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Seeding Management to Reduce Temperature Stress in Brassica Species

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Abstract

Fall seeding is a promising new technology for canola production in the prairie. A field trial was conducted to extend this technology to the semiarid prairie, where at least some drought and heat stress is expected routinely. The objective was to see whether fall seeding is better suited to all oilseed Brassica species. Fall seeding advanced growing season and flowering in all B. species. Fall seeded crops were less stressed due to heat or water shortage. Species and seeding dates influenced seed yield. Early spring seeding was higher yielding than fall seeding due to large yield decline observed in Polish canola and mustard (8 to 30%) due to fall seeding, while the same decline in Argentine canola was only 1-9%. However, delaying seeding to late spring reduced yield significantly in all three species. The result needs to be confirmed under hotter and drier season.
Keywords: Canola, Mustard, Fall Seeding, Heat Stress, Yield

Introduction

Water and temperature are the two major factors limiting crop productivity in the semiarid prairie. Traditionally cropping season on the prairie is from May to August. Precipitation deficit during the season increases gradually and flowering usually occurs at the peak temperature period. Thus water and/or heat stress reduce yield in typical mid May seeded crop.

Fall seeding is a new technology, which can be used to extend the growing season (Johnson et al., 1998). The development of herbicide tolerant crops enables to use fall seeding technology without weed problem. Benefits of fall seeding include reducing heat and water stress at flowering, more efficient use of limited water, advancing maturity, reducing disease and pest problems and spreading a workload. In the semiarid prairie, where crop choice is limited due to the susceptibility of many crops to water and heat stress, reducing heat and water stress by fall seeding has a significant role in designing the cropping systems.

Cropping systems in the semiarid prairie are changing. Oilseed and pulse crops are being added to the crop rotation. Due to the better economics, canola is occupying the oilseed component of the rotation. However, canola is a cool season crop and is susceptible to heat stress. Mustard is more stress tolerant than canola and is recommended to replace canola in the semiarid prairie. But our recent study has revealed that the optimum temperatures of three oilseed Brassica are different. Therefore, it is necessary to study the response of different Brassica species to seeding dates with special emphasis on fall seeding.

Objectives:

-To study the effect of fall and spring seeding on the growth and water use characters of three Brassica species.

-To observe the yield responses of three Brassica species to fall and spring seeding under fallow and stubble conditions.

Materials and Methods

The experiment was conducted on a Swinton loam soil (Orthic Brown Chernozem) at the Agriculture and Agri-Food Canada, Semiarid Prairie Agricultural Research Centre (SPARC), Swift Current during 1998-1999 season. Three oilseed Brassica species, B. napus (cv. Arrow), B. rapa (cv. Sunbeam) and B. juncea (cv. Cutlass) were seeded on three seeding dates, late fall (Nov 10, 1998), early spring (April 24, 1999) and late spring (May 25, 1999) in a factorial RCBD design. The trial was run both on standing stubble and chemical fallow. The plot size was 2.5m X 10m. Fall seeding was done using a disc drill, while spring crops were seeded with an air drill. Seed rate of 10-14 kg ha^{-1} was used to get an acceptable stand of both fall and spring seeded crops. The fertilizer P and N recommended for the region were seed banded and broadcasted, respectively.

Days to emergence, flower initiation and growth stage were recorded. In the stubble, soil moisture was measured with a neutron probe to a depth of 1.80m. A plot combine was used to take yield samples. The data of stubble and fallow treatment were analyzed separately, as a factorial RCBD.

Results and Discussion

Fall seeded crop started emerging last week of April, when the early spring crop was being seeded. Thus, fall seeding increased growing season duration by about 10-12 days over early spring seeding and by about 20-25 days compared to late spring seeding. Most of the extension in growing season occurred during cooler and moister weather (Fig. 1). Before the loss of moisture from surface soil layers due to increasing temperature and evaporation, the fall seeded crop was established with a well developed root system. The benefit of early seeding was also reflected in earlier flowering,

Table 1. Brassica species yield response to seeding dates under stubble and fallow conditions.

Treatments	Late Fall	Early Spring	Late Spring	Mean
		Fallow		
Brassica napus	2200	2229	1400	1943a
Brassica rapa	2002	2181	1291	1825a
Brassica juncea	2093	2363	1587	2014a
Mean	2099a	2258a	1426b	
		Stubble		
Brassica napus	1600	1757	923	1427ab
Brassica rapa	1018	1449	1032	1533a
Brassica juncea	1497	1779	1322	1166b

Mean	1372	1662	1662

avoiding heat stress (Fig. 2). Post-flowering GDD_{20} was about 50% higher for late spring seeding crop compared to fall seeding. Early spring seeding accumulated 16% extra heat above 20 °C compared to fall seeding.

Soil moisture extraction varied due to Brassica species and seeding date (Fig.3). In general, the fall seeded crop extracted less soil moisture. Delaying seeding to early spring and to late spring resulted in 37 and 72 % more water extracted from the soil profile than fall seeded crops(Fig. 3). The growing season was fairly wet with regular rains until July 24. After that rainfall stopped. Compared to mustard and Polish canola, Argentine canola tended to use more soil moisture; the late spring seeding extracted 84 % more water from the profile than fall seeding. The lower extracted amounts of water from the soil by fall seeded crops suggest that the fall seeded crops were less stressed.

. Seed yield varied due to seeding date and Brassica species (Table 1). The trial on fallow produced 40 % higher mean yield over that of stubble trial. Pooled over the three Brassica species, early spring seeding increased yield over fall seeding by 7 to 17 %, while late spring seeding yield was 34 to 37 % lower than early spring seeding under fallow and stubble conditions, respectively. The higher yield of early spring seeding over fall seeding was mainly due to the 8 and 11 % yield decline of B. rapa and B. juncea due to fall seeding under stubble and 13 and 30 % yield decline under fallow, respectively. While the same yield decline for B. napus under fallow and stubble was only 1 and 9 %, respectively

The results are from the first year of a three year study, hence are preliminary. However few observations need be mentioned. First, in our previous studies we have observed that the optimum temperature for B. napus is lower than B. rapa and B. juncea. In the first year of this field study species were responding differently. Were species differences in yield response observed in the field were related to the species differences for optimum temperatures among species? Second, fall seeding reduced heat and water stress. Why then was higher in early spring seeding? Finally, the inconsistent results from fall seeding may be related to seeding practices like depth, soil cover, seeding equipment, etc. The reasons for the above responses need to be looked into.

Summary

Seeding dates significantly influenced water use and yield of Brassica species. Fall seeding did not increase seed yield in any of the Brassica species. Early fall seeding produced highest yield. Although, fallow crop was high yielding compared to stubble crop, the nature of response to seeding date was similar. Results need to be confirmed under hot and dry season.

Acknowledgement

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References

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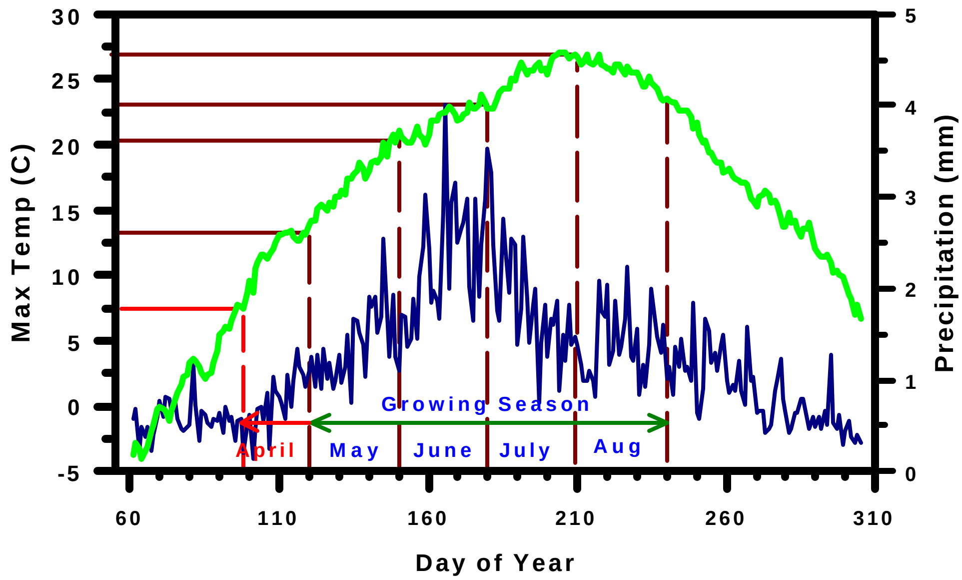

Fig. 1. Extending growing season with fall seeding. Long term maximum daily temperature and rain fall are presented for comparing actual growing season with extended growth period.

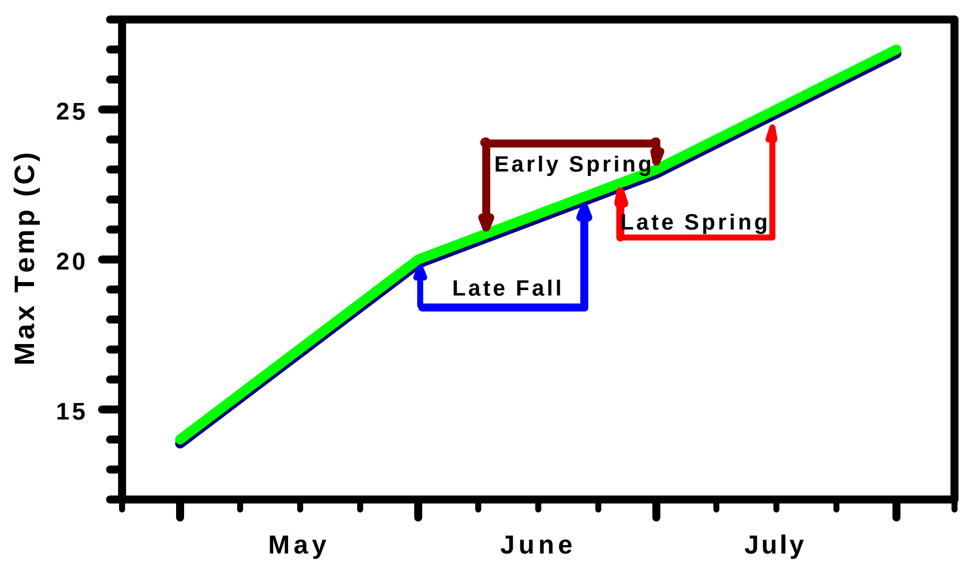

Fig. 2. Long term maximum daily temperature for Swift Current area that coincides with the flowering of canola seeded on different seeing dates

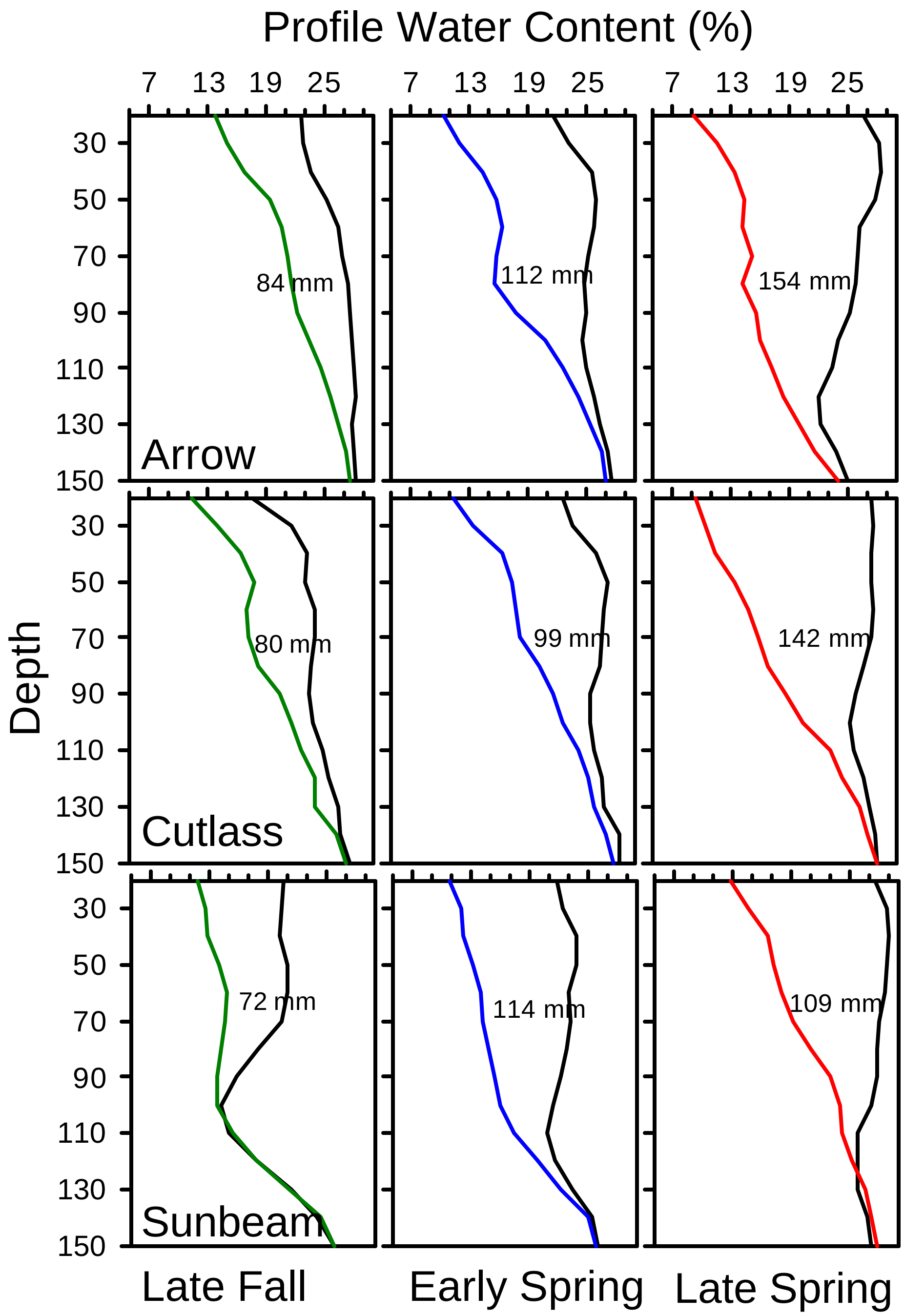

Fig. 3. Profile water content and water extraction of fall early spring and late spring seeded Brassica species between June 18 and August 23, 1999 at Swift Current.