A COMPARISON OF A GLYPHOSATE-TOLERANT SYSTEM WITH MORE CONVENTIONAL HERBICIDE REGIMES IN DIRECT-SEEDED CANOLA IN WESTERN CANADA

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ABSTRACT

Virtually all of the canola (*Brassica napus* L.) grown in western Canada is herbicide-tolerant. Field experiments were conducted at three locations in Alberta over three years to compare the glyphosate-tolerant system with more traditional herbicide regimes. Glyphosate applied prior to seeding in spring resulted in better weed control and higher canola yields and net returns than 2, 4-D applied in the fall. Glyphosate applied once or twice in-crop provided similar weed control and canola yield as ethalfluralin applied pre-emergence in the fall followed by an in-crop mixture of sethoxydim, ethametsulfuron and clopyralid; and superior weed control and canola yield than ethalfluralin alone or an in-crop mixture of sethoxydim and ethametsulfuron. The in-crop glyphosate applications resulted in higher net revenues than the other treatments. There was little or no advantage to applying glyphosate twice compared to once in-crop. The amount of herbicide active ingredient was lower with the glyphosate system than with most of the other regimes especially when glyphosate was applied only once in-crop.

INTRODUCTION

Virtually all canola grown in western Canada is tolerant to glyphosate, glufosinate, or imidazolinone herbicides. Before the introduction of herbicide-tolerant canola, growers had to rely on mixtures of herbicides of different mechanisms of action for broad-spectrum weed control. A common treatment was a pre-plant soil incorporation of a dinitroanniline herbicide, ethalfluralin or trifluralin in fall or spring. This was often followed by in-crop herbicides alone or in mixtures including sethoxydim, clopyralid and ethametsulfuron for control of monocot weeds, Canada thistle (*Cirsium arvense* L.) and closely related cruciferous weeds, respectively. While these herbicide mixtures were often effective, there was concern that costs may be prohibitive (Blackshaw and Harker 1992), and that the risk of herbicide induced canola injury may increase with some of the mixtures (Harker et al. 1995). In addition, these herbicide mixtures were often ineffective on weeds such as *Galium aparine* L. and *Erodium cicutarium* (L.) L'Her. ex Ait.

Concomitant with the introduction of herbicide-tolerant canola, minimum or zero tillage cropping systems have been increasing in popularity in western Canada. Where spring tillage is eliminated, canola growers often apply glyphosate prior to seeding to reduce the competitive impact of early emerging weeds on the crop (Clayton et al. 2002). The objectives of this study were to compare the relative merits of the glyphosate-tolerant canola system with more traditional herbicides applied pre-plant and in-crop, and to assess the effectiveness of a fall application of 2,4-D compared to a pre-seed spring application of glyphosate.

MATERIALS AND METHODS

A field experiment was conducted under zero tillage management systems in 2001, 2002 and 2003 at Beaverlodge (119°26'W, 55°13'N), Lacombe (113°44'W, 52°28'N) and Lethbridge (112°47'W, 49°38'N), Alberta, Canada. The weed spectrum present at each location was representative of that present in farmers' fields in Alberta during a typical growing season.

Glyphosate-tolerant canola was direct-seeded at 8 kg/ha in 20 cm rows. The same canola variety was used for the traditional herbicide regimes as well as for the glyphosate-tolerant system to avoid any confounding effects of varietal differences on canola yield and other variables. Seeding occurred between April 24 and May 14. The first in-crop glyphosate application was at the 2 to 4 leaf stage of canola, and the second at the 5 to 6 leaf stage. All other in-crop herbicides were applied at the 2 to 4 leaf stage. At approximately 6 wk after the last herbicide application, weed biomass samples were harvested from two 0.5 m^2 quadrats in each plot. Canola was harvested at maturity.

Net economic return for each herbicide treatment was caculated from the equation:

$$N = (YP) – (T + S + H + A)$$

where N = net economic return (Canadian $ /ha), Y = canola seed yield (kg/ha), P = market price of canola seed (Canadian $/ha), T = technology use agreement cost (Canadian $/ha) for the glyphosate tolerant system, S = seed cost (Canadian $/ha), H = the herbicide cost (Canadian $/ha) and A = herbicide application cost (Canadian $/ha).

The two factor (3 by 5 treatments) experiment was designed as a randomised complete block with four replicates. Three pre-seed herbicide treatments were allocated to Factor 1 while five in-crop treatments were allocated to Factor 2. The in-crop treatments included fall-applied ethalfluralin since its activity would likely persist and affect weed seed that germinated after the crop emerged.

Canola yield (kg/ha), net return ($/ha), and weed biomass (g/m^2) data were analysed using PROC MIXED of SAS (Littel et al. 1996). Replicate and location by year combinations were considered as random effects and herbicide treatments as fixed effects. Treatment means were compared using single degree of freedom contrasts. Differences were deemed significant at $\alpha < 0.05$.

RESULTS AND DISCUSSION

The analysis of variance indicated significance of main effects (pre-seed and in-crop herbicide treatment factors) for all variables, but none of the interactions were significant. Thus further analysis was conducted within each factor. Averaged over in-crop herbicide treatments, weed biomass was lower and canola yield and net return higher when glyphosate was applied pre-seed in spring compared to when 2,4-D was applied in the fall (data not shown).

Glyphosate applied once or twice in-crop provided superior weed control and higher canola yield than ethalfluralin applied in fall or an in-crop mixture of sethoxydim and ethametsulfuron (Table 1). This is in agreement with a previous study where the glyphosate-tolerant system was also shown to result in superior weed control and sometimes higher canola yields than a conventional treatment of sethoxydim and ethametsulfuron (Harker et al. 2000).

The relatively poor weed control and reduced canola yields with the non-herbicide tolerant regimes (compared to the glyphosate-tolerant system) reflects the difficulty in controlling the broad spectrum of weeds that were present at each location. For these reasons, many canola growers in western Canada have traditionally followed a pre-plant ethalfluralin application with one or more in-crop herbicides. In our study, pre-plant ethalfluralin followed by sethoxydim, ethametsulfuron and clopyralid applied in-crop resulted in similar weed biomass and canola yields as one or two in-crop glyphosate applications; and superior weed control and canola yields compared to ethalfluralin or the sethoxydim and ethametsulfuron in-crop combination (Table 1).

The in-crop glyphosate applications (glyphosate-tolerant system) resulted in higher net revenues than any of the other treatments (Table 1). Net return with the single in-crop glyphosate application was more than twice that with the four-herbicide combination (Table 1, treatments 2 and 4). The lower net return with ethalfluralin and sethoxydim plus ethametsulfuron compared to the glyphosate-tolerant system (Table 1) was mainly due to reduced canola yields caused by weed competition rather than to the relative costs of the systems. There was no advantage to applying glyphosate twice compared to once in-crop in terms of weed biomass, dockage and canola yields (Table 1). Net returns were also similar ($p = 0.063$) but there was a strong trend to higher returns with the single glyphosate application.

The results of the study indicate that the glyphosate-tolerant canola system was as good or superior to several more traditional herbicide regimes in terms of maximizing weed control and canola yield. More importantly, in spite of the technology use agreement and higher seed costs, the glyphosate system resulted in higher net revenues than the other herbicide regimes especially when glyphosate was applied only once in-crop.

The amount of herbicide active ingredient entering the environment varied with the herbicide regime but was lower with the glyphosate-tolerant system than with most of the traditional regimes especially when glyphosate was applied only once in-crop (data not shown). This suggests that risk in terms of herbicide load on the environment may be less with the glyphosate-tolerant canola system than with other herbicide regimes that have been traditionally used in canola. Other studies have also indicated that environmental and ecological risks, including groundwater contamination, were less with glyphosate than with most other active ingredients (Peterson and Hulting 2004).

Thus there was relatively little or no short-term agronomic, economical or environmental risk associated with the adoption of the glyphosate-tolerant canola system in western Canada.

ACKNOWLEDGMENTS

The Alberta Canola Producers Commission and the Matching Investments Initiative of Agriculture and Agri-Food Canada provided financial support for this research. Bob Pocock, Larry Michielsen, Jim Drabble, Greg Semach and Randall Brandt provided excellent technical support.

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