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PESTICIDE RISK REDUCTION IN SOYBEAN PRODUCTION

Final Research Report E2008-36

INTRODUCTION

In field crop production, farmers may be hesitant to move to organic or other reduced pesticide practices due to challenges in weed management. Soybean in particular can be a difficult crop to grow during the transition phase: weed pressure often increases in years two and three of transition. The priorities in weed management for soybean are weed resistance in zero-till systems and the need for a systems approach to weed management.

OBJECTIVES

The objectives of this on-farm study were:

- To evaluate the effectiveness of three weed management strategies for soybean: i) conventional zero-till, ii) integrated weed management, and iii) organic;
- To provide a cost benefit analysis and a measure of risk reduction from pesticides for these strategies.

WHAT WAS DONE?

In 2006 and 2007, on-farm studies were conducted at 5 locations in Ontario (2006: Palmyra, Blenheim, Fairview, and 2 locations west of Chatham; 2007: Palmyra, Blenheim, Pain Court, Ridgetown and Thamesville). Soybean ('92M70') was direct-seeded into the stubble of a previous field corn crop at 175,000 seeds ha^{-1} from May 21 to June 5.

The experiments were arranged in a completely randomized design with 4 replications, and 3 weed management systems:

1. Conventional: 2 applications of glyphosate (900 g a.e. ha^{-1} each) made to soybeans at the 1st and 4th trifoliate leaf stage;
2. Integrated Weed Management (IWM): in-crop banded application of the growers' traditional herbicide program (at the 1st trifoliate) plus interrow cultivation at the 4-5th trifoliate stage of the soybeans;

Good management can produce a clean organic soybean crop

3. Organic: interrow cultivation and hand-weeding at the 1st and 3rd trifoliate leaf stages.

A field day was held at two locations each year to demonstrate the trials and to survey the likelihood of growers to adopt the IWM or organic practices.

Data collection and analysis

Visual weed control was rated on a scale of 0 to 100% at 28 and 56 days after treatment (DAT) (0% = no weed control and 100% = complete weed control). Weed biomass was collected from three 1-m^2 quadrats per plot at 28 DAT and separated into broadleaf and grass weed species. Weed biomass was dried and weighed.

The innermost three rows of each plot were harvested by hand (from Nov 20th to Dec 2nd in 2006; Nov 10th to 24th in 2007) and yields were adjusted to 13% moisture.

Data at each location were subjected to analysis of variance (ANOVA). Treatment means were separated using orthogonal contrasts.

Cost of weed control and Environmental Impact Quotient (EIQ)

The cost of weed control was determined at each location by considering the herbicide, fuel and hand-weeding costs. Herbicide costs were recorded on a per grower basis, and therefore reflected differences among retail outlets. To offset these differences, prices were averaged among the different retail outlets to come up with the final herbicide cost. Fuel costs were added for each pass required in the various treatments – an average price of $1 per litre was used. Hand-weeding costs were determined by multiplying the amount of time required to weed a plot by $10 per hour, factored on a per hectare basis.

The EIQ was determined by a method to measure the Environmental Impact Quotient (toxicity) of pesticides (Kovach *et al.*, 1992). EIQ is a score for the potential risk of pesticides to farmworkers, consumers and the environment.

RESULTS & DISCUSSION

To discuss the results of these experiments, the 10 field trials were grouped based on the degree of weed infestation in each field.

- *Low weed infestation* (Palmyra 06-07, Blenheim 06-07) had a weed biomass <5 g m^{-2} in the organic treatment. On these farms, no-till Roundup Ready® soybean is grown following a 3-year rotation of soybean-wheat-field corn.
- *Moderate weed infestation* (Pain Court, Ridgetown, Thamesville) had weed biomass levels between 5 and 10 g m^{-2}. These farms have a long history of residual herbicide use in conjunction with growing Roundup Ready® soybean. In all cases, soil organic matter was greater than 4%.
- *High weed infestation* (2 Chatham locations, Fairview) had weed biomass >10 g m^{-2}. On these farms, non-transgenic soybean is grown, following rotation with vegetable crops. A combination of interrow cultivation was used with reduced rates of non-residual herbicides.

In fields with low weed infestation, weed control at 56 DAT was generally highest in the conventional treatment followed by the IWM treatment and lowest in the organic treatment (Figure 1).

Researcher Darren Robinson (University of Guelph) stands in a field of soybean that was part of the on-farm trial

The trend was not as clear when fields had moderate and high weed infestation at the beginning of the trial. Weed control was variable in all treatments but generally lowest in the organic treatment. A yield reduction was observed in the organic treatment compared to the other treatments for fields with low infestation.

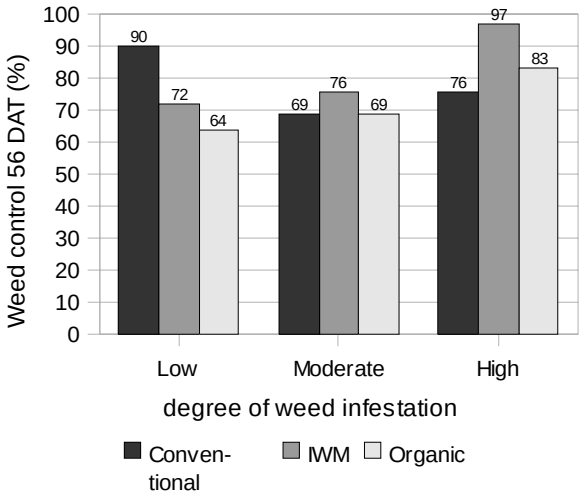

Figure 1. Weed control 56 DAT (%) for fields with low, moderate and high weed infestation

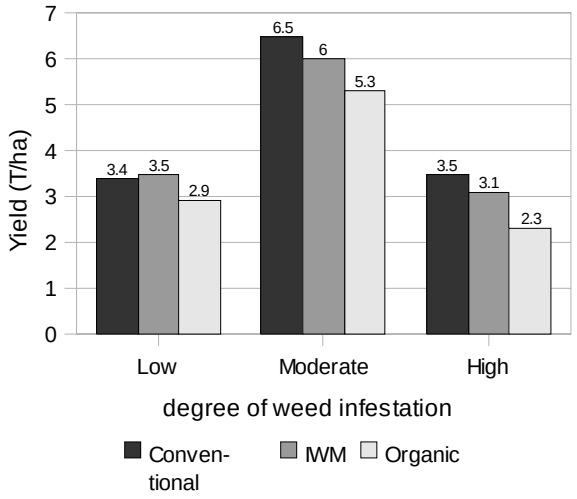

Figure 2. Yield (T/ha) for fields with low, moderate and high weed infestation
Data from Palmyra 2006 (low), Ridgetown 2007 (moderate), Chatham #2 2006 (high)

For fields with moderate and high infestation, yield was highest in the conventional treatment and lowest in the organic treatment (Figure 2). The reduced yield in the organic treatment for fields with moderate weed infestation may be explained by poor weed control early in the season. Broadleaf weeds interfered with the crop between 1st and 3rd trifoliate stages, which is the critical period of interference in soybean.

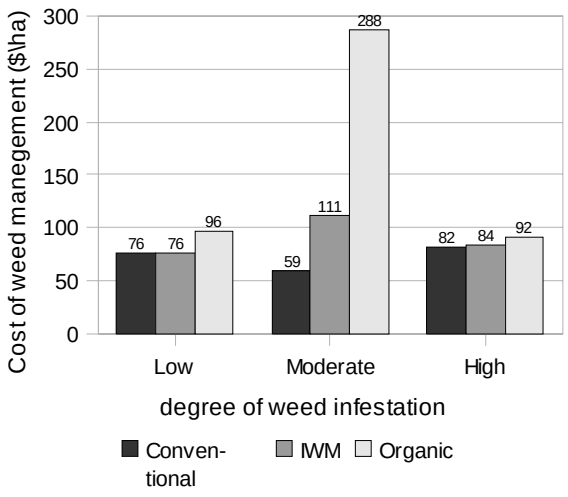

Figure 3. Cost of weed management ($/ha) for fields with low, moderate and high weed infestation
Data from Palmyra 2006 (low), Ridgetown 2007 (moderate), Chatham #2 2006 (high)

For fields with moderate weed infestation, the cost of weed management was generally 50-100% higher in the IWM and organic treatments than in the conventional treatment (Figure 3). Differences in cost were not as apparent in the other fields. It is generally higher in the organic treatment due to the cost of hand-weeding.

For fields with low weed infestation, EIQ was highest in the conventional treatment and lowest in the organic treatment (Figure 4). As a result of reduced herbicide applications, the EIQ was lower in the conventional treatment than in the IWM, in moderate infestation fields. In fields with high weed infestation, a second herbicide application was made in the IWM treatment which translated to the highest EIQ in this treatment. EIQ was 0 in organic treatments in all fields.

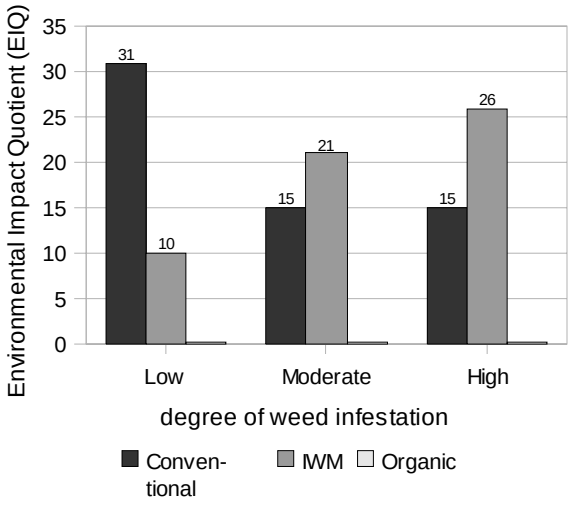

Figure 4. Environmental Impact Quotient (EIQ) for fields with low, moderate and high weed infestation
Data from Palmyra 2006 (low), Ridgetown 2007(moderate), Chatham #2 2006 (high)

CONCLUSIONS

Soybean is a difficult crop to grow during the transition phase from conventional to organic. These trials showed that with the exception of fields with low weed infestation, soybean grown during the transition phase will likely require very high input costs. If a price-premium can be guaranteed for 'transitionally-grown' soybean, the additional cost might be justified. The high price of soybean in the current market also provides an excellent opportunity for transition to organic while reducing financial risk.

It is important to remember that the purpose of this research was to demonstrate to growers the potential disadvantages of growing soybean during the transition phase rather than the development of weed management practices. Environmental Impact Quotients (EIQs) for the Integrated Weed Management and Conventional fields were always higher than for organic soybean production, but varied by the degree of weed infestation.

Field days offered good opportunities for growers to observe differences between low, moderate and high weed infestations and the likely outcome of growing soybean during the transition phase. Two growers who participated in the trial have expressed interest in transitioning a portion of their farm into organic production.

Some organic farmers hire labour to hand-weed soybean fields

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THE BOTTOM LINE...

The high price of soybean in the current market provides an excellent opportunity for transition to organic while reducing financial risk. However, unless fields have very low weed pressure, soybean grown during the transition phase will have very high input costs for weed control.

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CREDITS

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