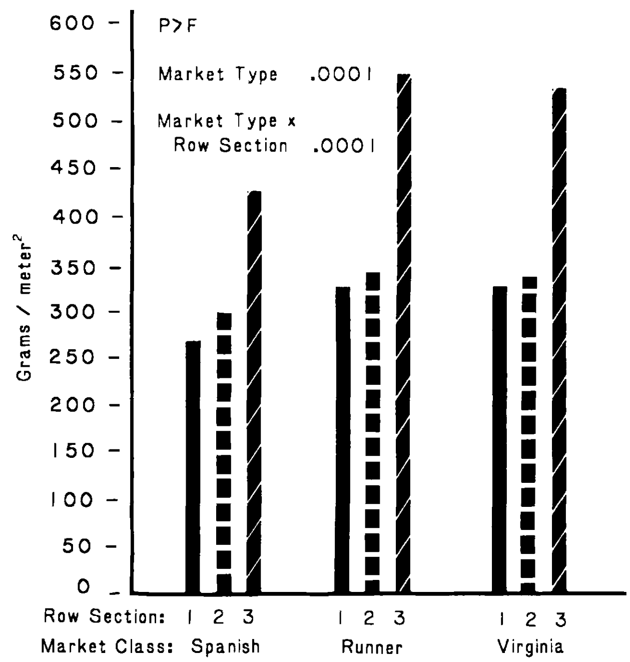

Fig. 1. Mean yield of cultivars by market class for three row sections (1 = center; 2 = sub-terminal; 3 = terminal) for two irrigated and two non-irrigated yield tests for each two years.

Minimal yield increase occurred for row section 2 compared to row section 1 at Bryan but a 10 to 18% increase was recorded at Stephenville. The unequal responses for the two locations possibly related to lower rainfall at Stephenville compared to Bryan.

Table 1. Pod yields of the terminal, sub-terminal, and total row sections as a percentage of the pod yield of the center row section (1), Bryan and Stephenville, 1979 and 1981.

Location Row Section	Market Type Spanish	 Runner	 Virginia
		%	
Bryan			
Terminal	146	155	156
Sub-terminal	104	100	102
Total Row	109	110	111
Stephenville			
Terminal	168	183	179
Sub-terminal	118	110	110
Total Row	117	119	118

Entry performance within market types differed only among the center row section when data were averaged over all test (Table 2). Tifrun yielded higher than Florunner and Early Bunch yielded more than Florigiant with full competition, but these differences did not persist for the outer row sections.

All entries responded to the increased moisture provided by irrigation, but the increase was not uniform among entries (Table 3). Starr, Tamnut 74 amd Tifrun yielded approximately one-third more under irrigated than non-irrigated management for row section 1, and the response was greater for the other entries. Less benefit from irrigation was reflected among yields of the terminal row section: numerically, the terminal section

Table 2. Pod yields by row section of six peanut cultivars grown irrigated and non-irrigated at Bryan and Stephenville, 1979 and 1981.

Cultivar	Market Type	Row Section		
		1	2	3
		g/m²		
Starr	Spanish	273	304	418
Tamnut 74	Spanish	270	304	443
Florunner	Runner	310	334	540
Tifrun	Runner	348	356	574
Early Bunch	Virginia	341	355	551
Florigiant	Virginia	316	343	550
Prob.>F				
Market Type		.0001	.0001	.0001
Cv. (Market Type)		.01	.50	.46
Cv. (Market Type) x Row Section		(.38)		

yields of Starr, Tamnut 74 and Tifrun averaged lower in the irrigated than in the non-irrigated tests. As a result, the difference in total row yield between the spanish and the other two market types was less in the non-irrigated than in the irrigated test. The greater yield potential of the later maturing cultivars was more nearly expressed under irrigation. Interestingly, the relative yields among and within market types were similar for row section 1 and total row at both moisture levels. However, the statistical significance for differences among cultivars changed from P = .01 for section 1 to P = .05 for the total row.

Table 3. Pod yields by row section of six peanut cultivars grown with and without irrigation at Bryan and Stephenville, 1979 and 1981.

Irrigation	Row Section 1/			
Cultivar	1	2	3	T.R.
	g/m²			
Non-irrigated				
Starr	235	281	433	283
Tamnut 74	235	277	453	286
Florunner	241	278	513	302
Tifrun	300	313	578	357
Florigiant	245	264	517	301
Early Bunch	280	312	513	332
Irrigated				
Starr	311	328	404	333
Tamnut 74	305	331	433	336
Florunner	379	390	567	418
Tifrun	396	399	569	430
Florigiant	387	423	584	433
Early Bunch	402	397	588	438
Prob.> F				
Irrigation	.0001	.0001	.0001	.0001
Cv. (Market Type) x Irrigation	.35	.12	.68	.34

1/ 1 = center, 2 = sub-terminal, 3 = terminal; T.R. = total row sections.

Rank orders of entries were compared for center-of-row and total plot yields for two-year means of the Stephenville irrigated and non-irrigated, and Bryan irrigated and non-irrigated test. The rankings were identical at Bryan and differed only at one position in each of the Stephenville tests. Entries ranked 5 and 6 for yield based on the center-of-row sections in the Stephenville non-irrigated tests were reversed in order when yields were based on total row length. A similar situation existed for entries ranked 3 and 4 in the Stephenville irrigated tests. In both situations the differences in yield among the two entries with altered rank were small and non-significant at either row length.

Examinations of fruit traits were made in the 1981 Bryan test to ascertain which components of yield were affected most by differences in competition. Averaged over market type, the 100-pod weight for two-segmented, mature pods decreased from row section 1 to 3, respectively (Table 4). The percentage of two-seed pods was higher in row section 1 than in section 3, but the difference was not statistically significant in the irrigated test. Seed weight was higher for row section 1 than for section 3 in both the irrigated and non-irrigated test. Results of the two tests indicate that the increase in yield for sections at the ends of the row resulted from the production of more pods. In fact, these data indicate that the increase in pod numbers for row section 3 was great enough to more than compensate for small pods and seed in section 1.

Table 4. Pod and seed characteristics by row section for six peanut cultivars grown with and without irrigation at Bryan, 1981.

Irrigation	Pod				Seed	
	Weight	Number per 100 with			Weight (g/100) from:	
Row Section	g/100[1]	2-seed	1-seed	0-seed	2-seed pods	1-seed pods
Non-irrigated						
Center	128 a*	80 a	18 a	2 a	55 a	52 a
Sub-terminal	124 b	77 ab	20 a	3 ab	54 a	51 a
Terminal	120 c	76 b	21 a	4 b	51 b	50 a
Irrigated						
Center	130 a	71 a	28 a	2 a	59 a	60 a
Sub-terminal	125 ab	69 a	29 a	1 a	57 b	58 a
Terminal	124 b	68 a	30 a	2 a	56 b	57 a

* Values within columns and irrigation levels bordered by the same letter are not different (P = .05), Duncan's Multiple Range Test.

[1] mature, two-segment pods.

These data indicate that end-of-row effects on plots approximately five meters in length with fallowed alleys inflate yields over that of adequately end-trimmed plots. The end-of-row effect may extend for more than 46 cm into the plot. The end-of-row effect was greater on plots with moisture stress and all cultivars did not respond equally to the reduced competition at the end of the row. In general, the end-of-row effects on yield were greater for the runner and virginia market types than for the spanish. This would tend to amplify the yield advantage of virginia botanical type entries over spanish in tests where cultivars of both types are being compared. Disproportionate differences in yield increase of the terminal over the center section for Florunner (213%) compared to Tifrun (193%) in the dryland test might cause some concern about within market type effects on yield comparisons. However, the non-significant entry (market types) x row section interaction, and the very slight differences in rank for row section 1 and total row yields indicate that little error in selection for yield would have resulted from end-of-row effects if the total row yields were used as the criterion for decision. We would expect that the end-of-row effects and risk of error would be greater in smaller plots and less in larger plots.

The effect of reduced competition on fruit traits was partially unexpected. Higher pod numbers on plants at the ends of rows or adjacent to skips are commonly observed, especially if moisture stress has occurred. The decrease in 100 seed weight for plants in the terminal row segment was not expected *a priori*, although it should not have been surprising in retrospect. The effect of these smaller seed on grade factors in plots of the size used in this study is assumed negligible.

These data indicate that pre-harvest end-of-row trimming of peanut plots 5 m in length can reduce error in yield comparison, especially if available moisture is limited. However, peanut researchers have severe time constraints late in the growing season, especially at digging time when observations on fruiting characteristics, disease, and other measures of the pods and roots must be made. The results of this study suggest that major selection error from end-of-row effects is not likely, especially if comparisons are on genotypes of the same market type. The effect on genotypes differing greatly in growth duration within market types is uncertain. Differences in growth duration of the spanish and the other cultivars was confounded within market type in this study. Based upon the precision required, plot size, and environment encountered, each researcher must decide whether the increase in precision from late season end-trimming in comparative yield evaluations justifies the expense and time required for the task.

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Accepted November 23, 1985