THE EFFECTS OF PRESEEDING 2,4-D AND DICAMBA + 2,4-D APPLICATION ON SUBSEQUENT CROPS

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ABSTRACT

The development of reduced tillage systems and direct seeding systems require the use of herbicides in the fall and prior to seeding to control weeds. A study was initiated in 1988 at Indian Head to examine the effects of 2,4-D amine and 2,4-D amine + dicamba applied in the fall or spring prior to seeding on flax, safflower, mustard, canola, lentil and field pea. Herbicides were applied at the low, high,and double the high rates recommended for use in cereal crops (420, 560 and 1120 g/ha of 2,4-D; and 110 + 420, 140 + 420 and 280 + 840 g/ha of dicamba +2,4-D). Visual crop tolerance ratings, plant populations and yield were assessed in 1988 and 1989. In general, none of the crops tested were adversely affected by fall application of 2,4-D amine alone at up to 1120 g/ha. Spring application of 2,4-D amine alone at 560 and 1120 g/ha caused significant yield reductions in safflower and lentil in 1 out of 2 years but none of the other crops were affected by spring 2,4-D application in either year regardless of the rate. Dicamba +2,4-D did not cause significant yield reductions in flax, canola or mustard, however, safflower, lentil and pea yields were significantly reduced by spring application of dicamba + 2,4-D regardless of rate and by all but the lowest rate (110 + 420 g/ha) of this mixture applied in the fall.

INTRODUCTION

Winter annual weeds such as stinkweed, flixweed and shepherd's purse are among the top ten weeds in oilseed and pulse crops in Saskatchewan (Douglas and Thomas 1986; Thomas and Wise 1987). These and other fall or early spring germinating weeds were traditionally controlled by tillage. In an attempt to minimize soil erosion and degradation, however, farmers are turning to herbicides for preseeding weed control. Winter annual weeds are relatively easy and inexpensive to control with 2,4-D, while dicamba + 2,4-D increases the weed control spectrum to include some of the more difficult to control weeds. Unfortunately, both of these herbicides have residual properties which may cause significant yield reductions in broadleaved crops sown in treated soils (Sask Agric. and Food 1990). Crop injury is quite variable. Significant yield reductions of Span and Zephyr rapeseed resulted when 560 or 1120 g/ha of 2,4-D was applied 1 and 2 weeks before seeding at Saskatoon(Ashford and Downy 1972). At Melfort, in the same year, these rates of 2,4-D applied late fall and from early spring until after seeding of Span rapeseed did not significantly affect yield (Bowren 1972). Differences in crop tolerance such as these are related to differences in herbicide availability or crop sensitivity.

Herbicide persistence and bioavailability are affected by many factors (Hance 1988, Frear 1975 and Smith 1989). Microbial degradation appears to be the primary mode of breakdown of both 2,4-D and dicamba. Environmental factors which are favorable for microbial activity such as high organic matter, adequate moisture, warm temperature and suitable pH, reduce herbicide persistence. High organic matter and pH also favor herbicide adsorption, which would protect the herbicide from degradation, but research results indicate that adsorption does not seriously affect degradation of 2,4-D (Smith 1989). In a three year field study conducted in Saskatchewan, no residues of either 2,4-D or dicamba were detected in Regina heavy clay, Asquith sandy loam or Melfort silty loam in October, 5 months after application (Smith 1976). Under lab conditions, the half life of 2,4-D in heavy clay at 75% of field capacity at 20^{o}C was approximately 6-8 days (Smith 1989). Conditions which influence herbicide persistence are not easily manipulated, however, given that certain environmental conditions increase herbicide persistence, differences in sensitivity between species and how this is affected by time and rate of application would be of interest to producers.

The objectives of this study were to examine the tolerance of six broadleaved crops; canola, mustard, flax, safflower, lentil and pea to several rates of 2,4-D and dicamba + 2,4-D applied late in the fall or early in the spring.

MATERIALS AND METHODS

Field experiments were conducted at Indian Head in 1988 and 1989 on thin black chernozemic Indian Head Clay with 3-4% organic matter. Plots were located on chem fallow, treated in the fall with liquid trifluralin at 1.4 kg/ha and incorporated with a light duty cultivator, to provide broad spectrum annual weed control. No other tillage was performed.

2,4-D amine and dicamba + 2,4-D amine rates were based on rates required to control winter annual (2,4-D) and perennial (dicamba) weeds in other crops. This preseeding treatment is not recommended for any broadleaved crops. They were applied at the low and high rates of the rate range and double the high rate , to simulate overlaps. 2,4-D rates were 420, 560 and 1120 g/ha and dicamba + 2,4-D was applied at 110 + 420, 140 + 420 and 280 + 840 g/ha. Herbicides were applied with a CO^2 backpack spayer equipped with SS80015 nozzles in a water volume of 110 L/ha at 275 kPa. on Oct. 14,1987, April 21,1988, Oct. 6,1988 and April 25,1989.

Canola (Westar), mustard (Brown), flax (Norlin), safflower (Saffire), lentil (Laird) and pea (Tipu) were seeded at 8, 8, 40, 25, 70 and 120 kg/ha respectively, at 3.0 cm depth with a double disc press drill. Seeding dates were approximately 1-3 weeks after spaying; safflower on April 29, lentil on May 5 and the other crops on May 11 in 1988 and all crops were seeded on May 2 in 1989. In 1989, drought, combined with high winds resulted in severe crop damage and consequently, flax, canola and mustard were reseeded on May 29. All plots were fertilized with 200 kg/ha of 46-0-0 each fall. In addition, flax plots recieved 25 kg/ha, canola, mustard and safflower received 20 kg/ha and pea received 10 kg/ha of 12-51-0 with the seed.

Precipitation was well below normal in the fall of 1987 and 1988. The week before spraying in Oct.,1987, there was only 1 mm of rainfall recorded but 6.0 mm was received the day after spraying and another 3.2mm occurred in the second week after spraying. In April of 1988, there was no precipitation recorded in the week before spraying. The first significant rainfall (20 mm) occurred 9 days after spraying with a total of 26.4 mm in the second week after spraying.

Dry conditions prevailed in 1988/89, as well with the first significant precipitation (7.8mm) occurring 38 days after spraying in the fall and 28 days after spraying in the spring (11.6mm).

Each crop was treated as a separate experiment with a split-split plot design. Time of application (fall/spring) was the main plot, herbicide (2,4-D/dicamba +2,4-D) , the subplot and rate(0,1,2,3) , the sub-sub plot. Each plot was 2x5 m in size. Visual crop tolerance(0-9), crop stand (plants/m^2) and yield were assessed. Crop stand data was transformed (log(plants/m^2+1)) and all data was analyzed by year using an analysis of variance with mean separation at 95% level according to Fisher's least significant differences test (L.S.D.).

RESULTS AND DISCUSSION

The Saskatchewan Agriculture and Food publication "Chemical Weed Control In Cereal, Oilseed, Pulse and Forage Crops 1990" states, "2,4-D or MCPA should not be applied in the spring either pre-emergence or prior to the seeding of a broadleaved crop" and "The use of high rates of 2,4-D or MCPA in the fall as spot treatments to control Canada thistle can carryover and will affect sensitive broadleaved crops sown early the following spring". Results of this study indicate that under certain conditions, 2,4-D or dicamba + 2,4-D applied in the spring or fall at up to double the recommended rate does not result in significant yield reductions.

Flax, canola and mustard were all relatively tolerant to both herbicides, regardless of time or rate of application. In 1989, flax stand was significantly thinner in plots which were treated with herbicides in the spring than those treated in the fall . This may have been due in part to weed pressure since stand inproved as rate of dicamba + 2,4-D increased. There was, however, a trend towards stand reduction as rate of 2,4-D, applied in fall, increased and this trend was also apparent in flax yield, although the yield in treated plots was higher than in the untreated check. Even though yields in treated plots were higher than in the untreated check plots, under certain weather conditions this could result in significant yield losses. Dicamba + 2,4-D treated plots tended to yield more grain than those treated with 2,4-D alone and this difference was significant in 1989. Weed control was not ideal in 1989 due to adverse weather conditions and this yield improvement was likely due to improved weed control.

Mustard stand and yield were generally very similar in both treated and untreated plots. In 1988, there was a trend towards reduced yield with increasing rates of 2,4-D regardless of time of application. This was not the case in 1989, but indicates a source of potential problems under certain conditions.

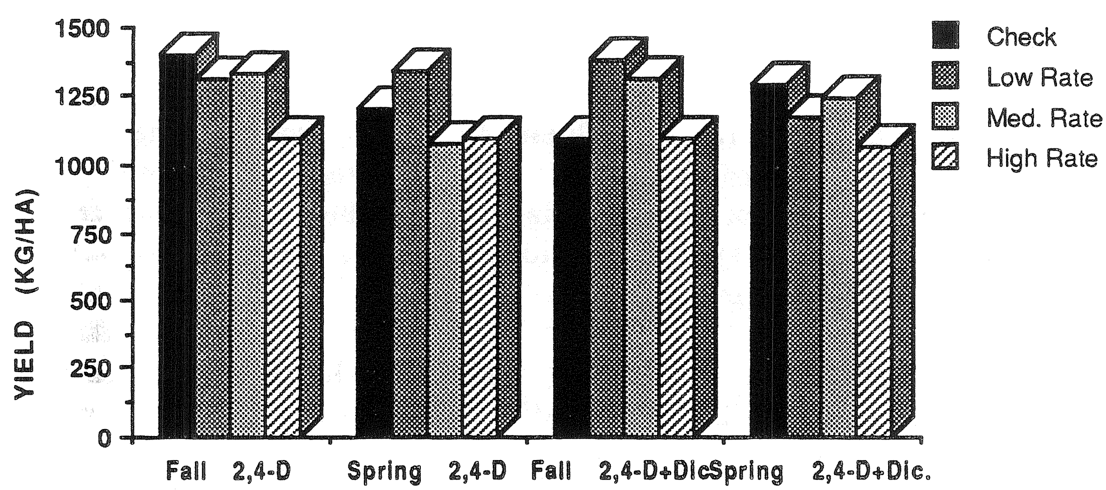

Figure 1 The effects of preseeding 2,4-D and 2,4-D + dicamba on mustard yield, 1988.

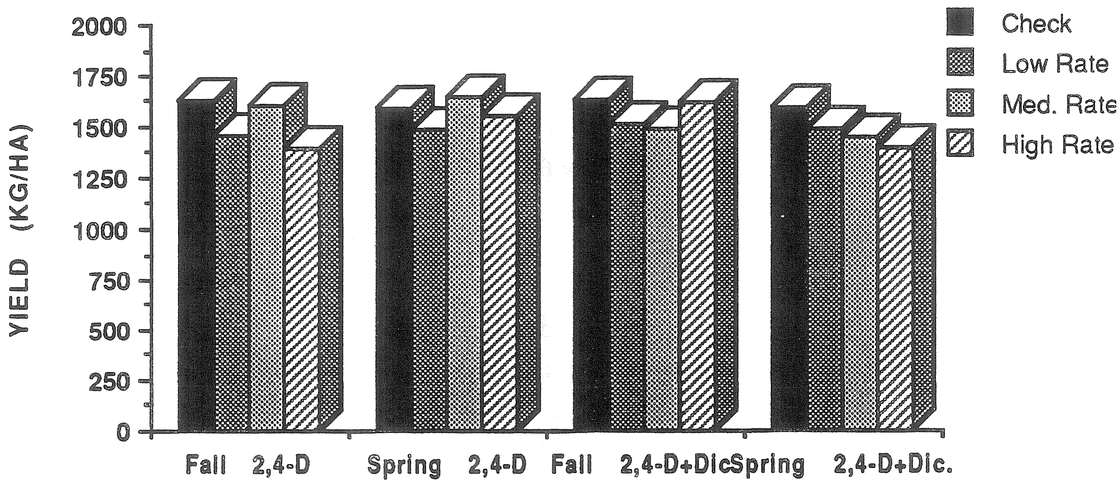

Figure 2 The effects of preseeding 2,4-D and 2,4-D + dicamba on mustard yield, 1989.

The only significant factor influencing canola was a time x rate interaction effect on crop stand. There were no significant differences in crop stand or yield related to herbicide, herbicide rate or time of application or any interactions between these factors other than the aforementioned interaction.

On the other hand, safflower, pea and lentil were not as tolerant to pre-seeding 2,4-D or dicamba + 2,4-D application, particularily spring application. Significant reductions in plant stand and yield resulted from spring herbicide application and dicamba + 2,4-D was significantly more damaging in both years than 2,4-D alone.

In general, safflower yield was significantly lower in plots treated with 2,4-D + dicamba than 2,4-D alone. In 1989 however, safflower yield was significantly lower following fall application than spring application, in contrast to 1988. there was a significant rate response in 1988 but not in 1989.

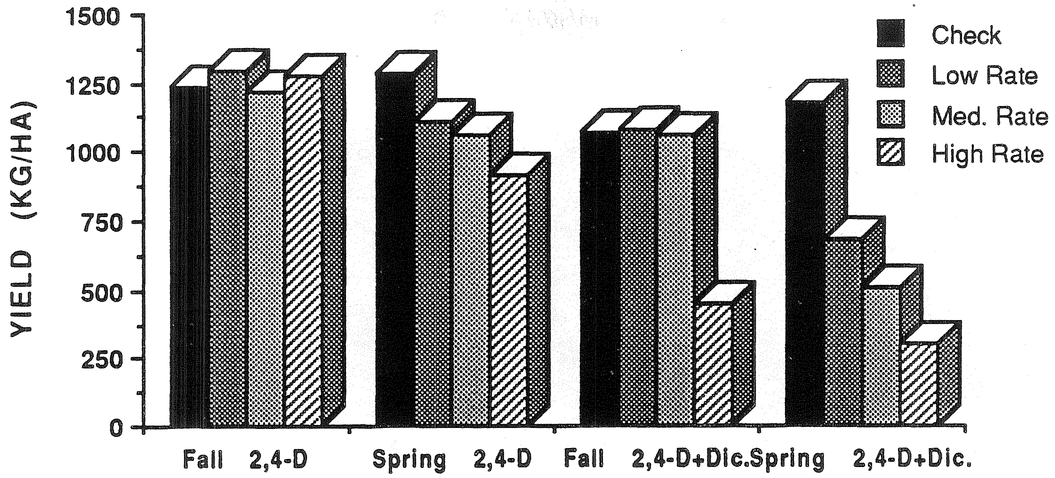

Figure 3 The effects of preseeding 2,4-D and 2,4-D + dicamba on Safflower yield, 1988.

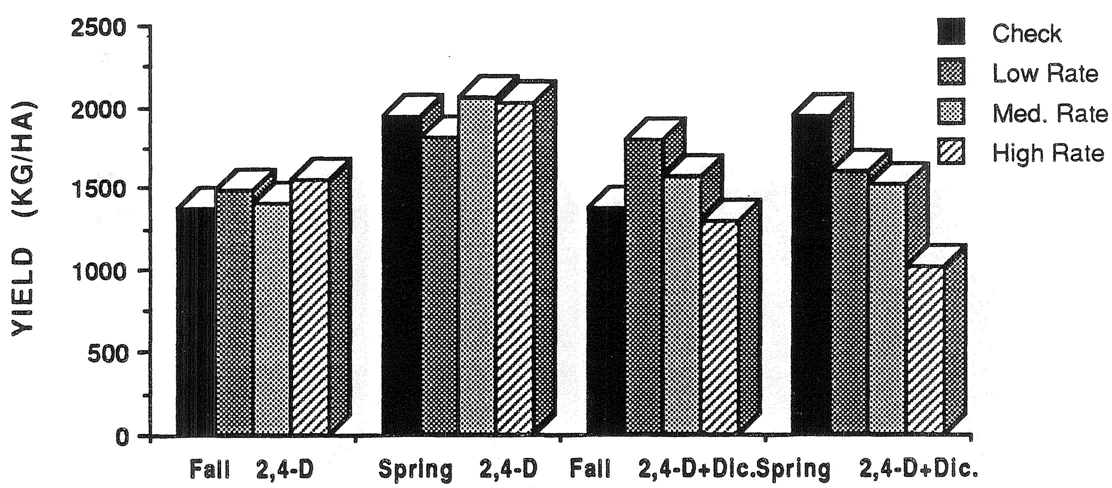

Figure 4 The effects of preseeding 2,4-D and 2,4-D + dicamba on Safflower yield, 1989.

Peas were relatively tolerant to both herbicides in 1988 while in 1989, yield reductions were associated with the highest rate of 2,4-D (1120 g/ha) applied in the spring. Yield was significantly lower in plots treated with 2,4-D + dicamba. Injury increased with increasing rates of dicamba + 2,4-D and with spring application compared with fall.

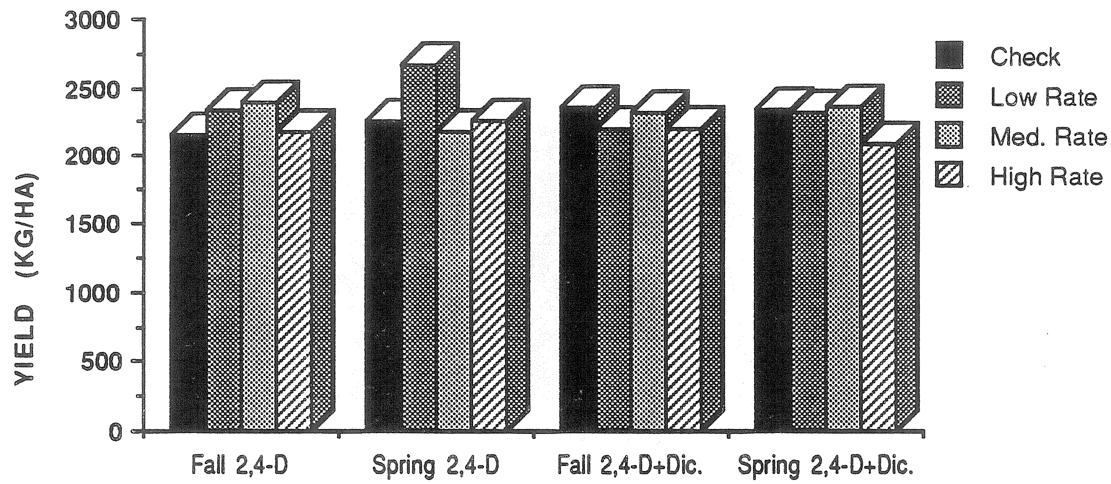

Figure 5 The effects of preseeding 2,4-D and 2,4-D + dicamba on pea yield, 1988.

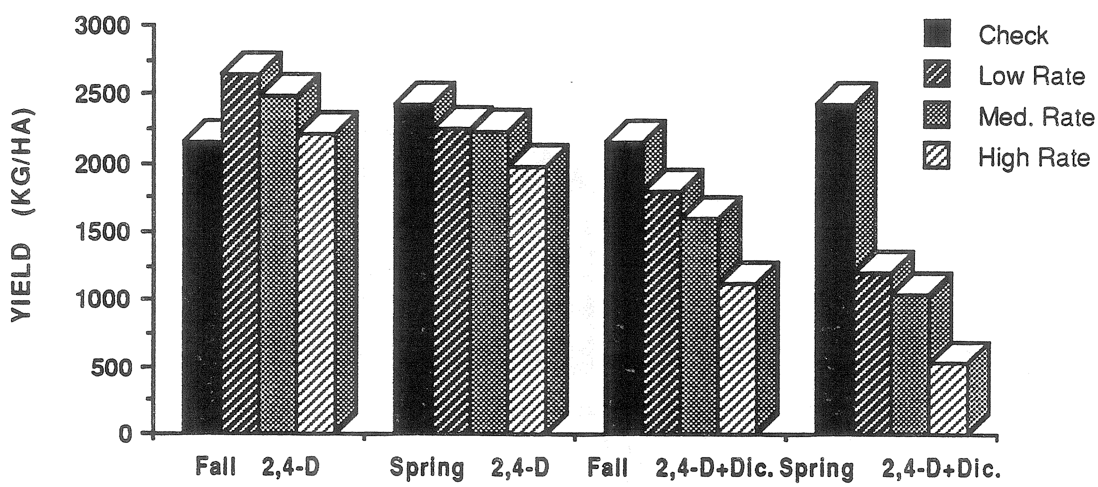

Figure 6 The effects of preseeding 2,4-D and 2,4-D + dicamba on pea yield, 1989.

The most sensitive of the crops tested was lentil. In 1988 significant yield reductions resulted from dicamba + 2,4-D application regardless of rate or date of application. Injury was more severe with higher rates of herbicide applied in the spring. 2,4-D alone also caused significant yield reductions when applied at 1120 g/ha in the spring. Injury was somewhat less severe in 1989 - although all rates of dicamba + 2,4-D caused significant yield reductions when applied in the spring. Only the higher rates caused significant yield losses with fall application. 2,4-D alone did not significantly reduce yields regardless of rate or date of application. The apparent improvement in lentil tolerance in 1989 may be related to the fact that all plots were severely damaged by wind at the end of May. This may have eliminated any advantage in the untreated plots that was gained earlier.

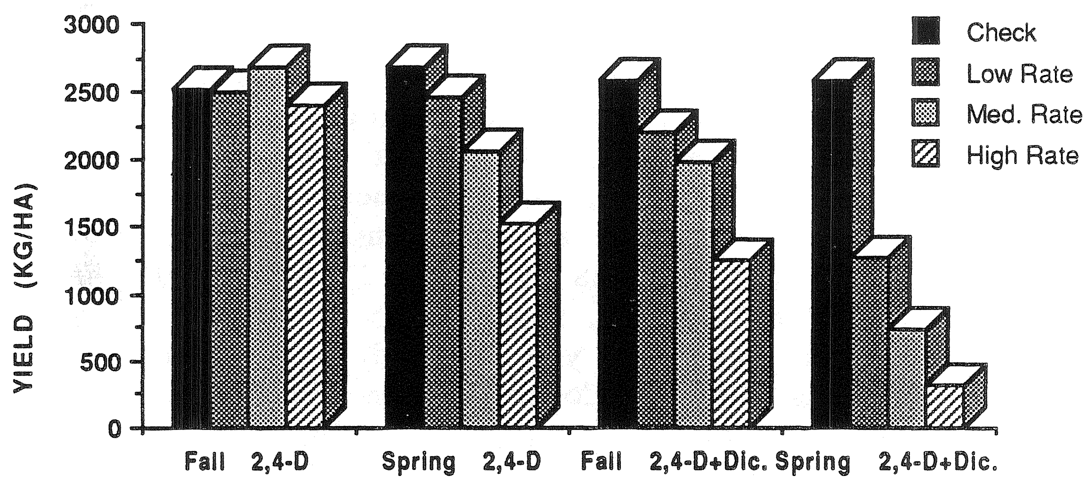

Figure 7 The effects of preseeding 2,4-D and 2,4-D + dicamba on lentil yield, 1988.

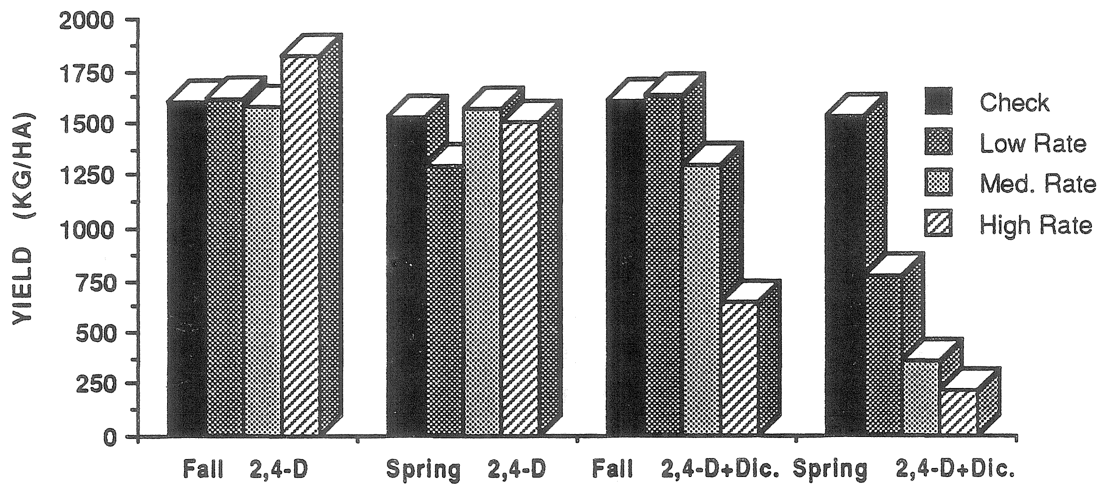

Figure 8 The effects of preseeding 2,4-D and 2,4-D + dicamba on lentil yield, 1989.

Although these results illustrate some definite tolerance problems and treatments which could cause significant yield loss, we did not observe the same degree of injury that others have reported. As mentioned earlier, significant yield reductions were reported when 2,4-D was applied to canola at Saskatoon(Ashford and Downey 1972). At Lethbridge (Moyer 1988 1989), 2,4-D ester (550 g/ha) or dicamba + 2,4-D (140 + 550 g/ha), applied 0-15 days prior to seeding in the spring, caused significant yield reductions in both pea and lentil crops but not in canola. Conditions in 1988 were very dry such that the crop didn't emerge until it was irrigated early in June but under more normal conditions in 1989, a similar pattern was observed. Fall application of 2,4-D amine or lv ester (400 and 800 g/ha) , dicamba (600 and 140 g/ha) and 2,4-D + dicamba (400 + 140 g/ha) in canola pea and lentil revealed that canola and pea yield was not significantly affected by any of the treatments except dicamba at 600 g/ha. Lentil yield was not significantly affected by either 2,4-D amine or lv ester at 400 g/ha but all other treatments , particularily dicamba at 600 g/ha caused significant yield reductions.

Variability exists in crop tolerance to preseeding treatments of 2,4-D and 2,4-D + dicamba. Herbicide persistence, bioavailability and the biological expression of these phenomenon are interrelated and dependent on many factors, making predictions of crop response difficult. It does seem apparent however that certain species(canola and flax) are more tolerant than others (lentil, pea and safflower) to 2,4-D and 2,4-D + dicamba application. Sensitive species are generally more seriously affected by spring than fall application indicating that some breakdown occurs in the late fall and early spring. 2,4-D alone is generally less phytotoxic than 2,4-D + dicamba and under certain conditions, even sensitive species such as lentil will tolerate spring applications of 2,4-D at the recommended rates. Research which would elucidate the role of soil type, pH, organic matter, ammendments and cropping and tillage practices on herbicide persistence would help us to refine our use of these pesticides.

Table 1: Significance of Factors Affecting Yield.

CROP	TIME OF APPLICATION		HERB		RATE		HERB*RATE		TIME *HERB		TIME *RATE		TIME*HERB*RATE	
	'88	'89	'88	'89	'88	'89	'88	'89	'88	'89	'88	'89	'88	'89
CANOLA	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MUSTARD	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
FLAX	NS	NS	NS	**	*	**	NS	NS	NS	NS	NS	NS	NS	NS
SAFFLOWER	**	*	**	*	**	NS	NS	NS	NS	NS	NS	NS	NS	NS
PEA	NS	NS	NS	**	NS	**	NS	NS	NS	NS	NS	NS	NS	NS
LENTIL	**	**	**	**	**	**	NS	*	NS	**	NS	*	NS	NS

NS= NON SIGNIFICANT F VALUE (P .05)
* SIGNIFICANT AT P .05
**SIGNIFICNT AT P .01

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