Comparisons of Single-Row and Twin-Row Soybean Production in the Mid- South

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ABSTRACT

A Maturity Group (MG) IV and MG V soybean [*Glycine max* (L.) Merr] cultivar were planted on beds in 102 cm single-rows or 25 cm twin-rows with 102 cm centers at 20, 30, 40, and 50 seeds m^{-2} in a Beulah fine sandy loam (coarse-loamy, mixed, active, thermic Typic Dysrudepts) in 2008, 2009, and 2010 and in Sharkey clay (very-fine, smectitic, thermic Chromic Epiaquerts) in 2009 and 2010 at Stoneville, MS. Despite furrow irrigation, drought and consistent maximum temperatures –32°C during 2010 reduced stands, yields, and seed weight at both sites. Twin-rows produced more plants than similar single-rows, which helped increase twin-rows yields compared to single-rows on the clay. Yields on the clay did not differ among seeding rates. Yields from twin-rows on the sandy loam were only greater than single-rows at 40 and 50 seeds m^{-2} for the MG IV cultivar and did not differ for the MG V. The MG IV cultivar tended to yield better than the MG V at both sites. The MG IV cultivar averaged 20 nodes $plant^{-1}$ compared to 15 for the MG V. Both cultivars on the sandy loam average 59 pods $plant^{-1}$, while the MG V cultivar produced 70 pods $plant^{-1}$ vs. 63 pods $plant^{-1}$ for the MG IV cultivar on the clay. Twin-rows did not produce more pods $plant^{-1}$. Row type or seeding rate did not effect seed weight at either site. Seeds m^{-2}were greater for the MG IV cultivar on the sandy loam and corresponded with yield, but not so on the clay.

The early soybean production system (ESPS) as developed and implemented in the Mississippi Delta (Heatherly, 1999) has become the normal soybean production practice in the Mid-South. It involves planting MG IV or MG V cultivars during April to mid-May, as opposed to the previous practice of planting MG VI or MG VII cultivars beginning in mid-May through early June. The ESPS, combined with irrigation, helps avoid considerable drought stress that MG VI and MG VII cultivars experience during reproductive growth in August (Bowers, 1995). This allows increased stability in soybean production by reducing the risk of crop failure brought on by drought which furthers the acceptance of ESPS (Boquet, 1998).

Most soybeans produced in the lower Mississippi River Valley are grown in raised beds on comparatively wider row widths than those grown in other regions to accommodate furrow irrigation and better use equipment also used for cotton (*Gossypium hirsutum* L.) and/or corn (*Zea mays* L.) production (Ebelhar, 2010; Mississippi State University, 2010). Row widths of between 88 to 102 cm are common for soybeans produced in the Mississippi Delta (Ebelhar, 2010). A major change to occur in soybean production in the Mid-South since 2000 is the introduction and adoption of twin-row planting. It is estimated that nearly 80% of the soybean hectarage in the Mississippi Delta in 2010 was planted in twin-rows (P. Giachelli, personal communication, 2011). Popular opinion is planting soybean in twin-rows vs. conventional single-row configurations results in more pods per plant and increased seed yields (Bell, 2005). Similar opinions with respect to yield exist in the Mid-South for twin-row corn production compared to single-row planting (Ebelhar, 2010; Smith, 2010) which further encourages the adoption of twin-row crop production for both crops.

Research information on comparing twin-row vs. conventional single-row soybean production is limited, especially in the ESPS. Mascagni et al. (2008) reported seed yield increases of 12.6 and 13.1% in twin-row configurations vs. single-row plantings at two of three experiments in Louisiana. Grichar (2007) reported an average 17% yield increase in twin-row plantings over single-rows with both a MG IV and MG V cultivar at two of four site-years along the Texas Gulf Coast. Graterol et al. (1996) working in central Nebraska, observed that twin-row soybean only expressed an increase in seed yield over single-row plantings when all growth elements, particularly temperature and soil moisture, were not yield limiting. The objectives of this research were to compare single-row vs. twin-row soybean production of both a MG IV and MG V cultivar at various seeding rates, irrigated, and grown on both a sandy loam soil and a clay soil in a humid subtropical environment.

MATERIALS AND METHODS

The study was conducted at Stoneville, MS during 2008, 2009, and 2010. Two different sites were used for the experiment in 2009 and 2010. The soil at one site was a Beulah fine sandy loam and the other site, was a Sharkey clay. Both sites had previously been in soybeans and were prepared for planting by fall disking followed by forming 40-cm ridges spaced 102 cm apart in late winter using a bedding hipper. Ridges were

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Abbreviations: ESPS, early soybean production system; MG, maturity group.

Table 1. Total days above ≥32.0 and ≥37.5°C, precipitation, and irrigation events on two maturity group × row type × seeding rate experiments conducted at Stoneville, MS.

Year	Month	Days ≥32.0°C	Days >37.5°C	Precipitation	Irrigations	Total water
				mm	25 mm	mm
2008	April	0	0	23		23
	May	4	0	235		235
	June	25	0	11	1	36
	July	31	4	42	3	118
	August	18	1	153		153
						Total = 565
2009	April	0	0	58		58
	May	0	0	343		343
	June	24	2	7	3	83
	July	16	1	222	1	247
	August	20	0	36		36
						Total = 767
2010	April	0	0	32		32
	May	9	0	134		134
	June	27	2	32	3	108
	July	29	1	48	2	73
	August	30	13	7	1	32
						Total = 379

later prepared for planting by harrowing immediately before seeding to form a seedbed approximately 40 cm wide.

The experimental design used in this study was a split-plot in a randomized complete block replicated four times. Whole plots were one of two cultivars, Armor GP-533 (Armor Seed Company, Waldenburg, AR)[1] rated as a mid-MG V requiring 142 d to maturity in the Mid-South (Levy et al., 2008) and Pioneer brand 94M80 (Pioneer Hi-Bred Int., Huntsville, AL)[1] rated as an late MG IV requiring 124 d to maturity, which were assigned at random within each block. Subplots were assigned at random within each whole plot and consisted of a combination of either a single- or twin-row planting configuration and a seeding rate of 20, 30, 40, or 50 seeds m^{-2}. Plant growth stages in this research are those defined by Pedersen (2004). Individual plots were four ridges wide planted 11 m long and end-trimmed to 9 m at the V4 growth stage (four fully developed trifolioate leaf nodes). Single-row plantings were made using an Almaco cone plot planter (Allen Machine Company, Neveda, IA)[1] and twin-row plots were planted with a four unit Monosem NG-3 (Monosem Edwardsville, KS)[1] twin-row vacuum planter set on 102 cm centers between planting units and 25 cm between rows within a unit. Seeding depth on the Beulah fine sandy loam site was adjusted to place the seed in approximately 25 mm of moist soil to facilitate germination (Ashlock et al., 2006). Planting occurred at this site on 16 Apr. 2008, 18 Apr. 2009, and 14 Apr. 2010. On the Sharkey clay site seed were placed approximately 15 mm in the muck according to recommendations by Ashlock et al. (2006) with planting occurring on 22 Apr. 2009 and 12 Apr. 2010.

[1]Trade names are used in this publication solely for the purpose of providing specific information. Mention of a trade name, propriety product, or specific equipment does not constitute a guarantee or warranty by the USDA-Agricultural Research Service and does not imply approval of the named product to exclusion of other similar products.

Soil tests taken at both sites before winter tillage indicated no need for supplemental fertilizer applications to achieve a 4.0 Mg ha^{-1} seed yield (Blaine et al., 2010). Weed control was achieved at both sites by a pre-plant application of trifluralin [2,6-Dinitro-*N*,*N*-dipropyl-4-(trifluoromethyl)aniline] at 0.7 kg ai ha^{-1} followed by two postemergence applications of metolachlor [2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy- 1-methylethyl) acetamide] and glyphosate [2-[(phosphonomethyl)amino]acetic acid] at factory label recommended rates, one at growth stage V2 to V3 (two to three trifolioates) and the second one at V5 to V6 (five to six trifolioates). Pyraclostrobin (carbamic acid, [[[1-(4-cholrophenyl)-H-pyrazol-3-yl]oxy]methyl]phenyl]methoxy-,methyl ester) (BASF, Research Triangle, NC)[1] was also applied at factory label directions at V5 to V6 for control of fungal diseases.

Plots at both sites were furrow irrigated beginning at R1 (beginning flowering) and continuing to R6 (green seed fills pods in upper most four nodes) as shared irrigation equipment became available. The equivalent of approximately 25 mm ha^{-1} of water was applied at approximately 10 d intervals or 10 d after a rain event of 25 mm or more. Data collected included plants m^{-2} at growth stage R4 (2 cm pod at one of four upper most nodes) acquired by counting the plants within an m^2 area near the center of each plot, and nodes and pods $plant^{-1}$ at R6 (full seed) of four randomly select plants in the interior of each plot. Seed yield and seed moisture content at harvest were determined with a Kincaid 8-XP[1] combine equipped with a Juniper Systems[1] Single HCGG Harvest Data System and seed weight by counting and weighing 100 seeds dried at 50°C for 24 h. Seed yields were adjusted to a standard moisture level of 130 g kg^{-1}. Seeds produced per m^2 (seeds m^{-2}) were estimated using yield data per plot and corresponding seed weight. Data were analyzed using PROC MIXED of SAS (Statistical Analysis System, Research Triangle, NC)[1]. Sites were analyzed separately and reported as such. Year at both sites was considered and analyzed as a fixed effect. Minimum probability levels for reporting significant differences and performing means separation by LSD were set at $P \leq 0.05$.

RESULTS AND DISCUSSION

Climatic conditions during the three growing seasons of the experiment varied considerably. Days ≥32.0 and ≥37.5°C, precipitation totals, and irrigation events for each month of the three growing seasons during the experiment are presented in Table 1. Four irrigations were required in 2008 with both June and July being dry and July having 4 d with temperatures ≥37.5°C. In 2009 May had 343 mm of rain while June was exceptionally dry with only 7 mm of rain, necessitating three irrigations. Then in July 2009 a total of more than 200 mm rain fell along with only 16 d of temperatures ≥32.0°C and only 1 d ≥37.5°C. Rainfall in 2010 was very limited throughout most of the growing season with the total water received by rainfall and irrigation being about half of that from the previous year and about 200 mm less than 2008. Most of June, July, and August of 2010 had daytime maximum temperatures ≥32.0°C with a total of 16 d ≥37.5°C which likely had an adverse effect on crops at both sites.

Established plant density at R4 varied considerably among the seeding rates used in this experiment at both sites (Tables 2 and 3). This was also reflected in most of the data on percent of established plants relative to seeding rates. It is usually assumed that the established plant density of soybean in the Mid-South will be about 80% of the seeding rate (Heatherly et al., 1999). At the Beulah fine sandy loam site the established plant density was greater in the twin-row plantings, than the single-row plantings except at the 50 seed m^{-2} rate in 2008 (Table 2). Purported better singulation of planted seed by vacuum planting systems such the Monosem twin-row planter may have contributed to these observed differences. In 2010 both the mean established plant density and percentage to seeding rates were lower than in the previous 2 yr except in twin-rows at the 20 seeds m^{-2} seeding rate. This was probably due to there being less rainfall between planting and growth stage V1 (first trifoliate) in 2010 (see Table 1) which occurred in mid-May. This was particularly true with the single-row plantings of 2010 where there was likely more intra-row competition between plants for the limited available moisture.

At the Sharkey clay site in 2009 the established plant density was higher in the twin-rows than the single-row plantings except at the 20 seeds m^{-2} seeding rate (Table 3). A similar trend was noted in 2010 except the twin-row plantings were higher for all seeding rates except at 40 seed m^{-2}. The relatively established plant density to seeding rate had significant differences among the means. However no clear trend was evident though seeding rates >20 seeds m^{-2} in both row configurations at this site were less than the 80% usually assumed for soybeans planted in the Mid-South (Heatherly et al., 1999).

Data on nodes plant^{-1} and pods plant^{-1} yielded a limited amount of information. Though there were statistically significant interactions in the nodes plant^{-1} data (Table 2), after rounding to the nearest whole number, the only meaningful observed difference was among cultivars. The cultivar 94M80 averaged 20 nodes plant^{-1} while GP-533 averaged 15 nodes plant^{-1} from both the Beulah fine sandy loam and Sharkey clay, across all seeding rates, all years, and both row types. Increased seeding rates had no effect on nodes plant^{-1} with a mean of 17 nodes produced at all seeding rates by plants grown on the sandy loam and 18 nodes plant^{-1} produced at all seeding rates by plants grown on the clay (Table 4). Data on pods plant^{-1} had statistically significant interactions but lacked explainable differences that would merit discussion beyond those of the main effects (Table 2). With respect to pods plant^{-1}, over the course of the experiment both cultivars produced 59 pods plant^{-1} on the Beulah fine sandy loam, while GP-533 produced an average 70 pods plant^{-1} on the Sharkey clay vs. 63 pods plant^{-1} for 94M80. At both sites twin-row plantings tended to produce fewer pods plant^{-1} than single-row plantings with 57 vs. 61 pods plant^{-1} on the Beulah sandy loam and 63 vs. 70 pods plant^{-1} on the Sharkey clay. This is contrary to what has been reported by Bell (2005). Seeding rates of 50 seed m^{-2} produced fewer pods plant^{-1} than 20 seeds m^{-2} at both sites (Table 4). These data are similar to those reported by Ball et al. (2001), who observed increased soybean yields were related to increased plant densities which increased fertile nodes m^{-2} and pods m^{-2} but that pods per fertile node were negatively correlated with plant density.

Seed yields for twin-row plantings were approximately 6% greater for both cultivars at all seeding rates on the Sharkey clay except for GP-533 at the 20 seed m^{-2} rate (Table 2 and Table 5). However, differences in seed yield were not observed in either single-row or twin-row plantings among the different seeding rates of each cultivar at this site. Among cultivars grown on the Sharkey clay site, 94M80 had about 10% greater yields than GP-533.

Similar observations were made at the Beulah fine sandy loam site with respect to cultivar yields (Table 5). The cultivar 94M80 produced about 25% greater yields at all seeding rates than did the GP-533. However, twin-row plantings of 94M80 only yielded more than the single-row plantings at the 40 seeds m^{-2} and 50 seeds m^{-2} seeding rates. In fact, at the 20 seeds m^{-2} seeding rate, the single-row planting of 94M80 produced a 6% greater yield than the twin-row planting. Within twin-row plantings the 40 and 50 seeds m^{-2} rates did have higher yields than at 20 seeds m^{-2} rate for 94M80 but not more than the 30 seeds m^{-2} rate. No differences among seeding rates in either single-row or twin-row plantings or between single-row and twin-row plantings at individual seeding rates of GP-533 were observed. This observation is similar to that reported by Mascagni et al. (2008), regarding a MG IV soybean cultivar grown in single- vs. twin-rows at different locations.

Across years seed yields of 94M80 ranged from 1.0 to 1.6 Mg ha^{-1} greater than in GP-533 all 3 yr of the study at the Beulah fine sandy loam site (Table 6). Seed yields were also 15 to 20% less at this site in 2010 for both cultivars than they were the previous 2 yr, most likely due to there being less soil moisture and a greater number of days with temperatures ≥37.5°C compared to the previous two. At the Sharkey clay site seed yields were greater for GP-533 in 2009 (4.4 Mg ha^{-1}) than in 2010 (3.9 Mg ha^{-1}) but did not differ among years for 94M80 (4.7 Mg ha^{-1}) (Table 6). Again the lower total rainfall and higher temperatures experienced in 2010 compared to 2009 probably contributed to the lower yield observed for GP-533 at this site as well. Maturity Group V soybean cultivars grown in the lower Mississippi River Valley and planted in mid-April can begin filling seed (R5) 4 to 21 d later than a MG IV cultivar (Heatherly, 1999). By requiring about 18 d more to mature than 94M80 (Levy et al., 2008), GP-533 was likely exposed to more heat and drought stress in

Table 2. Type three tests of fixed effects and covariance parameter estimates of two soybean cultivar × row type × seeding rate experiments conducted at Stoneville, MS on a Beulah fine sandy loam soil in 2008, 2009, and 2010 and a Sharkey clay soil in 2009 and 2010.

		Beulah fine sandy loam						
		Yield	Plants m^{-2}	Percent estimated plants	Pods $plant^{-1}$	Nodes $plant^{-1}$	Seed wt.	Seeds m^{-2}
Source	**DF**	$P > F$	$P > F$	$P > F$	$P > F$	$P > F$	$P > F$	$P > F$
Cultivar	1	≤0.010	≤0.010	≤0.010	0.686	≤0.010	≤0.010	≤0.010
Seeding rate	3	0.755	≤0.010	≤0.010	≤0.010	0.063	0.910	0.702
Row type	1	0.102	≤0.010	≤0.010	0.019	0.017	0.178	0.013
Year	2	≤0.010	≤0.010	≤0.010	≤0.010	≤0.010	≤0.010	≤0.010
Year × row type	2	0.897	≤0.010	≤0.010	0.045	0.076	0.198	0.343
Cultivar × row type	1	0.626	0.076	0.084	0.298	≤0.010	0.764	0.529
Seeding rate × row type	3	0.265	0.568	≤0.010	0.063	0.583	0.711	0.633
Cultivar × seeding rate	3	0.621	0.667	0.997	0.835	0.558	0.793	0.774
Cultivar × year	2	≤0.010	≤0.010	≤0.010	≤0.010	≤0.010	≤0.010	≤0.010
Seeding rate × year	6	0.886	≤0.010	0.016	≤0.010	0.100	0.807	0.888
Cultivar × seeding rate × row type	3	0.032	0.428	0.765	0.428	0.719	0.146	0.296
Cultivar × seeding rate × year	6	0.334	0.326	0.243	0.092	0.621	0.975	0.253
Cultivar × year × row type	2	0.946	0.474	0.381	0.164	≤0.010	0.563	0.968
Seeding rate × year × row type	6	0.795	0.050	≤0.010	0.135	0.972	0.970	0.884
Cultivar × seeding rate × year × row type	6	0.401	0.363	0.153	0.413	≤0.010	0.639	0.534
Components of variance for random effects		Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
σ Seeding rate × Rep(Year)		0.015	0	5.70	0	0	1.27	1167.8
σ Rep(Year)		0.015	0	0	0	0	0	6404.67
σ Residual		0.25	12.2	84.78	202.5	3.1	11.74	107024
		Sharkey clay						
Cultivar	1	≤0.010	0.034	0.058	0.016	≤0.010	≤0.010	≤0.010
Seeding rate	3	0.037	≤0.010	≤0.010	0.052	0.118	0.678	0.059
Row type	1	≤0.010	≤0.010	≤0.010	≤0.010	0.290	0.112	≤0.010
Year	1	≤0.010	0.769	0.681	0.236	≤0.010	≤0.010	≤0.010
Year × row type	1	≤0.010	0.016	0.127	0.140	0.290	≤0.010	0.227
Cultivar × row type	1	≤0.010	0.636	0.300	0.203	0.109	0.890	≤0.010
Seeding rate × row type	3	0.407	0.603	0.958	0.925	0.519	0.879	0.567
Cultivar × seeding rate	3	0.468	0.751	0.848	0.686	0.194	0.147	0.440
Cultivar × year	1	≤0.010	0.636	0.569	≤0.010	≤0.010	0.262	≤0.010
Seeding rate × year	3	0.981	0.035	≤0.010	0.890	0.938	0.780	0.936
Cultivar × seeding rate × row type	3	0.541	0.157	0.092	0.251	0.698	0.399	0.539
Cultivar × seeding rate × year	3	0.643	0.342	0.401	0.123	0.038	0.957	0.688
Seeding rate × year × row type	1	≤0.010	0.291	0.549	0.859	0.310	0.465	0.128
Cultivar × year × row type	3	0.508	0.012	0.037	0.850	0.258	0.308	0.597
Cultivar × seeding rate × year × row type	3	0.253	0.130	0.203	0.886	0.769	0.518	0.624
Components of variance for random effects		Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
σ Seeding Rate*Rep(Year)		0	0	0	84.8	0	0	0
σ Rep(Year)		0.001	0	0	0	0	1.41	0
σ Residual		0.056	15.3	163.21	236	1.9	30	1314.6

2010 during growth stages R5 to R8 which contributed to its lower seed yields at both sites. Also, the lower water holding capacity of the Beulah fine sandy loam compared to the Sharkey clay exposes crops to drought stress more readily which would help explain the observed lower yields in 2010 for both cultivars at that the sandy loam site despite being irrigated.

Seed weights on the Beulah fine sandy loam site in 2010 were from about 20 to 23% less for both cultivars than the previous years (Tables 2 and 6). This was most likely a result of the drought and heat stress in 2010 that was previously described. This reduced seed weight in 2010 would have contributed to the reduced yields observed that year. Cultivar differences in seed weight were observed at this site in individual years but lacked consistency needed to make firm conclusions. At the Sharkey clay site seed weights of 94M80 were consistently greater than for GP-533 which was a contributing factor to the observed yield differences between cultivars (Table 6). Seed weights from this site were also less in 2010 than 2009 which again is likely related to previously reported climatic differences between the 2 yr. However, seed weight differences between 2009 and 2010 for 94M80 did not result in a significant yield difference but was a contributing factor to the lower yield of

Table 3. Established irrigated soybean plants of two cultivars (94M80 and GP-533) at R4 (full pod stage), planted in single- and twin-rows replicated four times on beds of a Beulah fine sandy loam soil and a Sharkey clay soil at Stoneville, MS.

Year	Row type†	20		30		40		50	
Beulah fine sandy loam									
		Seeding rate, seeds m^{-2}							
		plants m^{-2}‡	%§	plants m^{-2}	%	plants m^{-2}	%	plants m^{-2}	%
2008	Single	16	81	21	69	31	79	37	73
	Twin	17	84	25	85	33	83	38	76
2009	Single	14	75	22	74	28	71	36	72
	Twin	20	100	27	89	33	81	41	82
2010	Single	12	60	18	61	20	52	23	45
	Twin	19	95	23	78	27	68	34	68
Sharkey clay									
		Seeding rate, seeds m^{-2}							
Year	Row type†	20		30		40		50	
		plants m^{-2}¶	%#	plants m^{-2}	%	plants m^{-2}	%	plants m^{-2}	%
2009	Single	16	80	17	56	18	45	24	48
	Twin	17	86	22	72	28	70	31	62
2010	Single	12	61	18	66	23	56	28	56
	Twin	16	79	23	77	21	54	31	62

† Single-rows were planted 102 cm apart. Twin-rows were planted on 102 cm centers with 25 cm between planting units.

‡ For comparing means of plants m^{-2} within a row or a column LSD (0.01) = 2.

§ For comparing percent of established plants to seeding rate (stand) within a row or a column LSD (0.01) = 9.

¶ For comparing means of plants m^{-2} within a row or a column LSD (0.01) = 4.

For comparing percent established plants to seeding rate (stand) LSD (0.01) = 12.

GP-533 in 2010 compared to 2009. Seeding rate also had no significant effect on seed weight at either site, either year of the study, or across row type (Table 2). The range in average seed weights among the seeding rates at the Beulah fine sandy loam site was 151 to 152 mg and on the Sharkey clay, 152 to 154 mg.

Seeds produced per m^2 were calculated from total seed yield data and weights per seed. Seeds per m^2 for 94M80 were consistently greater than those for GP-533 for all 3 yr of the experiment conducted on the Beulah fine sandy loam (Tables 2 and 6). Seeds per m^2 for both 94M80 and GP-533 were greater in 2008 than 2009 but no differences in seeds per m^2 were observed between 2009 and 2010 for either cultivar. The seeds per m^2 produced by GP-533 in 2008 also did not differ from those produced by it in 2010. In 2008 greater seeds per m^2 for 94M80 compensated for the observed lower seed weight compared to that of GP-533 and resulted in a greater yield. Seed production per m^2 on the Sharkey clay site was greater for GP-533 than 94M80 in 2009, though seed yields were the opposite (Table 6). The greater seed weight of 94M80 evidently compensated sufficiently to make the greater contribution to yield and thus resulted in the higher

Table 4. Pods per plant of two irrigated soybean cultivars (94M80 and GP-533) grown at different seeding rates in single- and twin-rows on beds on two soils at Stoneville, MS.†

	Seeding rate, seeds m^{-2}							
	20		**30**		**40**		**50**	
Soil type	Nodes $plant^{-1}$	Pods $plant^{-1}$	Nodes $plant^{-1}$	Pods $plant^{-1}$	Nodes $plant^{-1}$	Pods $plant^{-1}$	Nodes $plant^{-1}$	Pods $plant^{-1}$
Beulah fine sandy loam	17	63‡	17	60‡	17	59‡	17	53‡
Sharkey clay	18	75§	18	70§	18	62§	18	59§

† Means of four replications.

‡ Mean of 3 yr (2008, 2009, and 2010) to compare means within the row LSD (0.01) = 5.

§ Mean of 2 yr (2009 and 2010) to compare means within the row LSD (0.01) = 12.

Table 5. Seed yields of two irrigated soybean cultivars grown at different seeding rates in single- and twin-rows on beds of a Beulah fine sandy loam soil and a Sharkey clay soil at Stoneville, MS.

		Yield, Mg ha^{-1}							
		Seeding rate, seeds m^{-2}							
	Row	**20**	**30**	**40**	**50**	**20**	**30**	**40**	**50**
Cultivar	**type**	**Beulah fine sandy loam†**				**Sharkey Clay‡**			
94M80	Single	4.8	4.7	4.3	4.5	4.3	4.5	4.3	4.6
	Twin	4.5	4.7	4.8	4.9	4.5	4.9	5.0	5.0
GP-533	Single	3.3	3.3	3.5	3.4	4.1	4.0	4.0	4.1
	Twin	3.5	3.4	3.4	3.6	4.2	4.3	4.2	4.3

† Means of 3 yr (2008, 2009, and 2010) and four replications. To compare means within a column or a row LSD (0.05) = 0.3.

‡ Means of 2 yr (2009 and 2010) and four replications. To compare means within a column or a row LSD (0.05) = 0.2.

Table 6. Seed yield, seed weight, seeds produced per m^2 of two soybean cultivars grown on a Beulah fine sandy loam soil and a Sharkey clay soil at Stoneville, MS.†

Year	Cultivar	Beulah fine sandy loam			Sharkey clay		
		Yield	Seed wt.	Seed	Yield	Seed wt.	Seed
		Mg ha^{-1}	mg	m^{-2}	Mg ha^{-1}	mg	m^{-2}
2008	94M80	5.0	151	3342			
	GP-533	4.0	160	2493			
2009	94M80	5.0	177	2831	4.7	179	2605
	GP-533	3.4	158	2170	4.4	154	2918
2010	94M80	4.0	140	2820	4.6	151	3059
	GP-533	2.9	123	2348	3.9	128	3061
LSD (0.01)‡ =		1.0	5	260	0.2	3	144

† Means of both single-row and twin-row plantings on 102 cm beds, four seeding rates (20, 30, 40, and 50 seeds m^{-2}), and four replications.

‡ LSD is for comparing means within a column, both between cultivars within a year and a cultivar across years.

yield for 94M80 that year. No differences in seeds per m^2 were observed between the cultivars in 2010 and the observed differences in yield corresponded with the observed differences in seed weight that year at this location.

Twin-row plantings produced more seed per m^2 than single row plantings on both soil types (Table 2). A mean of 2727 seed m^{-2} were produced by twin-row plantings on the Beulah fine sandy loam as opposed to 2608 seed m^{-2} in single rows at that site. At the Sharkey clay site twin-rows produced an average of 3027 seed m^{-2} vs. 2794 for single-row plantings. This helps explain the higher yields observed in twin- vs. single-row plantings in this experiment. Because there were fewer pods $plant^{-1}$ produced by twin-row plantings than single row plantings in this experiment, the greater numbers of established plants in the twin-rows compared to the single-row plantings resulted in more seed per m^{-2}.

This experiment demonstrates that seed yields of soybean grown using the ESPS in twin-rows can be more than 10% greater than those from single-row plantings in a humid subtropical environment. However, such a difference may be cultivar dependent and/or vary with the soil type in which the crop is grown. These findings are similar to those described by Bell, (2005), who report 2 to 10% yield increases, Grichar, (2007), who observed 0 to 23% yield increases and Mascagni et al. (2008) who observed 0 to 13% yield increases with twin-row plantings over single-row seedings. Equally important though is there were no yield increases in either row configuration as seeding rates increased beyond 30 seeds m^{-2} on either soil.

Before the current high seed and fuel costs, seeding rates on many farms in the lower Mississippi River Valley, like in other soybean production areas, were generally more than 30 seed m^{-2}, especially on fine sandy soils (Nafziger, 2005). This was "insurance" against stand losses due to crusting of these soils after heavy spring rains which impair emergence and reduce stands. Seeding rates above 30 seeds m^{-2} are believed to better break through such crust and avoid the need to do an expensive replant.

Sharkey clay cracks as it dries and tillage to prepare a seedbed facilitates soil moisture loss below the planting zone cause poor germination and thus reduce stands (Elmore and Heatherly, 1988). Careful selection of a seeding depth in clay soils that places the seed in about 15 mm of moist soil is vital to completing emergence and is as critical to stand establishment as seeding rate (Ashlock et al.,2006). Heatherly et al. (1999), states that seldom do emergence rates equal seeding rates, and that seeding rates in production situations should be adjusted for both the relative germination rate of the seed to be planted, and the projected emergence failure in a particular soil. These data do not address the concerns of poor stand establishment by the factors just mentioned, but based on these data and the current high cost of seed and fuel, seeding rates above 30 seeds m^{-2} in either soil are most likely going to be less profitable.

Based on a value of \$375.00 Mg^{-1} paid for soybean during most of the 2010 harvest season (Index Mundi, 2011), the range of increased gross value of the twin-row production over single-rows in this experiment, among both sites and all seeding rates, was \$0.00 to \$262.00 ha^{-1}. With the more common seeding rate currently being used in the Mississippi Delta of 30 seeds m^{-2}, there was no gross income advantage of twin-rows over single-rows at the sandy loam site with either cultivar and a \$150.00 ha^{-1} advantage for 94M80 only on the Sharkey clay. These data do not strongly support a transition to twin-row soybean production as a means of consistently increasing seed yields and thus profits, neither does it discourage the use of twin-rows for soybean production. Making a change from single-row soybean production to a twin-row system is a large expense and remains mainly a personal preference. Producers though who grow large hectarages of soybean may more readily recover the cost of the planter and reap the potential financial benefits of increased yields (M. Walker, personal communication, 2011). Versatility of the equipment in the production of other row crops, particularly corn and cotton, should still be considered before making the transition, especially on smaller operations.

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