

Influence of Soybean Row Spacing and Plant Population on Development and Yield Across Planting Dates in Minnesota.

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ABSTRACT

Agronomists in the upper Midwest often suggest that producers who are forced to plant soybean (*Glycine max* (L.) Merrill) at later than optimal seeding dates plant at greater seeding rates and/or in narrower rows to maximize seed yields. A study was established in 2000 to examine row spacing by plant population by date of planting interactions. Soybean was planted in two row spacings, at two populations, and at three planting dates in 2000, 2001, 2002, 2003, and 2004 at Lamberton, Minnesota. Analysis of yield data from these four years found only one significant interaction (population * date of planting). This interaction was due to an extremely late (23 June) planting date in a cool growing season (2004). Although narrow rows significantly increased seed yields, the increase was not greater with later planting dates than with early planting dates.

MATERIALS AND METHODS

LONG-TERM SOYBEAN PLANTING DATE STUDY: A soybean planting date study has been conducted at the Southwestern Research and Outreach Center (SWROC) at Lamberton, Minnesota for the past seventeen years. Each year, two commercial soybean (late MG (maturity group) I or early MG II) varieties are planted on four to six planting dates in a randomized block design where each variety/planting date treatment combination is replicated 4 times. Planting dates approximate very early soybean planting (as early as possible - usually mid April) through very late planting dates (June). Planting dates in this study vary greatly from year to year depending on environmental conditions.

ROW SPACING X POPULATION X DATE OF PLANTING STUDY: Field trials were established at the SWROC in 2000-2004. Soybean (*Glycine max*) var. Asgrow AG2201 (2000-2003) and Asgrow AG2107 (2004) was planted at different planting dates, population densities and row spacing to examine all combinations of treatments (total=12 treatments). Early, Middle, and Late planting dates were in mid- to late-April, mid-May, and early June, depending on the spring field conditions. These dates correspond to common early, normal, and late planting dates in Minnesota. Population densities were either 247,000 or 617,500 seeds/hectare. Row spacing was either 75cm or 25 cm. Treatments were randomized in a complete block design and repeated 4 times. Due to heavy infestation of soybean aphid (*Aphis glycines*) in 2003, treatments were divided and one half was sprayed with an insecticide (Warrior - Syngenta LLC at 0.233 l · ha⁻¹); only treated data is considered in this paper. Half of each treatment was also sprayed for insects in 2004; however, low insect populations did not affect yield and treatment data was combined. Weather patterns throughout the first three years of this study could be considered average for temperature and rainfall. The fourth year (2003), was marked by a late season drought. Rainfall in July and August totaled 75mm (42% of normal rainfall). The fifth year (2004) was marked by cool temperatures. Despite a warm September, season long growing degree days totaled only 90% of average. The cold growing season reduced vegetative growth (nodes · plant⁻¹).

Data was analyzed in two separate manners for this poster. First, planting dates were grouped into Early, Middle, and Late dates in each of the 5 years. Each year, the early planting date was based on the first advent of suitable field conditions. The second planting date was based on traditional soybean planting conditions for the area. The third date represented the latest date that most local soybean producers might plant soybean. The second analysis was performed to allow integration of numerical dates (in Days after 1 April (Da1A)) into the analysis. Ignoring years, four blocks across five years were grouped into 20 "blocks". Data was analyzed with SAS, version 8.2 using general linear models.

The terms "population" and "seeding rate" are used interchangeably for this poster, and relate to the number of live seeds · ha⁻¹ planted.

RESULTS

LONG-TERM SOYBEAN PLANTING DATE STUDY:

- Figure 1 describes soybean yield responses to planting date over 17 years in southwest Minnesota.
- The asymptote of a second order regression drawn through all data points indicates that, on average, maximum soybean yields may be harvested from soybean planted ca. 2 May (32 days after 1 April (Da1A)), at Lamberton, Minnesota.
- Within years, maximum soybean yields were achieved on planting dates of 6 April (6 Da1A) through 19 May (50 Da1A).
- Yields from planting dates before 2 May were more variable from year to year (69-100% of maximum yields) than from later planting dates.
- Yields were greatly reduced from plots planted after 1 June (62 Da1A).
- By 1 July (92 Da1A), yields were reduced to about 50% of maximum yields.

ROW SPACING X POPULATION X DATE OF PLANTING STUDY:

- Across populations and planting times (Early, Middle and Late), 25 cm row spacing produced significantly greater seed yields than 75 cm row spacing (3250 vs 3020 kg · ha⁻¹) (Table 1).
- Across row spacings and planting times, seeding rates of 247,000 and 617,500 seeds · ha⁻¹ did not produce significantly different yields.
- Across populations and row spacing, planting time significantly affected seed yields; were the late planting time produced significantly lower yields than the early and middle planting times.
- No row spacing * population interaction was evident.
- Likewise, there was no row spacing * planting time interaction.
- The population * planting time interaction was nearly significant (P = 0.08 and 0.07).
- When analyzed so that numerical planting dates (Days after 1 April) might be evaluated, the only major change to the above results was an increased significance in the population * Days after 1 April interaction (P = 0.0023 and 0.0033) (Table 2).
- Grain yield varied from year to year; with 2003 producing significantly lower yields (Figures 2 and 3) than the other four years.
- The higher seeding rate produced significantly greater yields on four of fifteen planting dates, and significantly lower yields on one date (Figures 2 and 4).
- The narrow row treatment produced significantly greater yields on fourteen of fifteen planting dates (Figures 3 and 5).
- These yield difference were not significantly larger at the late planting date than the early planting date (Figure 5).

F1

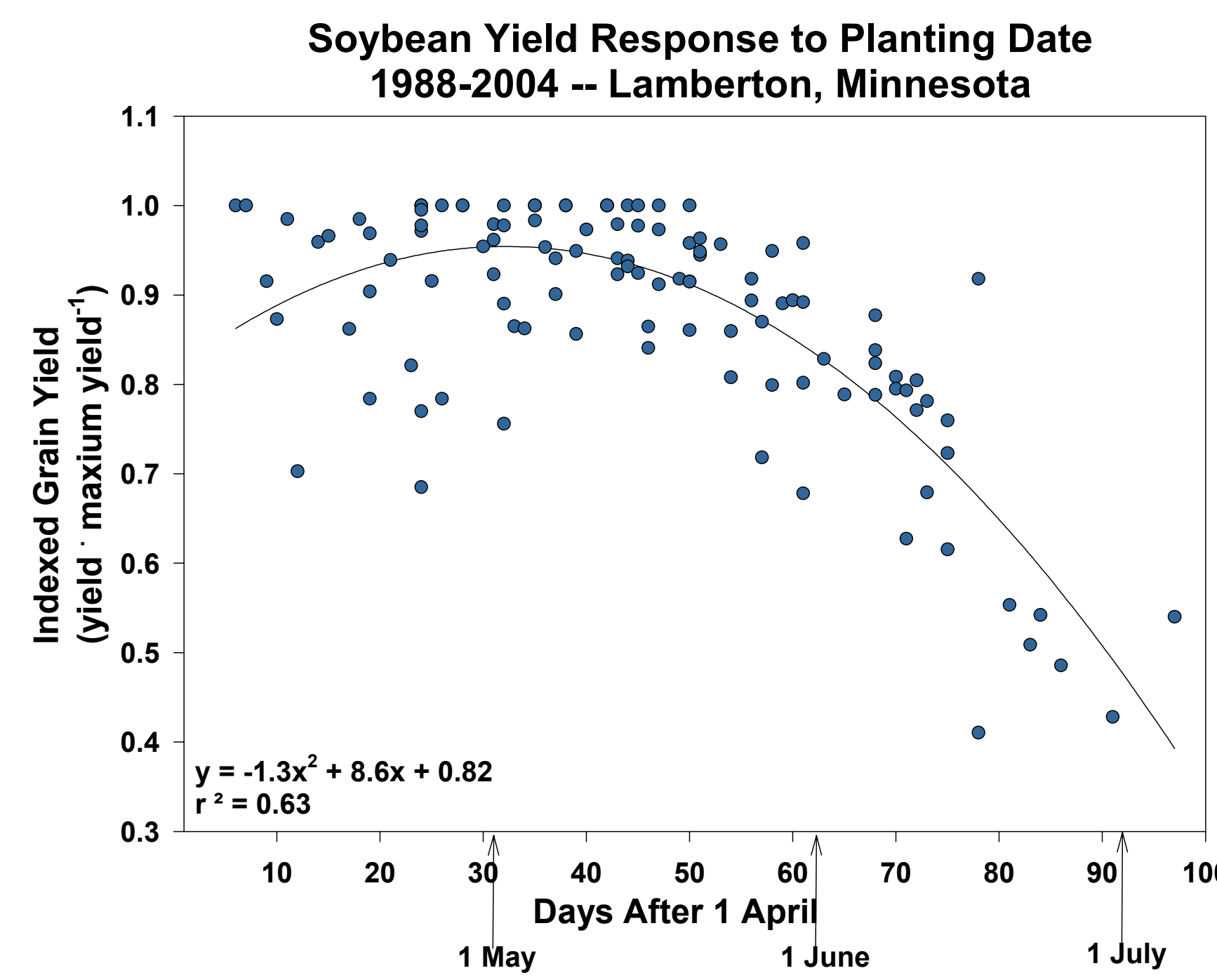


Fig. 1. Date of planting effects on soybean yield at Lamberton, Minnesota. Seventeen years of data from 1988 through 2004 are shown. Data points indicated the fraction of maximum yielding treatment within years. Data points are means of two varieties replicated four times each.

F4

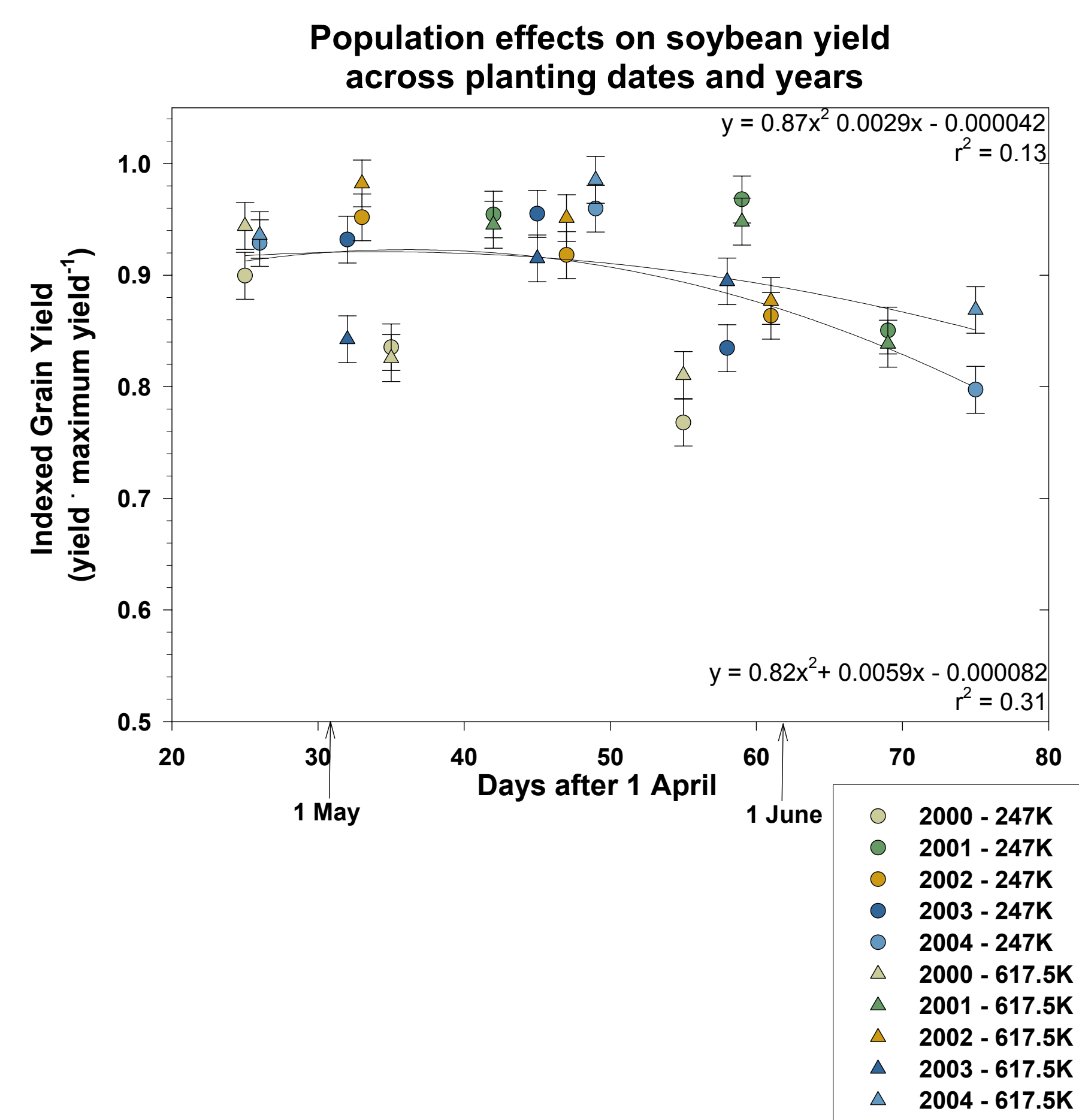


Fig. 4. Population and date of planting effects on soybean seed yield across years. Data are averaged across row spacing treatments and four replications per year. Yields were indexed to the greatest yielding treatment within a particular year and are reported on a fractional basis. Error bars at data points indicate standard error of the mean (n = 8).

T1 and T2

Source	df	Yield (kg · ha ⁻¹)	Yield (% of max yield)
Year	4	<.0001 ***	<.0001 ***
Blocks(Year)	15	<.0001 ***	<.0001 ***
Row spacing	1	<.0001 ***	<.0001 ***
Population	1	0.1054 NS	0.1988 NS
Row spacing * Population	1	0.8054 NS	0.7947 NS
Planting time	2	<.0001 ***	<.0001 ***
Row spacing * Planting time	2	0.6298 NS	0.7452 NS
Population * Planting time	2	0.0817 NS	0.071 NS
Row spacing * Population * Planting time	2	0.4833 NS	0.465 NS

Planting time refers to 3 discrete times (early, middle, or late planting)
* indicates significance at P = 0.05.
*** indicates significance at P = 0.001.
NS indicates not significant at P = 0.05.

Row spacing	Yield (kg · ha ⁻¹)	Yield (% of max yield)
25 cm	3250 a	0.931 a
75 cm	3020 b	0.867 b
LSD	51	0.0152

Population	Yield (kg · ha ⁻¹)	Yield (% of max yield)
247,000 seeds · ha ⁻¹	3120 a	0.894 a
617,500 seeds · ha ⁻¹	3160 a	0.904 a
LSD	51	0.0152

Planting time	Yield (kg · ha ⁻¹)	Yield (% of max yield)
Early	3260 a	0.931 a
Middle	3220 a	0.926 a
Late	2930 b	0.940 b
LSD	62.5	0.0186

Values followed by the same letter are not significantly different at P=0.05

Source	df	Yield (kg · ha ⁻¹)	Yield (% of max yield)
Blocks	15	<.0001 ***	<.0001 ***
Row spacing	1	<.0001 ***	<.0001 ***
Population	1	0.0533 NS	0.1473 NS
Row spacing * Population	1	0.7682 NS	0.7688 NS
Days after 1 April	10	<.0001 ***	<.0001 ***
Row spacing * Days after 1 April	14	0.3029 NS	0.8521 NS
Population * Days after 1 April	14	0.0023 **	0.0033 **
Row spacing * Population * Days after 1 April	14	0.2305 NS	0.22 NS

Days after 1 April refers to numerical planting dates
* indicates significance at P = 0.01.
** indicates significance at P = 0.001.
NS indicates not significant at P = 0.05.

F5

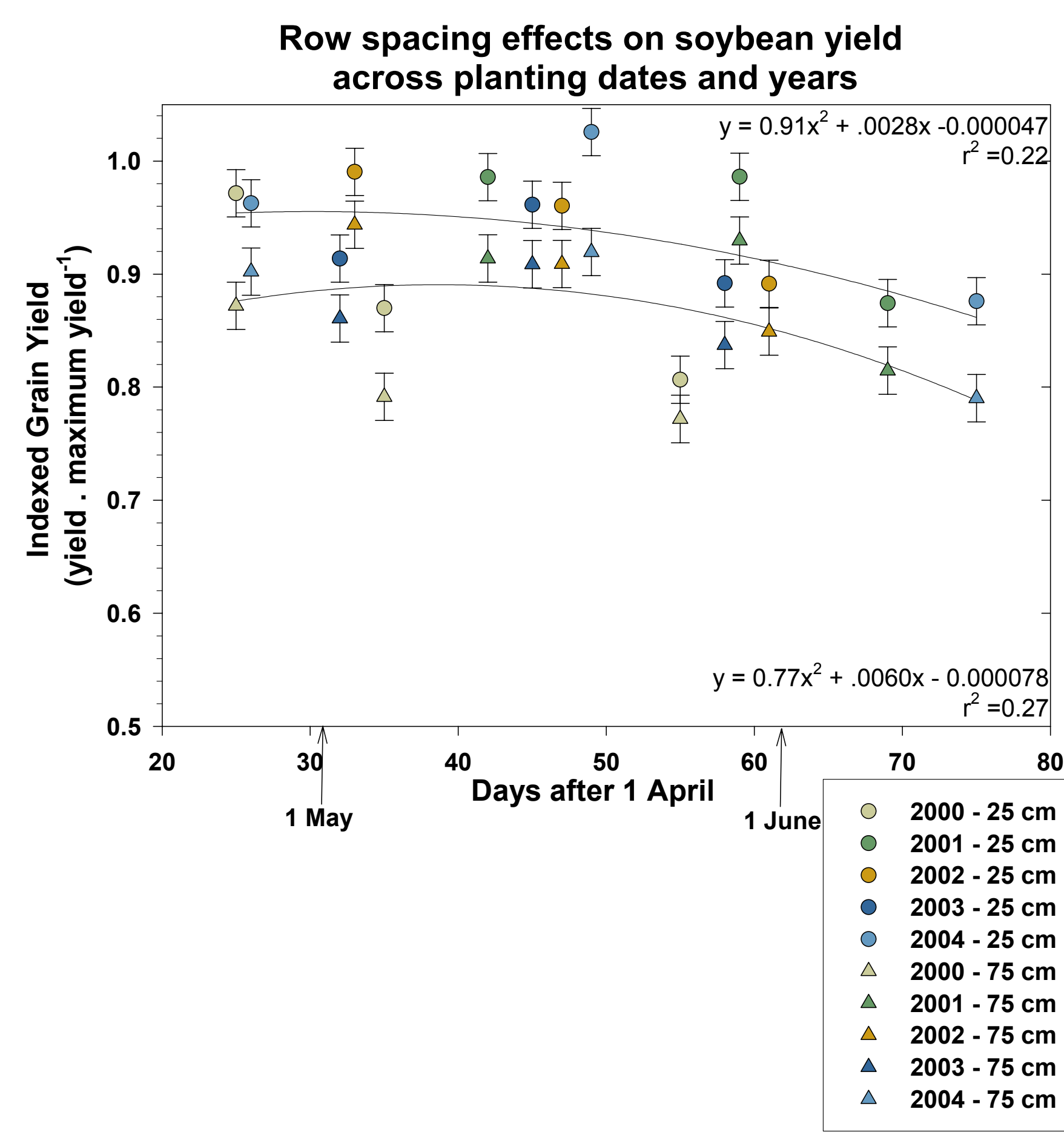


Fig. 5. Row spacing and date of planting effects on soybean seed yield across years. Data are averaged across seeding rate treatments and four replications per year. Yields were indexed to the greatest yielding treatment within a particular year, and are reported on a fractional basis. Error bars at data points indicate standard error of the mean (n = 8).

F2 and F3

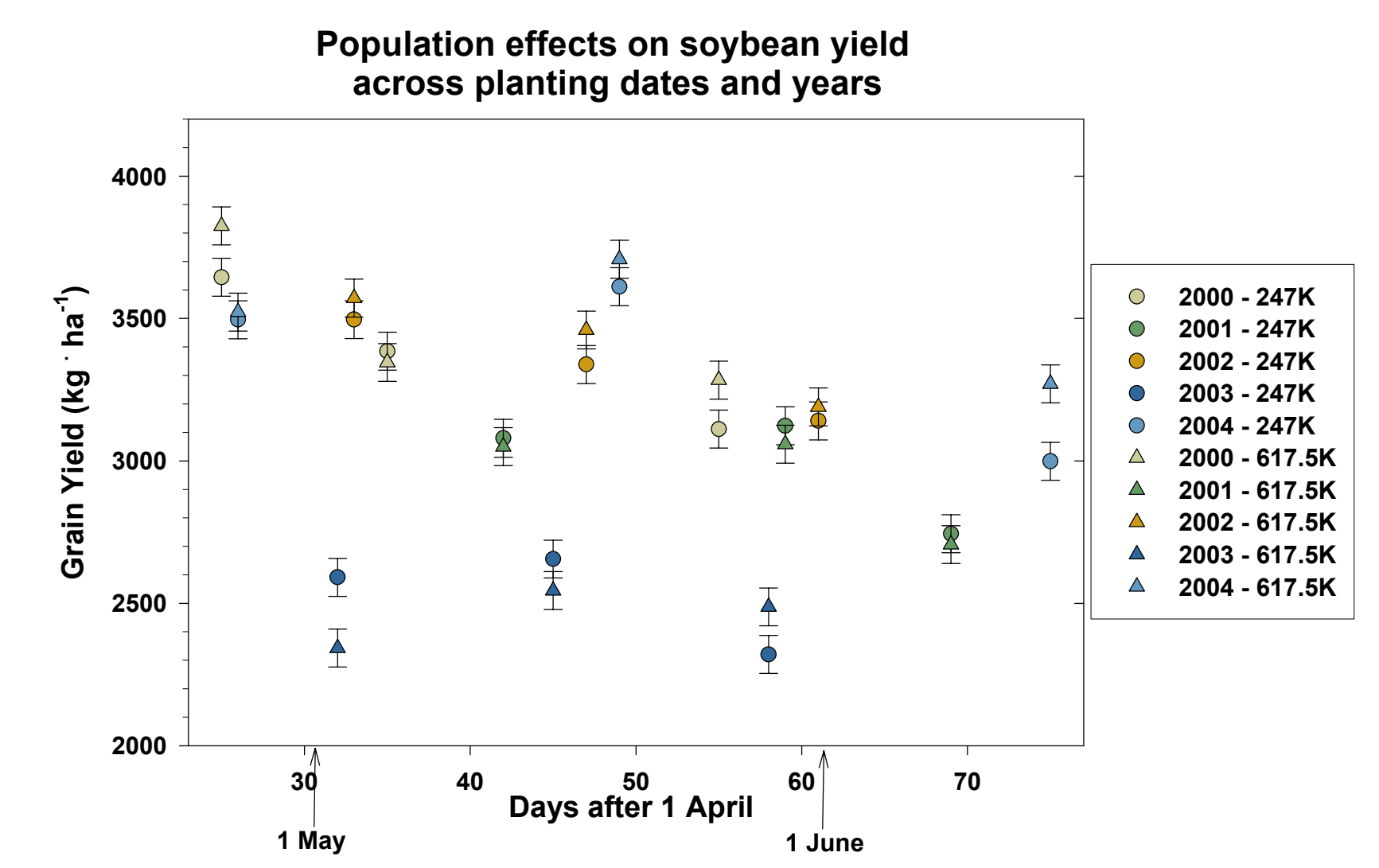


Fig. 2. Population and date of planting effects on soybean seed yield across years. Data are averaged across row spacing treatments and four replications per year. Yields are reported on a kg · ha⁻¹ basis. Error bars at data points indicate standard error of the mean (n = 8).

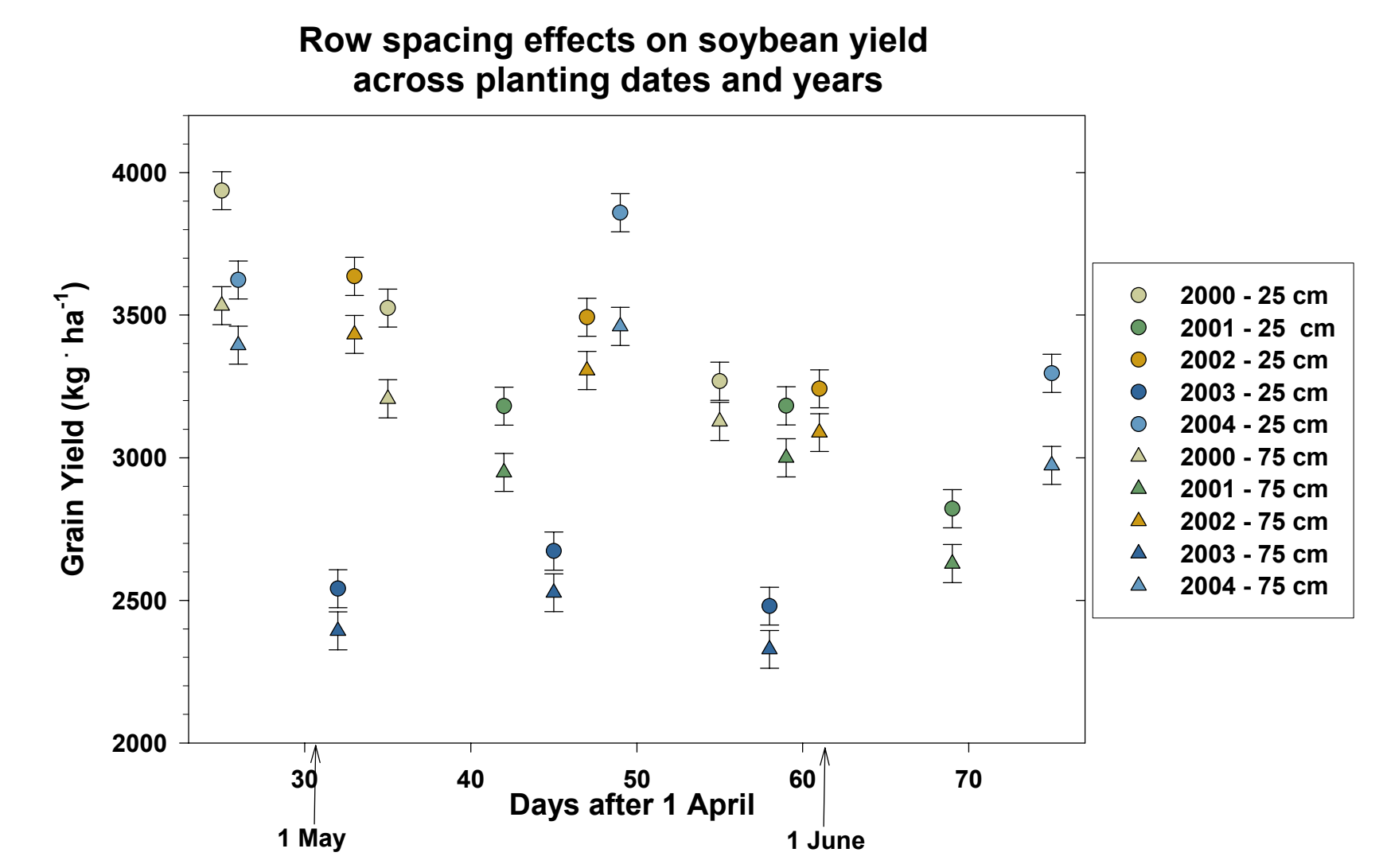


Fig. 3. Row spacing and date of planting effects on soybean seed yield across years. Data are averaged across seeding rate treatments and four replications per year. Yields are reported on a kg · ha⁻¹ basis. Error bars at data points indicate standard error of the mean (n = 8).

Conclusions

- Within years, maximum soybean yields were achieved through planting dates of 6 April through 19 May.
- A large amount of yield variability occurred with early planting dates. This is likely due to poor seedbed conditions (cold and wet) at the time of planting in some seasons. Other reasons for yield variability with early planting may be early season diseases, seed damaging insects, frost or longer periods of weed competition (primarily before 1999 when glyphosate tolerant soybeans were employed).
- Yields were greatly reduced when treatments were planted after 1 June.
- Increasing seeding rates from 247,000 to 617,500 seeds · ha⁻¹ did not significantly increase soybean seed yields across five years and a range in planting dates.
- A small but significant seeding rate by population interaction found in this study was due to a large seeding rate effect of the 13 June 2004 planting date. This effect was likely driven by the cool growing season experienced at this location.
- This yield response was likely due to either an increased number of reproductive sites (nodes · ha⁻¹) or by an increased PAR interception during early season growth.
- Recommendations for producers:
 - Soybean producers in southwest Minnesota need not fear early (late-April) soybean planting; however, soil conditions and long-range weather forecasts should be conducive to quick soybean germination and emergence before planting occurs.
 - Soybean producers need not alter proven planting practices for very early planted soybean, or if planting is delayed.