CCA ADVANTAGE

Continuing Education Self-Study Course

spacing and seeding for g SOYBE

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Glyphosate-resistant soybean is produced in both full-season and double-crop (following small grain) production systems using both conventional tillage and no-till practices in the Mid-Atlantic. Shibles and Weber (1966) reported that to attain maximum yield potential for soybean, it is necessary to establish a leaf area index (LAI) of 3.2 or greater by the R2 reproductive stage as defined by Fehr and Caviness. It has since been learned that a LAI of 3.5 to 4.0 by early reproduction is necessary to achieve 95 percent light interception and that this level of light interception is positively correlated with yield. A number of production practices (choice of relative maturity for cultivars at a location, suitable planting dates, row spacings, and plant populations) that can influence the attainment of the desired LAI have been investigated extensively.

Two commonly used row spacings in the Mid-Atlantic region are 19 and 38 cm (7.5 and 15 in), reflecting farmers' use of either grain drills or splitter-mounted planting units on row crop planters, respectively, for planting soybean. The adoption of narrower row planting has been based upon numerous, favorable reports concerning reduced row spacing for soybean production. The one limitation to these findings regarding narrow-row soybean is that all the studies were done with non-glyphosate-resistant cultivars.

Our study evaluated a range of seeding rates within the two most commonly used row spacings for full-season and double-crop production systems in Maryland. The objectives of this study were (i) determine if seeding rate reductions from the current standards for the two production systems would produce equivalent grain yields to those standards and (ii) determine if the yield potential for soybean produced in the two commonly used narrower row spacings was affected by seeding rates.

MATERIALS AND METHODS

During 2000 through 2002, glyphosate-resistant soybean cultivars were grown under both full-season and double-crop production systems at two locations each year. Whole plots were the two row-spacing treatments (19 and 38 cm). The 19-cm plots consisted of seven rows, and the 38-cm plots had four rows each. Plot length was 7.6 m (25 ft). The split plots were four glyphosate-resistant soybean cultivars. These cultivars represented the range of relative maturity for soybean cultivars commonly grown in Maryland. The split-split plots were the four seeding rate treatments of the (i) the recommended seeding rates for full-season (432,250 seeds ha^{-1}, or 175,000 seeds/A) and double-crop (555,750 seeds ha^{-1}, or 225,000 seeds/A) production systems and rates that were (ii) 40 percent and (iii) 20 percent less than and (iv) 20 percent greater than those two recommended rates. Seeding rate treatments were individually packaged for each plot by counting the appropriate number of live seeds for each cultivar.

The full-season studies were planted into field sites that had been planted to corn the previous year. The double-crop studies were no-till planted into wheat stubble. All other production practices followed standard management procedures for the two cropping systems.

A combined analysis of variance (ANOVA) for each respective cropping system was performed for each year using PROC MIXED procedure. Interactions that occurred were evaluated utilizing the SLICE option of the LSMEANS procedure. A primary objective of this research was to determine if seeding rate reductions from the currently recommended standards for full-season and double-crop production of glyphosate-resistant soybean were a feasible production strategy for reducing input costs.

Fisher's Protected Least Significant Difference Test was utilized in this study for the planned comparisons between the recommended standard seeding rate and each of the three seeding rate treatments evaluated. In addition, orthogonal polynomial contrasts were conducted where appropriate to assist with elucidation of differences.

CULTIVAR EFFECTS

Significant cultivar and location × cultivar differences for yield were observed for both full-season and double-crop production systems. Yield differences among cultivars were expected given the influence relative maturity has on a cultivar's performance. Interactions between locations and cultivars were also not an unexpected result as they emphasized the influence environment has on the performance of a cultivar. Though cultivar differences existed, they are only considered to be an important factor if they interacted with the row-spacing and seeding rate variables in this study and will be discussed where pertinent.

ROW-SPACING EFFECTS—FULL-SEASON PRODUCTION

The ANOVA for full-season production for 2000 indicated a significant location × row spacing × cultivar interaction. To elucidate this three-way interaction, the SLICE option of the LSMEANS procedure was employed. The SLICE option was also used to identify if yield differences

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Study tests row-spacing and seeding rate effects on glyphosate-resistant soybeans in the Mid-Atlantic area

occurred among the cultivars within a row-spacing treatment at each location. At the Wye Research and Education Center (WREC), near Queenstown, Md., no significant yield difference among the four cultivars was indicated at the 19-cm row spacing even though the trend as maturity of the four cultivars increased was an increase in yield. However, a significant yield difference was present for the 38-cm row spacing.

At Central Maryland Research and Education Center-Beltsville Facility (CMREC), a significant yield difference among cultivars was indicated for 19-cm row spacing, but at 38-cm row spacing, no differences were present.

For 2001, the combined ANOVA for full-season production indicated a significant row spacing effect with no interactions between this factor and the other treatment variables.

The ANOVA for 2002 full-season production indicated a significant row-spacing effect and no interactions with other variables. That season was highlighted by severe drought. The yield advantage observed for 19-cm rows during 2002 was clearly the result of the ability of the soybean produced in narrower rows to generate a closed vegetative canopy earlier than the wider-row treatment, enhancing moisture-holding capacity for the narrow-row treatment and resulting in better yield.

ROW-SPACING EFFECTS—DOUBLE-CROP PRODUCTION

The ANOVA for double-crop production system for 2000 indicated no significant row-spacing effect and no interaction between row spacing and the other factors. Timely planting for double-crop production coupled with sufficient rainfall throughout the growing season provided suitable growing conditions that resulted in good double-crop yield in both row-spacing treatments for this year.

The ANOVA for 2001 double-crop system indicated that the row-spacing effect was confounded by both a row spacing × location and a row spacing × cultivar interaction. The SLICE option was employed to identify interaction differences. For the location × row spacing interaction, the two row-spacing treatments averaged over the four cultivars at WREC had significantly different yields. At CMREC, no significant difference was observed.

Since the combined ANOVA indicated a row spacing × cultivar interaction, but since the two locations performed so differently because of both planting date differences and an early killing frost at CMREC, mean separation analyses were conducted on the two row-spacing treatment means for each of the four cultivars at each location. At WREC, three of four cultivars had significantly better production in the 19-cm row-spacing treatment. Within the 19-cm row-spacing treatment, no significant yield differences among the cultivars were observed. In 38-cm row spacing, yield response among the cultivars varied. It did appear as though the yield performance in 38-cm rows improved with increasing maturity of the cultivars.

At CMREC, within a cultivar, no yield differences occurred between the two row-spacing treatments. Within a row-spacing treatment at this location, the significant loss of yield for the two later-maturing cultivars is apparent in both row-spacing treatments.

For double-crop production in 2002, the combined ANOVA indicated a significant row-spacing effect with no interactions with the other variables. The results for double-crop production indicate the positive effect that the narrower rows had upon the development of LAI, creating a better plant canopy earlier than for the wider rows and ultimately improving yield under the droughty conditions that occurred during 2002.

SEEDING RATE EFFECTS ON EMERGED STANDS

Though the goals for the four seeding rate treatments were not attained, incremental increases for the emerged stands were found across the four rates. Overall, the emerged stands ranged from 70 percent to 94 percent of the goals.

SEEDING RATE EFFECTS—FULL-SEASON PRODUCTION

The combined ANOVA for 2000 full-season production indicated a cultivar × seeding rate interaction that confounded the seeding rate effect. Within a cultivar, the 40 percent reduced seeding rate for three of four cultivars was significantly less compared with the standard seeding rate.

SEEDING RATE EFFECTS—DOUBLE-CROP PRODUCTION

The combined ANOVA for 2000 double-crop production system indicated a significant location × cultivar × seeding rate effect. The SLICE option was used to delineate the interaction effects. For the within-cultivar seeding rate comparisons at WREC, three of four cultivars produced statistically the same at the four seeding rates. For the within-cultivar seeding rate comparisons at the Lower Eastern Shore Research and Education Center (LESREC), the three latest-maturing cultivars had no significant yield differences among the four seeding rates.

The SLICE option also indicated yield differences among the cultivars existed within seeding rates at the two locations. At WREC, there appeared to be a trend for improved yield as the maturity of the cultivars decreased at each of the seeding rates. However, the only significant yield differences among cultivars within a seeding rate treatment occurred at the 20 percent increased rate.

At LESREC, a different response occurred among the cultivars within the seeding rates. At LESREC, there was no significant response for the two earlier-maturing cultivars to the 20 percent increased seeding rate.

For 2001 double-crop production, the combined ANOVA identified a significant effect for seeding rate and no interactions between this treatment factor and the others. Mean separation analysis (Fisher's Protected $LSD_{0.05}$) determined that the yield at the 40 percent reduced seeding rate was significantly less than at the standard seeding rate. However, the 20 percent reduced seeding rate had yield that was not different from the standard. The standard rate was determined to be not different from the 20 percent increased rate. Orthogonal polynomial contrast for linear and quadratic response across the four seeding rates was conducted, and it was determined to be not significant for either.

The 2002 ANOVA for double-crop soybean determined the presence of a significant seeding rate effect, the same as occurred in 2001. Mean separation analysis was done using Fisher's Protected $LSD_{0.05}$ and determined that the 40 percent reduced rate had significantly less yield compared with the standard seeding rate. The yields for the three highest seeding rates were not significantly different.

CONCLUSIONS

Over the three years of the study for full-season production system, the 19-cm row-spacing treatment produced significantly better yield compared with the 38-cm treatment in two of three years. During 2000, when row spacing was influenced by location and cultivar causing the result to be less clear, there was only one instance where a cultivar was found to produce better in the wider row spacing. For the 24 row spacing × cultivar combinations that were evaluated during the 3 years of the full-season study, only once did the 38-cm row spacing prove superior. As with the full-season production system, a total of 24 row spacing × cultivar combinations were compared for double-crop production. There was not one instance where a significant yield advantage was observed for the wider, 38-cm row-spacing treatment. At best, this wider row-spacing treatment produced yield that was equivalent to that attained in 19-cm rows.

During two of three years of the full-season study (2000 and 2001), the yield response to seeding rates was relatively consistent. The reduced seeding rate of 40 percent compared with the standard rate resulted in significantly lower yield. The 20 percent reduced rate was found to yield comparably to the standard rate. Averaged over the two locations, all four cultivars were found to not differ at the three lowest seeding rates. However, at each of the locations, a different response occurred. At WREC, a significant yield response was observed for the two higher seeding rates. However, at CMREC, no differences among the four seeding rate treatments were observed. Because the prediction of weather conditions at the time the crop is planted is impossible and because none of the cultivars expressed significant yield differences between the 20 percent reduced rate and the standard, a seeding rate 20 percent less than the standard full-season rate of 432,250 seed ha^{-1} would appear to be a viable option.

Seeding rate response for double-crop production was straightforward in two of three years (2001 and 2002). During those two years, very different weather conditions prevailed. However, soybean yield responded to the seeding rate treatments during both those years similarly, and they were not confounded by interactions with row spacing, cultivars, and location. A 40 percent reduced seeding rate had yield that was significantly less than the standard. During both those years, the 20 percent reduced rate produced yield equivalent to the standard seeding rate. And there was no significant yield benefit for double-crop soybean to the 20 percent increased seeding rate. During 2000, location and cultivar both influenced the seeding rate response to some degree. During this year, which had timely and sufficient rainfall, yield differences among the seeding rates were less evident. Only one of the eight cultivar × location combinations had a significant yield difference between the 40 percent reduced rate and the standard seeding rate. And, for the comparison between the 20 percent reduced rate and the standard, there were no significant yield differences. A 20 percent reduction in seeding rate from the standard rate of 555,750 seed ha^{-1} for double-crop production did not cause significant yield loss.

There was no occurrence of interactions between row spacing and seeding rate. These new seeding rate recommendations of 346,000 and 445,000 seeds ha^{-1} (140,000 and 180,000 seeds/A) for glyphosate-resistant soybean grown under full-season and double-crop production systems, respectively, in Maryland apply to both 19- and 38-cm row spacing.

DETACH HERE

Row-spacing and seeding rate effects on glyphosate-resistant soybean for Mid-Atlantic production systems

February Self-Study Examination

1. Production practices tested over the years by soybean researchers to maximize leaf area index and ultimately yield have included all of the following EXCEPT

[ ] a. planting dates.
[ ] b. row spacings.
[ ] c. populations.
[ ] d. harvest timing.

2. The purpose of this study was to

[ ] a. determine if seeding rate reductions from current standards would produce equivalent grain yields.
[ ] b. evaluate the water use efficiency of different soybean row spacings.
[ ] c. assess weed control responses to glyphosate at various row spacings and populations.
[ ] d. compare the performance of glyphostate vs. non-glyphosate resistant varieties.

3. A characteristic of the setup of this study was in the use of

[ ] a. both full-season and double-crop systems for evaluation.
[ ] b. row spacings of 19 and 38 inches.
[ ] c. irrigated plots.
[ ] d. treated seed to assure intended stands.

4. In the full-season production system, the 19 cm row spacing treatment produced significantly better yield than the 38 cm treatment in

[ ] a. 0 of 3 years.
[ ] b. 1 of 3 years.
[ ] c. 2 of 3 years.
[ ] d. 3 of 3 years.

5. Results from the 2002 growing season were impacted by

[ ] a. high levels of precipitation.
[ ] b. severe drought.
[ ] c. unusual early-season cool temperatures.
[ ] d. premature leaf loss from foliar disease.

6. A characteristic when comparing seeding rates with emerged stands was that

[ ] a. seeding rate goals were not attained.
[ ] b. emerged stands ranged from 87% to 96% of seeding rate goals.
[ ] c. smaller seeds had lower rates of emergence.
[ ] d. harvest stands were affected by significant plant mortality through the season.

7. A conclusion of the full-season part of the study was that

[ ] a. 38-cm rows yield better than 19-cm rows.
[ ] b. a 20% stand reduction performed as well as a full stand.
[ ] c. there were no differences among locations.
[ ] d. seed treatments are an economical form of insurance for protecting stands.

8. A conclusion of the double-crop part of this study was that

[ ] a. a 20% stand reduction performed as well as a full stand.
[ ] b. a 40% stand reduction performed as well as a full stand.
[ ] c. cultivars were not influenced by other variables.
[ ] d. results were similar among years.

9. Interactions that occurred among variables in the study were statistically analyzed using

[ ] a. Fisher's Protected $LSD_{0.05}$.
[ ] b. Tukey's multiple range test.
[ ] c. orthogonal polynomial contrasts.
[ ] d. SLICE.

10. For the double-crop production system, the 38-cm row spacing treatment produced yields that were

[ ] a. superior to 19-cm rows for certain cultivars.
[ ] b. superior to 19-cm rows when using a 20% increased seeding rate.
[ ] c. at best equivalent to 19-cm rows.
[ ] d. always significantly lower than 19-cm rows.

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2. Answer the questions by clearly marking an "X" in the box next to the best answer for each question.
3. Complete the self-study exam registration form on the back of this page.
4. Clip out this self-study examination page, fold and place in envelope.
5. Enclose a check for $10.00 made payable to the American Society of Agronomy, for processing fees. Payment in U.S. funds only.
6. **Mail your self-study exam and fee to:** ASA c/o CCA Self-Study Exam, 677 S. Segoe Road, Madison, WI 53711. *Please allow 60 days for processing.*
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SELF-STUDY EXAM EVALUATION FORM

Rating Scale: 1=Poor 5=Excellent

Information presented will be useful in my daily crop advising activities: 1 2 3 4 5

Information was organized and logical: 1 2 3 4 5

Graphics/tables were appropriate and enhanced my learning: 1 2 3 4 5

I was stimulated to think how to use and apply the information presented: 1 2 3 4 5

This article addressed the stated competency area and performance objective(s): 1 2 3 4 5

Briefly explain any "1" ratings: ______________________________

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