Pre-Emergence Tillage in Field Pea Effective, But Timing Critical

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Introduction

On the semi-arid prairies, it is generally recommended to seed field pea early and at a depth of 4 to 7.5 cm. Crops that emerge before weed emergence are more competitive than crops emerging at the same time or after weed emergence. Delayed seeding to control late-emerging weeds and seeding at shallower depths to promote rapid emergence may be an alternative weed management strategy. The objective of this experiment was to identify combinations of seed date, seed depth, and pre-emergent weed control to optimize yield of field pea grown without the use of herbicides.

Materials and Methods

The experiment was conducted on a Scott loam soil at Scott, Saskatchewan in 1999 and 2000. The previous crop was cereal greenfeed. An early spring cultivation was performed on the experimental area. Wild oat (*Avena fatua* L.) and wild mustard (*Brassica kaber* (DC.) L.C. Wheeler) were cross-seeded in the plots prior to the first seed date at a target density of 100 viable seeds m $^{-2}$ for each species. Field pea (*cv.* Grande) was seeded at 80 plants m^{-2}. Treatment design was factorial and experimental design was a split-plot. Seed date (early, mid- and late May) was the main plot factor while seed depth/weed control system was the sub-plot factor.

Actual seed dates were May 4 and May 6 (early), May 18 and May 16 (mid) and June 1 and May 30 (late) in 1999 and 2000, respectively. No further pre-seed tillage was conducted after the early spring cultivation. The plots were seeded directly into weedy stubble with a hoe drill plot seeder (22-cm row-space). Seed depth/ weed management systems were:

I. 2.5 cm seed depth – no weed control;
II. 2.5 cm seed depth – two pre-emergent tine harrow passes;
III. 2.5 cm seed depth – post-emergent herbicide;
IV. 7.5 cm seed depth – no weed control;
V. 7.5 cm seed depth – two pre-emergent rod-weed passes;
VI. 7.5 cm seed depth – post-emergent herbicide.

Two pre-emergence tillage treatments were done approximately 3 and 5 days after seeding, however unfavorable weather sometimes delayed the second pass up to 7 days. In 2000, the second pre-emergence tillage treatments for the early seed date were inadvertently delayed until 10 days after seeding. The rod-weeder was set to a depth of 2.5 cm. The tine harrow was set very aggressively by angling the tines 10° backward. Tillage speed was 6 km hr^{-1}. The post-emergence herbicide treatment was a sequential application of metribuzin at a rate of 212g ai ha^{-1} for broadleaf weed control and sethoxydim at a rate of 200g ai ha^{-1} for grass weed control. A crop-oil concentrate/ surfactant blend was added to the sethoxydim at a rate of 0.5% v/v. Metribuzin was applied at the 4-5 node stage of the field pea with the sethoxydim treatment applied 5 days later. A 80% sulphur formulation was sprayed on all treatments during early flowering at a rate of 1.2 kg ai ha^{-1} to control powdery mildew (*Erisyphe polygoni*).

Plot size was 6 meters wide by 5 meter long with four replications. Data collected included crop density and fresh weight, wild mustard density and fresh weight, wild oat density and crop yield.

Environmental Conditions

Environmental data for the 1999-2000 growing seasons are shown in Tables 1 and 2.
Both years were quite favorable for crop production. Growing season precipitation was 27 and 4% above the long-term average for 1999 and 2000, respectively. Mean monthly air temperatures were similar to the long-term average.

Table 1: Mean monthly air temperatures for the 1998-2000 growing season and long-term average (1911-1990) at Scott, Saskatchewan.

	April	May	June	July	August	Mean
1999	5.1	9.4	13.1	15.0	16.6	11.8
2000	3.2	9.4	13.5	17.4	15.6	11.9
Long –Term Average 1911-1990	3.0	10.0	14.0	18.0	16.0	12.2

Table 2: Mean monthly precipitation for the 1998-2000 growing season and long-term average (1911-1990) at Scott, Saskatchewan.

	April	May	June	July	August	Total
1999	51.7	66.4	42.8	81.0	48.0	289.9
2000	39.1	23.6	38.6	76.4	60.2	237.9
Long –Term Average 1911-1990	23.0	36.0	61.0	62.0	46.0	228.0

Results and Discussion

Weed density was much higher in 1999 than 2000 with a mean weed density of 104 and 24 plants m^{-2}, respectively. Weed species composition was 56% broadleaf weeds and 44% wild oat in both years. Wild mustard accounted for 99% of the broadleaf weed species, with the balance consisting of very low inherent populations of common lambsquarters (*Chenopodium album* L.) and wild buckwheat (*Polygonum convolvulus* L.). Broadleaf weeds accounted for 67%, 33% and 51% of the total weed composition in 1999 for the early, mid, and late May seed dates, respectively. 2000 was a mirror image with broadleaf weeds accounting for 54%, 40%, and 70% of the total weed composition for the respective seed dates.

Crop establishment was excellent at all seed dates in both years due to good soil moisture conditions. Deep seeding delayed crop emergence by one day and the rod-weed treatment delayed emergence an extra day. This was consistent over all seed dates and both years. However, emergence differences did not affect crop maturity. Seed date had no effect on crop density when pooled over the two years (data not shown).

In 1999, total weed density was highest with the early seed date, with delayed seeding resulting in lower weed populations (Figure 1). There was no significant difference in weed populations between seed dates in 2000.

There was a significant seed date by weed control interaction for weed density in both years (Figure 1). In 1999, pre-emergence tillage had marginal effects on weed density at the early seed date as weed emergence was low at time of tillage. Pre-emergence tillage effectively reduced weed density at the mid- and late May seed dates. In 2000, pre-emergence tillage reduced weed density at both the early and mid- seed dates. The delayed second pass of the pre-emergence tillage may have contributed to the success at the early seed date. Pre-emerge tillage at the late seed date resulted in higher weed populations since rainfall occurred shortly after the tillage operations, resulting in stimulation of wild mustard recruitment.

Rod-weeding was more effective in reducing weed populations than harrowing in 1999, however there was no difference in 2000. Herbicides were very effective in reducing weed density at the early seed date in 1999. However, they were less effective at late seed dates since there was no pre-seeding weed control. The weeds were quite advanced at the later seeding dates, resulting in reduced control. In 2000, herbicides were effective at all seed dates. Weed fresh weights showed similar trends to weed densities in both years (data not shown).

Crop yield was excellent in both years. Yield response to weed control was less in 2000 than in 1999 due to lower weed densities (Figure 2). Delayed seeding until late-May resulted in up to a 40% reduction in field pea yield. In 1999, overall yields were highest for the mid-May seed date, due to the efficacy of both the tillage and herbicide treatments. In 2000, the early and mid-May seed dates had similar overall yield. Relative field pea yields were 100%, 121%, 80% and 100%, 100%, 60% for the early, mid, and late May seed date in 1999 and 2000, respectively.

Highest crop yield was achieved with early seeding and herbicide application in both years. Pre-emergence tillage did not improve crop yield at the early seed date in 1999, but improved yields at the early seed date in 2000. This is due to the reduction in weed interference caused by the delay of the second post-plant tillage. Pre-emergence tillage generally improved crop yield at the mid- and late seed date in both years.

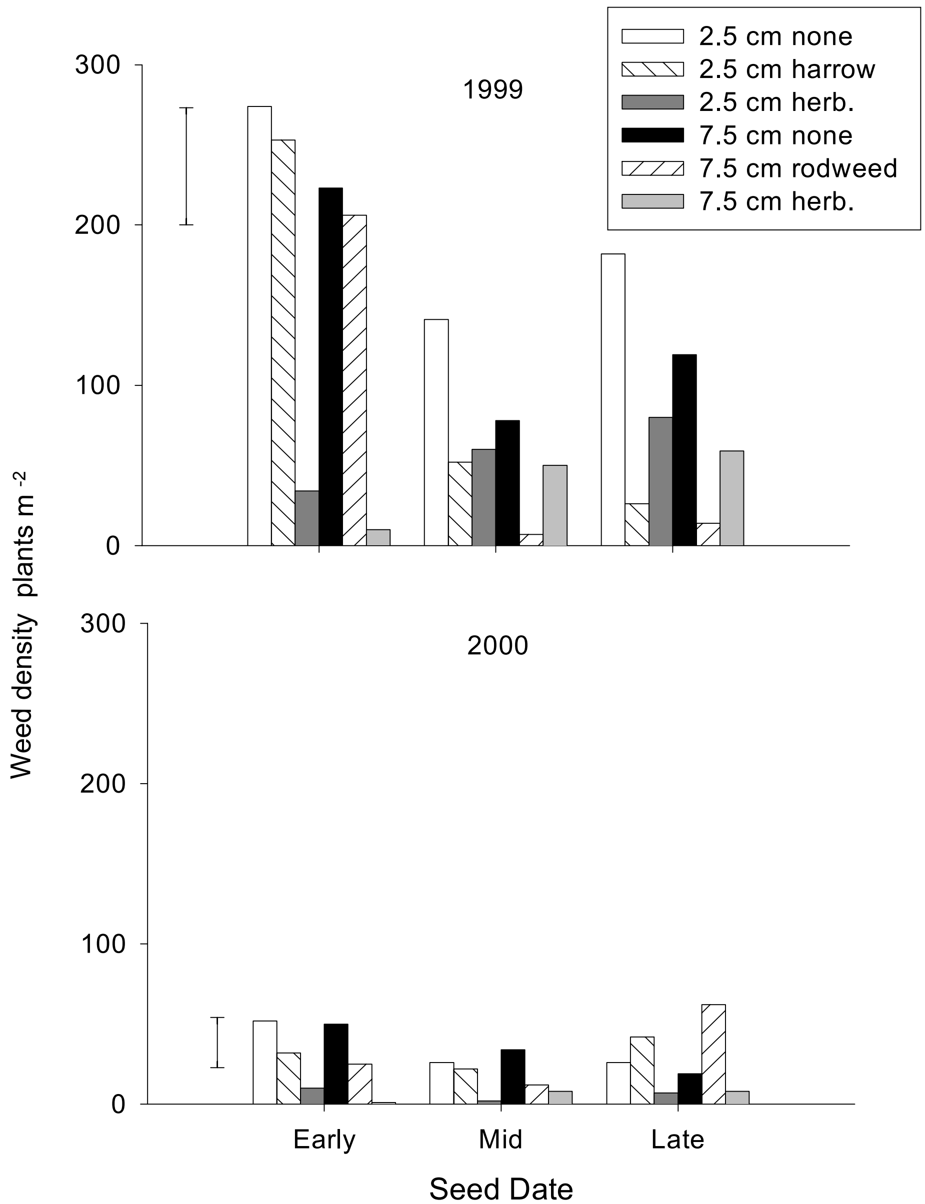

Figure 1.: Effect of seed date, seed depth and weed control treatments on weed density (plants m^{-2}) at Scott, Sk. 1999-2000. Bar on left side of graph represents the $LSD_{0.05}$ to separate two subplot means within or between main plots.

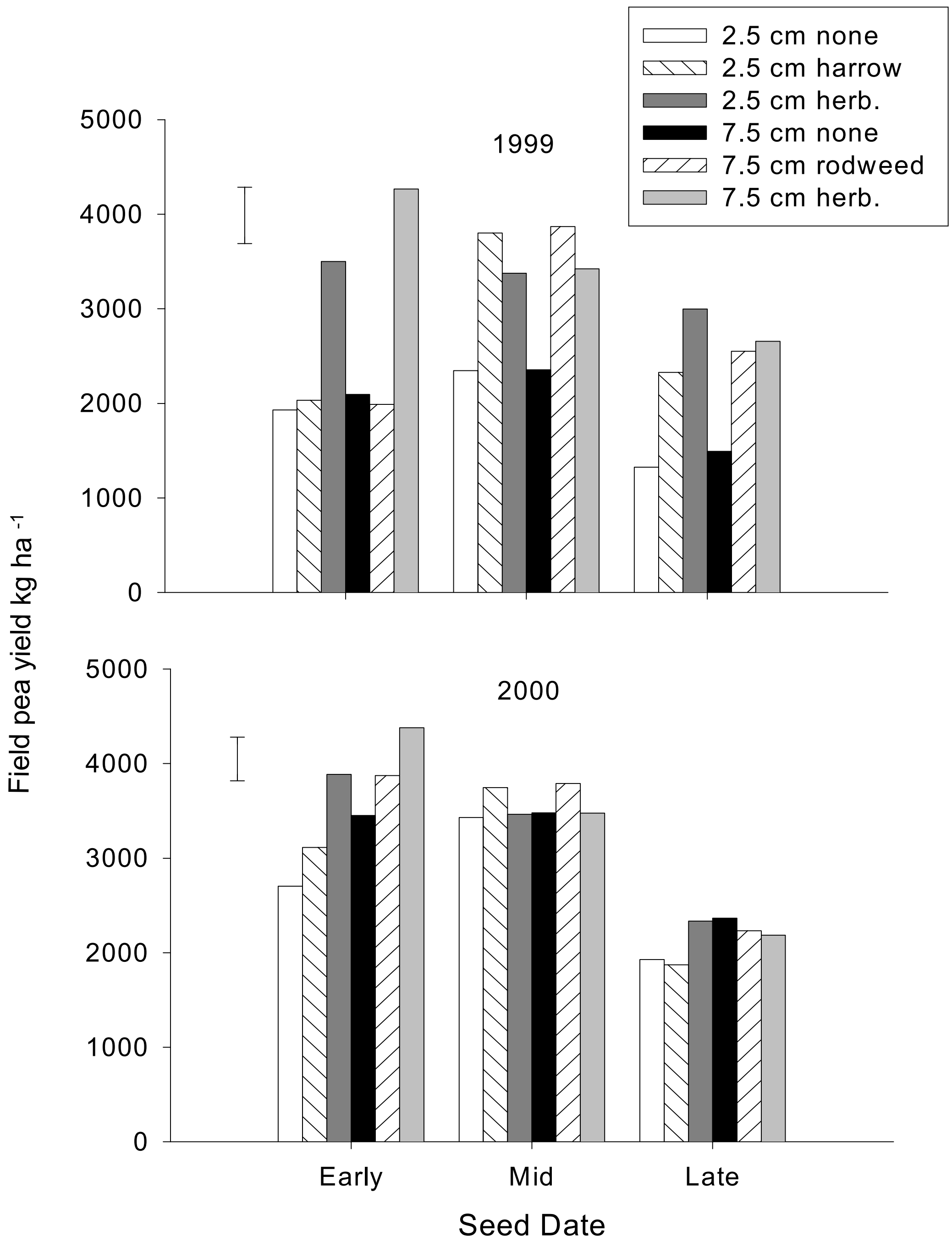

Figure 2.: Effect of seed date, seed depth and weed control treatments on field pea yield (kg ha^{-1}) at Scott, Sk. 1999-2000. Bar on left side of graph represents the $LSD_{0.05}$ to separate two subplot means within or between main plots.

The pre-emergence tillage treatments at the mid-May seed date resulted in yields of 90% and 86% of the highest yield obtained for 1999 and 2000, respectively. In 1999, rod-weeding did not result in higher crop yield than harrowing even though it provided better weed control. The harrow treatment reduced competition by causing physical damage to the plants, particularly at more advanced growth stages. Rod-weeding provided superior yields than harrowing in 2000 ($p=0.004$), particularly at the early and late seed date. The untreated checks seeded at 7.5 cm were higher yielding than the checks seeded at 2.5 cm in 2000 ($p=0.006$) but seed depth had no effect on the yield of the untreated checks in 1999. This study does not provide any evidence that shallow seeding and faster emergence will improve competition of field pea.

Conclusions

Pre-emergence tillage between the time of seeding and crop emergence can be very effective in reducing weed density and improving crop yield provided there is adequate weed growth at the time of tillage. This may require a delay in seeding date, however the seeding operation should only be delayed to allow for a high proportion of weed emergence. Seeding in late May results in a severe yield penalty. Crop yields for the best seed date/ tillage combination were 10-15% lower than that achieved by the best seed date/ herbicide combination. Early seeding with a herbicide treatment resulted in the highest crop yields in both years.