The Effect of Three Digging Dates on Oil Quality, Yield, and Grade of Five Peanut Genotypes Grown Without Leafspot Control[1]

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ABSTRACT

Five peanut (*Arachis hypogaea* L.) genotypes, Southern Runner, Dixie Runner, Florunner, UF82206, and UF714021, were grown for three years, 1982-1984, near Gainesville, Florida without fungicide applications. Three digging dates, averaging 105 days after planting (DAP), 118 DAP, and 132 DAP, were used each year to determine the effects of early harvest as a management practice for peanut production under leafspot pressure. The different digging dates had no effect on fatty acid composition of the five genotypes, and had only minimal effect on the oil content and iodine value. The largest oil quality differences in this study were due to differences among genotypes and year-to-year variation.

The earliest digging date tended to reduce market grade characters, but major pod yield differences were the result of genotype x digging date interactions. Genotypes with little or no resistance to leafspot diseases, such as Florunner and UF 714021, produced nearly 3000 kg/ha without leafspot control up to 118 DAP and then had sharp yield decreases, while resistant genotypes such as Southern Runner and UF 82206 continued to produce pod yields of 3000 kg/ha or higher up to 132 DAP.

Key Words: Leafspot resistance, market grade factors, digging dates, fatty acids.

Early digging of peanuts can be a beneficial production practice when disease pressure is severe. Studies of different digging dates on peanut production and quality have generally used fungicide treatments for leafspot control. Mixon and Branch (3) found yield losses with a corresponding decrease in market grade characteristics such as extra large kernels, sound mature kernels, kernel weight and shelling percentage when Florunner or Pronto peanuts grown in Georgia were dug earlier than 110 days after planting (DAP).

Young *et al.* (7) grew eight different peanut cultivars in Oklahoma for one year to assess effects of digging date

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on oil quality. They dug at five different digging dates, starting with 113 DAP for early maturing and 120 DAP for later maturing genotypes. Digging delays tended to give peanut oil with higher stearic and oleic acid and less linoleic acid. This relationship gave higher oleic/linoleic acid ratios in later diggings, indicating that the oil from these diggings would be more stable.

Mozingo and Steele (4) grew six genotypes in Virginia and North Carolina over a two year period and found that fatty acid composition varied more as a result of year, location, and genotype differences than from digging date differences.

Court *et al.* (1) utilized five successive digging dates in Ontario ranging from 113 to 151 DAP over two years to examine differences in two genotypes. They found that delayed digging increased yield, sound mature kernels, shelling percentage, and oil content. The later digging dates produced seed with a higher proportion of oleic acid, while most other oil quality factors measured showed only slight differences due to harvest date. Cultivar and year differences tended to be as large or larger than digging date differences for most characteristics studied.

Little information is available on the effects of digging date when foliar diseases, particularly the cercospora leafspots (*Cercospora arachidicola* (Hori) and *Cercosporidium personatum* (Berk. and Curt.) Deighton), have not been controlled. The purpose of this study was to examine the effects of early digging on five peanut genotypes grown without leafspot control. Traits studied included various parameters of oil quality, market quality, and pod yield.

Materials and Methods

Three cultivars, Dixie Dunner, Florunner, and Southern Runner, along with two breeding lines, UF 82206 and UF 714021, were grown for three years (1982-1984) at the University of Florida Green Acres Agronomy Farm near Gainesville. Standard cultural practices followed recommendations of the University of Florida Cooperative Extension Service, with the exception of fungicide applications, which were omitted. Tests were grown under irrigated conditions and were planted near May 21 in each year of the study. Plots consisted of 2 rows 6.1 m long and 90 cm apart. Each entry was replicated three times for each of three digging dates, which averaged 105, 118, and 132 days after planting (DAP). For ease of digging, replications were nested within digging dates.

Pod yields were calculated on an 8% moisture basis for each replication. The first two replications were graded according to USDA procedures for peanuts. Grading information obtained included percentage of total sound mature kernels (TSMK), which was the sum of sound mature whole seed and splits riding on 0.6 x 2.54 cm screen, extra large kernels (ELK) that rode a 0.85 x 2.54 cm screen, other kernels (OK) that pass through the 0.6 x 2.54 cm screen, shelling percentage and weight in grams of 100 sound mature seed.

Oil quality analyses were made on sound mature seed from the same two replications by Dr. C. T. Young, Food Science Department, North Carolina State University, Raleigh, following procedures by Metcalf, *et al.* (2). Analyses included determination of the 16:0, 18:0, 18:1, 18:2, 20:0, 20:1, 22:0, and 24:0 fatty acid contents as well as the total oil content, iodine value, oleic/linoleic ratio, polyunsaturated/saturated fatty acid ratio (p/s) and the sum of the four long chain fatty acids. Data will not be presented for the 20:1, 22:0, 24:0 fatty acids, the p/s ratio or the long chain fatty acid sum, as these characters showed the same response pattern as other oil quality factors.

Data were examined through the use of an analysis of variance for each trait, using harvest dates as main plots, reps nested within digging dates, and genotypes as subplots. Years and digging dates were considered as fixed effects. Analysis indicated no data transformations were necessary.

Results and Discussion

Effects of Digging Dates

There were significant differences among genotypes for palmitic, linoleic, oleic, stearic and arachidic acid content. However, the characteristic fatty acid composition of each of the genotypes remained the same regardless of the digging date (Tables 1 and 2). This is different

Table 1. Fatty acid content in the oil of five peanut genotypes harvested at three digging dates, averaged over three years (1982-1984).

Palmitic acid (16:0)	Digging date (DAP) 105	118	132	Average
Genotype	%			
Southern Runner	10.2a	10.1a	10.1a	10.1a
UF 82206	8.9c	8.8c	8.8c	8.9c
UF 714021	8.6d	8.4d	8.4d	8.4d
Dixie Runner	9.4b	9.3b	9.3b	9.3b
Florunner	10.3a	10.2a	10.2a	10.2a
Average	9.5	9.4	9.4	

Linoleic acid (18:2)	Digging date (DAP) 105	118	132	Average
Genotype	%			
Southern Runner	25.4b	25.8b	25.5b	25.6c
UF 82206	20.9d	20.9d	21.0d	20.9e
UF 714021	22.1c	22.9c	23.5c	22.9d
Dixie Runner	27.3a	27.7a	27.5a	27.5b
Florunner	28.1a	28.1a	28.3a	28.2a
Average	24.7	25.1	25.2	

Oleic acid (18:1)	Digging date (DAP) 105	118	132	Average
Genotype	%			
Southern Runner	53.1b	53.2b	53.4b	53.3b
UF 82206	58.1a	57.9a	58.0a	58.0a
UF 714021	59.0a	58.5a	57.3a	58.2a
Dixie Runner	53.4b	53.0bc	52.9b	53.1b
Florunner	51.7c	52.1c	51.4c	51.7c
Average	55.0	55.0	54.6	

Differences among digging dates were not significant. Genotype means within digging dates or genotype averages followed by the same letter are not significantly different at the 5% level according to DMRT.

Table 2. Stearic and arachidic acid contents and oleic to linoleic acid ratio of five peanut genotypes harvested at three digging dates, averaged over three years (1982-1984).

Stearic acid (18:0)	Digging date (DAP) 105	118	132	Average
Genotype	%			
Southern Runner	2.6c	2.6c	2.6b	2.6c
UF 82206	3.4a	3.3a	3.3a	3.4a
UF 714021	3.1b	3.0b	3.3a	3.1b
Dixie Runner	2.3d	2.4d	2.4b	2.4d
Florunner	2.2d	2.3d	2.4b	2.3d
Average	2.7	2.7	2.8	

Arachidic acid (20:0)	Digging date (DAP) 105	118	132	Average
Genotype	%			
Southern Runner	1.4b	1.3b	1.3b	1.4b
UF 82206	1.6a	1.6a	1.5a	1.6a
UF 714021	1.4b	1.4b	1.5a	1.4b
Dixie Runner	1.2c	1.2c	1.3b	1.2c
Florunner	1.2c	1.2c	1.2c	1.2c
Average	1.4	1.3	1.4	

Oleic/Linoleic	Digging date (DAP) 105	118	132	Average
Genotype	%			
Southern Runner	2.13c	2.08c	2.11c	2.11c
UF 82206	2.85a	2.79a	2.79a	2.81a
UF 714021	2.69b	2.59b	2.47b	2.58b
Dixie Runner	1.97d	1.93d	1.94d	1.95d
Florunner	1.86d	1.86d	1.83d	1.85e
Average	2.30	2.25	2.23	

Digging date differences were not significant. Genotype means within digging dates or genotype averages followed by the same letter are not significantly different at the 5% level according to DMRT.

than the results obtained by Mozingo and Steele (4), Court *et al.* (1) and Young *et al.* (7). Slack and Browse (6) have pointed out that fatty acid composition changes occur as oilseeds mature, but that for most oil seeds the timing of these changes is not known. They also point out that temperature differences can affect fatty acid composition, especially through a change in the activity of oleate desaturase, the enzyme responsible for the proportion of oleic to linoleic acid. It is difficult to separate the effects of temperature and the effects of maturity, but evidence on grading data, which will be given later in this paper, suggests that the peanuts in this study were not mature at the first digging (105 DAP). Since the previous reports also indicated the peanuts were not totally mature at the early diggings, the different results of this study may, in fact, be due to temperature differences between locations. Warm temperatures continue into at least the middle of September in north central Florida, while temperatures may be decreasing in the other locations where studies were carried out. This may account for the consistency of fatty acid compositions in the Florida study and the changes observed in the research from other locations.

The average oil content of the five genotypes was significantly greater at the first digging date than at the subsequent two digging dates (Table 3). Although the proportion of oil fell from 49.1% for the first digging date to 48.0% for the second digging date, the total production of oil was still higher for the second digging date because of the higher yields at that time.

Table 3. Oil content and iodine value of five peanut genotypes harvested at three digging dates, averaged over three years (1982-1984).

Oil content	Digging date (DAP) 105	118	132	Average
Genotype		%		
Southern Runner	49.0a	49.0a	49.0a	49.0a
UF82206	50.1a	48.7a	49.5a	49.4a
UF714021	48.1a	47.4a	46.5b	47.3b
Dixie Runner	49.1a	47.9a	48.0ab	48.2ab
Florunner	48.9a	46.8a	46.7b	47.5b
Average	49.1	48.0	47.8	

LSD (0.05) for digging date averages = 0.8 and for comparisons of the same or different genotypes at different digging dates = 2.0.

Iodine value	Digging date (DAP) 105	118	132	Average
Genotype				
Southern Runner	90.7b	91.4b	91.3b	91.1b
UF82206	87.0d	87.1c	87.3c	87.1c
UF714021	89.9c	91.0b	91.1b	90.7b
Dixie Runner	94.2a	94.6a	94.3a	94.4a
Florunner	94.2a	94.5a	94.3a	94.3a
Average	91.2	91.7	91.6	

LSD (0.05) for digging date averages = 0.4.

Values within digging dates or genotype averages followed by the same letter are not significantly different at the 5% level according to DMRT.

The iodine value was lowest at the first digging date, although the differences among digging dates were slight (Table 3). This relationship is consistent with the lack of fatty acid composition differences among digging dates. Thus, oil quality is essentially the same at the three digging dates studied when peanuts are grown without leafspot control.

Agronomic performance was affected much more dramatically when leafspot was not controlled. Pod yields for five of the genotypes were greater at 118 DAP than at 105 DAP, (Table 4) although the increase was significant only for UF 82206. Beyond that date, pod yields for genotypes without leafspot disease resistance dropped as much as 1670 kg/ha for UF 714021. Southern Runner produced approximately the same yields at 118 and 132 DAP (2869 and 2801 kg/ha, respectively).

Table 4. Pod yield and market grade factors of five peanut genotypes harvested at three digging dates, averaged over three years (1982-1984).

Pod yield	Digging date (DAP) 105	118	132	Average
Genotype		kg/ha		
Southern Runner	2177b	2869a	2801b	2616b
UF82206	2141b	3022a	3203a	2789a
UF714021	2887a	2909a	1238d	2345c
Dixie Runner	1843c	2516b	2105c	2155d
Florunner	2828a	2828a	1364d	2340c
Average	2375	2829	2142	

LSD (0.05) for comparisons of the same or different genotypes at different digging dates = 809.

Shelling percentage	Digging date (DAP) 105	118	132	Average
Genotype		%		
Southern Runner	72.8b	78.3b	80.7b	77.3b
UF82206	64.0e	71.2e	75.4d	70.2e
UF714021	69.0d	72.2d	74.8d	72.0d
Dixie Runner	70.3c	74.9c	77.5c	74.2c
Florunner	79.8a	82.0a	82.8a	81.5a
Average	71.2	75.7	78.2	

LSD (0.05) for digging date averages or for comparisons of the same or different genotypes at different digging dates = 2.2.

Total sound mature kernels	Digging date (DAP) 105	118	132	Average
Genotype		%		
Southern Runner	58.2c	75.0b	77.8a	70.4b
UF82206	49.9d	65.9d	73.3b	63.0c
UF714021	66.9b	70.3c	71.3b	69.5b
Dixie Runner	47.3d	64.5d	67.7c	59.8d
Florunner	74.6a	79.6a	79.2a	77.8a
Average	59.4	71.1	73.9	

LSD (0.05) for digging date averages = 6.9, and for comparisons of the same or different genotypes at different digging dates = 7.4.

Values within digging dates or genotypic averages followed by the same letter are not significantly different at the 5% level according to DMRT.

Shelling percentages were higher at each subsequent digging date for all genotypes except Florunner, which showed a nonsignificant difference between the second and third digging dates (Table 4). Overall the shelling percentage increased from 71.2% for the first digging date to 78.2 for the third digging date.

The proportion of total sound mature kernels (TSMK) increased from 59.4% for 105 DAP to 71.1% for 118 DAP (Table 4). While the differences between these digging dates for Florunner and UF 714021 were not significant, the proportion of TSMK for the other three genotypes in this study improved dramatically when digging was delayed until at least 118 DAP. Further delay to 132 DAP did not significantly improve the proportion of TSMK, except for UF 82206.

The kernel weight of all genotypes except Dixie Runner increased from the first to second digging date (Table 5). However, only UF 82206 produced larger kernels at the 132 DAP digging.

The kernel weight trends are reflected in the digging date effects on the proportion of extra large kernels (ELK) shown in Table 5. Digging date did not affect the ELK proportions for Dixie Runner or Florunner, but UF 714021 improved from 25.9% to 36.6% ELK by a

Table 5. Market grade characteristics of five peanut genotypes harvested at three digging dates, averaged over three years (1982-1984).

100-seed (SMK) weight	Digging date (DAP) 105	118	132	Average
Genotype	g/100 seed			
Southern Runner	45.9c	50.6d	53.1c	49.9d
UF 82206	52.4b	59.0b	64.4b	58.9b
UF 714021	75.9a	80.8a	80.3a	79.0a
Dixie Runner	38.5d	40.0e	39.7d	39.4e
Florunner	50.6b	55.0c	52.4c	52.7c
Average	52.6	57.1	58.0	

LSD (0.05) for digging date averages = 3.3 and for comparisons of the same or different genotypes at different digging dates = 3.7.

Extra large kernels	Digging date (DAP) 105	118	132	Average
Genotype	%			
Southern Runner	7.8b	12.4c	17.3b	12.5c
UF 82206	11.1b	19.2b	30.5a	20.3b
UF 714021	25.9a	36.6a	32.5a	31.7a
Dixie Runner	1.1c	2.7d	3.1d	2.3d
Florunner	10.8b	15.2c	13.0c	13.0c
Average	11.3	17.2	19.3	

LSD (0.05) for digging date means = 5.9 and for comparisons of the same or different genotypes at different digging dates = 6.7

Other kernels	Digging date (DAP) 105	118	132	Average
Genotype	%			
Southern Runner	14.5b	4.2bc	2.7b	7.1b
UF 82206	13.9b	5.0b	1.9b	6.9b
UF 714021	1.8d	1.5d	1.2b	1.5d
Dixie Runner	22.8a	10.3a	9.6a	14.2a
Florunner	5.0c	2.2cd	3.2b	3.5c
Average	11.6	4.6	3.7	

LSD (0.05) for digging date means = 4.7 and for comparisons of the same or different genotypes at different digging dates = 5.2

For all characters, values within digging dates or genotype averages followed by the same letter are not significantly different at the 5% level according to DMRT.

delay in digging to 118 DAP. UF 82206 benefited from each delay in digging date, reaching a total of 30.5% ELK at the third harvest. The 17.3% ELK at 132 DAP for Southern Runner was significantly greater than the proportion at the first digging date.

The proportion of other kernels decreased from 11.6% to 4.6% from first to second digging date, but only decreased to 3.7% for the third digging date (Table 5).

Effects of genotypes

Significant genetic differences existed for all characteristics examined in this study. The two breeding lines, UF 714021 and UF 82206, had the highest oleic acid and lowest linoleic acid at all three digging dates (Table 1). Florunner consistently had the lowest oleic acid content (averaging 51.7%) and the highest linoleic acid (averaging 28.2%) for all three digging dates. Genotypic differences for palmitic acid contents also remained the same at the different digging dates.

UF 82206 consistently had the highest proportion of stearic and arachidic acids (Table 2) at all digging dates, but the differences among genotypes for these acids and for the other fatty acids not reported were a minor factor in the total fatty acid composition of the lines.

Iodine values largely reflected the differences seen for oleic and linoleic acids, and ranged from 94.4% for Dixie Runner and 94.3% for Florunner to 87.1% for UF 82206 (Table 3). The oil content differed among the genotypes used in this study, although the differences were minor, ranging from 47.3% for UF 714021 to 49.4% for UF 82206.

Pod yield differences among genotypes depended on digging date (Table 4). The complex interaction of genotype with digging date largely reflects the amount of leafspot resistance present in the different lines. Overall, UF 82206 gave the highest yields, averaging 2789 kg/ha, and Dixie Runner produced the least (2155 kg/ha). While the latter genotype was consistently the lowest yielding for each of the digging dates, UF 714021 and Florunner produced relatively high yields at the first two digging dates and then dropped off dramatically at the third digging date. Although neither of these lines have appreciable leafspot resistance, both produced satisfactory yields if dug at 118 DAP or earlier. Southern Runner and UF 82206 are both leafspot resistant, late maturing lines. The late maturity is obvious when Table 5 is examined. These two genotypes produced nearly 15% other kernels when dug at 105 DAP, but this figure fell to 5% or less at 118 DAP. The proportion continued to fall at the third digging date, but the differences between the last two digging dates were not significant since there was a great deal of variation in this trait, resulting in a large error variance.

Each of the two resistant genotypes produced its lowest yield at the first digging date. Yields of UF 82206 increased from the first to the second and from the second to the third digging date. Pixley (4) has shown that the maximum yield for this genotype may not even be reached at 150 DAP.

Shelling percentages (Table 4) were highest for Florunner (81.5%, on the average) and lowest for UF 82206 (averaging 70.2%). Florunner was least affected by digging date and UF 82206 gave the greatest response to delayed digging.

The proportion of total sound mature kernels (TSMK) was highest for Florunner at all thre digging dates (Table 4), averaging 77.8%. Southern Runner, UF 82206 and Dixie Runner produced a significantly higher proportion of sound mature kernels at the second digging date compared to the first. Neither Florunner nor UF 714021 had a change in sound mature kernels with the different digging dates, and only UF 82206 improved when digging was delayed from 118 DAP to 132 DAP.

Genetic differences were expected for the proportion of extra large kernels, since different market types of peanuts were used. Both Southern Runner and UF 82206 produced more extra large kernels as digging was delayed, with UF 82206 increasing from 19.2% to 30.5% between the second and third digging dates (Table 5). The highest proportion of extra large kernels was 36.6%, produced by UF 714021 at the second harvest date.

The weight of 100 sound mature kernels followed the same pattern as did extra large kernels (Table 5). All genotypes improved from first to second digging dates, while only UF 82206 produced significantly larger seeds at the third digging date.

Effects of years

Oil quality varied considerably from year to year, with all traits but oil content showing significant differences among years. Some of the variation was great, such as the range of oleic acid from 52.4% to 57.3%, or linoleic acid range from 23.0% to 27.5%. Iodine values ranged almost four points, from 90.0 the first year of the study to 93.8 the third year.

Table 6. Year averages for the oil quality and agronomic performance of five peanut genotypes harvested at three digging dates, 105, 118 and 132 days after planting.

	Oil quality trait							
	16:0	18:0	18:1	18:2	20:0	Oil Content	O/L	Iodine Value
Year	%							
1982	9.2b	3.0a	57.3a	23.0c	1.4a	47.9	2.57a	90.0c
1983	9.5a	3.0a	54.9b	24.6b	1.4a	48.5	2.27b	90.8b
1984	9.5a	2.3b	52.4c	27.5a	1.2b	48.4	1.95c	93.8a

	Agronomic trait					
	Pod yield	Wt 100 SMK	TSMK	ELK	OK	Meats
	kg/ha	g	%			
Year						
1982	2549b	57.2	71.3a	35.5	8.3a	75.6a
1983	1734c	54.5	65.1b	30.9	15.9b	73.3b
1984	3064a	56.0	67.9ab	29.3	15.7b	76.2a

Means for each character are not significantly different at the 5% level if followed by the same letter, according to DMRT.

Differences also existed among years for the agronomic traits in this study, especially yield. From 1983 to 1984 there was a 1330 kg/ha yield increase. In this study the differences are due, not only to climatological differences, but also to a possible difference in the leafspot pressure from year to year.

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Literature Cited

1. Court, W. A., R. C. Roy and J. G. Hendel, 1984. Effect of harvest date on agronomic and chemical characteristics of Ontario peanuts. Can. J. Plant Sci. 64:521-528.
2. Metcalf, L. D., A. A. Schmitz and J. K. Pelka. 1966. Rapid preparation of fatty acid esters from lipids for gas chromatographic analysis. Anal. Chem. 38:514-515.
3. Mixon, A. C. and W. D. Branch, 1985. Agronomic performance of a spanish and runner cultivar harvested at six different digging intervals. Peanut Sci. 12:50-54.
4. Mozingo, R. W. and J. L. Steele, 1982. Fatty acid composition of peanut genotypes in the Virginia-Carolina production area. Proc. Am. Peanut Res. Ed. Soc. 14:29-39.
5. Pixley, K. V. 1984. Physiological and epidemiological characteristics of leafspot resistance in four peanut genotypes. M. S. Thesis. University of Florida, Gainesville. 76 pp.
6. Slack, C. R. and J. A. Browse, 1984. Synthetis of storage lipids in developing seeds. Chapter 6, pp. 209-244 *In D. R. Murray*, (ed.). Seed Physiology, Vol. 1, Development. Academic Press Australia.
7. Young, C. T., M. E. Mason, R. S. Matlock and G. R. Waller, 1972. Effect of maturity on the fatty acid composition of eight varieties of peanuts grown at Perkins, Oklahoma in 1968. J. Am. Oil Chem. Soc. 49:314-317.

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