Weed Management for Long-Term Sustainability of Soybean in Manitoba

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SOYBEANS HAVE BEEN widely adopted by Manitoba producers and are also making in-roads into Saskatchewan and Alberta. As local recommendations are being developed, production practices from regions where soybean are the break crop from corn production are being used in Manitoba. However, in all regions where Roundup Ready (RR) soybean production is high and corn-based management practices such as wide-row spacing have been used extensively, serious herbicide resistance problems are common, making weed management difficult and costing producers money.

Soybean, like most other legumes, are sensitive to many herbicides and only a limited number of herbicide modes of action may be used (specifically groups 1, 2, 6 and 14). In traditional soybean growing areas, high reliance on these herbicides has led to the development of weeds resistant to many of these herbicides. This has been particularly problematic where, prior to the introduction of RR soybean 20 years ago, herbicide resistance to other modes of action had already become a serious production issue. RR soybean provided a solution to these resistance issues. Glyphosate's high efficacy and simplicity resulted in the rapid adoption of RR production systems. As glyphosate is not a residual herbicide and soybeans are slow growing, multiple in-crop applications are necessary to prevent yield loss from weeds. Unfortunately, repeated use of the same single herbicide mode of action throughout the growing season imposes the highest selection pressure for development of resistant weeds. In response to such high selection pressure in RR soybean, weeds such as ragweed and other species have developed resistance to glyphosate in as few as four years.

In Minnesota and North Dakota, five glyphosate-resistant weed species (giant ragweed, common ragweed, tall waterhemp, Canada fleabane and kochia) have developed over the last 10 years. The same has occurred in Ontario, with the exception of kochia, since it is not present there. These weeds are often also resistant to other herbicide modes of action and, in some cases, they can no longer be controlled with herbicides in soybean. As an example, tall waterhemp in Illinois is resistant to five different modes of action. This weed now occurs at densities of several thousand seedlings per square metre in some farmers' fields with no remaining herbicide options for control in soybean. No new herbicides to deal with this problem are on the horizon.

Corn-based management practices and the assumption that herbicides alone will provide all necessary weed management have contributed to this rapid development of herbicide resistance in soybean and other legume crops. These practices include wide-row spacing, reduced planting densities and varieties with unknown competitive potential, all of which make soybean less competitive. If western Canadian producers choose to adopt the same management practices, we should not expect a different outcome. In fact, glyphosate-resistant kochia was first discovered in Manitoba in wide-row production systems three years ago. To prevent this, the main question we are addressing with this research is the following – *Can we improve the competitive ability of soybean enough to eliminate the need for additional in-crop herbicide applications?* – This project aims to reduce the risk of developing more glyphosate-resistant weeds in Manitoba so that soybean remains a viable crop option over the long term.

To answer this question, we examined whether the critical weed-free period in soybean can be shortened using three different cultural weed management tools (row spacing, crop density and choice of variety). An earlier end to the critical weed-free period in soybean will reduce the number of in-crop herbicide applications required to prevent yield loss, thereby greatly reducing the risk for development of herbicide resistant weeds. Using simple management practices that make the crop more competitive with weeds should go a long way towards accomplishing this.

This research was conducted over two years at three locations. During the 2016 and 2017 growing seasons, experiments were conducted at sites representing the Red River valley, west-central Manitoba, and the northeastern regions of southern Manitoba. The base treatment for all experiments were Dekalb 23-60 soybean in 15" rows at a target density of 180,000 plants/ac. The target density experiment determined the end of the critical weed-free period at lower (0.75x = 135,000 plants/ac) and higher (1.5x = 270,000 plants/ac) target densities. The row spacing experiment compared Dekalb 23-60 at 180,000 plants/ac in narrow (7.5") and wide (30") rows. The variety comparison study examined two additional varieties (DKB22-60 and DKB24-10).

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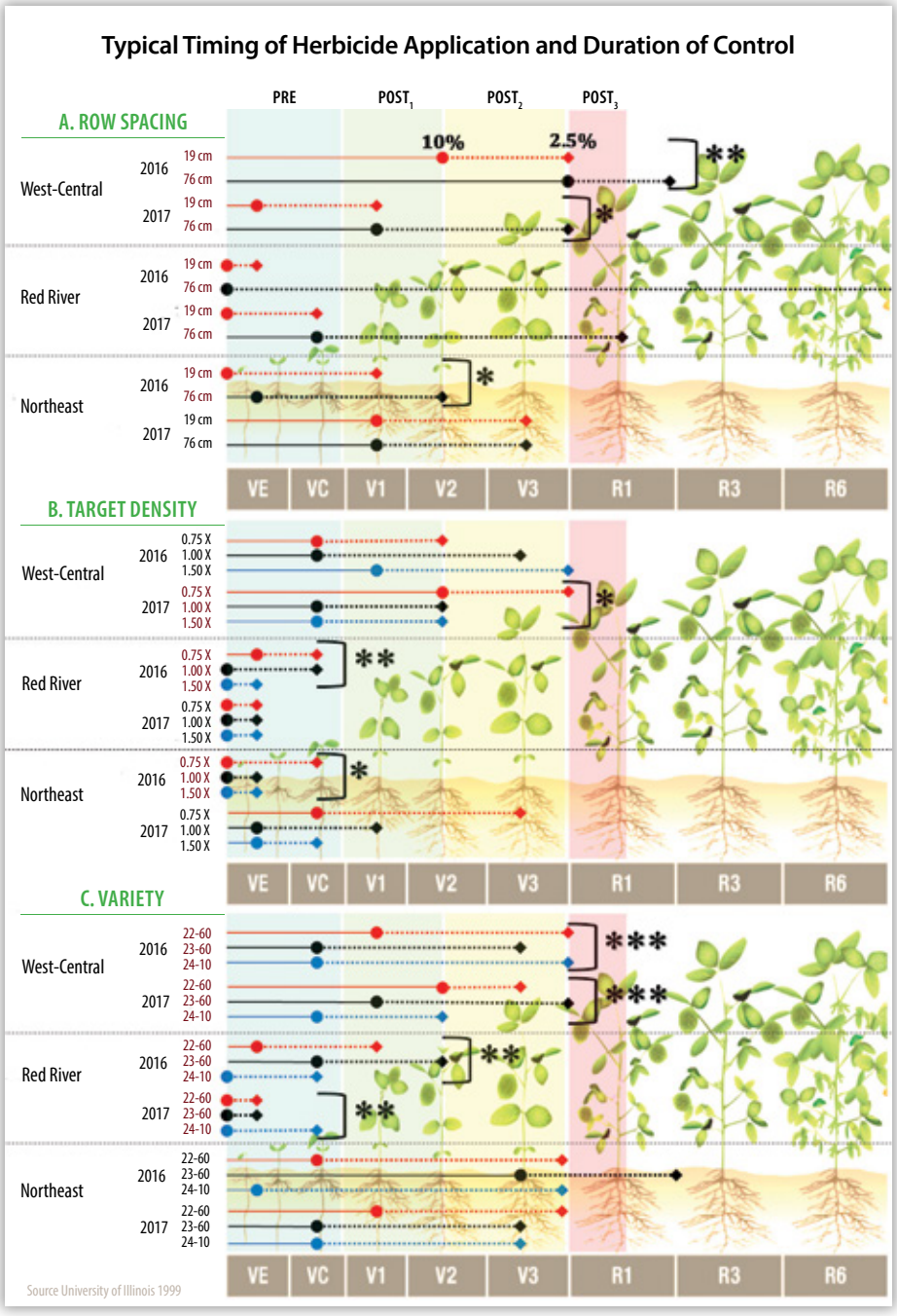
▼ *Figure 1. End of the weed-free period (WFP) in soybean for row spacing, target density, and variety at each site-year. Solid lines represent the end of the WFP at 10% acceptable yield loss while dotted line extensions represent the end of the CWFP at a 2.5% acceptable yield loss. Shaded, coloured areas (PRE, POST1 – POST3) indicate the typical timing of herbicide applications and duration of weed management assuming limited residual activity. Significant differences within sites-years are indicated (p-value: * <0.05, ** < 0.01, *** <0.001).*



ROW SPACING

Row spacing, target density and choice of variety all affected the end of the critical weed-free period in soybean to varying degrees. Of the three cultural practices, reducing soybean row spacing had the greatest and most consistent effect on shortening the critical weed-free period. At five of the six site-years and across a broad spectrum of weed densities and species composition, the critical weed-free period ended earlier in narrow-row plantings (Fig. 1a). In fact, narrow-row soybean never required more than one in-crop application of glyphosate to limit yield losses to less than 10%. In four of six cases, an in-crop herbicide application was not even necessary if 10% yield loss was acceptable. Relying on pre-seed herbicide applications alone greatly lowers the risk of developing herbicide resistance as only a small portion of the total weed seedlings emerging during that season are exposed to the pre-seed glyphosate application. Narrow-row spacing shortened the soybean weed-free period by up to three development stages compared with wide-row spacing. This technique was particularly effective at moderate to heavy weed pressures.

TARGET STAND DENSITIES

Decreasing soybean target densities below 180,000 plants/ac lengthened the critical weed-free period in many instances, while increasing soybean target densities to 270,000 plants/ac generally had little effect on the end of the critical weed-free period, (Fig. 1b). Soybeans clearly were more sensitive to yield loss from weeds at lower densities and provided little biological insurance to yield protection at these densities. In these experiments, the highest density soybean stands yielded three bushels more on average than the lowest stand densities under weed-free conditions. The target density effect was less pronounced than the row spacing effect but occasionally contributed to

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fewer necessary in-crop herbicide applications. These results demonstrate that reductions in target densities below 180,000 plants/ac may lead to additional in-crop herbicide requirements.

VARIETY

Choosing the right soybean variety for the growing environment also plays an important role in reducing the number of in-crop herbicide applications required to limit yield losses (Fig. 1c). At the west-central location, the taller-statured Dekalb 23-60 and the mid-height Dekalb 24-10 soybean varieties had shorter critical weed-free periods than the short, and therefore presumably less competitive, Dekalb 22-60. At both the Red River and northeastern sites in 2016, Dekalb 23-60 had a longer weed-free period than the other varieties. In 2017, Dekalb 24-10 had a longer critical weed-free period in the Red River valley while at the north-eastern location Dekalb 22-60 tended to have a longer critical weed-free period. Choice of variety lengthened the critical period by up to two developmental stages requiring at least one additional herbicide application. The variety effect however, was difficult to predict, likely related to differences in growing season environment and weed pressure, and requires further investigation.

SUMMARY

In these experiments, soybean responded well to cultural weed management practices. Narrowing the row spacing, maintaining adequate soybean stand densities and growing a locally more competitive variety all contributed to reducing the duration of the critical weed-free period. This led to significant reduction in the number of in-crop herbicide applications required to limit yield losses due to weeds. Individually, using these tools reduced the risk of developing herbicide resistant weeds in soybean and reduced herbicide costs. Their efficacy could be improved even more when used in combination, as these tools tend to act synergistically. ■