Row Orientation and Seeding Rate on Yield, Grade, and Stem Rot Incidence of Peanut with Subsurface Drip Irrigation[1]

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ABSTRACT

A 2-yr study was conducted on a Tifton loamy sand (fine-loamy, kaolinitic, thermic Plinthic Kandiudults) soil near Sasser, GA during the 2001 and 2002 growing seasons to determine the effects of three plant row orientations (single, twin, and multi-row) and two plant populations on the pod yield, market grade, and stem rot disease incidence of peanut when irrigated with subsurface drip irrigation (SDI). Seeds were planted at the recommended rate [20 seeds/m; 1.0R (recommended rate)] and half the recommended rate (10 seeds/m; 0.5R). Plots were irrigated daily to replace estimated daily evapotranspiration (ET_a). Twin row orientation had the highest pod yield with 5407 kg/ha compared with the other row orientations, which averaged 4897 kg/ha. Market grade (total sound mature kernels, TSMK) for the twin and diamond row orientation was 1% point higher (74.7%) compared with the single row orientation. Pod yield was 8.5% greater for the 1.0R seeding rate compared with the 0.5R seeding rate. Stem rot incidence was highest in the single row orientation and lowest in the diamond row orientation. Within the three row orientations, kernel size distribution characteristics showed jumbo kernels had mixed percentages, with medium and ones showing no differences. The 1.0R plant population did have 4.4 % more jumbo kernels than the 0.5R plant population. This study indicates that twin row orientation and planted at the recommended rate (1.0R) had the best pod yield and market grade compared with single row orientation when irrigated with SDI.

Key Words: *Arachis hypogaea* L., kernel size distribution, seed density.

Increasing pod yield while decreasing input costs is of major importance to peanut (*Arachis hypogaea* L.) growers. Past research has shown that planting peanut in twin versus single rows can increase pod yield by as much as 336 kg/ha and total sound mature kernels (TSMK) by 1% (Baldwin *et al.*, 2000; Beasley *et al.*, 2000). In addition to yield and grade increases, the twin row orientation has also shown reductions in tomato spotted wilt virus (TSWV) incidence. Though the relationship between reduction in TSWV and twin row orientation is not fully understood, planting in twin rows has become a standard recommendation to reduce the risk of TSWV incidence (Brown *et al.*, 2002a, b).

Roy *et al.* (1980) showed that seeding rates for a final stand count between 180,000 and 300,000 plants/ha produced higher pod yields than did lower or higher plant populations. Mozingo and Wright (1994) showed that planting bunch type variety on a small diamond-shaped pattern (15.2 × 15.2 cm) had higher yields than a runner-type variety. Overall, Mozingo and Wright (1994) showed that peanut yields can be increased using certain cultivars in a diamond-shaped planting configuration. Humphrey and Schupp (2000) reported reduced plant competition for water, nutrients, and light stemming from population reductions that permitted more plant energy to be diverted from survival and maintenance mechanisms to reproductive functions. Sternitzke *et al.* (2000) reported that reduced plant populations decreased yield but increased

[1]Mention of trade names or commercial products in this article is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Dept. of Agric.

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peanut pod mass per plant. Analogous observations have been reported with other commodities. Granberry *et al.* (1999) reported that decreasing population tended to increase fruit size for watermelon *(Citrullus lanatus* L.), cantaloupe (*Cucumis melo reticulatus* L.), cabbage (*Brassica oleracea capitata* L.), broccoli (*Brassica rapa* L.), and sweet corn (*Zea mays rugosa* L.). Reiners and Riggs (1999) reported that sparser populations decreased yield but increased pumpkin (*Cucurbita pepo* L.) size. Bakelana and Regnier (1991) reported that domestic oat (*Avena sativa* L.) dry matter, leaf area, and tiller number per plant increased with decreasing population. Zadeh and Mirlohi (1998) reported that reduced rice (*Oryza sativa* L.) populations decreased yield but increased grain mass per plant.

Producers in the southeast normally plant 19.7 seed/m runner-type peanuts in single rows on 0.91 m raised beds (Wehtje *et al.*, 1994). The relatively high seeding rate is a hedge against poor germination and emergence in the hope of attaining a stand of approximately 13.1 plants/m or 144,000 plants/ha (Baldwin, 1997). In addition to better yield, closer spacing and higher population benefits include: a) enhanced weed suppression (Hauser and Buchanan, 1981; Buchanan *et al.*, 1982), b) faster canopy coverage (Mozingo and Wright, 1994), and c) reduced incidence and severity of TSWV (Brown *et al.*, 1997; Brown *et al.*, 2001; Brown *et al.*, 2002a,b).

Decreasing inter-row plant spacing and increasing plant populations can increase yield. However, the cost of peanut seed is one of the major expenses to the grower. Recommendations suggest that plant populations greater than 13 plants/m of row would reduce the risk of TSWV while achieving high yields (Brown *et al.*, 2002a,b). With the twin row orientation that would be ca. 6.5 plants/m in each twin row, effectively spreading the plants out and allowing more space between plants, i.e., less plant competition. Spreading that same number of plants out over a broader area would further reduce plant competition, but it is unknown what the pod yield, grade parameters, and stem rot incidence response would be, especially in the multi-row orientation. Therefore, the objectives of this project were: a) to compare the yield and grade response of peanut to three plant row orientations (single, twin, and diamond) at two plant populations, and b) determine the effect of row orientation and plant populations on stem rot incidence when irrigated with subsurface drip.

Material and Methods

The research site was installed 3 km north of Sasser, GA (Sasser Farm) on a Tifton loamy sand (fine-loamy, kaolinitic, thermic Plinthic Kandiudults) with 2 to 5% slope. A subsurface drip irrigation system (SDI) was installed in the spring of 2000. The SDI system had drip laterals buried at 0.3 m deep and spaced at 0.91 m with emitters spaced at 0.3 m. Water flow rate was 5.6 L/m per 100 m or 1.0 L/hr per emitter. Peanut was planted during the 2001 and 2002 growing seasons following cotton.

Land preparation was the same both years with disk harrowing two times followed by an experimental bedder (USDA-ARS Natl. Peanut Res. Lab., Dawson, GA) used to make 1.83 m beds. The peanut cultivar Georgia Green was planted both years with planters centered on the 1.83 m beds. The single and twin row orientation was planted with a commercial vacuum type planter (Monosem planter, ATI Inc, Lenexa, KS). The single row planter placed seeds at 0.91 m row spacing for two rows on a bed. Twin row orientation was planted at 1.17 m outside rows × 0.7 m inside rows with 0.22 m between the twin rows with four rows on a bed. The diamond row orientation was planted using an experimental air seeder (USDA-ARS Natl. Peanut Res. Lab., Dawson, GA) with 1.11 m between the outside rows, 0.51 m between the middle rows, and 0.10 m between each set of rows with a total of eight rows per bed. Within the single row pattern the shortest distance between seeds was approximately 5 cm. For the twin row pattern the shortest distance was ca. 10 cm and for the diamond row pattern the distance was ca. 20 cm (Fig. 1).

The experiment was a split block randomized design with one block planted at the 20 seeds/m [1.0R (recommended rate)] rate and the other block planted at the 10 seeds/m (0.5R) rate. The higher seeding rate is

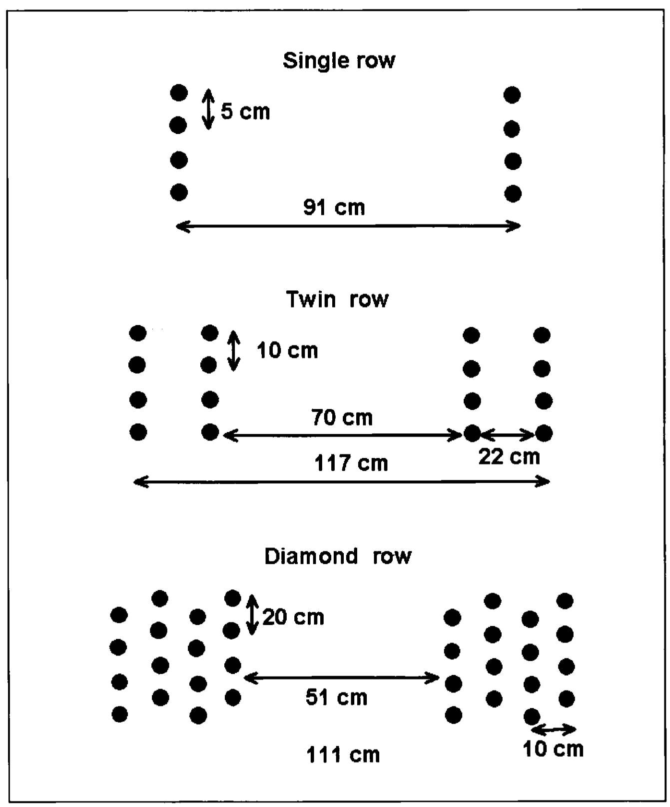

Fig. 1. Distance between seeds within row and adjacent row for single, twin, and diamond row orientations at the recommended seeding rate (1.0R).

the recommended rate (1.0R) for reducing the risk of TSWV, with the final stand counts of 14.4 plants/m (Brown *et al*, 2002a,b). The lower seeding rate was half the recommended rate (0.5R). Row orientations were randomized within each block with three replications per row orientation. Pest management practices followed Univ. of Georgia Agric. Ext. Serv. recommendations for peanut production (Harris, 2002). Irrigation water was applied daily based on replacement of crop water use for peanut described by Stansell *et al.* (1976) except when precipitation amounts exceeded estimated water use.

Crop maturity was determined by the hull scrape method (Williams and Drexler, 1981). Yield rows were dug with a 2-row inverter and combined with a 2-row combine. All plots were dug on the same day and harvested when conditions were acceptable. Stem rot ratings and plant populations were documented within 24 h after digging and prior to combining. Stem rot disease ratings were obtained by determining the percentage of 30.5 cm segments of the 30 m sample length that showed signs or symptoms of stem rot (Rodriguez-Kabana *et al.*, 1975). Pod yield was weighed and adjusted to 7% moisture (wet basis). Kernel size distribution was determined using screens specified in USDA grading procedures (USDA, 1993). Market value of peanut ($/ha) was calculated using the 2002 marketing loan rate ($392/t), farmer stock grade, and pod yield. Seed cost ($/ha) was estimated by multiplying the seeding rate of 1.0R (130.3 kg/ha) and 0.5R (65.1 kg/ha) by a seed cost of $1.17/kg.

Data were analyzed by standard analysis of variance procedures. Least significant difference range test was used to show differences among means (P = 0.05) when ANOVA F-test showed significance.

Results and Discussion

Rainfall during the two growing seasons (May to Oct.) was 433 mm (2001) and 442 mm (2002). These rainfall amounts are below the normal rainfall value of ca. 568 mm typically received during the growing season (Georgia Agricultural Statistical Service 2001). Total irrigation applied was 279 mm for 2001 and 283 mm during 2002.

Seeding Rate. Plant population was determined for each seeding rate and row orientation at harvest. The 1.0R seeding rate had a final plant stand of 14.8 plants/m and the 0.5R rate had an average of 10.1 plants/m. The TSWV index recommends plant populations greater than 12.8 plants/m to reduce the risk of TSWV disease (Brown *et al.*, 2002a,b). The 1.0R seeding rate exceeded the seeding standard by 12.5% and the 0.5R seeding rate was 22% less than the standard. During the 2001 planting, it was observed that the twin row planter was more consistent with the final plant stand than the other two planter types when analyzed across replications. The single row planter was slightly less consistent than the twin row planter with the experimental air seeder being the least consistent. This was especially true the first planting season (2001); however, during the second season, adjustments were made to all planters and the final stand counts were more consistent (data not shown).

Pod Yield. There were no pod yield differences between years; therefore, pod yield was pooled for analysis (Table 1). Pod yield data (Fig. 2) show that the twin row orientation had 10% higher yield (5407 kg/ha) than the single (4906 kg/ha) and diamond (4889 kg/ha) row patterns when averaged across both planting rates. Average pod yield for 1.0R was 5262 kg/ha, while the average pod yield for 0.5R was 4873 kg/ha—an increase of 8.5% (Table 2). The highest pod yield was for the twin row orientation at the 1.0R seeding rate (Table 2) followed by diamond row orientation at the same seeding rate. The lowest pod yield was for the diamond row orientation at the 0.5R planting rate. Higher pod yields with twin row orientations compared with single row orientations are consistent with findings by Baldwin—*et al.* (2000). Beasley *et al.* (2000) showed that peanut planted using a six-row orientation had no yield increase over single or twin row patterns.

Farmer Stock Grade. The twin and diamond row orientation had 1% higher value of total sound mature kernels (TSMK) than the single row orientation (Table 1). The higher plant population (1.0R) had higher TSMK percentage than the lower plant population (0.5R) (Table 2). These data are consistent with Mozingo and Coffelt (1984), which showed that virginia-type peanut had higher TSMK with a higher plant population than lower plant population. Kernel size distribution data showed some differences in the jumbo category, but not in the medium or number one kernel percentages with row orientation (Table 2).

Stem Rot Incidence. There was a significant year × row orientation interaction, so each year was analyzed separately (Table 1). In 2001, there was no significant difference between row orientations. In 2002, there was a significant difference between row orientations, and

Table 1. Analysis of variance probability values for pod yield, total sound mature kernels (TSMK), stem rot incidence, and market value.

Source	df	Pod yield	TSMK	Stem rot	Market value
		------- P-values from ANOVA -------			
Year (Y)	1	0.105	0.000	0.0161	0.021
Row orientation (R)	2	0.006	0.026	0.000	0.239
Seed rate (S)	1	0.011	0.039	0.729	0.026
Y × R	2	0.105	0.089	0.003	0.099
Y × S	1	0.539	0.055	0.326	0.058
R × S	2	0.412	0.638	0.505	0.624
Y × R × S	2	0.966	0.747	0.604	0.733

Table 2. Pod yield, total sound mature kernels (TSMK), kernel size distribution (jumbo, medium, and ones), loose shelled kernels (LSK), and economic parameters for three row orientations (single, twin, and diamond) and two plant densities. Means with different letters or case within a column are significantly different at the P ≤ 0.05 level.

Plant row	Pod yield	TSMK	Kernel size distribution: Jumbo	Medium	Ones	LSK	Economic parameters: Value	Seeding cost	Net cost
	kg/ha	%	%			%	$/ha		
			10 seeds/m						
Single	4833 bc	73.6 c	16.7 bc	44.2 a	10.8 a	1.4 ab	1895 b	76.06	1819
Twin	5208 ab	74.6 abc	18.8 bc	44.9 a	10.4 a	1.0 a	2118 ab	76.06	2042
Diamond	4577 c	74.2 bc	16.5 c	45.0 a	10.2 a	1.1 ab	1906 b	76.06	1830
			20 seed/m						
Single	4979 bc	74.0 c	20.1 abc	43.4 a	10.0 a	1.1 ab	2009 b	152.14	1858
Twin	5607 a	75.1 ab	24.2 a	42.5 a	9.3 a	1.6 b	2264 a	152.14	2112
Diamond	5201 ab	75.2 a	21.0 ab	44.5 a	9.1 a	1.4 ab	2103 a	152.14	1951
			Average by seeding rate						
20 seed/m	5262 A	74.8 A	21.9 A	44.7 A	10.5 A	1.4 A	2178 A	152.14	2026
10 seed/m	4873 B	74.1 B	17.3 B	43.4 A	9.4 A	1.1 A	1986 A	76.06	1910

single rows had significantly greater stem rot than twin or diamond configurations (Fig. 3). Similar results have been found in other studies. Fungal diseases (root rot caused by *Rhizoctonia solani*) on other crops have also been reduced by row pattern modification, such as planting twin or paired rows (Cook *et al.*, 2000). Sconyers (2003) also found less stem rot when peanuts were planted in twin rows rather than single rows, and the difference in physical distance between plants in the different row patterns may be a critical factor that determines stem rot development. In our study, stem rot ratings were higher in the single row orientation and were probably due to the plants being less than 7 cm apart while the other multi-row orientations had plants much farther apart (Fig. 1). Therefore, in the single row orientation when one plant becomes infected, the next plant is in close proximity and would have a higher risk of infection. Plants that have a longer distance between them, i.e., the 0.5R plant population and diamond row orientation, would have a lower risk of disease infection from an adjacent plant. The distances between the plants are greater in the twin and diamond orientations, resulting in reduced plant

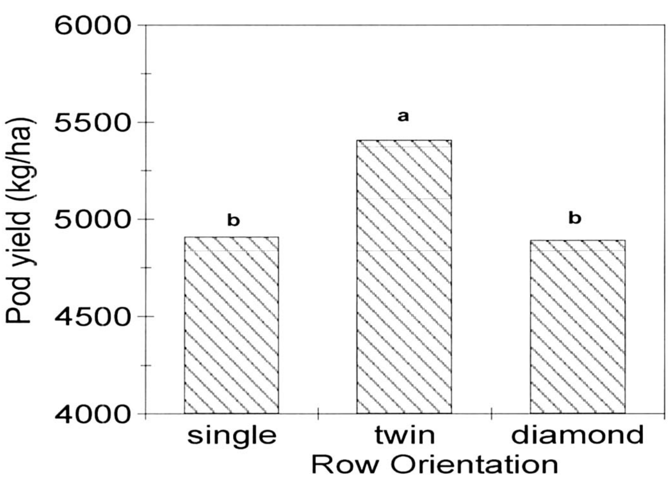

Fig. 2. Average pod yield for single, twin, and diamond row orientations. Means with different letters are significantly different at the P ≤ 0.05 level.

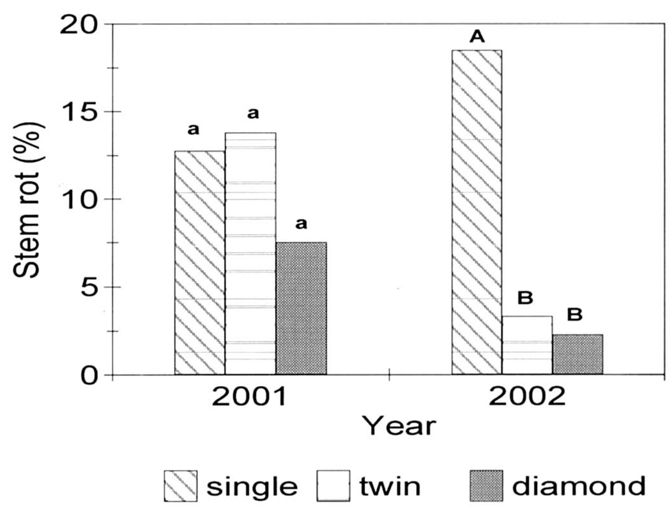

Fig. 3. Percent stem rot disease incidence for 2001 and 2002 for single twin and diamond row orientation. Means with different letters within years are significantly different at the P ≤ 0.05 level.

competition and stress (Humphrey and Schupp, 2000). It is known that less-stressed plants are less susceptible to disease (Agrios, 1997).

Market Value. The average market value of peanut indicated that the twin row orientation had a $219/ha and $233/ha higher market value than the single and diamond patterns, respectively (Table 2). Also, at the recommended plant population the market value that was $192/ha higher than for the 0.5R plant population. Seed cost (Table 2) for the 1.0R and 0.5R populations was $152/ha and $76/ha, respectively. With the seed costs removed, the 1.0R seeding rate had a positive net return of $116/ha over the 0.5R seeding rate.

Summary

This 2-yr study showed that twin row plant orientation had higher pod yields than either the single or diamond plant orientations when irrigated using subsurface drip irrigation. Twin row pod yield was ca. 10% higher than other row orientations. The single row orientation had 1% lower grade (TSMK) when compared with twin or diamond row orientations. There was no difference in kernel size distribution (jumbo, medium, or ones) between row orientations. Stem rot ratings were over three times higher in the single row orientation compared with the average disease rating for the twin and diamond row orientation in 2002. Spreading plants farther apart on the bed may further reduce the risk of stem rot spreading from one plant to another. Reduced stem rot incidence with the higher number of rows per bed may imply a reduction of fungicide applied, which could reduce input costs. However, the results of applying less fungicide to multi-row planting patterns would need further study.

When irrigating peanut with subsurface drip irrigation, the use of twin row or multi-row plant patterns should be recommended for higher yield and grade with reduced stem rot incidence compared with single row orientations. When looking specifically at yield and grade, it is recommended to have final plant stands greater than 13 plants/m.

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