Irrigation and Tillage Effects on Peanut Yield in Virginia[1]

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ABSTRACT

During crop years 1980-1983, a field study was conducted in southeastern Virginia on a Norfolk loamy fine sand soil to evaluate the effect of irrigation, underrow ripping, and seedbed preparation methods on peanut yields. The seedbeds were prepared conventionally (flat), with a rotary tiller and bed shaper, with a disk bedder, and with a rolling cultivator. Irrigation increased peanut yield only for crop year 1980 peanuts when there was a severe drought. Irrigation decreased yields for the other 3 years when rainfall was near normal. Some of the decrease in yields with irrigation can be attributed to an increase in the severity of several diseases including leafspot, pod rot, and Sclerotinia blight.

Underrow ripping and seedbed preparation methods had no significant effect on yield and crop values. The effect of an interaction between underrow ripping and irrigation was indicated. Results from this study and previous studies indicated that underrow ripping does not appear to be an advantageous tillage operation for use in peanut production systems in the Virginia-Carolina area. Comparisons of seedbed preparation methods do not suggest that one method was superior to another method. The inconsistent trends in seedbed methods between years can be attributed to elements other than irrigation or underrow ripping treatments. Further studies need to define irrigation methods and amount of irrigation water to apply for efficient peanut production.

Key Words: *Arachis hypogaea* , underrow ripping, seedbed preparation methods, diseases.

Irrigation throughout the southeastern United States has increased rapidly over the past six years. Water, directly or indirectly, influences crop growth and plant processes. (5). Most soils in the Coastal Plain region are coarse textured with low water-holding capacities. Under controlled soil water regimes, yield and quality tended to increase as irrigation amounts increased from 40 to 60 cm depths (17). Lack of sufficient soil moisture at a critical

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period in the plant production cycle can severely limit yields. Although the eastern United States is considered a humid region, the distribution of rainfall does not always occur in a timely manner and frequent drought periods occur covering several days to several weeks (1,6). A 2-year field study of peanut yield and quality responses to soil moisture levels showed lower maximum yields under irrigation 1 year as compared to the other year (12). Possible causes suggested were a different location and soil moisture stresses during different portions of the season.

In recent years, chiseling directly under the plant row (underrow ripping) has received considerable attention in corn (*Zea mays* L.), peanut (*Arachis hypogaea* L.), and soybean (*Glycine may* L.) production. In Virginia, yield responses (2,15,16) of several crops were shown to be closely related to soil type and soil conditions. Emporia loamy sand soils showed a favorable yield response with the highest corn yields obtained where moisture stress was not a factor during the critical part of the growing season. One study at several locations in Virginia (20) showed a slight adverse effect on peanut yields when underrow ripping was used.

Generally, peanut is grown in a peanut-corn rotation (4). The soil is moldboard plowed in the spring and disked two to three times to prepare a level seedbed before planting. Pesticides are incorporated during the disking operations or with a rotary tiller during planting. Various methods of seedbed preparation and cultivation during the growing season have shown no significant effect on peanut yields (19,20). These studies were conducted where soil moisture could not be managed with supplemental irrigation.

Some plant pathogens including *Sclerotinia minor* Jagger, causal agent of Sclerotinia blight (7,8), and *Cercospora arachidicola* Hori and *Cercosporidium personatum* (Berk. & Curt.) Deighton, the causal agents of peanut leafspot (8), and *Pythium myriotylum* Dresch., causal agent of peanut pod rot (3), occur sporadically but often cause significant economic losses under favorable environmental conditions. Disease severity is usually directly related to environmental conditions that favor the growth and proliferation of specific fungal pathogens. The most effective control measures often depend upon prophylactic methodologies in conjuction with prevailing environmental conditions which are less conducive to fungal proliferation. When supplemental water is applied, especially with sprinklers, environments may develop that are conducive to the proliferation of foliar as well as soilborne pathogens (13).

The purpose of the 4-year study reported herein was to evaluate the effect of sprinkler irrigation, underrow ripping, and seedbed preparation methods on peanut yield, and to evaluate the severity of leafspot, pod rot, and Sclerotinia blight under water management and tillage production practices. Preliminary results of this study have been published (21).

Materials and Methods

The Florigiant cultivar, a virginia-type peanut, was planted in a peanut-corn rotation near Carrsville, Virginia, in 1980-83. The soil type was described as a well-drained Norfolk loamy fine sand, classified as Typic Paleudult (fine loamy, siliceous, thermic). Fertility analyses of soil samples collected from the plow layer each year were used as a guide for applying lime. Fertilizers were applied to the corn crop (22) to maintain a fertility level adequate for the peanut crop. Field equipment commercially available to growers was used to perform all tillage operations.

A water-balance model (9), described previously by Ritchie (10,11), was used to schedule irrigation. The model utilizes plant, soil, and climatic data. Plant data needed for the model included leaf area index and stage of crop development. The upper and lower limits of plant available water within the plant root zone, soil surface condition, and soil-water transmissivity coefficients are the soil data needed for the model. Climatic data needed for the model on a daily basis (14,18) included daily maximum and minimum temperatures, daily precipitation and/or irrigation, and daily total incoming solar radiation. The model was programmed (9) to report the percent plant available water remaining in the plant root zone on a daily basis. The root zone depth used in the water balance model was 61 cm (24 in).

The irrigation equipment consisted of a Hobbs Reel Rain hose tow traveling gun. The Reel Rain was equipped with a 10 cm (4 in) I.D. hose and a Nelson P200 gun (3.7 cm ring). Operating pressure at the gun was 580 kPa (84 psi). The test plot was located in a large field surrounded by the same crop to allow the traveling gun to start beyond the plot area and return with the gun set on a quarter-circle arc. Since the irrigated test plot width was about two-thirds the radius that water was applied, uniformity of application was satisfactory over the test plot area.

Because the traveling gun restricted the manner in which water was applied, a buffer zone of 16 plant rows was provided between the nonirrigated and irrigated blocks. The tillage treatments were arranged in a split-split plot experimental design within the two irrigation blocks. Plot sizes were 15.2 m (50 ft) long by 4 rows wide (row width 0.9m). The two center rows of each plot were harvested for yield data. In 1981, data for the tillage treatments are not available since sample identity was lost during harvesting.

Tillage treatments included no ripping vs. underrow ripping, each with four methods of seedbed preparations. Seedbed preparations were made: 1) in a conventional manner (flat), 2) with a rotary tiller and 3-inch bed shaper (tiller), 3) with a disk bedder (disk), and 4) with a rolling cultivator (RC).

Tillage operations common to all tests included moldboard plowing in late March or early April. Two diskings were made prior to performing the underrow ripping and bed-forming operations. Preplant herbicides were incorporated into the flat and tiller plots by use of a rotary tiller and into the disk and rolling cultivator plots by use of a rolling cultivator.

Prior to harvest, the percentage of leaflets infected with *C. arachidicola* and *C. personatum* was determined. Ten main branches were collected at random from each plot. The number of leaflets on the uppermost eight petioles (32 leaflets) infected were counted and recorded as percentage infected. Pod rot, caused by *P. myriotylum*, was determined by hand-digging four plants from each plot, picking the pods off by hand, counting and visually scoring for evidence of rot and recorded as pod rot percentage. Sclerotinia blight, caused by *S. minor*, was determined by a disease index rating of 1 to 5 (1 = healthy plant and 5 = dead plant).

Results and Discussion

Rainfall and irrigation data (Table 1) illustrate that the need for irrigation was less in 1981, 1982, and 1983 than in 1980. For example, water applied by irrigation in 1981, 1982, 1983 was 56, 34, and 65% of that applied in 1980, respectively. The amount of water applied per application ranged from 30 mm (1.2 in) to 41 mm (1.6 in) and the number of irrigations per season ranged from 8 in 1980 to 3 in 1982. Rainfall in 1980, 1981, 1982, and 1983 were 32, 94, 100, and 76%, respectively, of the normal rainfall for the growing season. According to the water-balance model, the timeliness of rainfall and amount per rainfall event were not adequately distributed to satisfy moisture requirements of the peanut plant. Therefore, the irrigations were scheduled to supply the daily plant water

Table 1. Rainfall (R) measurements and amount of water applied by irrigation (I) during four growing seasons.

Month	Normal rainfall	Amount of rainfall or irrigation water (mm)							
		1980		1981		1982		1983	
		R	I	R	I	R	I	R	I
May	97	91 1/	0 2/	89	0	188	0	97	0
June	114	0	30	97	0	66	0	135	0
July	152	64	152	97	81	173	33	76	76
Aug	152	46	109	216	41	112	33	66	114
Sept	107	0	0	84	41	84	33	99	0
Subtotal	622	201	292	582	163	622	99	472	191
Total	622	493		744		721		663	

1/ Rainfall recorded daily.

2/ Irrigation water applied with big gun traveler.

requirements even though total rainfall for the growing season appeared to be sufficient for peanut production.

The effect of irrigation on peanut yield varied significantly between years (Table 2). In 1980, increase in yield for irrigated plots as compared to nonirrigated plots was 196%, or about 2-fold; whereas, in 1981, 1982, and 1983, the yields in the irrigated plots were 26, 29, and 8% less than those in the nonirrigated plots, respectively. High peanut yield losses, primarily attributed to plant diseases, were observed at digging time.

Table 2. Effect of sprinkler irrigation on peanut yields.

Year	Yield (kg/ha)		
	Nonirrigated	Irrigated	% Increase
1980	2289 b 1/	4483 a	196
1981	5553 a	4095 b	-26
1982	5447 a	3885 b	-29
1983	4959 a	4539 b	- 8
AV	4562	4250	- 7

1/ Treatment within a year followed by unlike letters are significantly different at the 5% level as determined by Duncan's new multiple range test.

The value per hectare for irrigated plots when compared to nonirrigated plots was similar to the response presented for the yield data. However, grade factors such as extra large kernels (ELK), sound mature kernels (SMK), and total meat content were higher for irrigated plots when compared to nonirrigated plots. The grade factors, some of which were significant, did not significantly increase the price per lb. The higher grade for peanuts from irrigated plots increased the price per lb (based on the price support schedule) by about 4% over peanuts from nonirrigated plots.

Peanut yield comparisons for the ripping tillage treatment showed no significant differences. However, there was an average increase of 1.4% in favor of underrow ripping (Table 3). An interactive effect was indicated between underrow ripping and irrigation. Although the differences were insignificant, peanut yields from underrow ripping compared to no ripping were 6.8% higher in nonirrigated plots and 3.6% lower in irrigated plots (Table 4). Previous studies on underrow ripping for peanut production have been inconsistent between locations (20). These results, along with the small average increase in yields, support little or no advantage for underrow ripping in peanut production. The lack of a significantly higher response in peanut yield to underrow ripping here and in other studies may be attributed to an increase in plant diseases.

Table 3. Effect of underrow ripping on peanut yields.

Year	Yield (kg/ha)		
	Nonripped	Ripped	% Increase
1980	3349 a 1/	3424 a	2.2
1982	4629 a	4703 a	1.6
1983	4735 a	4764 a	0.6
AV	4238	4297	1.4

1/ Treatment within a year followed by unlike letters are significantly different at the 5% level as determined by Duncan's new multiple range test.

Table 4. Interactive effect of sprinkler irrigation and underrow ripping treatments on peanut yields.

Year	Yield (kg/ha)			
	Nonirrigated		Irrigated	
	Nonripped	Ripped	Nonripped	Ripped
1980	2134 a 1/	2446 a	4564 a	4403 a
1982	5296 a	5597 a	3961 a	3809 a
1983	4848 a	5071 a	4621 a	4458 a
AV	4092	4371	4383	4222

1/ Treatment within an irrigation treatment and a year followed by unlike letters are significantly different at the 5% level as determined by Duncan's new multiple range test.

The method of seedbed preparation before planting significantly affected peanut yield in 1980 and 1982 (Table 5). The effects on yield were not consistent between years. When the peanut yields were normalized about the overall average (4267 kg/ha = 1.00) for 1980, 1982 and 1983, the variation was 3% or less between the flat, tiller, disk and rolling cultivator seedbed preparation

Table 5. Normalized effect of seedbed preparation methods on peanut yield.

Year	Seedbed type				
	Flat	Tiller	Disk	RC	AV
1980	0.84 a 1/2/	0.78 bc	0.75 c	0.80 ab	0.79
1982	1.05 b	1.08 ab	1.11 a	1.13 a	1.09
1983	1.12 a	1.08 a	1.14 a	1.11 a	1.11
AV	1.00	0.98	1.00	1.01	1.00

1/ Grand average - 4267 kg/ha = 1.00

2/ Treatment within a year followed by unlike letters are significantly different at the 5% level as determined by Duncan's new multiple range test.

methods. These results along with results from previous studies (20) under different soil types indicate that yields may vary 9% within 1 year for the four seedbed methods. However, on the average, seedbeds prepared with different types of commercially available equipment have little effect on peanut yields. Similarly, crop value for the four seedbed preparation methods varied in the same manner as peanut yield. No interactive effects were observed for peanut yields between irrigation treatment and seedbed preparation treatment, or tillage ripping treatment and seedbed preparation treatment.

Leafspot was more prevalent in irrigated plots than in nonirrigated plots (Table 6). Leaflet infection was 1.5 times greater in irrigated plots than in nonirrigated plots although fungicide applications were made during July, August, and September on a 14-day schedule.

Table 6. Effect of no irrigation (NI) and sprinkler irrigation (I) on defoliation caused by the leafspot fungi, pod rot and severity of Sclerotinia blight.

Year	Defoliation (%)1/		Pod rot (%)2/		Sclerotinia blight3/	
	NI	I	NI	I	NI	I
1980	---	---	1a	6b	1a	3b
1981	8a4/	18b	4a	13b	2a	4b
1981	36a	56b	6a	10b	2a	4b
1983	27a	30b	7a	18b	1a	2b
AV	24	35	4.5	11.5	1.5	3.3

1/ Percentage of 32 uppermost leaflets of the main branch infected with the leafspot fungi.

2/ Percentage of pods exhibiting pod rot symptoms.

3/ Disease index: 1 = healthy plant; 5 = dead plant.

4/ Treatment within a disease rating and a year followed by unlike letters are significantly different at the 5% level as determined by Duncan's new multiple range test.

Pod rot was 2.5 times more severe in irrigated plots when compared to nonirrigated plots (Table 6). The incidence of pod rot averaged slightly higher for the underrow ripping treatment when compared to the no ripping treatment. The severity of pod rot for underrow ripping and seedbed preparation methods for other locations were discussed elsewhere (20).

The disease index for Sclerotinia blight was 1.5 and 3.3 for nonirrigated and irrigated plots, respectively. In other words disease severity was 1.9 times greater in irrigated plots than in nonirrigated plots (Table 6). As the disease severity of Sclerotinia blight increased, higher peanut losses observed at digging resulted in lower yields. Where sprinkler irrigation is used in fields with a history of Sclerotinia blight, these results suggest that some precautions may need to be taken as part of the production management scheme.

Conclusions

Peanut yields were significantly increased in only 1 out of 4 years by sprinkler irrigation. This increase occurred during the severe drought year of 1980 when peanut yields were doubled by irrigation. In the other 3 years when rainfall was 76-100% of normal, irrigation reduced yields 8-29%. The tillage treatments of underrow ripping and various seedbed preparation methods had no significant effect on peanut yields and crop values. These results can probably be attributed to higher incidence of pod rot and Sclerotinia blight in the irrigated plots. Both of these soilborne diseases were more severe under irrigation. Additional research is needed to evaluate methods of irrigation and amounts of irrigation water to apply for maximum economic yields in peanut production.

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