Mechanical Weed Control in Pulse Crops

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Introduction

The use of mechanical weed control practices has declined over the past half-century due to the success of chemical weed control (Edwards and Regnier, 1989). In addition, the deleterious effects of tillage on soil quality have been well-documented (Campbell *et al.,* 1990). However, some European countries and the United States are trying to reduce agriculture's reliance on pesticides. (Matteson, 1996; Economic Research Service USDA, 1997). Mechanical weed control may be an important component of pesticide reduction.

The Canada-Saskatchewan Agri-Food Innovation Fund (AFIF) Special Crop Program was established in Saskatchewan in 1995. The program identified organic crop production as a priority area with the objective to develop weed control technology for the industry. In 1997, funding was provided to initiate mechanical weed control studies at the Scott and Melfort Research Farms. Numerous studies have been undertaken, however this paper focuses on two objectives:

1) to determine the effect of harrow type and aggressiveness on selectivity of weed control in post-emergent harrowed pulse crops.;
2) to determine the impact of inter-row cultivation on weed interference and field pea yield.

Materials and Methods

Three field experiments were conducted at the Scott Research Farm, Scott, Sk in 1998 and 1999:

1) Selective post-emergent weed control of a rotary harrow vs. tine harrow in field pea.
2) Selective post-emergent weed control of a spring-tooth weeder vs. tine harrow in pulse crops (done at Scott and Saskatoon, 1999).
3) Inter-row cultivation in field pea.

<u>Experiment 1</u>: Treatments consist of a single and double pass of rotary or tine harrow set at a low and high level of aggressiveness. The treatments were performed when field pea (*cv.* Grande) was in the 4 to 5 node growth stage. Treatment design is a 2 x 2 x 2 factorial with factors being harrow type, aggressiveness, and number of passes (single vs. double). Experimental design is a randomized complete

block with four replicates. Check treatments include a weedy control and a herbicide treatment of imazethapyr/imazamox at 30 g ai/ha.

Experiment 2: A tine harrow is compared with a spring-tooth weeder set at a low, moderate, and high level of aggressiveness. Treatment design is a 4 x 4 factorial with factors being harrow and number of passes (single, double, three, four). Experimental design is a randomized complete block. Two experiments were conducted in 1999, one in field pea on a loam soil at Scott and the other in lentil on a clay soil at Saskatoon. The spring-tooth weeder has been evaluated as a blind harrowing treatment in winter wheat (Welsh *et al.,* 1996), onions and sugar-beets (Ascard and Bellinder, 1996).

Experiment 3: Inter-row cultivations were performed on field pea (*cv.* Radley) seeded in 34-cm rows. Cultivation treatments are single cultvation at the 6-7 node stage; single cultivation at the 8-10 node stage; two cultivations (6-7 node and 8-10 node); and three cultivations (6-7, 8-10, and 11-12 node stage). Check treatments consist of an untreated seeded in 33-cm rows, an untreated seeded in 22-cm rows, and herbicide (22-cm rows). The herbicide check is a sequential treatment of sethoxydim and metribuzin. Inter-row cultivation has also been evaluated on flax, canola, chickpea, lentil, and barley but only field pea results will be reported.

The predominate weed species in all of the experiments were wild mustard (*Brassica kaber* (DC.) L. C. Wheeler) and wild oat (*Avena fatua* L.). Wild mustard and wild oat were seeded perpendicular to the crop rows prior to seeding the crop. Data collection for all four experiments included crop density, crop fresh weight, grassy and broadleaf weed density, grassy and broadleaf fresh weight, and crop yield.

Results

Experiment 1

In 1998, broadleaf weed density was slightly lower in the tine harrow treatments, relative to the rotary harrow. There was no difference in crop density, crop fresh weight, broadleaf weed fresh weight, grass weed density, or grass weed fresh weight between the harrow types. Two passes significantly reduced broadleaf weed density relative to a single pass. Harrowing had no effect on grass weed density, grass weed fresh weight or crop yield. Herbicide application increased pea yield by 22% over the untreated check.

In 1999, harrow treatments significantly reduced crop density, broadleaf weed density, and grain yield, but had no effect on broadleaf weed fresh weight, grass weed density, and grass weed fresh weight.

Similar to 1998, the tine harrow treatments had lower broadleaf weed densities than the rotary harrow treatments (Figure 1). However, the tine treatments had higher grass weed fresh weight than the rotary treatments (Figure 2). Reduction in crop density and removal of wild mustard competition by the tine implement may account for the increase in grass fresh weight. Although there was a difference in the ratio of broadleaf/grass weed interference, there was no difference in crop yield response between the two harrow types. Post-emergent harrowing and the herbicide treatment increased pea yields by 17% and 109%, respectively.

Experiment 2

Results on field pea at Scott showed a linear increase in yields as the number of harrow passes increased (Figure 3). There was no harrow type X number of passes interaction. Harrow and herbicide treatments increased pea yield by 44% and 109% over the untreated check, respectively. The low aggressive setting on the spring-tooth weeder resulted in higher broadleaf weed density, grass weed density, and grass weed fresh weight than the other harrow treatments. However, the differences between the low setting and the other harrow type/setting combinations declined as the number of passes increased.

At Saskatoon, there was a quadratic yield response to the number of passes (Figure 4). Lentil yield peaked at 3 passes then dropped dramatically with the fourth pass. This may be due to a lower tolerance of lentil to post-emergent harrowing than field pea. Unpublished studies by Johnson and Kirkland (1998) suggest that lentil is not as tolerant to post-emergent harrowing as field pea. There was no harrow type X pass interaction for crop yield. Yield increases from the best harrow treatment and the herbicide treatment was 272 and 518 kg/ha, respectively. Wet conditions at Saskatoon were detrimental to lentil yields in 1999.

Experiment 3

In 1998, a single inter-row cultivation reduced grass weed density and grass weed fresh weight, with sequential cultivations having no further effect. Inter-row cultivation reduced broadleaf weed density but had no significant effect on broadleaf fresh weight. There was a linear increase in crop yield from zero to three inter-row cultivations (Figure 5) even though there was no significant improvement in weed control from repeated cultivations. Gonsolus (1990) reported that non-weed control benefits to inter-row cultivation have been reported in corn and soybean. The highest yielding inter-row cultivation treatment and the herbicide treatment increased pea yields by 34% and 57%, respectively.

In 1999, broadleaf weeds were dominant. There was a linear decline in broadleaf weed density from inter-row cultivation. Inter-row cultivation had no effect on grass weed density or fresh weight, likely due to the low numbers of grass weeds present (13 plants/m^2 in untreated check). There was a linear yield response to cultivation, similar to 1998. The highest yielding cultivation treatment and the herbicide treatment increased pea yields by 78% and 196%, respectively.

The difference in yield between the herbicide and cultivation treatments is due to significant in-row weed growth in the inter-row cultivation treatments.

Conclusions

The harrow experiments indicate limited potential to improve selective post-emergent weed control with new harrow implements. Post-emergent harrowing tends to be most effective on small-seeded broadleaf weed species, and their removal may select for tolerant grass species.

Potential weed control benefits of inter-row cultivation are limited by significant in-row weed competition. Cultivar selection may be an important component of mechanical weed management. Post-emergent harrowing and inter-row cultivation have limitations as stand-alone weed management tools. Future studies should evaluate mechanical weed management practices in a long-term integrated system to gain an understanding of how these techniques could augment other cultural and chemical weed control practices.

References:

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FIGURES:

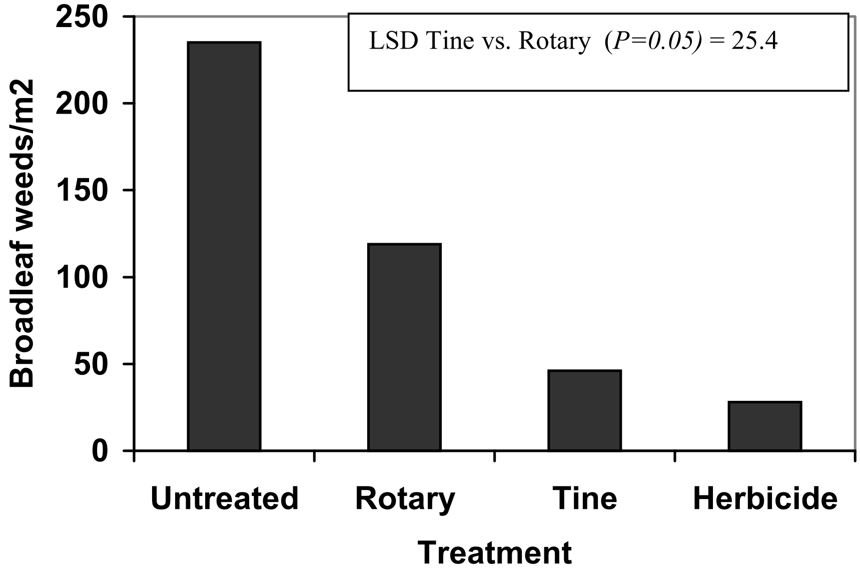

Figure 1: Effect of tine vs. rotary harrow (mean of 2 levels of aggressiveness and 2 passes), and herbicide application on broadleaf weed density (plants/m2), Scott, 1999

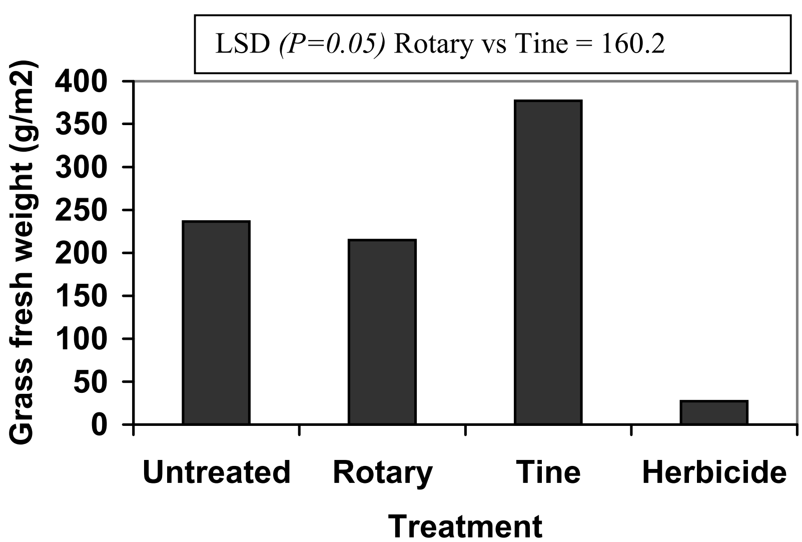

Figure 2: Effect of rotary and tine harrow treatment (mean of 2 levels of aggressiveness and 2 passes), and herbicide on grass weed fresh weight, Scott, 1999.

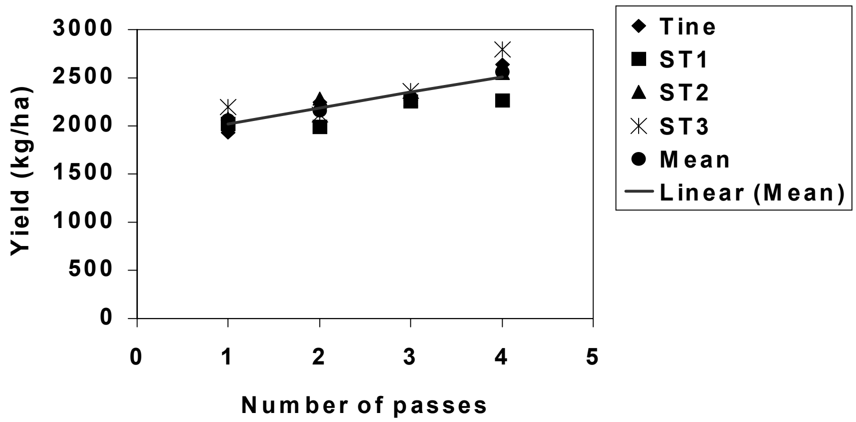

Figure 3: Effect of harrow type (tine and flex-tine harrow set at 3 levels of aggressiveness - ST1 – low, ST2- moderate, ST3 - high) and no. of passes on yield of Grande field pea, Scott, 1999

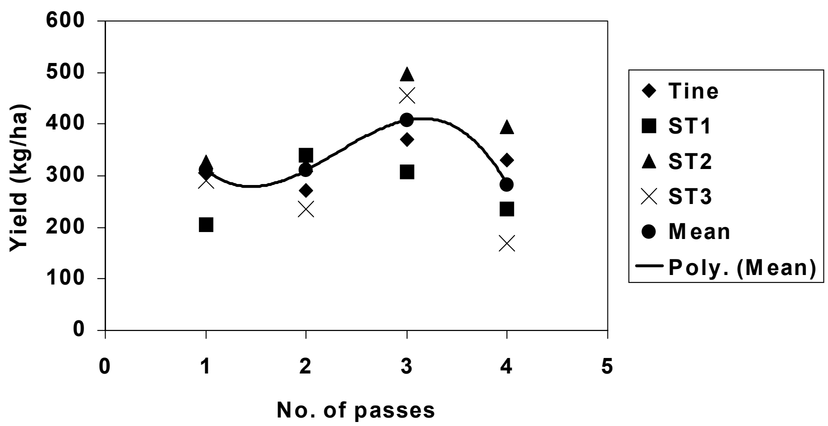

Figure 4: Effect of harrow type (tine and flex-tine harrow set at 3 levels of aggressiveness - ST1 – low, ST2- moderate, ST3 - high) and no. of passes on yield of Laird lentil, Saskatoon, 1999

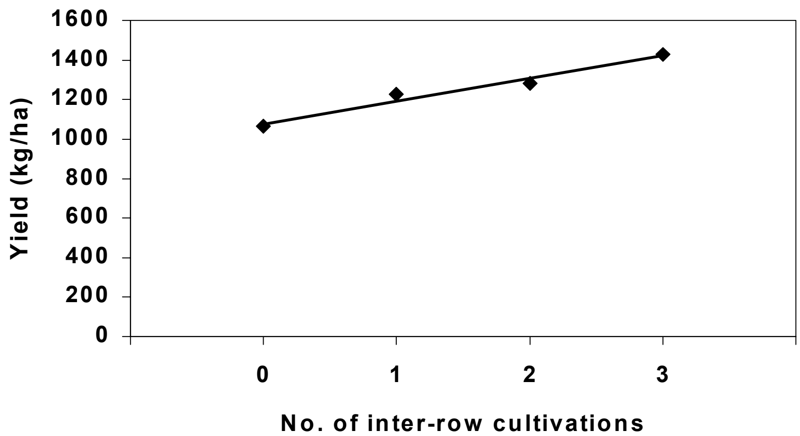

Figure 5: Effect of inter-row cultivation on yield of field pea, Scott, 1998.