Effect of residue management on growth, yield and quality of soybean

Project duration: May 2018 – August 2019

Objectives: To determine the effect of residue management on soybean planted in early versus later May

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Results:

Manitoba's soybean industry has grown rapidly over the past decade. The introduction of short-season cultivars has resulted in an expansion in production from traditional growing areas in the Red River Valley to shorter-season areas, leading to a record soybean acreage of 1.6 million acreas in 2016 (Statistics Canada 2016). Despite ongoing improvements in soybean genetics, soybean is inherently a cold-sensitive crop that can be prone to low-temperature damage in both the spring and the fall. As such, planting either too early or too late may pose a risk. Management practices that modify the micro-climate that soybeans are exposed to early in the growing season, and/or that give the crop a competitive advantage under stressful conditions, may help to create a set of conditions that are more conducive to soybean establishment, growth and yield and thereby potentially reduce production risk.

A series of small-plot and controlled environment studies were initiated in fall 2017 to better understand the effect of management on early-season temperature and moisture conditions and, in turn, on soybean establishment, growth, yield and quality. In 2019, early seeding increased yield at 2 of 3 sites, suggesting the potential benefit of early planting in a year like 2019 where spring frosts were not an issue, but where an early and cold fall delayed crop maturity and harvest. These results contrast with 2018 where planting date had no effect on yield. Residue management affected soybean yield only at Indian Head in 2019, with tall stubble enhancing yield in some cases, similar to the results at this site in 2018. These are preliminary results only from ongoing field trials.

Study 1: Effect of residue management and planting date on soybean (A. Glenn, C. Holzapfel, H. Abbas, R. Mohr)

A four-year study was initiated in 2017 near Brandon, MB (AAFC-Brandon), Carberry, MB (Canada-Manitoba Crop Diversification Centre), and Indian Head, SK (Indian Head Agricultural Research Foundation) to assess the effect of residue management practices on the following soybean crop. Treatments consisted of a factorial combination of six residue management treatments [fall-tilled; fall-burned; short stubble (+straw); tall stubble (+straw); short stubble (-straw); tall stubble (-straw)], and two soybean planting dates. A split plot design with four replicates was employed, with planting date assigned to main plots and residue treatments to subplots. Residue treatments were imposed on wheat (Brandon, Carberry) or canaryseed (Indian Head) stubble in fall 2017 and 2018, and these plots were planted to soybean in 2018 and 2019, respectively. This will be repeated in 2019/20. Immediately after residue treatments were imposed, self-logging temperature sensors (Model DS1922L, iButton

Temperature Logger) were installed at a 5 cm depth in each plot to monitor soil temperature until spring. In 2019, soybean (R2, 00.3, 2375 CHU) was planted into residue treatments in early or late May (May 9, 10, 14 and May 29, 23, 30 at Brandon, Carberry and Indian Head, respectively). Preliminary analysis of the 2019 data indicated no date x residue management interactions for the data presented, therefore main effects of data and residue management are reported herein.

Dry early season conditions and a wet, cool fall with early snowfall contributed to challenging growing season conditions for soybean in 2019. While soil temperature at planting was significantly lower for the early than late planting date at all sites, soil temperatures for the early planting date were near or above the recommended 10 C (Fig. 1a). Residue management influenced soil temperature only at Brandon, with higher temperatures measured in short stubble (-straw) and tall stubble (+/- straw) than in short stubble (+straw) treatments (Fig. 1a). Soil moisture at planting varied among sites and planting dates (Fig. 1b). Soil moisture was higher for the early than late planting date at Indian Head with the opposite evident at Brandon. Residue management had no effect on soil moisture at planting at Brandon or Indian Head; however, soil moisture was lower in the tilled than all other treatments at Carberry.

In 2019, seeding date had a marked effect on days to emergence (DTE). Early seeding increased DTE by an average of 5 to 13 days depending on site whereas, in cases where differences in DTE due to residue management were observed, differences among treatments often averaged only about 1 day (data not presented). While planting date and residue management influenced plant stand at both Carberry and Indian Head, average plant stands met or exceeded the provincial recommendation of 40 plants/m2 regardless of treatment (Fig. 1c).

In 2019, early planting increased soybean yield at Brandon and Indian Head (Fig. 1d). These findings demonstrate the potential benefit of early planting in a year like 2019 in which spring frosts were not an issue, but where an early and cold fall delayed crop maturity and harvest. These results contrast with 2018 where planting date had no effect on yield. Residue management affected soybean yield only at the Indian Head site in 2019 (Fig. 1d). Tall stubble resulted in a higher yield than either short stubble (+straw) or tilled treatments, with tall stubble (-straw) also producing higher yields than either the burn or short stubble (-straw) treatments. Tall stubble also out-yielded burn and short stubble (-straw) treatments at this site in 2018. It is interesting to note that, although residue management did not have a statistically significant effect on yield at Brandon (P=0.08) or Carberry (P=0.12) in 2019, contrast analysis identified higher yields in stubble treatments where straw was removed. This appeared to be associated with differences in plant stand at Carberry but not at Brandon.

Treatment had no effect on seed quality (protein, oil, seed weight, test weight) at Brandon or Carberry, except for test weight at Brandon which was higher for early than late seeding. At Indian Head, however, test weight, seed weight and %oil were higher with early planting, and were also influenced by residue management (data not presented).

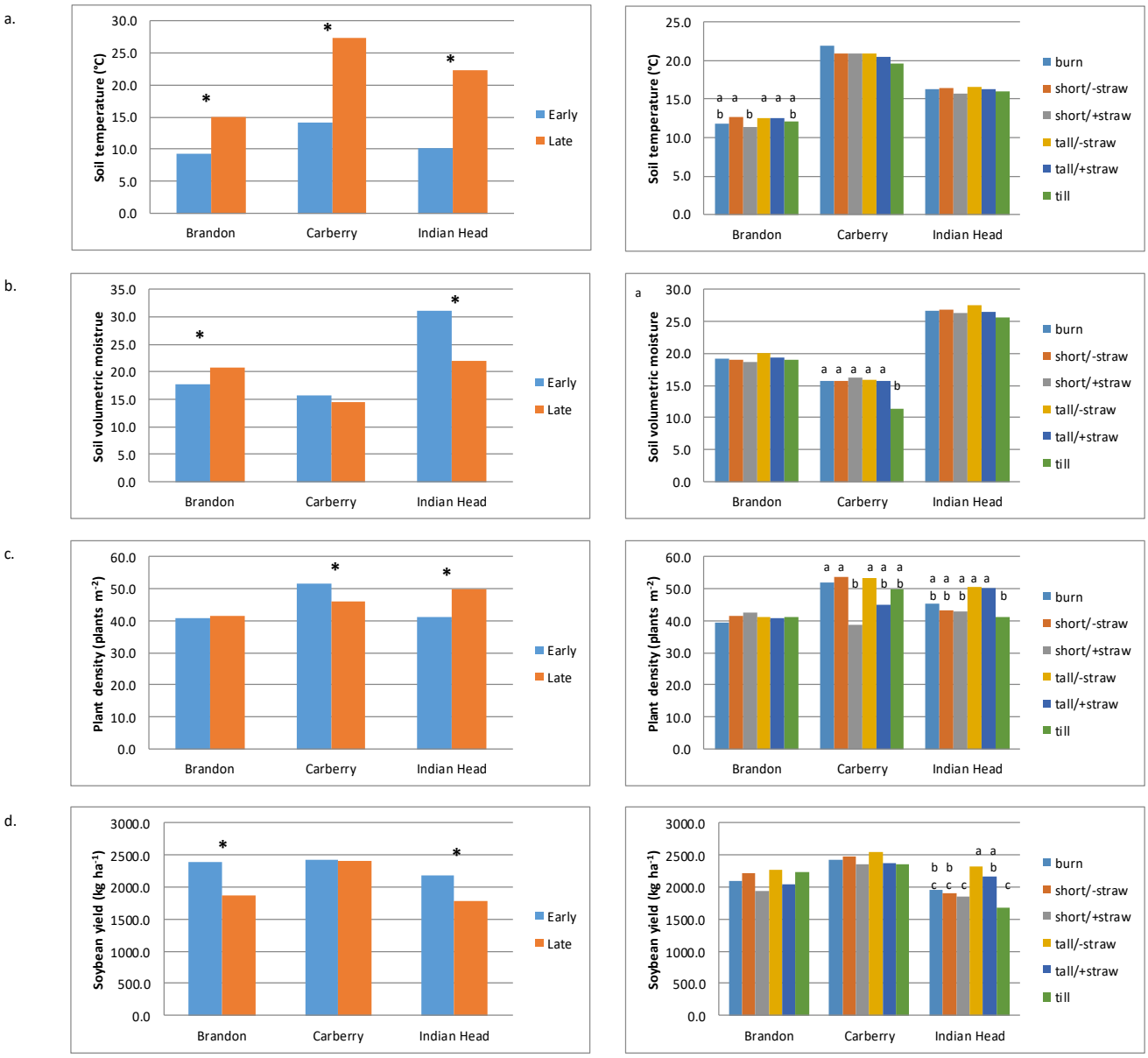

Figure 1. Effect of planting date (early vs late May) and preceding residue management (fall burn, short stubble with and without straw, tall stubble with and without straw, fall tillage) on soil temperature and moisture at soybean planting, and on soybean plant stand and yield, at Brandon, Carberry, and Indian Head in 2019. Reported values for planting date are averaged across residue management practices, and for residue management practices are averaged across planting dates. (*indicates that planting dates are significantly different within a given site. Residue management practices within a site that are denoted by the same letter are not significantly different from one another)

Fig 2. Residue management treatments established near Carberry, MB at time of iButton installation (left) and near Brandon, MB in late October 2017 (right).

Study 2: Temperature effects on soybean emergence under controlled conditions (D. Tomasiewicz, R. Mohr)

To complement the field studies, a series of controlled environment studies are ongoing to more closely assess temperature effects on early soybean development. Studies will be conducted during the winter over the duration of the project based on availability of the specialized controlled environment facility at AAFC-Saskatoon.

Preliminary testing of methodologies was done in 2017 to refine experimental protocols. Beginning in January 2018, a series of controlled environment studies have been conducted annually for several months each year to assess the effect of temperature and seed characteristics on soybean germination and emergence. In each case, a completely randomized design with three or four replicates are employed, and a range of temperature treatments are assessed. The effect of various factors including soybean size, seedlot, and conditions under which soybeans were produced is being investigated, with studies underway currently.

Background:

The Canadian prairies mark the northern fringe of soybean production in North America. Despite ongoing improvements in soybean genetics, soybean is inherently a cold-sensitive crop that requires a relatively long growing season. Frost, and near freezing temperatures in spring and fall can damage soybean. Early planting into cool and wet conditions can increase seedling disease and reduce plant stand (NDSU Extension Service 2010), with soil temperature acting together with soil moisture to affect establishment (Helms et al. 1996a; Helms et al. 1996b; Wuebker et al. 2001). Residue management practices may influence soil temperature as well as soil moisture, and thus potentially affect early-season growth.

Materials & Methods:

Experimental Design:	Split plot design with four replications
Entries:	12
Seeding:	May 10, 2019 (Date 1), May 23, 2019 (Date 2)

Harvest: October 08, 2019

Treatments

Main plots: two planting dates of soybean (May 10; May 25)

Sub-plots: Six spring wheat stubble treatments:

1. Short stubble with straw removed (15 cm standing stubble)
2. Short stubble with straw chopped & retained (15 cm standing stubble)
3. Tall stubble with straw removed (30 cm standing stubble)
4. Tall stubble with straw chopped & retained (30 cm standing stubble)
5. Fall-tilled wheat residue (straw chopped and returned prior to tillage)
6. Fall-burned wheat stubble (straw chopped and returned prior to burn)

Agronomic info:

Standard recommended agronomic protocols were adopted for each crop. Fertilizers were applied with respect to soil test results. Herbicide were applied, when required.