Soybean Planting Technology for the Northern Plains

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ABSTRACT

Low yields limit the expansion of soybean (*Glycine max* [L.] Merr.) acreage across the northern plains. Productive cultivars are available, but current planting recommendations are based upon data from more humid regions. The objective of this research was to develop recommendations for drier regions. Optimum and delayed planting dates were compared. Full- (Traill, Group 0.0) and short-season (Daksoy, Group 00.5) cultivars were sown at target populations of 247,000, 370,000, and 494,000 plants ha^{-1} and row spacings of 0.18, 0.53, and 0.76 m. Planting date did not affect days to maturity, harvestabiliy, or yield. With early planting, Traill out-yielded Daksoy by 337 kg ha^{-1}. The yield of Daksoy was unaffected by planting date, while Traill yielded 606 kg ha^{-1} less when planting was delayed 17 d. Delayed planting resulted in faster canopy closure and a better stand. Increasing the seeding rate reduced the time to canopy closure and maturity, but did not affect plant height or lodging. Pod height increased with seeding rate. Grain yield improved 472 and 135 kg ha^{-1} with the high seeding rate compared to the low and medium rates, respectively. Narrower rows resulted in less lodging, shorter plants, and higher pods, but prolonged the time to maturity. Grain yield was more than 270 kg ha^{-1} higher with solid-seeding than with narrow or wide rows. The 1999 yield advantage observed with the highest seeding rate and narrowest row spacing may have resulted from above-normal precipitation during podfill.

INTRODUCTION

Many growers in central and western North Dakota are interested in soybean production, but low and inconsistent yields have limited the acreage planted. Since current planting recommendations (Table 1) are based upon research done in the 1970s and 1980s in the more humid, eastern region of the state, these seeding rates and row spacings may not be the best for drier growing conditions. Over five site-years in Nebraska, yield in 0.51 m rows was consistently superior to that in 0.25 or 0.76 m rows, both with and without irrigation (Elmore, 1998). This response was especially pronounced under dryland conditions, which prompted the author to conclude that the 0.51 m row spacing combines the yield benefits of solid seeding and the improved conservation (slower canopy closure and lower evapotranspiration) of soil moisture for the pod-filling phase in wider rows.

Relatively less research attention has been directed toward plant population. Within population limits and in the absence of high levels of stress, the soybean plant compensates for differences in population and grain production is unaffected. However, differences in plant density may impact the height of the lowest pods, lodging, branching, seed weight, leaf area index, and disease occurrence (Elmore, 1998; Grau and Radke, 1984; Costa, et al., 1980; Oplinger, 1980). These factors may significantly affect the harvested yield.

Also, late springs, wet weather, large acreages, time conflicts with planting other crops, late frost, or hail damage often result in the need for delayed soybean planting. In this case, a shorter-season cultivar and higher seeding rate are advised. However, the effects of seeding rate and row spacing on the performance of short- and full-season cultivars under drier conditions are not known. In these drier areas, improving planting technology may contribute as much to increasing soybean profitability as the development of better cultivars. When higher yields, improved harvestability, and / or lower production costs are achieved, soybean profitability will increase and acreage will expand.

OBJECTIVES

The objectives of this research were to study the effects of row spacing, seeding rate, and planting date on the performance of two soybean cultivars in central North Dakota to:

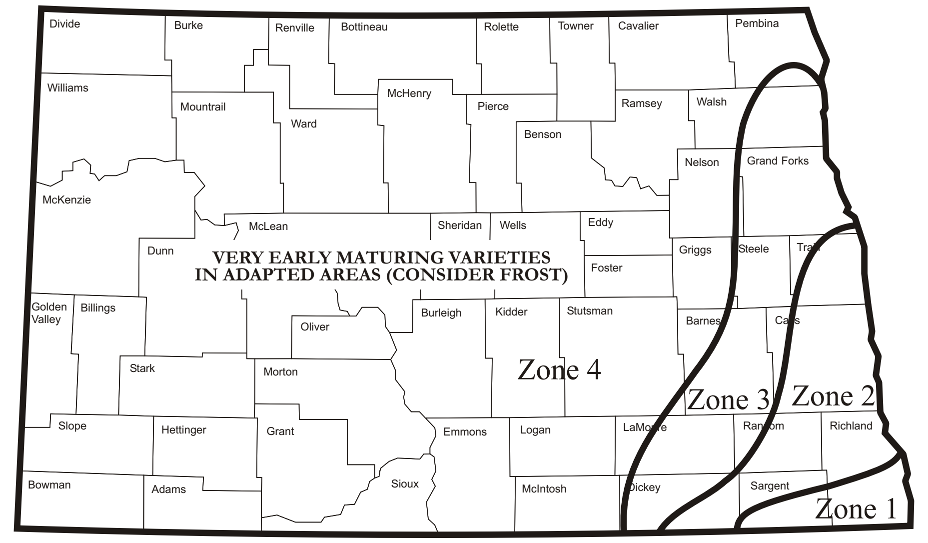
- Maximize Yield
- Minimize Losses
- Optimize Inputs

Table 1. Current planting recommendations for central North Dakota.

Cultivar:	Maturity Group 00 for Zone 3 (Figure 1)
Planting Date:	Not more than 5 days before last killing frost
Seeding Rate:	370,500 plants ha^{-1} in 0.76 m rows
	432,250 plants ha^{-1} in 0.30 – 0.38 m rows
	494,000 plants ha^{-1} in 0.15 – 0.20 m rows

Source: Berglund, D.R., and T.C. Helms. 1998.

Figure 1. North Dakota Soybean Maturity Zones



MATERIALS AND METHODS

In 1999, a 3-year experiment was initiated at the North Dakota State University Carrington Research Extension Center. Cultivars Traill (full-season, Group 0.0) and Daksoy (short-season, Group 00.5) were planted on 21 May (optimum) and 6 June (delayed). For both cultivars on each date, all combinations of three row spacings (0.18, 0.53, and 0.76 m) and three seeding rates (247,000, 370,500, and 494,000 plants, live seeds ha^{-1}) were planted. Weeds were controlled with herbicides; disease and insect pressure was minimal.

Stand establishment was measured, as well as the number of days to canopy closure and physiological maturity. At harvest maturity, harvestability (plant height, lodging, height to first pod), grain yield, and grain quality (test weight, seed weight, oil content) were determined.

ACKNOWLEDGEMENTS

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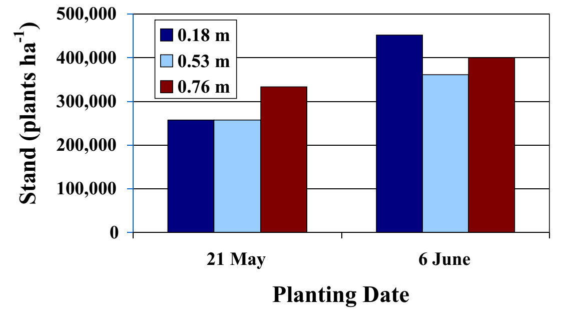
RESULTS AND DISCUSSION

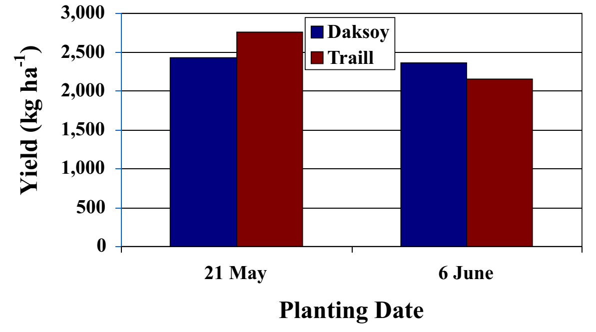
Planting Date. Averaged across all row spacings, seeding rates, and cultivars, delaying planting did not significantly affect the days from planting to physiological maturity, harvestabiliy (plant height, lodging, height to first pod), yield, test weight, or oil content (Table 2). Early planting resulted in a higher seed weight, but slower canopy closure and a poorer stand than late planting. The reduced stand was probably due to slower emergence in cooler soil and was especially evident in solid-seeding and narrow rows (Figure 2). Wide rows result in more seed and closer seed placement within the row and more collective force to break through soil crusting.

Figure 2. Effect of Planting Date and Row Spacing on Stand Establishment



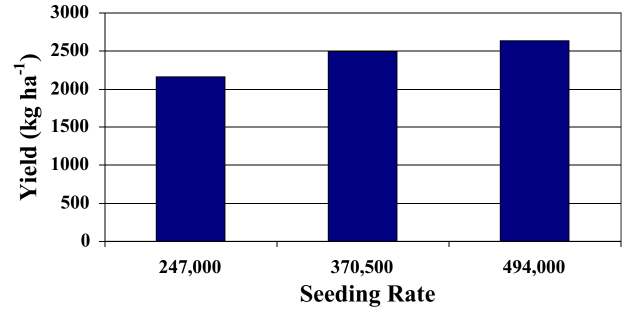
Cultivars. The full-season cultivar, Traill, showed a faster canopy closure than Daksoy, but matured later (Table 2). At maturity, Traill plants were taller and not as lodged as Daksoy and the first pod was higher off the ground. Across all other treatments, yield of the two cultivars was similar, but test weight and kernel weight of Traill were higher. The higher oil content of Daksoy may be related to the generally inverse relationship between percent oil and yield. With early planting, the full-season cultivar out-yielded the short-season cultivar by 337 kg ha^{-1} (Figure 3). The yield of Daksoy was unaffected by planting date, while Traill yielded 606 kg ha^{-1} less when planting was delayed until 6 June. In part, this yield reduction was due to the failure of some plots to mature during the cool September of 1999.

Figure 3. Effect of Planting Date and Cultivar on Grain Yield



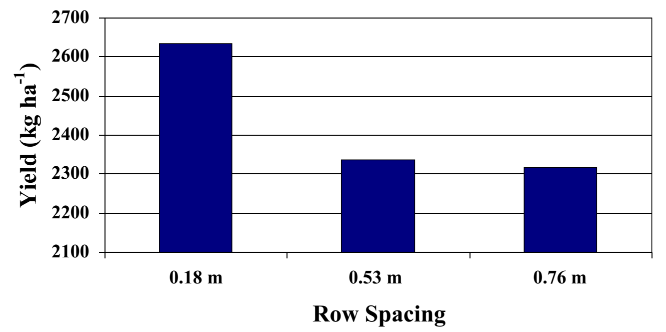
Seeding Rate. Increasing the seeding rate reduced slightly the time to canopy closure and physiological maturity, but did not affect plant height or lodging (Table 2). Height to the lowest pod increased with seeding rate, as did grain quality. Grain yield improved 472 and 135 kg ha^{-1} with the high seeding rate compared to the low and medium rates, respectively (Figure 4). Oil content decreased as yield increased.

Figure 4. Soybean Yield Response to Seeding Rate



Row Spacing. Narrower rows resulted in less lodging, slightly shorter plants, and higher pods, but prolonged the time to physiological maturity (Table 2). Grain yield was more than 270 kg ha^{-1} higher in 0.18 m rows than at the 0.53 m and 0.76 m row spacings (Figure 5). Again, oil content decreased as yield increased (Table 2).

Figure 5. Soybean Yield Response to Row Spacing



COMMENTS

Although the highest seeding rate (494,000 seeds ha^{-1}) and narrowest row spacing (0.18 m) resulted in the highest yields, these data must be interpreted with caution. Rainfall was slightly below normal in June and July, but 61 mm above the long-term average during the podfilling phase in August. In a season of more normal precipitation, high seeding rates and solid-seeding may result in soil water deficits and lower yields.

This project will be continued at Carrington. In addition, the work will expand to the NDSU North Central (Minot) and Hettinger Research Extension Centers, where varieties, seeding rates, and row spacings will be evaluated under no-till and conventional tillage systems. Additional results from Carrington and the two western sites will provide a firmer basis for drawing conclusions and forming recommendations.

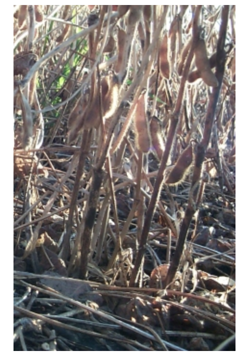


Table 2. Response of two soybean cultivars to planting date, seeding rate and row spacing.

Treatment	Stand	Canopy Closure	Physiological Maturity	Pod Height	Lodging	Plant Height	Test Weight	Seed Weight	Grain Yield	Oil Concentration
Planting Date	(plants ha^{-1})	(DAP[1])	(DAP)	(mm)	(1 - 9[2])	(m)	(kg m^{-3})	(g 250^{-1})	(kg ha^{-1})	(proportion)
21 May	282,000	78	111	68	1.9	0.78	749	43.9	2590	0.203
6 June	405,000	61	111	81	2.1	0.79	750	39.8	2280	0.201
t -test	*	*	NS[3]	NS	NS	NS	NS	*	NS	NS
Variety										
Daksoy	348,000	70	108	67	2.3	0.76	745	41.2	2400	0.208
Traill	341,000	65	115	82	1.7	0.81	755	42.5	2460	0.196
t -test	NS	**	**	**	**	**	**	**	NS	**
Seeding Rate										
100,000	237,000	69	112	67	1.9	0.78	749	41.0	2160	0.204
150,000	358,000	68	111	74	2.0	0.79	752	42.2	2490	0.202
200,000	437,000	67	110	82	2.0	0.79	750	42.3	2630	0.200
LSD (0.05)	10,000	1.3	0.8	12	NS	NS	2.1	0.9	100	0.001
LSD (0.01)	12,000	1.8	1.1	NS	NS	NS	NS	1.2	120	0.001
Row Spacing										
7"	356,000	53	117	84	1.5	0.77	750	41.0	2630	0.200
21"	309,000	67	109	72	1.8	0.78	749	41.9	2340	0.202
30"	366,000	77	107	67	2.8	0.81	750	42.7	2320	0.204
LSD (0.05)	10,000	1	1	12	0.2	0.02	NS	0.9	100	0.001
LSD (0.01)	12,000	2	1	NS	0.3	0.02	NS	1.2	120	0.001

[1]Days after planting [2]1 = erect, 9 = flat [3]statistically non-significant difference at P < 0.05

* and ** denote statistically significant differences at P < 0.05 and P < 0.01, respectively

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