Peanut Response to Row Pattern and Seed Density when Irrigated with Subsurface Drip Irrigation

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ABSTRACT

A two year study (2001 and 2002) was conducted at Sasser and Shellman, GA to determine the effects of planting pattern and plant population on the pod yield, market grade, and market value of peanut (*Arachis hypogaea* L.) when irrigated with subsurface drip irrigation (SDI). Soils were a Tifton loamy sand (fine-loamy, kaolinitic, thermic Plinthic Kandiudults) and Greenville sandy loam (fine, kaolinitic, thermic Rhodic Kandiudults) with 1% slope. Seeds were planted at recommended (20 seeds/m; 1.0R) and half the recommended rate (10 seeds/m; 0.5R) in a single and twin-row pattern. Plots were irrigated daily to replace estimated daily evapotranspiration (ET_a). This study showed that twin-row plant pattern had 490 kg/ha higher pod yield compared with single-row pattern when irrigated using subsurface drip irrigation. The twin-row pattern also had a one percentage point increase in grade value (TSMK) compared with the single-row pattern. There was no difference in kernel size distribution with planting pattern. Twin-row planting had a $213/ha higher market value compared with single-row. There was no difference in yield on market value for seeding rate. This implies that it may be possible for a grower to plant in a twin-row pattern at half the recommended seeding rate without sacrificing net market value but may increase the risk of yield due to TSWV damage.

Key Words: *Arachis hypogaea* L., farmer stock grade, kernel size distribution.

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 450 kg/ha and total sound mature kernels (TSMK) by one to two percentage points (Beasley *et al.*, 2000; Baldwin *et al.*, 2000, Beasley *et al.*, 2004). In addition to yield and grade increases, the twin-row pattern has shown reductions in the incidence of tomato spotted wilt virus (TSWV). Though the relationship between reduction in TSWV and twin-row patterns 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 of between 180,000 and 300,000 plants/ha produced higher pod yields than did lower or higher plant populations. Mozingo and Cofelt (1984) showed that Virginia type peanut (cv. VA81B) had higher yield when planted in twin rows at high plant populations compared with Florigiant variety. 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. 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 reduced plant populations decreased yield but increased peanut pod mass per plant. Analogous observations have been reported with other commodities. Granberry *et al.* (1999) reported 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 sparser populations' decreased yield but increased pumpkin (*Cucurbita pepo* L.) size. Bakelana and Regnier (1991) reported domestic oat (*Avena sativa* L.) dry matter, leaf area, and tiller number per plant increased with decreasing population. Zadeh and Mirlohi (1998) reported reduced rice (*Oryza sativa* L.) population's 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

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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 tomato spotted wilt virus (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 pattern that would be about 6.5 plants/m in each of the twin-rows, effectively spreading the plants out and allowing more space between plants, i.e. less plant competition. The TSWV Index was validated on non-irrigated and overhead sprinkler irrigation type systems. There has been little peanut yield data collected, especially concerning twin- and single-row patterns, on sites where SDI was used as the primary source of irrigation. Therefore, the objectives of this project were to determine the yield and grade response of peanut when planted in two row patterns (single and twin) at two plant populations (recommended, 1.0R and half recommended, 0.5R) and irrigated with subsurface drip irrigation.

Material and Methods

One research site was installed 3 km north of Sasser, GA (Sasser) on 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 0.91m 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.

The second site was installed 1 km south of Shellman, GA (Shellman) on a Greenville fine sandy loam (fine, kaolinitic, thermic Rhodic Kandiudults) with 1% slope. A subsurface drip irrigation system (SDI) was installed in the spring of 2001. The SDI system had drip laterals buried at 0.3 m deep and spaced at 0.91m with emitters spaced at 0.45 m. Water flow rate was 5.2 L/min per 100 m or 1.5 L/hr per emitter. Peanut was planted during the 2001 and 2002 growing seasons following cotton.

The experiment was a randomized complete block with two row patterns and two seeding rates replicated three times per treatment. Seeds were planted at the 20 seeds/m (1.0R) rate and at the 10 seeds/m (0.5R) rate. The higher seeding rate is 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).

Land preparation was the same for both sites and both years with disk harrowing two times followed by an experimental bedder (USDA-ARS-National Peanut Research Laboratory, Dawson, GA) used to make 1.83 m wide beds. The peanut cultivar 'Georgia Green' was planted both years with planters centered on the 1.83-m beds. The single and twin-row patterns were 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 pattern was planted at 1.17 m between the outside rows and 0.7 m between the inside rows with 0.22 m between the twin-rows with four rows on a bed. Pest management practices followed University of Georgia Agricultural Extension Service 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. If precipitation amounts were greater than 12.5 mm, an irrigation event would not occur for about 3 days to allow the soil to drain.

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. Yield samples were dried to 10% moisture content (wet basis) or less, weighed, and final yields adjusted to 7% moisture. 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 ($0.432/kg) for farmer stock grade and pod yield. Seed cost ($/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.

Yield data were analyzed by year, location, planting pattern, and seeding rate using the general AOV/AVOC procedures in Statistix8 (Analytical Software, 2003). Mean separation test (Tukey) was used to show differences among means ($P = 0.05$) when *ANOVA F*-test showed significance.

Results and Discussion

Plant date, harvest date, season precipitation, and irrigation amounts are shown in Table 1. The

Table 1. Planting date, harvest date, season precipitation, and irrigation applied for Sasser and Shellman sites during the 2001 and 2002 growing season.

Event	Location			
	Sasser		Shellman	
	2001	2002	2001	2002
Plant date	09 May	07 May	25 May	09 May
Harvest date	21 Sep	10 Sep	05 Oct	10 Sep
Precipitation (mm)	433	442	467	375
Irrigation (mm)	279	283	302	285

planting date in 2001 was late at the Shellman site due to delayed irrigation system installation. However, the planting date was within the recommended planting period of 01 to 25 May (Baldwin, 1997). Also, irrigation applied in 2001 at the Shellman site was higher than recommended due to programming malfunctions that occurred with the electronic controller.

Final plant population for the two seeding rates was 9.3 and 15.2 plants/m for the 0.5R and 1.0R, respectively (data not shown). 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 18% and the 0.5R seeding rate was 27% less the standard.

Pod Yield. There was no pod yield difference for year, site, or seed rate (Table 2). Average pod yield was 5100 kg/ha. There was a difference with pod yield between planting pattern with the twin-row yielding 490 kg/ha higher than the single row (Table 3). This yield increase is similar to those described by Baldwin *et al.* (2000, 2001), Beasley *et al.* (2002), and Sorensen *et al.* (2004).

It would seem that a lower seeding rate should have an effect on pod yield. Closer evaluation of the seeding rate by planting pattern interaction showed that the row pattern had more effect on yield than did seeding rate. There was no yield difference between the 1.0R and the 0.5R seed rate within the single- or twin-row pattern. Highest pod yield was with twin-row 1.0R (5500 kg/ha) and the lowest was single-row 0.5R (4810 kg/ha). These pod yields for single and twin-rows are similar to yields reported by Baldwin *et al.* (2000, 2001) and Beasley *et al.* (2002).

Farmer Stock Grade. Growing year 2002 had a higher total sound mature kernel (TSMK) percentage (74.5%) compared with the 2001 growing year (73.6%). There was no difference in TSMK with site or seeding rate. There was a difference in TSMK for row pattern. Twin-row had about one percentage point higher TSMK grade (74.5%) compared with the single-row pattern (73.7%). These findings are analogous to findings described by Baldwin *et al.* (2000, 2001), and Beasley *et al.* (2002).

There were differences in loose shelled kernels (LSK), single splits (SS) and other kernels (OK) by year and location (See Table 2). There was significantly higher SS in 2001 compared with 2002. There was higher LSK and SS at the Shellman site compared with the Sasser site. These differences can be explained by environmental and physical conditions that may have occurred at the time of harvest and grading. There could have also been changes in mechanical settings on the combine that could account for these differences. There was no difference in LSK and SS for the seed rate or the row pattern.

There were differences in the kernel size distribution for year, location, and seeding rate

Table 2. Analysis of variance probability values for pod yield, grade, kernels size distribution and market value. TSMK = total sound mature kernel, OK = other kernels, LSK = loose shelled kernels, SS = sound splits, Jum = jumbos, Med = mediums, Ones= ones.

Source	df	Pod Yield	TSMK	OK	LSK	SS	Jum	Med	One	Market value
		P-values from ANOVA								
Year (Y)	1	0.16	0.01	0.00	0.01	0.00	0.00	0.70	0.17	0.15
Location (L)	1	0.11	0.22	0.83	0.00	0.00	0.05	0.00	0.36	0.10
Row (R)	1	0.00	0.02	0.37	0.19	0.78	0.16	0.91	0.01	0.00
Seed (S)	1	0.09	0.82	0.84	0.20	0.70	0.01	0.11	0.39	0.10
Y * L	1	0.52	0.00	0.05	0.05	0.27	0.35	0.00	0.00	0.48
Y * R	1	0.00	0.00	0.02	0.10	0.01	0.03	0.13	0.01	0.01
Y * S	1	0.73	0.08	0.04	0.08	0.75	0.09	0.24	0.06	0.71
L * R	1	0.53	0.21	0.17	0.13	0.27	0.43	0.06	0.65	0.54
L * S	1	0.21	0.45	0.55	0.40	0.79	0.06	0.97	0.15	0.20
R * S	1	0.40	0.89	0.64	0.89	0.43	0.32	0.76	0.33	0.40
Y * L *R	1	0.52	0.58	0.78	0.06	0.00	0.17	0.15	0.07	0.51
L* R * S	1	0.56	0.76	0.70	0.19	0.84	0.89	0.81	0.45	0.57
Y * L * R * S	3	0.96	0.81	0.64	0.17	0.81	0.95	0.97	0.73	0.96

Table 3. Values for pod yield, grade, kernel size distribution, market and net value (minus seed cost only) by year, location, seeding rate, and row orientation. Abbreviations are: TSMK = total sound mature kernel, OK = other kernels, LSK = loose shelled kernels, SS = sound splits, Med = mediums. Means followed by the same letter are not significantly different at the P = 0.05 level.

Treatment	Pod Yield	TSMK	OK	LSK	SS	Jumbo	Med	One	Market value	Net value
	kg\ha	%							$\ha[1]	
					Year					
2001	5020a	73.6b	5.0a	2.9a	4.6a	27.4a	48.1a	10.5a	2252a	2060a
2002	5190a	74.5a	4.1b	2.1a	1.5b	15.4b	47.6b	9.9a	2173a	2138a
					Location					
Sasser	5200a	74.3a	4.6a	1.3b	2.3b	20.5b	44.8b	10.4a	2257a	2143a
Shellman	5000a	73.8a	4.5a	3.7a	3.8a	22.3a	50.9a	10.0a	2168a	2054a
					Seeding rate					
0.5R	5000a	74.1a	4.5a	2.3a	3.0a	20.1b	48.7a	11.0a	2167a	2098a
1.0R	5210a	74.0a	4.6a	2.7a	3.1a	22.7a	47.0a	10.5a	2258a	2106a
					Row orientation					
Single	4860b	73.7b	4.7a	2.7a	3.1a	21.0a	47.9a	10.9a	2106b	1992b
Twin	5350a	74.5a	4.4a	2.3a	3.0a	22.1a	47.8a	9.6b	2319a	2205a

but not for row pattern. There were more jumbo sized kernels in 2001 compared with 2002. There were more jumbos at the Shellman site compared with the Sasser site. In addition, there were more jumbos with the 1.0R seeding rate compared with the 0.5R seeding rate (Table 2). An increase in jumbo sized kernels can be explained by environmental conditions that may have occurred early in the growing season allowing pods to form and mature during one year but not the other.

Market Value. There was no difference in market value by year, location, or seeding rate (Table 3). There was a difference in market value for row pattern with twin-row having a $213/ha higher return ($2205/ha) compared with the single row ($19926/ha). Seeding costs for the 1.0R and the 0.5R seeding rates were $152/ha and $76/ha, respectively. With the seeding costs removed, there was not a significant difference in the net return for the seeding rate. This implies that it may be possible for the grower to plant in a twin-row pattern at half the recommended seeding rate without sacrificing yield or net market returns. The Tomato Spotted Wilt Virus (TSWV) Index (Brown *et al.* 2001; Brown *et al.* 2002a and 2002b) suggests that seeding rates less than 12.8 plant/ft may increase the risk of TSWV. Planting at 0.5R with a 100% germination rate would only have 9.6 plants/m. Therefore, planting at this lower rate may increase the risk of TSWV in the peanut fields. More research is needed to determine if there is a relationship between TSWV, seeding rate, and subsurface drip irrigation.

Previous researchers have shown an increase of yield and grade when planting with twin-row patterns. Yield data collected from these two sites, using SDI, have about the same yield potential and grade of twin versus single row patterns described by previous researchers (Baldwin *et al.* 2000 and 2001; Beasley *et al.* 2002).

Summary

This two-year study showed that twin-row planting pattern had 490 kg/ha higher pod yield compared with single row plant pattern when irrigated using subsurface drip irrigation. The twin-row pattern also had a one percentage point increase in grade value (TSMK) compared with the single row pattern. These yield and grade values for single and twin-row patterns correspond to literature values determined using overhead sprinkler. Yield data from this project imply that SDI could be used to irrigate peanut without reduction of yield or grade. There was no difference in kernel size distribution with row pattern. Twin-row pattern had a $213/ha higher market value ($2205/ha) compared with the single row pattern ($1992/ha). There was no difference in market value for seeding rate. This implies that it may be possible for a grower to plant in a twin-row pattern at half the recommended seeding rate without sacrificing net market returns but may increase the risk of loss of yield due to TSWV.

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