Soybean and Small Grains

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SOYBEAN PLANT DENSITY FOR OPTIMUM PRODUCTIVITY

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INTRODUCTION

Soybean production in the upper Midwest has increased dramatically in recent years. In Wisconsin, for example, total production increased by 84 from 1990 to 1994. Much of this new production has been in areas where soybeans have not been planted before and by new growers. Producers need information on basic soybean production practices including determination of optimum seeding rates. Soybean growers are also adopting reduced tillage practices and need more information on cultivar and seeding rate performance with higher residue planting conditions.

Previous seeding rate research in Wisconsin focused on one soil type (silt loam) in the southern part of the state. Though this information is helpful, it is inadequate to make recommendations for the expanded production areas. The objectives of research reported here were to determine the influence of seed density (planting rate) on the performance and growth characteristics of soybean grown in three maturity zones in Wisconsin and to determine the interaction of soybean cultivar maturity with seeding rates. A third objective was to determine the influence of tillage on optimum seeding rates.

WISCONSIN RESEARCH

Studies were conducted at 13 Wisconsin locations from 1993 to 1995 in three maturity regions: northern, central and southern. The southern region had both conventional tillage and no-till tests. Southern conventional tillage locations were Arlington, Janesville and Racine. Southern no-till locations were Arlington, Janesville and Lancaster. Central region locations were Hancock, Galesville and Fond du Lac. Northern region locations were Chippewa Falls, Marshfield, Seymour and Valders. At each location, four cultivars representing a range of adapted maturities was evaluated using seeding densities of 125 000, 175 000, 225 000 and 275 000 viable seeds/acre (Table 1). Row spacing was 7.5 in. at all sites. Measurements obtained included emergence (early) and final (late) plant population, plant height, lodging, physiological maturity date, seed weight, grain yield and grain moisture.

Table 1. Soybean cultivars and maturity groups (MG) used in the plant density study.

Region					
Southern		Central		Northern	
MG	Cultivar #	MG	Cultivar #	MG	Cultivar #
(1.4)	Parker	(0.9)	Lambert	(0.7)	NK S07-80
(1.9)	NK S19-90	(1.4)	Parker	(0.9)	Lambert
(2.0)	Sturdy	(1.5)	NK S15-50	(1.4)	Parker
(2.4)	KB 241	(1.9)	NK S19-90	(1.5)	KB 151

NK = Northrup King Seed Co,; KB = Kaltenberg Seeds; Parker, Lambert and Sturdy are public cultivars

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Southern Region – Conventional Tillage

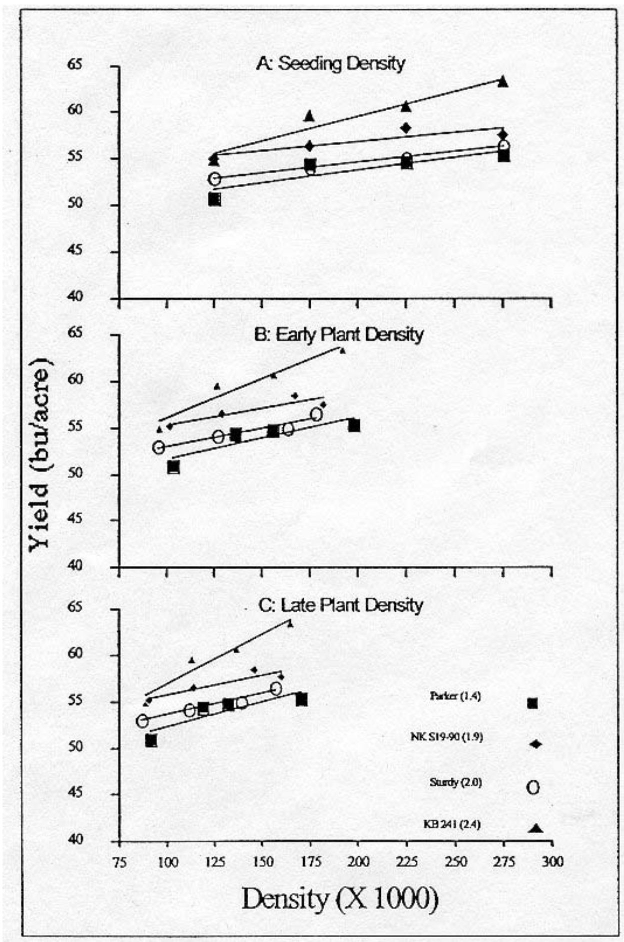

Figure 1. Soybean cultivar (maturity group) yield as influenced by A: seeding density, B: early plant density and C: late plant density when averaged over three southern Wisconsin locations using conventional tillage, 1993-95.

RESULTS

Highest yields were achieved at the 225 000and 275 000 seeds/acre planting densities when averaged across all locations and maturity groups (Figure 1). In this region, there was no yield difference between the 225 000 and 275 000 seeding densities.

Early and late plant stands increased with each increment increase in seeding density. Average early plant stands ranged from 99 000 to 188 000 plants/acre (Figure 1B) and average late plant stands ranged from 89 000 to 163 000 plants/acre (Figure 1C) as seeding rates increased. Plant survival from emergence to maturity was highest at 125 000 seeds/acre (91), which was higher than all other seeding densities. In general, when seeding density increased, plant survival decreased.

Figure 1A shows the yield response of the four cultivars to seeding density. All cultivars had a linear response of yield to increased seeding density and individual cultivar line slopes were not different. A seeding density of 275 000 plants/acre had a maximum grain yield of 63.0 bu/acre for a late maturing cultivar (MG 2.4) and 55.0 bu/acre for an early maturing cultivar. Since plant establishment rates were so low in this region even from the high seeding rate, it may have been beneficial to seed at an even higher rate. We conclude that by planting a full season cultivar in the southern region of the state under conventional tillage, an increase of 8.0 bu/acre can be realized over the yield for a short season cultivar, at the same seeding density.

Soybean planted with the 275 000 seeds/acre planting rate were slightly taller and were more lodged than soybean planted at the lower rates. However, this was not a hindrance for efficient harvesting.

Southern Region – No-Till

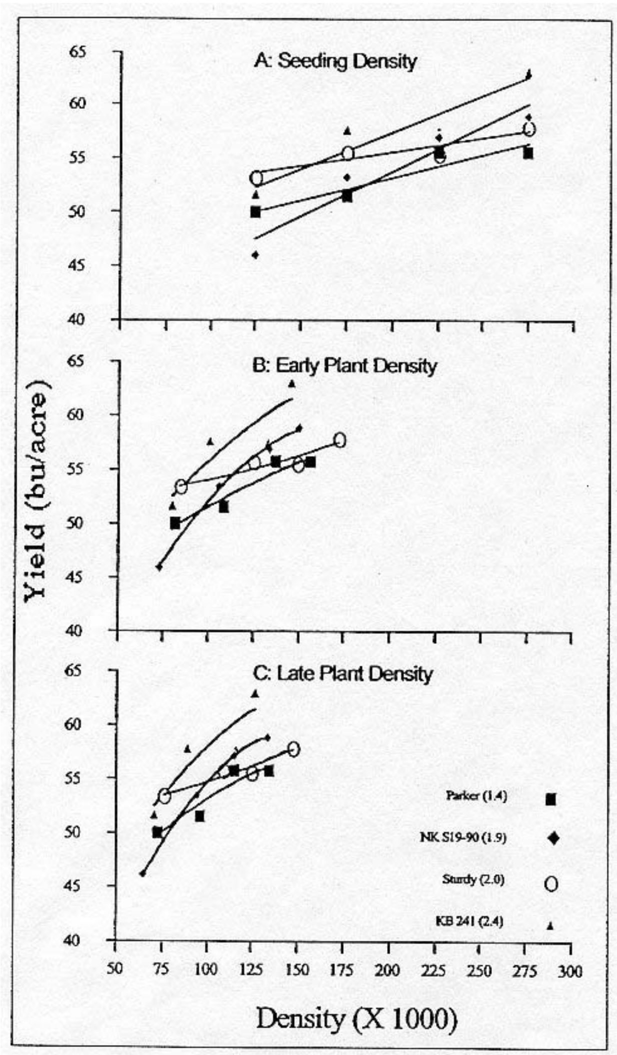

Figure 2. Soybean cultivar (maturity group) yield as influenced by A: seeding density, B: early plant density and C: late plant density when averaged over three southern Wisconsin locations using no-till, 1993-95.

Under no-till, the highest average yield of 58.9 bu/acre was obtained with the 275 000 seeding density and was higher than the yield for all other seeding densities (Figure 2). In this region, each increment increase in seeding density resulted in an increase in yield.

Average early plant stands ranged from 80 000 to 156 000 plants/acre (Figure 2B) and average late plant stands ranged from 71 000 to 135 000 plants/acre (Figure 2C) as seeding rates increased. The seeding density that achieved the highest plant survival (89) from emergence to maturity was 125 000 seeds/acre, which was higher than the plant survival for the 225 000 and 275 000 densities. In general, as seeding density was increased, plant survival decreased.

Figure 2A shows the yield response of the four cultivars to seeding density. All cultivars had a linear increase of yield to increased seeding density, and individual cultivar line slopes were not different. A seeding density of 275 000 seeds/acre had a maximum grain yield of 56.0 bu/acre for an early maturing cultivar (MG 1.4). The same seeding density had a maximum grain yield of 63.0 bu/acre for a late maturing cultivar (MG 2.4). We conclude that under no-till in the southern region of the state, selecting a full season cultivar can increase yields up to 7.0 bu/acre, without increasing the seeding density.

The 65.0 bu/acre average yield obtained by the combination of the latest maturing cultivar and the highest seeding density under no-till, out-yielded any maturity group/seeding density combination under conventional tillage. We conclude that yields in no-till can be equal to or greater than yields using conventional tillage when seeding densities are raised in excess of 225 000 seeds/acre. Just as with conventional tillage in this region, the results would suggest that higher yields of the late maturing cultivar may have resulted had seeding densities been higher or at least if the established plant stands were higher.

Plant height and lodging results under no-till were similar to those in conventional tillage. Seeding density under no-till did not effect seed size.

Central Region – Conventional Tillage

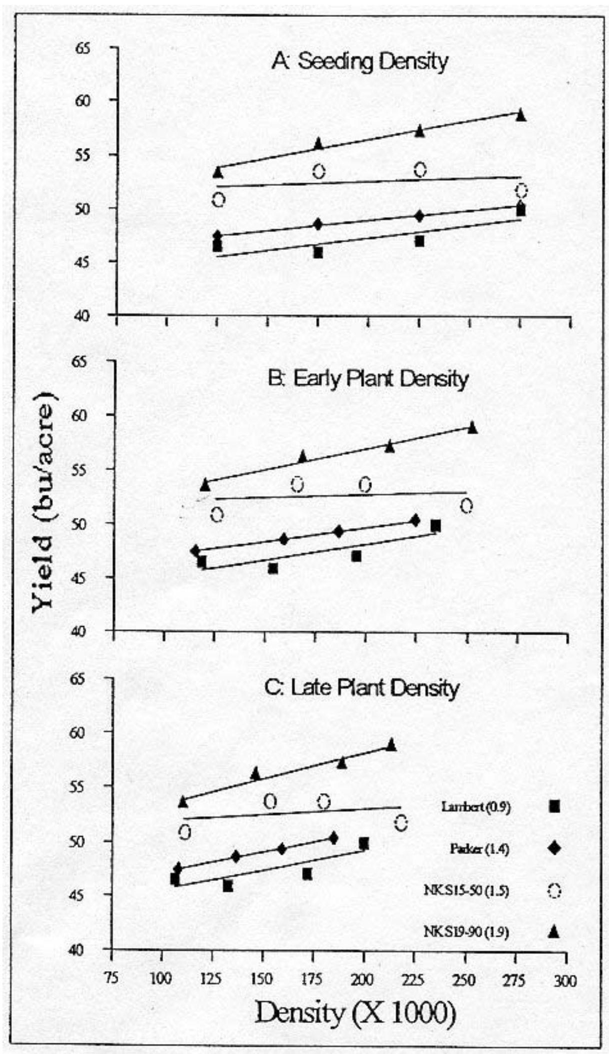

Figure 3. Soybean cultivar (maturity group) yield as influenced by A: seeding density, B: early plant density ans C: late plant density when averaged over three central Wisconsin locations using conventional tillage, 1993-95.

In central Wisconsin, averaged across all locations and maturity groups, highest yields were obtained when seeding density was raised above 175 000 seeds/acre (Figure 3).

Early and late plant stands increased with each increment increase in seeding density. Average early plant stands ranged from 120 000 to 240 000 plants/acre (Figure 3B) and average late plant stands ranged from 109 000 to 204 000 plants/acre (Figure 3C) as seeding rates increased. The seeding density that achieved the highest plant survival (90) from emergence to maturity was 125 000 seeds/acre, which was higher than plant survival from the 175 000 and 275 000 densities. Staying consistent with the southern region, the highest seeding density also had the lowest average plant survival(86).

Figure 3 A shows the yield response of the four cultivars to seeding density. All cultivars had a linear increase of yield with increased seeding densit y, and individual cultivar line slopes were not different. Early maturing cultivars (MG 0.9) had the maximum yield of 50.0 bu/acre when seeded at 275 000 seeds/acre while the maximum yield of 58.0 bu/acre of the late maturing cultivar (MG 1.9) occurred also at the highest seeding rate. These results indicate plant stands for a full season cultivar in the central region of the state should be increased 15 to 20 000 plants/acre over stands for a short season cultivar to achieve full yield potential. In this study, the yield advantage of a full season cultivar as 8.0 bu/acre, regardless of seeding rate. In the central region, plant height, lodging and seed size all increased slightly as seeding rate increased.

Northern Region – Conventional Tillage

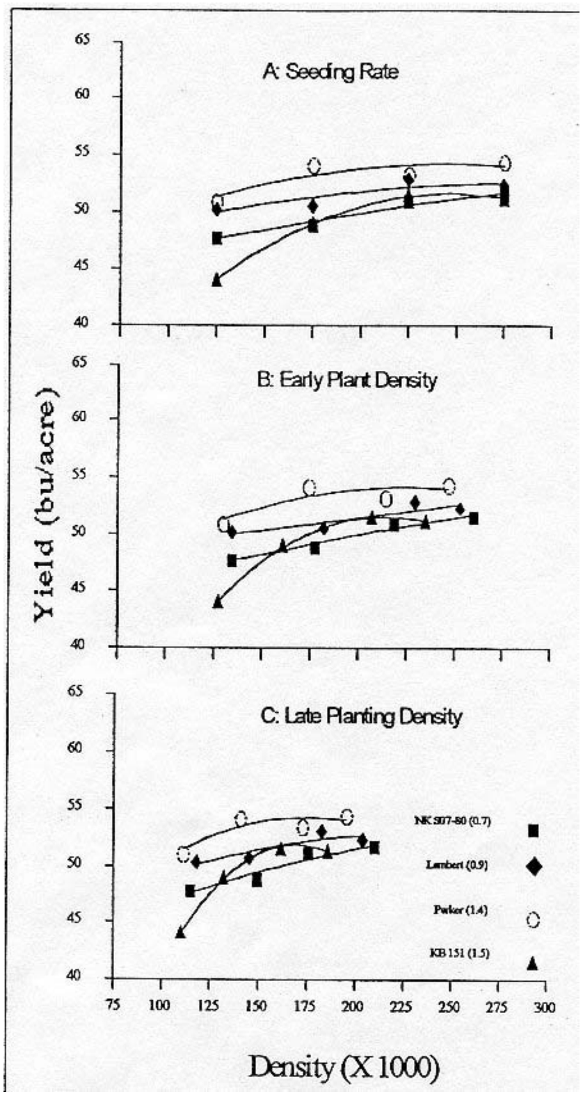

Figure 4. Soybean cultivar (maturity group) yield as influenced by A: seeding density, B: early plant density and C: late plant density when averaged over four northern Wisconsin locations using conventional tillage, 1993-95.

In northern Wisconsin, when averaged across all locations and maturity groups, highest yields were obtained with either the 225 000 or the 275 000 seeds/acre densities (Figure 4).

Early and late plant stands increased with each increment increase in seeding density. Average early plant stands ranged from 131 000 to 249 000 plants/acre (Figure 4B) and average late plant stands ranged from 114 000 to 199 000 plants/acre (Figure 4C) as seeding rates increased. Plant survival was highest (87) from emergence to maturity at the 125 000 seeds/acre seeding density, which was higher than all other seeding densities. The lowest survival (80) occurred at the 225 000 and 275 000 seeds/acre densities. In general, when seeding density was increased, plant survival decreased.

Figure 4A shows the yield response of the four cultivars to seeding density. Unlike the southern and central regions, cultivar response of yield to increased seeding density was quadratic. The two latest maturing cultivars (MG 1.5 & MG 1.4) had maximum grain yields of 52.0 and 54.0 bu/acre at a seeding density of 240 000 seeds/acre, whereas the earliest maturing cultivar (MG 0.7) had a maximum grain yield of 52.0 bu/acre at a seeding density of 275 000 seeds/acre. These results indicate a full season cultivar in the northern region was able to yield 2.0 bu/acre higher than a short season cultivar with 35 000 fewer seeds/acre. Unlike the other regions, the results suggest that yields for an early and late maturing cultivar would not be further increased with heavier seeding densities.

In the northern region, plant height and lodging increased for each increase in seeding density, while seed size was not affected.

SUMMARY

1) Each increment increase in seeding density results in higher early and late plant stands.

2) Regardless of region, plant survival from early to late season decreased as the seeding density increased.

3) In the southern region, plant stand response to seeding density increases were similar for conventional tillage and no-till, even though initial plant establishment was lower using no-till.

4) Soybean yields were the highest with the 275 000 seeds/acre planting rate when averaged over cultivars, locations and years, and were higher using no-till.

5) In southern Wisconsin, the highest overall average yield was obtained using the combination of no- till, the highest seeding density and a full-season cultivar.

6) Regardless of the region, as seeding density increased, so did average plant height and lodging, but this did not hinder harvest.

7) Maturity group, or cultivar, influenced yield response to increased seeding density.

8) In the southern region, planting full season cultivars increased yield 8 bu/acre using conventional tillage and 7 bu/acre using no-till with 5 000 to 10 000 fewer plants/acre than when early cultivars were used.

9) In the central region, full season cultivars also yielded 8 bu/acre more than early cultivars at the same seeding density.

10) In the northern region, a 2 bu/acre increase with a full season cultivar was obtained with 35 000 fewer seeds/acre, compared to short season cultivars.