AGR1113
Integrating Cultural, Chemical, and Mechanical Weed Management for Controlling Herbicide Resistant Broadleaf Weeds in Lentil
INVESTIGATORS
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STUDY SPONSORS
Saskatchewan Pulse Growers Association, Saskatchewan Agriculture Development Funds
TYPE OF STUDY
AGRONOMY
OBJECTIVES
The objectives are: 1) To determine optimum management of herbicide resistant broadleaf weeds (ALS or Group 2 resistant kochia and wild mustard) in lentil through a combination of physical, chemical and cultural methods 2) To develop an integrated weed management program that will reduce herbicide selection pressure in lentil 3) To determine the effect of lentil seeding rate on herbicide control of a new herbicide
WHY STUDY NEEDED
The occurrence of Group 2 herbicide resistance in wild mustard and kochia threatens lentil production. The objectives of this experiment are to determine optimum management of Group 2 resistant wild mustard in lentil using a combination of physical, chemical, and cultural methods. This would allow lentil growers to grow lentils with less yield loss, and on land where they may not have been able to due to the presence of herbicide resistant weeds. It will also create an integrated weed management system for lentil that will reduce herbicide usage and help to delay the onset of herbicide resistance.
HYPOTHESIS
Integrating the practices of increased seeding density, utilization of alternative herbicides, and rotary hoe will increase lentils' ability to compete against wild mustard and lead to improved crop yield. This experiment will evaluate seeding rate, herbicide applications, and

rotary hoeing for wild mustard control in lentil.

STUDY DESIGN

This three-year study, conducted at the Scott Research Farm and the University of Saskatchewan from 2011 to 2013, included two separate experiments because of differences in the weeds susceptibility to herbicides. A third experiment was added in 2012 and 2013 investigating the interaction between lentil seeding rate and the dose of a new lentil herbicide, Fluthyacet-methyl.

I) Integrated Weed Management for Wild Mustard Control
In this experiment, three seeding rates were used (130, 260, and 520 plants/m^2) and six levels of weed control (Control, Rotary Hoe, Heat, Half Sencor, Full Sencor, Heat & Half Sencor & Rotary Hoe) in replicated trials. Prior to crop emergence, glyphosate was applied to the entire plot area at a rate of 450 g ae/ha. The lentil variety seeded in each plot was CDC Impala, an extra small red imidazoline tolerant variety. Immediately following lentil seeding, the *Brassica Juncea* hybrid 'Xceed' was seeded perpendicular to the direction of lentil seeding at a rate of 100 seeds/m^2 as a proxy for wild mustard. Non-target weeds, insects, and diseases were controlled using cover sprays of appropriate products. Variables measured included crop and weed density, crop and weed biomass, and crop yield.

II) Integrated Weed Management for Kochia Control
Kochia was sown to the experimental area in order to ensure the weed's presence. The entire plot area had grassy weeds controlled with a grass weed herbicide. The lentil variety CDC Impala, an extra small red imidazoline tolerant variety, was sown at 260 plants/m^2 (double the current recommended target plant population). The treatments in replicated plots included: fall pre-emergence Ethafluralin application (applied and control (none)); pre-seeding incorporation of Ethafluralin by rotary hoe (two passes or none); and rotary hoeing (two-passes or none) all conducted at optimum stage for weed control i.e. before cotyledon stage of kochia. Non-target weeds, insects, and diseases were controlled using cover sprays of appropriate products. Variables measured included crop and weed emergence, plant biomass, weed biomass, and yield.

III) Lentil Seeding Rate Influence on Dose Response of Wild Mustard to Fluthiacet-Methyl
Field experiments were conducted at two locations near Saskatoon in both 2012 and 2013. Prior to seeding all plots were treated with glyphosate at a rate of 450 g ae/ha. The lentil variety seeded in each plot was CDC Improve, a large green imidazoline tolerant variety, identified in previous University of Saskatchewan research to have the greatest tolerance among current germplasm to fluthiacet-methyl. Four seeding rates (70, 140, 280, and 560 plants/m^2) and seven fluthiacet-methyl (Cadet) herbicide rates (0, 0.94, 1.87, 3.75, 7.5, 15, and 30 g ai/ha) with Agral-90 surfactant at 0.5% v/v were used. Immediately following lentil seeding, Xceed (*Brassica Juncea*) was seeded perpendicular to the direction of lentil at a rate of 100 seeds/m^2 as a proxy for wild mustard. Non-target weeds, insects, and diseases were controlled using cover sprays of appropriate products. The resulting effects on weed biomass and crop yield were evaluated using dose response analysis.

FINDINGS

I) Integrated Weed Management for Wild Mustard Control
Seeding small red lentils at 260 seeds/m^2 (double the normal rate) resulted in the greatest economic return under this system. At this rate yields were higher even with good herbicide

control. The results show that an integrated weed management system that combined high seeding rates, Heat, half rate of Sencor, and rotary hoeing resulted in lentil yield equivalent to full rate of Sencor and provided similar weed control. At the recommended seeding rate the full rate of Sencor effectively controlled mustard populations. The treatment using only mechanical weed control via the rotary hoe yielded as much at the highest seeding rate as the full herbicide treatment yielded at the recommended seeding rate.

These results also show that increasing seeding rate in extra small red lentils reliably increases lentil yield in more typical growing seasons and is yield neutral in very wet years. These results may suggest that a fully integrated approach is not required and yields can be maximized with a single weed control tactic or by combining a single weed control tactic with the cultural practice of increasing seeding rate. However, relying on a single tactic is risky because yields can be compromised if there is a failure in that particular weed control tactic.

II) Integrated Weed Management for Kochia Control
This trial was conducted again in 2014 to gain additional results, however due to technical challenges with this experiment, preliminary results of the 2012 trial at Scott and the 2013 trial at Saskatoon are included. The preliminary findings show that a fall application of Edge and spring rotary hoeing can be effective in controlling kochia populations.

III) Lentil Seeding Rate Influence on Dose Response of Wild Mustard to Fluthiacet-Methyl
The results of the dose response study indicate that increasing seeding rate is a very effective way to decrease mustard biomass when herbicides are not applied or are applied at low rates. Increasing seeding rate can also interact with herbicide application in some years to reduce the amount of herbicide required to reduce mustard biomass by 50 per cent. Overall the best return was achieved when large green CDC Improve lentils were seeded at the current recommended seeding rate and Cadet herbicide was applied at 3.75 g ai/ha. Returns with the recommended seeding rate dropped dramatically when application rates were lower than 3.75 g ai/ha. At herbicide rates of 1.87 and 0.94 g ai/ha returns were greatest when lentils were seeded at 280 plants/m^2. This indicates that if herbicides are applied at lower rates, enhancing weed control with increased seeding rate can be a useful tactic to maintain profits. With large green lentils there may not be a benefit to increasing seeding rates when herbicides can be applied at rates that provide adequate weed control and maintain yields. However, fluthiacet-methyl can effectively control mustard and provides superior weed control when extra-small red lentils are seeded at higher than normal seeding rates.

SIGNIFICANCE OF STUDY

This project provides firm evidence that producers growing the extra small red class of lentils should increase their seeding rate to 260 plants/m^2. The project also determined that full rate of Sencor is effective in controlling mustard. As well an integrated weed management system in lentils can provide similar weed control to a high rate of herbicide provided the seeding rate of the lentils is increased. The study also determined that the new herbicide Cadet (fulthiacet-methyl) has greater efficacy when lentil seeding rate is increased.

PUBLICATIONS, PRESENTATIONS, EDUCATIONAL MATERIALS PRODUCED

Field Days:

2011 Weed Tour, Saskatoon, SK; Oral presentation (Shirtliffe)
2012 Scott AAFC Field Day, Scott, SK; Oral Presentation (Redlick)

2012 Department of Plant Sciences Field Day, Saskatoon, SK; Oral Presentation (Redlick)

Conferences/Extension:
2011 Agronomy Update, Saskatoon, SK; Oral presentation (Shirtliffe)
2011 North East Weed Science Society, Philadelphia, PA; Oral presentation (Shirtliffe)
2012 North West Saskatchewan Organic Producers meetings, Saskatoon, SK; Oral presentation (Shirtliffe)
2012 Canadian Weed Science Society meetings, Winnipeg, MB; Oral Presentation (Redlick)
2013 Global Herbicide Resistance Action Conference, Perth, Australia; Oral presentation (Shirtliffe) (currently available on-line)
2013 Canadian Weed Science Society meetings, Vancouver, BC; Oral Presentation (Redlick)
2013 Soils and Crops Conference, Saskatoon, SK; Oral Presentation (Redlick)
2013 Soils and Crops Conference, Saskatoon, SK; Poster Presentation (Redlick)

A video featuring the rotary hoe was also produced and was posted on YouTube in 2012.

VALUE TO PRODUCERS

Herbicide resistant wild mustard and kochia will be able to be controlled or suppressed through a combination of higher seeding rates, pre-emergent herbicides, and timely rotary hoeing. This study will serve to develop new agronomic and weed control recommendations for lentil growers to maximize profits when faced with herbicide resistant weeds, such as glyphosate resistant kochia. As a result this research will ensure the continuation of the lentil industry in Saskatchewan.