Soybean performance as affected by early-season soil temperature, and planting date: Yield and quality

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Introduction

- Manitoba’s soybean industry has grown rapidly over the past decade leading to a record seeded area of 2.3 million acres in 2017, in part due to the introduction of short-season cultivars adapted to this region.
- Despite ongoing improvements in soybean genetics, soybean is inherently a cold-sensitive crop, with recommendations suggesting that soybean be planted when the average soil temperature is ≥10°C, with 18-22°C being ideal (Manitoba Agriculture, 2017).
- Field studies were conducted at sites across Manitoba to determine the effect of soil temperature treatments applied at two planting dates on soybean growth, yield, and quality.

Materials and Methods

Small plot studies were conducted at four Manitoba sites (Brandon, Carberry, Portage, Roblin) in each of 2014 through 2016 to determine the effect of soil temperature treatments at two planting dates on soybean yield and quality.

Treatments consisted of a factorial combination of the following, arranged in a split plot design with 4 replicates:

- Main plot: planting dates (2 dates, typically 9-15 days apart)
- Subplot: soil temperature (cold, control, warm)
- Coverings (1) Styrofoam and/or reflective material to insulate the soil (“cold”); 2) black plastic to warm the soil (“warm”); and 3) white/clear plastic to reflect the sun (“control”) (Figure 1). Coverings were removed shortly before a Roundup-Ready soybean cultivar was solid-seeded. Soybeans were grown using a randomized complete block design for each planting date, when averaged over all temperature treatments. Analysis of variance showed significant effects of planting date (D) and temperature (T) in all site-years except Brandon-15, with DxT interactions noted at Carberry and Portage, and PCDF. Funding for this research was provided by the Manitoba Agriculture. 2017.

Results and Discussion

Soil temperature at planting

- Soil coverings were effective in producing a range of soil temperatures at planting in most site-years (Figure 2). Differences between “cold” and “warm” treatments varied from 0 to 10°C depending on planting date and site-year, with temperatures ranging from 5 to 20°C in “cold” treatments in Date1 to 14 to 27°C in “warm” treatments in Date2. Temperature differences remained for varying lengths of time after planting (Glenn et al. 2017).

- Soil temperature treatments affected yield in three site-years (Figure 3). More detailed contrast analysis showed higher yields in “warm” than “cold” treatments for Date2 at Brandon-15 and -16, Carberry-15 and -16, and Roblin-15. In three cases (Brandon-16, Carberry-15 and 16), soil temperature measured at planting was higher in the “warm” than “cold” treatments for Date2, ranging from 15 to 16°C in “cold” to 18 to 21°C in “warm” treatments (Figure 2). (Data were not available for Carberry-14, and no difference in soil temperature at planting was measured in the other two cases.) For both Carberry-15 and Brandon-16, the earlier planting date treatments were also evident in “cold” than “warm” treatments (Glenn et al. 2017), likely contributing at least in part to lower yields.

Soybean quality

- Seed weight, test weight, % protein and % oil were determined for harvested soybean (data not presented). Preliminary analysis indicates that declines in seed weight and test weight were associated with late planting in several site-years. Temperature treatments occasionally influenced seed weight but no consistent and strong trends were evident, while effects on test weight were limited. Delayed planting frequently reduced % oil and occasionally increased % protein. Effects of temperature treatments on % oil and protein were infrequent.

Conclusions

- Delayed planting resulted in marked yield declines in most site-years. In the current study, delaying seeding by 9 to 15 days, from the 3rd to 4th week of May into June, resulted in 40 to 80% the yield of the May planting dates, depending upon site-year.

- Preliminary results suggest that, while soil coverings were effective in producing a range of soil temperatures at planting, and for varying lengths of time thereafter (Glenn et al. 2017), differences in soil temperature measured at planting were not consistently associated with differences in soybean yield. This was the case although soil temperatures at planting were often below the 18 to 22°C suggested as ideal, and occasionally <10°C. Of the five cases where yields were higher in “warm” than “cold” treatments, warmer temperatures at planting were evident in three cases, and higher plant stands in two cases.

- In part, the temperature differences achieved may not have been sufficient to influence yield in all cases, or the crop may have been able to compensate for early-season differences. As well, because soil temperature at planting represented a single point in time, it may not have accurately reflected the conditions the crop was exposed to. Additional analyses are planned.

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References