Interaction of Tillage and Cultivars in Peanut Production Systems[1]

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ABSTRACT

Two spanish peanut cultivars (SN 55-437 and Tamnut 74), two spanish germplasm lines (TxAG-4 and TxAG-5) with partial resistance to *Pythium myriotylum* and *Sclerotinia minor*, and one early maturing runner-type cultivar (Langley) were compared for three years under nonirrigated conventional-tilled, reduced-tilled, and no-tilled culture. Yield, percentage sound mature kernels + sound splits (SMK+SS), and southern blight disease comparisons were made to ascertain if certain cultivars or genotypes would be beneficial to peanut production under reduced-tilled systems. Tillage x genotype interactions were not statistically different. When the yields and percentage SMK+SS for no-tilled entries were averaged, it was found that they were lower than the other tillage systems one out of the three years. Neither southern blight nor pod disease, caused by *Sclerotium rolfsii*, were yield-limiting factors in any of the production systems. However, genotypic differences were apparent for yield and percentage SMK+SS; TxAG-4 was consistently among the best yield performers, while the yield of SN 55-437 was consistently low. Tamnut 74 and TxAG-4 produced lower percentage SMK+SS than the other entries in two of the three years of the test.

Key Words: Sustainable agriculture, conventional-tilled, minimum-tilled, no-tilled, groundnut, *Sclerotium rolfsii*, southern blight.

Cost effective, soil and water conserving peanut tillage systems are an essential component of sustainable agriculture in peanut (*Arachis hypogaea* L.) production areas. The use of minimum-tilled or reduced-tilled practices in other crops such as corn, grain sorghum, or soybeans has reduced production cost, soil erosion and water runoff (5, 8, 9, 10, 11, 16). Unger and co-workers (17) noted that the presence of crop residue on the soil surface could nearly eliminate erosion problems. Musick *et al.* (9) reported that a heavy mulch comprised of wheat straw could increase soil water storage 6 cm during an 11-month fallow. The extra soil water could increase subsequent grain sorghum yield by 1120 kg/ha.

Peanut pod yields vary under different tillage systems. In work done earlier by Boswell and Grichar (2), no-tilled plots yielded 1000 to 1200 kg/ha less than conventional-tilled, while reduced-tilled plots were intermediate in yield. In a later study (6), yield reductions of 600 to 2400 kg/ha were reported with a no-tilled system as compared to conventional-tilled. In these studies, tillage did not affect incidence of southern blight. Under irrigation and utilizing five runner cultivars with moderate resistance to pod rot and southern blight (*Sclerotium rolfsii* Sacc.), Grichar and Smith (7) noted yields of 500 kg/ha less under a no-tilled system, as compared with a conventional-tilled system. Use of the five soilborne disease resistant cultivars did not enhance peanut production under reduced-tilled systems.

Varnell *et al.* (18) concluded that pod yield and quality were reduced under a no-tilled system. In comparison with conventional-tilled practices, no-tilled production reduced foliage, pod, and kernel yields by 58, 64, and 62 percent, respectively. Soundara Rajan *et al.* (15) found no reduction in yield as a result of no-tilled management. They found that sandy loam soil facilitated easy peg penetration and pod development and that higher soil moisture retention in no-tilled plots accounted for no yield reduction.

Colvin and Brecke (3) found that reduced-tilled production did not affect peanut yield, and the runner, virginia, and spanish cultivars used did not differ in response to the tillage system. They concluded that there was no immediate need for peanut cultivar performance testing in different tillage systems.

Later work by Colvin *et al.* (4) determined that for maximum peanut growth and yield there was no substitute for a friable seedbed. They stated that plots which received some degree of surface tillage yielded better than plots with no surface preparation (4090 *vs* 3760 kg/ha avg.).

Southern blight has not become a severe problem in no-tilled production system (3, 4, 6, 7). Boswell and Grichar (2) reported southern blight to be a major problem in reduced-tilled work; however, later work (6) indicated no differences in southern blight disease development among tillage systems. Grichar and Smith (7) stated that southern blight was not a major deterrent to reduced-tilled production.

The objectives of this study were to evaluate pod yield, percentage SMK+SS, and disease response of one early maturing runner and two spanish cultivars, and two partially soilborne disease resistant spanish germplasm lines, under conventional-, reduced-, and no-tilled peanut culture.

Materials and Methods

Cultivars Langley (13), Tamnut 74 (12), SN 55-437 (1), and germplasm lines TxAG-4 and TxAG-5 (14) were compared under three tillage systems from 1986 to 1989. Langley (runner) and Tamnut 74 (spanish) are commercial Texas cultivars, SN 55-437 (spanish) is a popular drought tolerant cultivar in West Africa, and TxAG-4 and TxAG-5 are germplasm lines selected for yield and resistance to *Pythium myriotylum* Drechs and *Sclerotinia minor* Jagger.

Tillage systems included reduced-tilled, no-tilled, and conventional-tilled small plot tests on Experiment Station land at Yoakum, Texas. Annual rye grass (*Lolium multiflorum* Lam.) was planted in the fall in the test area. Under conventional-tilled the cover crop was shredded, soil was turned with a moldboard plow, and was then disced and bedded with disc bedders. The beds were leveled to planting height, treated with preplant incorporated herbicides, and planted. All the steps remained the same in the reduced-tilled plots except for the omission of the moldboard plow. In the no-tilled plots, the rye grass was shredded to a height of 25-30 cm, a herbicide was applied to kill vegetation, and then peanuts were planted into the stubble, undisturbed soil. Preemergence herbicides were then applied. There was no cultivation in any of the tillage systems. Postemergence herbicides were applied as necessary to control weeds.

Paraquat (1, 1' -dimethyl-4, 4' -bipyridinium ion) at 0.84 kg ai/ha or

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glyphosate (*N*-(phosphonomethyl)glycine] at 2.4 kg ai/ha in 187 L/ha of water was sprayed broadcast over the no-till areas to kill existing vegetation prior to planting. A tank mix of trifluralin [2, 6-dinitro-*N*, *N*-dipropyl-4-(trifluoromethyl)benzenamine] at 0.56 kg ai/ha plus metholachlor [2-chloro-*N*-(2-ethyl-6-methylphenyl)-*N*-(2-methoxy-1-methylethyl)acetamide] at 1.68 kg ai/ha was preplant incorporated 7 cm deep with a power tiller in the conventional-tilled and reduced-tilled plots. In the no-tilled plots, trifluralin plus metolachlor tank mix was applied preemergence. The herbicides, 2, 4-DB [4-(2, 4-dichlorophenoxy)butanoic acid], bentazon [3-(1-methylethyl)-(1*H*)-2, 1,3-benzothiadiazin-4(3*H*)-one 2,2-dioxide], and sethoxydim[2-1-(ethoxyimino)butyl]-5-[2-(ethylthio)propyl]-3-hydroxy-2-cyclohexen-1-one], were applied postemergence during the growing season to control broadleaf weeds, yellow nutsedge (*Cyperus esculentus* L.), and Texas panicum (*Panicum texanum* Buckl.), respectively.

Tillage treatments were arranged in a split-plot randomized complete block design 10 rows wide with four replications. Sub-plots were two rows wide (row width 0.9 m) by 10.7 m long. Main plots were tillage treatments while subplots were peanut genotypes. Soil type was a Strabor loamy sand (fine, mixed, thermic Aquic Palenstalfs) with a pH of 7.1 and 1% organic matter. A seeding rate of 16.4 seed/m was planted for each genotype during the three years of the study. Peanuts were planted June 26, 1986, June 25, 1987, and June 22, 1988. Peanuts were dug 132 days after planting (DAP) in 1986, 123 DAP in 1987, and 119 DAP in 1988. During the growing season, rainfall was the only source of moisture except in 1987 and 1988 when irrigation was used to aid digging and minimize pod loss. Leafspot and insect control were consistent with Texas Agricultural Extension Service recommendations.

After digging, diseased sites caused by *S. rolfsii* were determined by counting southern blight loci (a locus is 31 cm or less of continuous row with pod discoloration resulting from infection). *Sclerotium rolfsii* was isolated from diseased pod tissue in the laboratory to establish the presence of the disease. Pod samples (approximately 450 grams) were handpicked at random following digging and prior to combining. Visual ratings in the lab were used to ascertain the relative amount of *S. rolfsii* damage to pods. A rating scale of 0-10 (0=no disease, 10=completely discolored) was used. After combining, samples were dried to 7% moisture, foreign material was removed from samples, pod weights recorded, and percentage of sound mature kernels + sound splits (SMK+SS) determined for each plot. Data were subjected to analysis of variance and means were compared by Duncan's Multiple Range Test.

Results and Discussion

Analysis of the data combined over the three years indicated that the year by cultivar interaction was significant for yield, SMK+SS, and infection hits; therefore, each year was analyzed separately. The year by tillage interaction was significant only for yield and SMK+SS, therefore each year was analyzed separately. No tillage by cultivar or tillage by cultivar by year interactions were observed.

In 1986, most of the rainfall fell during August through October when moisture is critical for pod development. In 1987 and 1988, rainfall during the same period was considerably less and may have attributed to differences in the tillage systems (Table 1).

The use of the no-tilled system produced a significant decrease in yield in only one of three years (40% less than conventional-tilled). In the other two test years, no differences in yield were noted (Table 2). Heavy rainfall during September and October of 1986 contributed to the yield differences in tilled system that year. The results of 1986 compare favorably with the yields seen under conventional-tilled with irrigation in previous studies (2, 6, 7).

Genotypic differences indicated TxAG-4 and TxAG-5 provided the highest average yields in the three years, while SN 55-437 was consistently lower in yield (Table 2). Reduced yields with SN 55-437 varied from 21% in 1987 to 27% in 1986. TxAG-4 produced significantly higher yields in 1986 and 1988 and intermediate yields in 1987. TxAG-5 yields were significantly higher in 1986, but only intermediate in yield in 1987 and 1988. Langley provided excellent yields in two of three years, but in 1988, yields were lower than Tamnut 74, TxAG-4, and TxAG-5.

Percentages of SMK+SS were lower for the no-tilled system in 1986, but not in the other two years (Table 3). Wright and Porter (19) noted that conventional-tilled peanuts matured later than conventionally tilled peanuts, while Grichar and Smith (7) also observed lower percentage SMK+SS with runner cultivars under the no-tilled system. The wet August to October months in 1986 compared to the relatively dry period of 1987 and 1988 may have contributed to the tillage x year interaction for percentage SMK+SS. Moisture deficiency forced accelerated maturation under all tillage systems in 1987 and 1988. Percentage SMK+SS for all tillage systems were low in 1988 because rainfall ceased in October. However, the average percentage of SMK+SS was almost 3% higher in no-tilled than for conventional-

Table 1. Monthly precipitation for 3 years (1986-88) at Yoakum, Texas from planting to harvest.

	Precipitation (mm)			
Month	Normal[1/]	1986	1987	1988
Jun	106	194	403	64
Jul	72	3	56	202
Aug	76	91	35	53
Sep	103	133	28	47
Oct	84	113	20	12
Nov	77	59	91	6
Total	518	593	633	384

[1/]Sixty-one year long term average rainfall for the Texas Agricultural Experiment Station, Yoakum, Texas.

Table 2. Yield of peanuts for five cultivars grown under three tillage systems (1985-1988).

Tillage systems or cultivars	Years 1986	1987	1988	Avg.
	(kg/ha^{-1})			
Tillage systems				
Conventional	1660 a[1/]	1668 a	956 a	1428
Reduced	1889 a	1447 a	871 a	1402
No	1008 b	1674 a	921 a	1200
Cultivars/Genotypes				
Langley	1597 a	1819 a	780 c	1399
SN 55-437	1202 b	1444 b	825 bc	1157
Tamnut-74	1644 a	1452 b	974 ab	1356
TxAG-4	1587 a	1560 ab	1065 a	1405
TxAG-5	1564 a	1704 ab	937 abc	1401

[1/]Means within a column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

tilled, suggesting that water reserves might have been higher in the no-tilled plots. In 1986, moisture was more abundant, and it appears that maturation was slower under no-till because both yields and grades were low.

The relative percentage SMK+SS of the genotypes were not consistent over years; only TxAG-5 remained in the same statistical group each year (Table 3). The percentage of SMK+SS of Langley averaged over tillage systems, statistically was higher in 1987 and statistically lower in 1986 and 1988.

The infection hits of *S. rolfsii* was not different for the tillage systems when averaged over the three test years (Table 4). *Sclerotium rolfsii* damage to dryland peanuts is usually not a problem because of the lack of moisture for active fungal growth (personal observation). However, others (3, 4) have noted a lack of disease problems with conservation tillage systems under irrigation.

Table 3. Percentage of sound mature kernels plus sound split kernels (SMK+SS) of cultivars as influenced by tillage system (1986-1988).

Tillage systems or cultivars	Years 1986	1987	1988	Avg.
	(%)			
Tillage systems				
Conventional	70.2 b[1/]	69.6 a	55.7 a	65.2
Reduced	71.1 a	71.3 a	57.3 a	66.6
No	67.8 c	70.6 a	58.5 a	65.6
Cultivars/Genotypes				
Langley	69.8 b	72.3 a	53.7 b	65.2
SN 55-437	69.0 b	71.2 a	56.1 ab	65.4
Tamnut-74	69.0 b	69.0 b	58.9 a	65.6
TxAG-4	69.1 b	68.8 b	60.2 a	66.0
TxAG-5	71.2 a	71.3 a	56.9 ab	66.6

[1/]Means within a column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

Table 4. Infection sites (hits) caused by *Sclerotium rolfsii* for tillage systems and cultivars (1986-1988).

Tillage systems or cultivars	Years 1986	1987	1988	Avg.
	(hits/10.7 m of row)			
Tillage systems				
Conventional	5.9	4.2	7.3	5.5 a[1/]
Reduced	3.4	3.5	7.6	4.8 a
No	2.2	3.4	5.1	3.6 a
Cultivars/Genotypes				
Langley	3.9 ab	2.8 a	12.3 a	6.3
SN 55-437	2.8 ab	3.6 a	6.5 b	4.3
Tamnut-74	2.1 b	3.4 a	4.0 c	3.1
TxAG-4	5.3 a	4.5 a	3.6 c	4.5
TxAG-5	3.4 ab	4.3 a	6.8 b	4.8

[1/]Means within a column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

Differences in the incidence of *S. rolfsii* among genotypes were minor. However, Langley sustained significantly more disease hits in 1988 than either spanish entry. This may account for the low yield noted in this genotype in 1988 (Table 2). SN 55-437 and TxAG-5 also sustained significantly more hits than Tamnut 74 or TxAG-4. Disease hits in 1986 and 1987 indicated little disease pressure.

Ratings on pod disease (caused by *S. rolfsii*) on the surface of pods indicated no significant differences among tillage systems. However, the amount of pod disease was too low (about 1.5%) to make a valid comparison. The increased organic matter present in the reduced- or no-tilled plots did not result in an increase in pod disease. TxAG-4 and TxAG-5 had significantly less pod disease than the other entries in two of the three test years (data not shown).

Use of the spanish-type genetic materials with reduced-tilled systems under rainfed conditions may be feasible. Under normal low rainfall conditions, which are frequent in much of the Southwest, no-tilled compared favorably with the conventional-tilled systems. However, with high rainfall, especially late in the season, yields under no-tilled systems may be less, as was observed in 1986. This might be offset by delayed digging.

Water is a limiting factor in dryland peanut production. Its usage by a cover crop, such as rye grass, deletes available soil moisture. Therefore, it might be beneficial to kill or remove the rye grass early in the season to allow available moisture to accumulate. Pesticide usage, particularly herbicides, may be increased with any reduced tillage procedure. Growers will have to determine if increased pesticide costs will outweigh lower tillage costs that result in higher profit margins.

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