ADJUSTING MANAGEMENT PRACTICES WHEN PRODUCING GLYPHOSATE-RESISTANT SOYBEAN

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Introduction

The use of glyphosate resistant soybean (GRS) cultivars has increased rapidly from their introduction in 1996 to over 50% of Wisconsin soybean acres in 1999. While much research has been conducted using conventional cultivars to measure the influence of row spacing and seeding rates on soybean growth and yield, little has been done with new GRS cultivars. It may be necessary and/or more profitable to alter management practices with GRS cultivars. For example, does the increased seed costs of GRS cultivars justify decreased seeding rates? Greater seed costs at planting need to be offset by an optimized seeding rate, reduced herbicide costs, and/or increased yields to make GRS systems economically profitable to producers. Evaluating GRS versus conventional soybeans at several row widths and seeding rates will allow for the comparison of these variables measured by their effect on yield, leaf area index, plant height, lodging, disease incidence, and gross margin.

Experimental Methods

Field studies were conducted from 1997-99 at the following Wisconsin locations: Arlington, Janesville, Fond du Lac, Galesville (1998-99), Valders, and Chippewa Falls. At each location, three cultivar/herbicide systems (Table 1) were evaluated using three row spacings and three seeding rates in each row spacing (Table 2). Cultivars were chosen to represent a maturity suitable to each region and were the highest yielding cultivars available at the initiation of the study. Herbicides used in the conventional system were selected to control the spectrum and density of weeds present at each location.

Soybean at the Arlington location was planted using field size equipment and large plots. Soybean at other locations was planted using an experimental plot planter and small plots. Measurements made included emergence (early) and final (late) plant populations, plant height, lodging, leaf area index, seed weight, grain yield, moisture, protein and oil, and disease ratings (if applicable). An economic analysis was performed to determine the gross margin of each system based on the experimental yields and market price minus the seed cost and a sample herbicide system. Costs and prices are shown in Table 3.

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Table 1. Cultivar/herbicide systems used for management of glyphosate-resistant soybean studies, 1997-99.

Cultivar	Herbicide program
Conventional	Conventional
Glyphosate resistant soybeans	Conventional
Glyphosate resistant soybeans	Glyphosate

Table 2. Row spacings and seeding rates used for management of glyphosate-resistant soybean studies, 1997-99.

Row spacing	Seeding rate		
	Low	Medium	High
in	----------	viable seeds acre^{-1}	----------
7.5	175,000	225,000	275,000
15	125,000	175,000	225,000
30	75,000	125,000	175,000

Table 3. Values used for soybean market price, seed cost, and herbicide cost for the gross margin analysis for management of glyphosate-resistant soybean studies, 1997-99.

		Year		
Value	Herbicide System	1997	1998	1999
Market Price ($ bu^{-1})	both	$6.86	$5.65	$5.15 [1/]
Seed Cost ($ lb^{-1}) [2/]	conventional	$0.30	$0.31	$0.32
	GRS	$0.44	$0.45	$0.46
Herbicide Cost ($ acre^{-1}) [3/]	Pursuit Plus (2.5 pt A^{-1}) +Prowl (1 pt A^{-1})	$34.69	$35.21	$24.87
	Roundup Ultra (2 pt A^{-1})	$20.67	$20.76	$17.93

[1/] Reflects loan deficiency payment increase.

[2/] Final seed costs are adjusted for seeding rate and use 2600 and 2800 seeds lb-1 for conventional and glyphosate-resistant soybean cultivars, respectively.

[3/] Boerboom et al., 1997-99. Pest Management in Wisconsin Field Crops.

Results and Discussion

Effect of cultivar/herbicide system on yield

At three locations (Arlington, Janesville, and Fond du Lac) soybean planted in the conventional cultivar/conventional herbicide (CN/CN) system had greater yields than when using either of the GRS systems (Table 4). At Fond du Lac, the GRS with glyphosate (GRS/glyt) system outyielded the GRS/CN system. There was no difference between yields in the GRS/glyt and GRS/CN systems at Arlington and Janesville. Galesville had opposite results, with soybeans planted in the GRS/glyt system yielding the highest, followed by the CN/CN system and then the GRS/CN system. This was likely due to a thifensulfuron application in both 1998 and 1999 which was needed to control common lambsquarters. At Valders and Chippewa Falls, there were no significant differences between the two production systems. The lack of yield difference may have been due to the use of a slightly longer maturity GRS cultivar (M.G. 1.4) compared to the CN cultivar (M.G. 1.2).

Table 4. Yield of soybeans planted in three cultivar/ herbicide systems at six Wisconsin locations (averaged over three row spacings, three seeding rates and three years).

Cult./Herb. System	Location						Mean
	ARL	JAN	FDL	GAL[1/]	VAL	CHP	
	bu acre^{-1}						
CN/CN	62.0 [a]	70.6 [a]	64.7 [a]	51.2 [b]	55.9	41.3	58.0
GRS/CN	57.7 [b]	66.2 [b]	61.1 [c]	47.5 [c]	52.8	39.1	54.5
GRS/glyt	58.1 [b]	66.2 [b]	62.9 [b]	54.1 [a]	55.9	43.5	56.9
LSD (0.10)	1.5	1.4	1.5	1.6	NS	NS	
Mean	59.3	67.7	62.9	50.9	54.8	41.3	56.5

[1/] Averaged over two years at Galesville location.

-Numbers within columns followed by the same letter are not significantly different at *P* =0.10 by Fisher's Protected LSD.

Effect of row spacing x cultivar/herbicide system on yield and gross margin

Yield and gross margin was greatest for soybean grown in 15 in. rows (Figures 1,2). This was true for all cultivar/herbicide systems, with the exception that yield was not different between the 15 and 7.5 in. rows in the GRS/CN system. Soybean yield decreased 3% and 4% when using a GRS/glyt and CN/CN system, respectively, with 7.5 in. compared with 15 in. row spacings. Soybean yield was lower when using 30 in. rows compared with 15 or 7.5 in. rows in all three systems. Soybean yield and gross margin was less in the GRS/glyt system compared with the CN/CN system for both 7.5 and 15 in. rows. However, soybean yield was unchanged between the systems for 30 in. spacings and gross margin was higher for soybeans grown in the GRS/glyt system compared with the CN/CN system. This result was not expected, but it may be explained by the less competitive nature of soybean in 30 in. rows.

Effect of seeding rate x cultivar/herbicide system on yield and gross margin

Soybean yield decreased in all three systems when seeding rates were reduced from high or medium rates to low rates (Figure 3). In the GRS/CN system, yield decreased with each incremental decrease in seeding rate, whereas yield was the same between high and medium rates in the other systems. Decreasing seeding rates did not impact yield as much in the GRS/glyt system compared to the CN/CN system. Yields were reduced 4% by decreasing from a medium to low seeding rate in the CN/CN system compared to 2% in the GRS/glyt system.

The most profitable seeding rates were the medium and high rates in the CN/CN system and the low and medium rates in the GRS/glyt system (Figure 4). All of these combinations resulted in gross margin returns of $284 to $288/acre when averaged over locations and row spacings. Gross margin was less in the GRS/CN system regardless of seeding rate and was not affected by seeding rate.

Effect of row spacing x seeding rate on yield and gross margin

Soybean planted in 15 in. rows had the highest yield, regardless of seeding rate (Figure 5). Soybean in both 7.5 and 15 in. rows did not vary in yield between the high and medium seeding rates, but planting in low seeding rates resulted in decreased yields. Soybean planted in 30 in rows yielded the least, regardless of seeding rate. Soybeans planted using a common seeding rate of 175,000 viable seeds/acre yielded the best in 15 in. rows, followed by 7.5 and 30 in. rows. Soybean planted at low and medium rates had the highest gross margins in both 7.5 and 15 in. row spacings (Figure 6). Soybeans grown in 30 in. rows had the greatest gross margins at medium and high seeding rates. Gross margins were greatest in 15" rows, regardless of seeding rate.

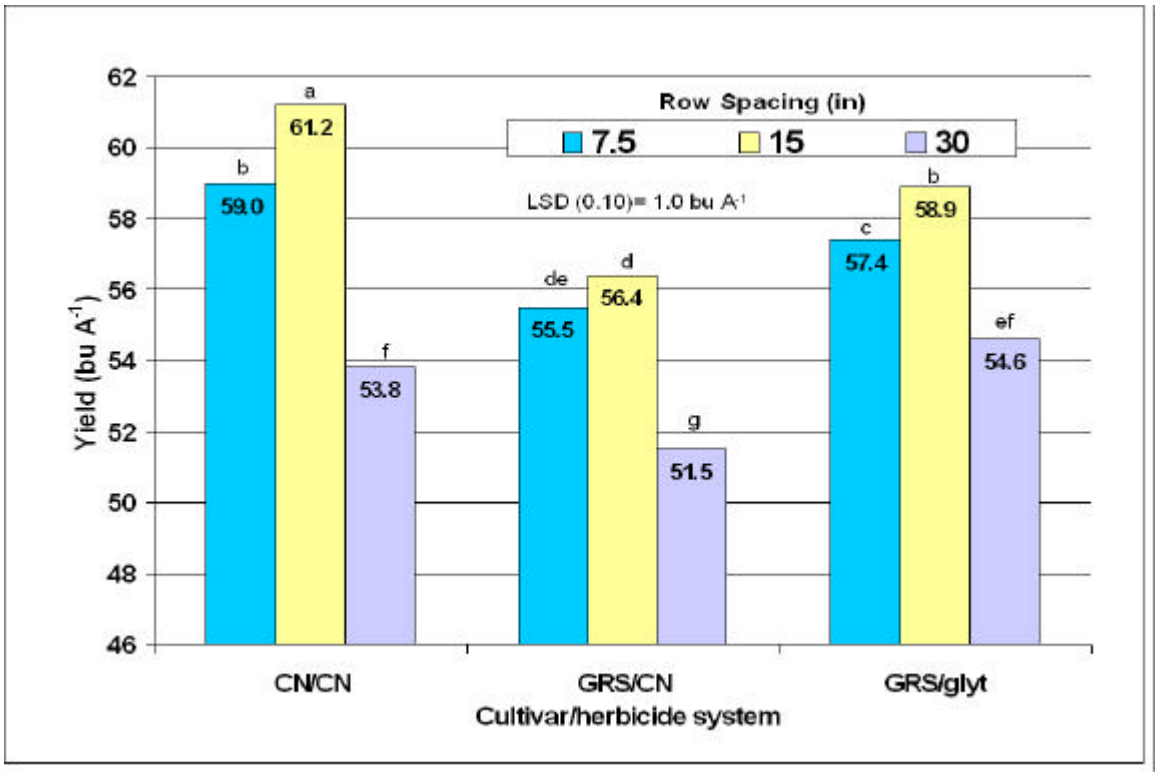

Figure 1. Yield of soybean in three cultivar/herbicide systems and three row spacings, (averaged over three seeding rates, six locations, and three years).

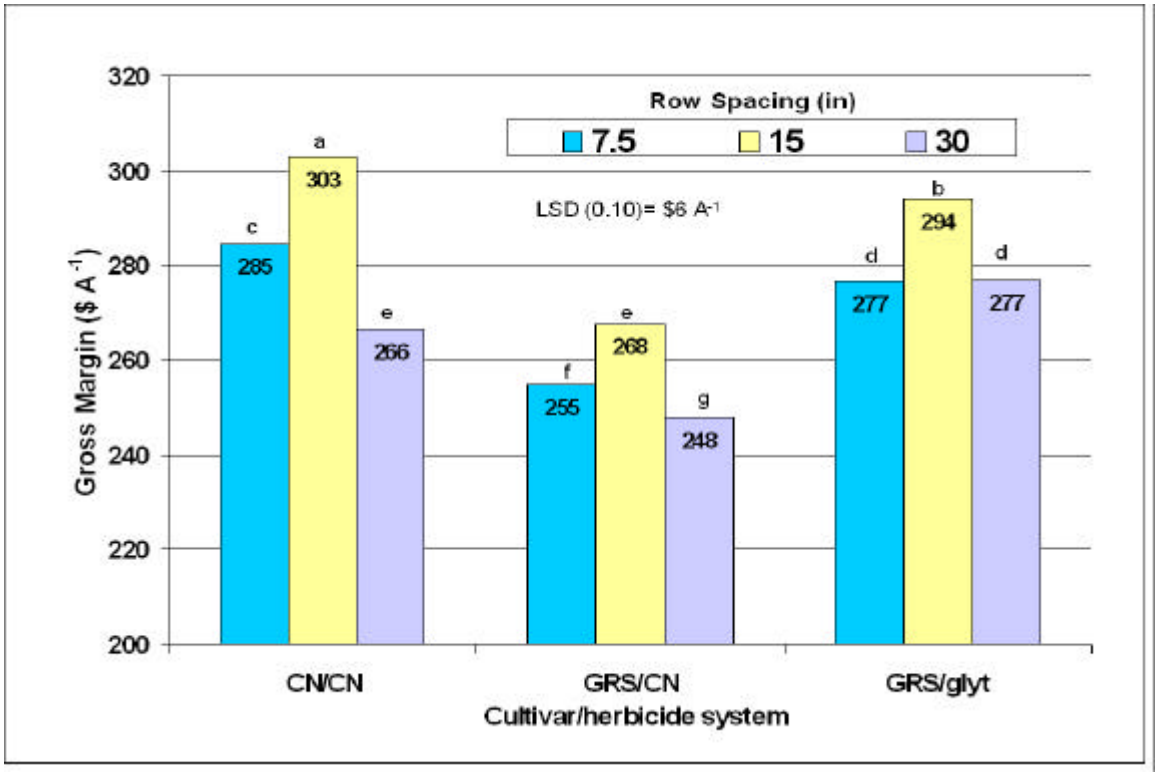

Figure 2. Gross margin of soybean in three cultivar/herbicide systems and three row spacings, (averaged over three seeding rates, six locations, and three years).

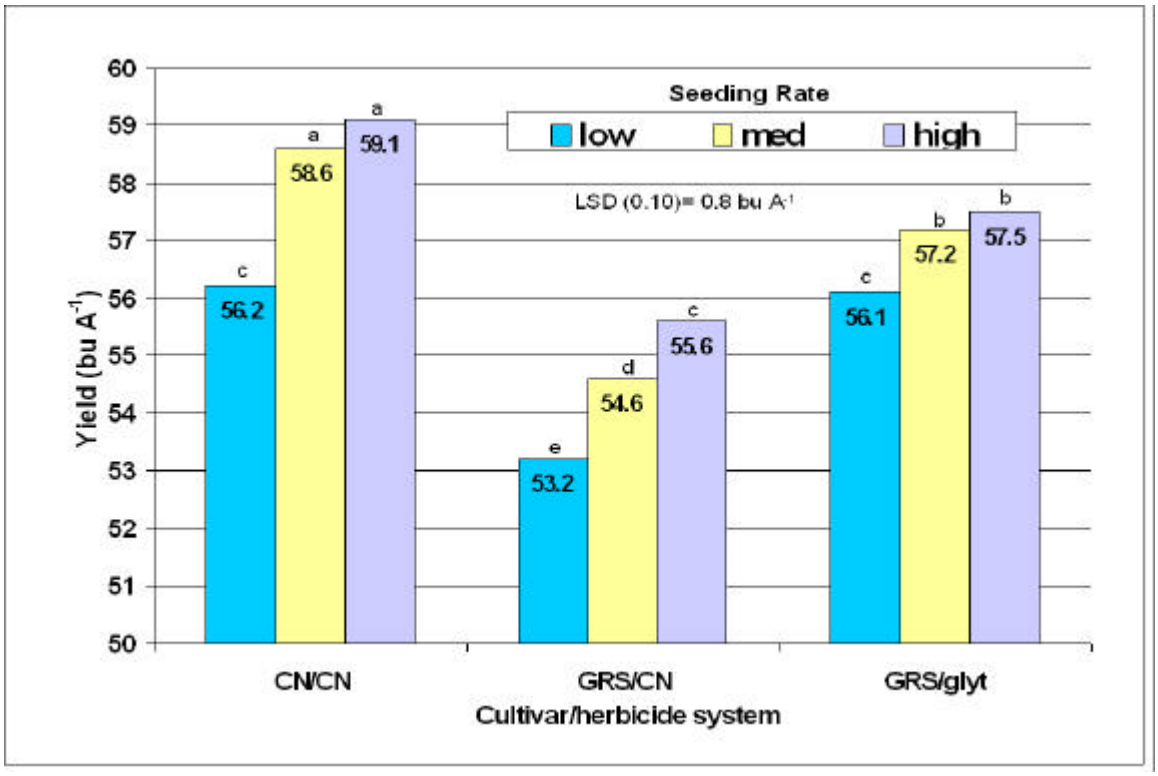

Figure 3. Yield of soybean in three cultivar/herbicide systems and three seeding rates, (averaged over three row spacings, six locations, and three years).

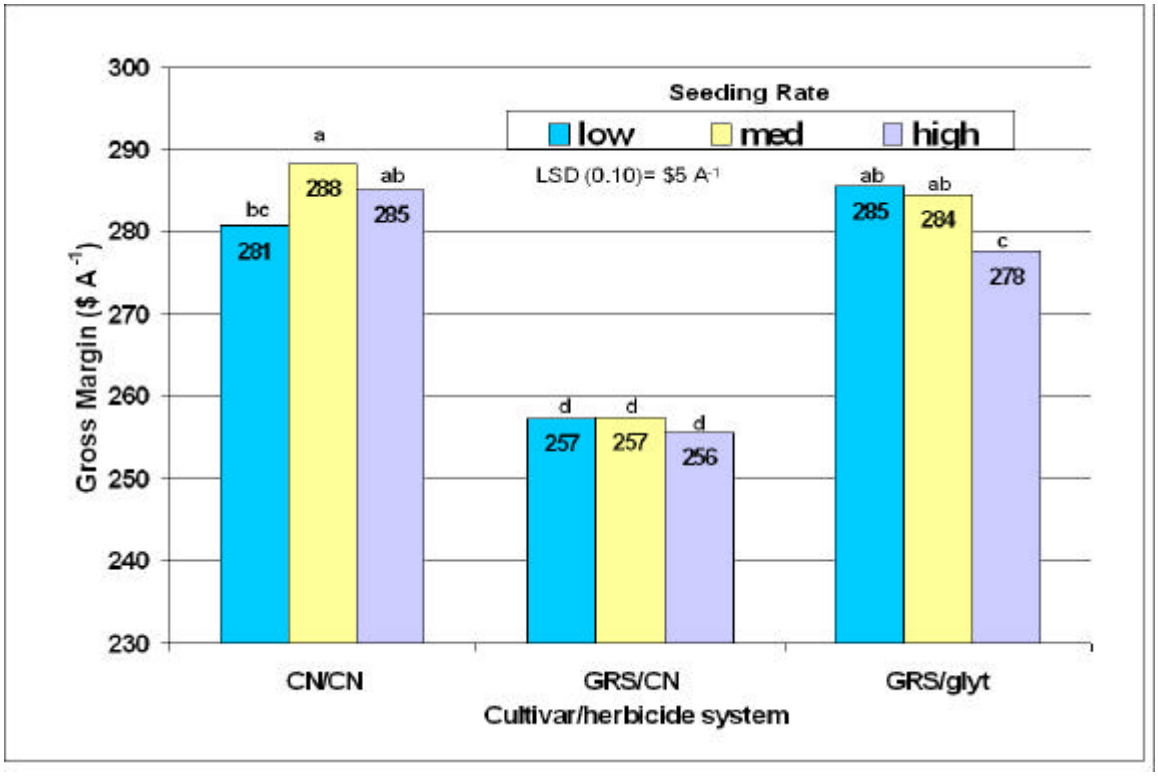

Figure 4. Gross margin of soybean in three cultivar/herbicide systems and three seeding rates, (averaged over three row spacings, six locations, and three years).

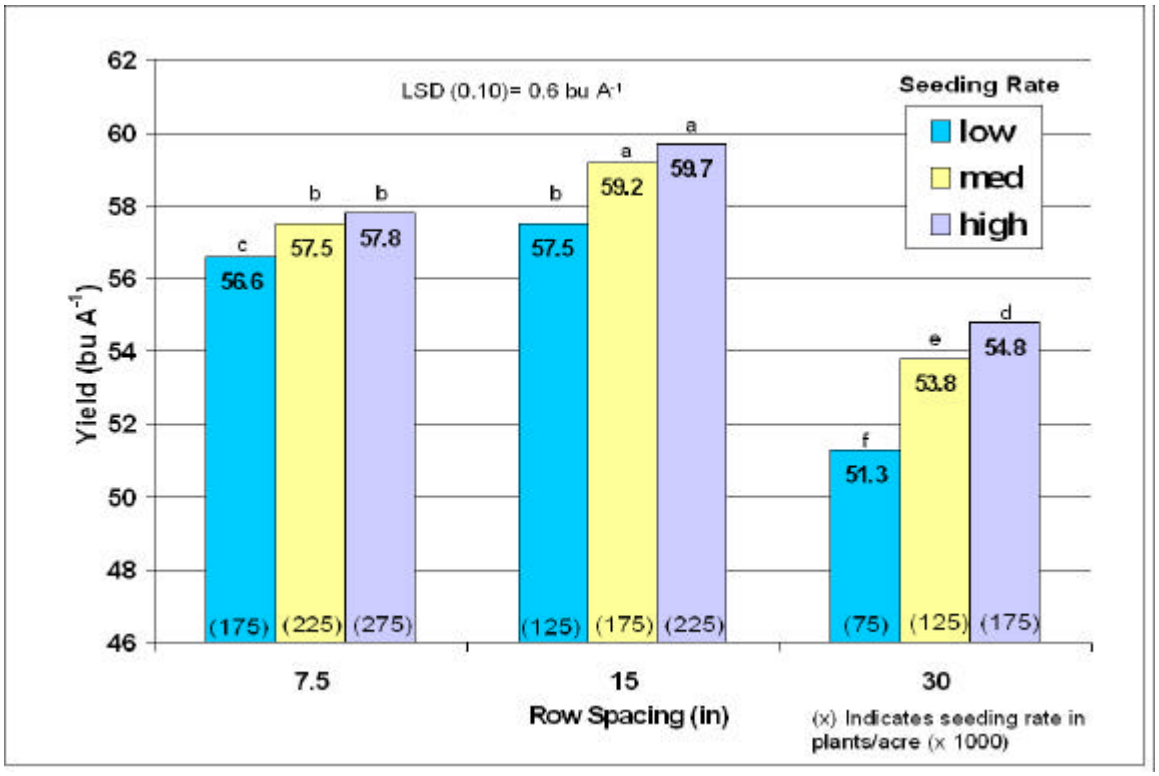

Figure 5. Yield of soybean in three row spacings and three seeding rates, (averaged over three cultivar/herbicide systems, six locations, and three years).

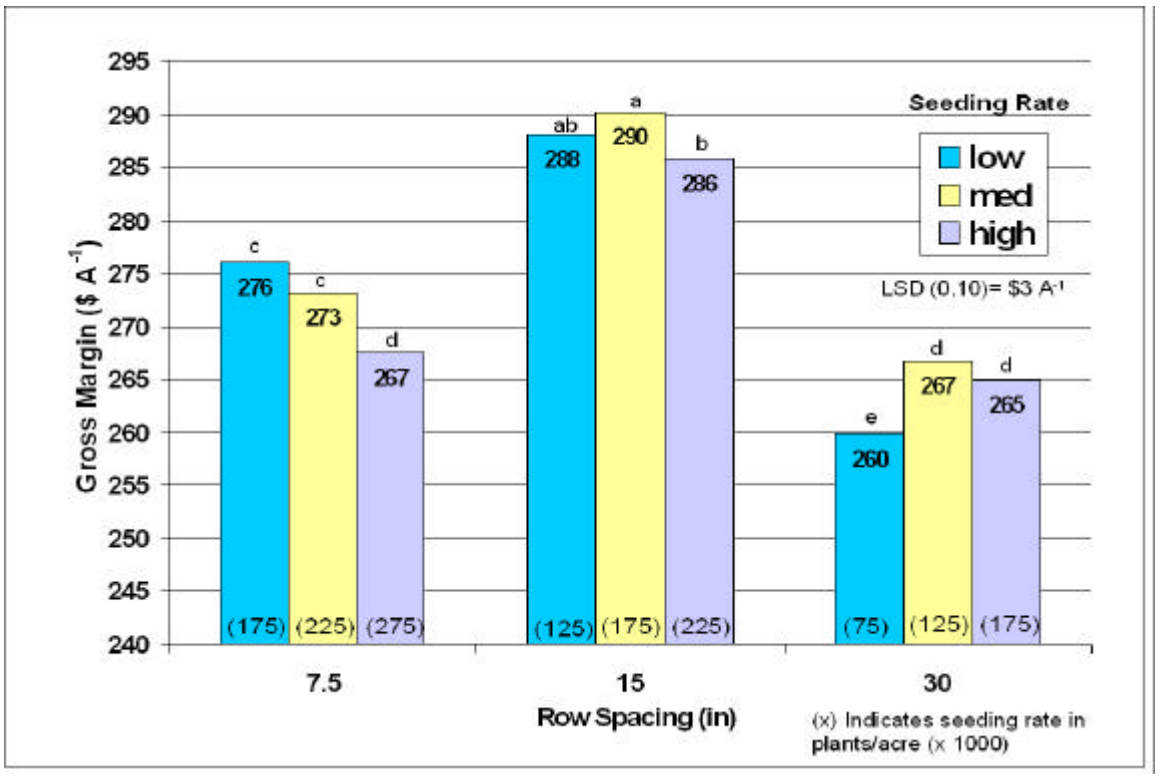

Figure 6. Gross margin of soybean in three row spacings and three seeding rates, (averaged over three cultivar/herbicide systems, six locations, and three years).

Effect of row spacing x seeding rate x cultivar/herbicide system on yield and gross margin

Mean yields and gross margin for the interaction of row spacing and seeding rate on the CN/CN and GRS/glyt system are presented in Tables 5 and 6. These results varied across locations. Many of the values do not vary much numerically. At most locations gross margin in the 7.5 and 15 in. rows increased as seeding rates decrease in the GRS/glyt system. Soybeans grown in 30 in. rows also had higher yields and gross margins in the GRS/glyt system, compared with the CN/CN system, regardless of seeding rate when averaged over all locations.

Table 5. Yield of soybean in two cultivar/herbicide systems, three row spacings, and three seeding rates at six Wisconsin locations (averaged three years) and total (averaged over six locations and three years).

		Location													
		ARL		JAN		FDL		GAL		VAL		CHP		Total	
Row	Seeding	CN/	GRS/	CN/	GRS/	CN/	GRS/	CN/	GRS/	CN/	GRS/	CN/	GRS/	CN/	GRS/
Spacing	Rate	CN	glyt	CN	glyt	CN	glyt	CN	glyt	CN	glyt	CN	glyt	CN	glyt
in		bu acre^{-1}													
7.5	low	59.8	56.1	68.7	66.7	63.7	63.4	52.8	52.6	57.0	57.6	41.2	46.3	57.4	57.4
	med	61.5	56.0	71.1	67.0	67.0	66.1	54.1	54.5	58.0	56.5	43.3	45.6	59.5	57.8
	high	62.3	55.7	71.6	66.7	67.9	65.3	53.8	56.5	58.7	54.7	44.2	43.0	60.1	57.0
15	low	63.1	60.2	76.1	67.5	65.5	63.1	53.1	55.1	57.7	58.0	41.7	44.7	59.9	58.3
	med	67.5	61.7	75.2	66.2	68.6	64.5	56.9	55.5	56.2	58.3	43.0	44.8	61.5	58.7
	high	65.3	61.5	75.8	70.4	67.9	64.8	56.6	58.0	60.3	59.7	45.2	43.7	62.1	59.8
30	low	56.8	55.4	65.3	62.7	59.0	57.4	41.6	49.8	47.2	48.4	35.2	41.0	51.4	52.6
	med	60.3	57.8	65.6	64.3	61.3	60.6	45.1	51.8	55.5	54.2	38.5	41.9	54.9	55.3
	high	61.2	58.9	66.3	64.7	61.5	60.7	47.0	53.2	52.2	55.3	39.8	40.9	55.1	55.8
Mean		62.0	58.1	70.6	66.2	64.7	62.9	51.2	54.1	55.9	55.9	41.3	43.5	58.0	56.9

Table 6. Partial return of soybean in two cultivar/herbicide systems, three row spacings, and three seeding rates at six Wisconsin locations (averaged three years) and total (averaged over six locations and three years).

		Location													
		ARL		JAN		FDL		GAL		VAL		CHP		Total	
Row	Seeding	CN/	GRS/	CN/	GRS/	CN/	GRS/	CN/	GRS/	CN/	GRS/	CN/	GRS/	CN/	GRS/
Spacing	Rate	CN	glyt	CN	glyt	CN	glyt	CN	glyt	CN	glyt	CN	glyt	CN	glyt
in		$ acre^{-1}													
7.5	low	295	275	344	338	323	324	235	237	281	289	197	229	282	285
	med	298	267	353	332	336	332	236	240	284	274	203	218	288	279
	high	298	256	349	321	334	319	228	244	280	256	202	194	285	266
15	low	321	309	395	352	339	330	243	259	290	298	204	227	302	298
	med	341	310	384	338	348	330	257	254	271	292	207	221	304	293
	high	320	300	380	353	339	321	250	259	292	293	214	206	302	291
30	low	291	291	340	335	308	306	184	239	232	247	170	212	258	274
	med	304	297	336	335	315	315	198	241	277	276	184	210	273	281
	high	303	295	335	331	309	306	203	241	250	275	186	197	268	276
Mean		308	289	357	337	328	320	226	246	273	278	196	213	285	283

Conclusions

- The conventional cultivar/conventional herbicide production system had greater yields and profitability than the GRS system at southern Wisconsin locations, but there was no difference at two northern locations. The GRS system had higher yields and profitability than the CN system at one central Wisconsin location.

- Planting soybeans in 15 in. rows is a viable alternative to traditional methods in both conventional and GRS production systems.

- Using low to medium seeding rates with GRS, especially in 7.5 and 15 in. row spacings, resulted in equal yields and greater profit compared to high seeding rates.

Acknowledgement

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