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Evaluating The Competitive Differences Among Barley Cultivars *(Hordeum vulgare)* Against Wild Oat *(Avena fatua);* As Part Of An Integrated Weed Management (IWM) Strategy

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Introduction

Until recently the goals of barley breeding programs have focused on disease resistance (Edney, 1999; Therrien, 1999) and producing plants with desirable agronomic characteristics (Talbert, 1993), whereas crop competitiveness against weeds has largely been ignored (Lemerele et al., 1996; Froud-Williams, 1997). Researchers realize the importance of increasing crop competitiveness and using inherently competitive crops to manage weeds and reduce herbicide usage (Lemerele et al., 1996; Lanning et al., 1997), however, research in western Canada is still lacking.

This study tests the competitiveness of eight spring barley varieties against wild oat at reduced herbicide rates. Barley was chosen since hog production on the western Canadian prairies is increasing, and the main feed for those hogs is barley (Rossnagel, 1999). The cultivars were chosen as representatives of typical 2 and 6 rowed, hulled and hulless, short and tall barley cultivars. Wild oat was chosen as the competing weed species since it is one of the most prolific and wide spread weeds on the prairies. The objectives of this study were to assess the competitiveness of eight barley cultivars against wild oat, and determine the morpho-physiological characteristics that result in increased cultivar competitiveness.

Materials and Methods

Research was conducted in 1998 and 1999 at the Brandon Research Center, Brandon, Manitoba. The following 4-row and 6-row barley varieties, which included both hulled and hulless types were selected based on contrasting growth characteristics: Candle -2 row hulless; Condor -2 row hulless; Dolly -2 row hulled; Earl -6 row hulled; Falcon -6 row hulless; Hanington -2 row hulled; Lacombe -6 row hulled; Virden -6 row hulled.

The experiment was a randomized complete block design with two sites each year on sandy loam and silty clay soils. Wild oat seeds collected locally in 1996 were sown with the barley at a rate of 120 plants/m^2 to achieve a target density of 60 wild oat plants/m^2. Barley was direct seeded at 1 ½ cm, after a glyphosate burnoff, at a target density of 200 plants/m^2 with 9 inch row spacings. The wild oat herbicide imazamethabenz (group 2) was applied at the 4-leaf stage of the wild oats in 1998. In 1999, due to excess spring moisture, the imazamethabenz was applied at the 6-leaf to tillering stage of the wild oats. Broadleaf weeds and cereal diseases were controlled throughout the year using Buctril M and Tilt, respectively.

Dose-response relationships were used to assess the relative competitiveness of the Eight barley varieties against wild oat. Competitiveness was based on the ability of the barley cultivars to reduce weed seed production (suppressive ability) and the ability of the barley cultivars to maintain yield at reduced herbicide rates (tolerance). Seven herbicide treatments (imazamethabenz) ranging from the recommended rate (.65 l/acre; 488 gai/ha) to no herbicide at 20% increments were tested. For each cultivar the wild oat seed production was regressed over herbicide dose using a log-logistic model (Seefeldt et al., 1995). A polynomial tit was used for the barley yield at varying herbicide rates.

Results

At both sites in 1998 and 1999 wild oat seed production decreased as herbicide rate increased (figure 1). In both years and both locations Falcon, Candle, and Earl had the highest number of wild oat seeds produced per m^2. Conversely, in both years and both locations Virden, Lacombe, and Harrington had the lowest number of wild oats per m^2 (figure 1). In 1998 and 1999 on the silty clay sites EK_{90} values (herbicide rate at which 90% of the weeds are controlled) were found to range from 20 to 40% of the recommended imazamethabenz rate for Virden, Lacombe, and Harrington, while, EK_{90} values for Candle, Condor, Dolly, Earl, and Falcon ranged from (table 1). In 1998 on the sandy loam site EK_{75} values were 40% of the recommended imazamethabenz rate for Virden, Lacombe, and Harrington, while, EK_{75} values ranged from 80% to N/A for the other cultivars (table 1).

At both sites 1998 and 1999, yields generally increased as herbicide rates increased. In all situations Lacombe, Virden, and Earl yielded higher than the other cultivars (figure 2), while, Hanington was the lowest yielding cultivar for the two year period at both locations. For maximum yield, herbicide rates ranged from 0 to 100% of recommended depending on cultivar, year, and site (table 2).

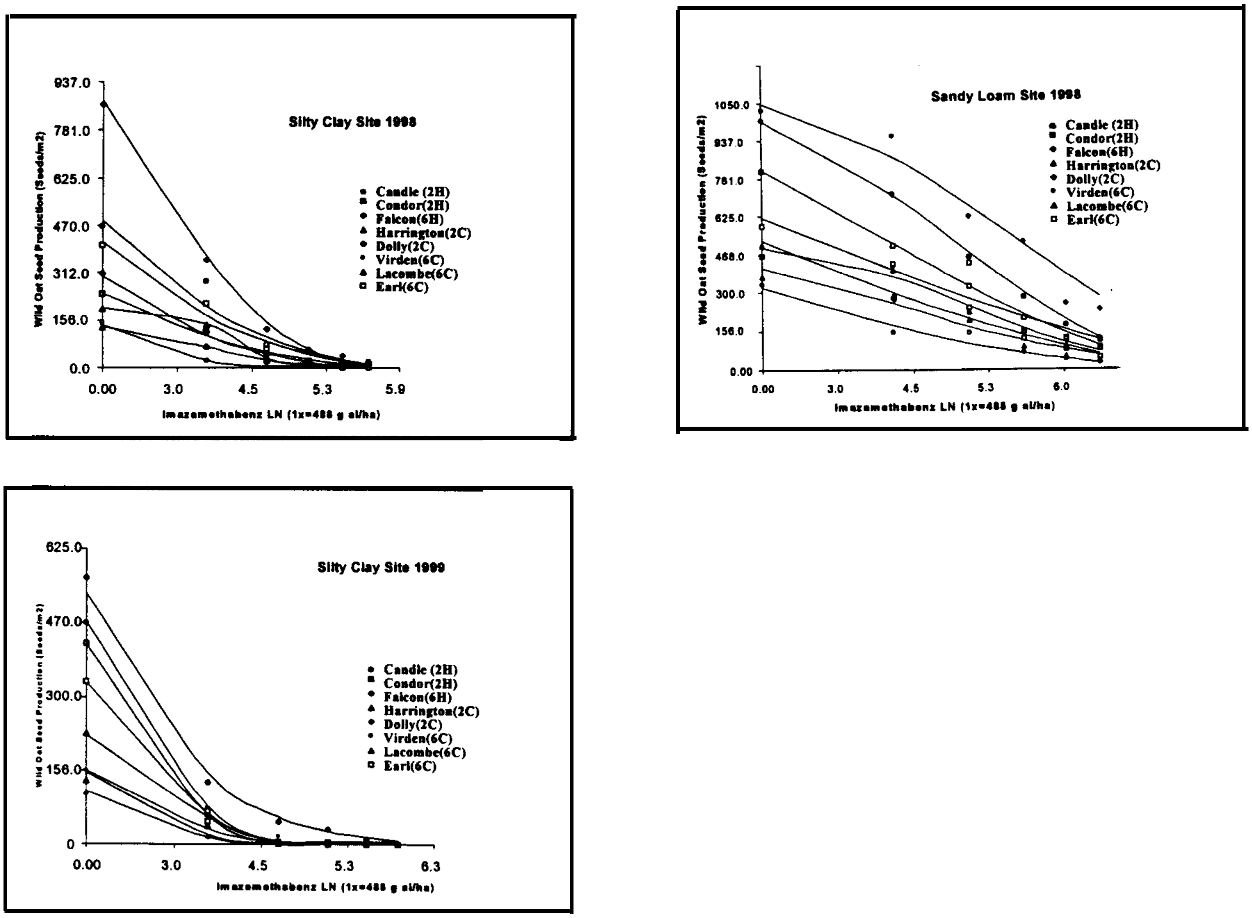

Figure 1. Wild oat seeds produced per m2 in eight barley varieties during a two year period at two sites. Data was fitted using a non-linear log-logistic model.

Table 1. Percent of recommended imazamethabenz rate to reach the EK_{90} or EK_{75} in eight barley varieties during a two year period at two sites.

Variety	EK_{90} Silty Clay Site 1999	EK_{90} Silty Clay Site 1998	EK_{75} Sandy Loam Site 1998	Competitive Rank
Virden	20%	20%	40%	1
Lacombe	20%	40%	40%	2
Harrington	40%	40%	40%	3
Condor	60%	60%	NA	4
Dolly	60%	60%	NA	5
Earl	60%	60%	80%	6
Falcon	75%	70%	NA	7
Candle	80%	70%	100%	8

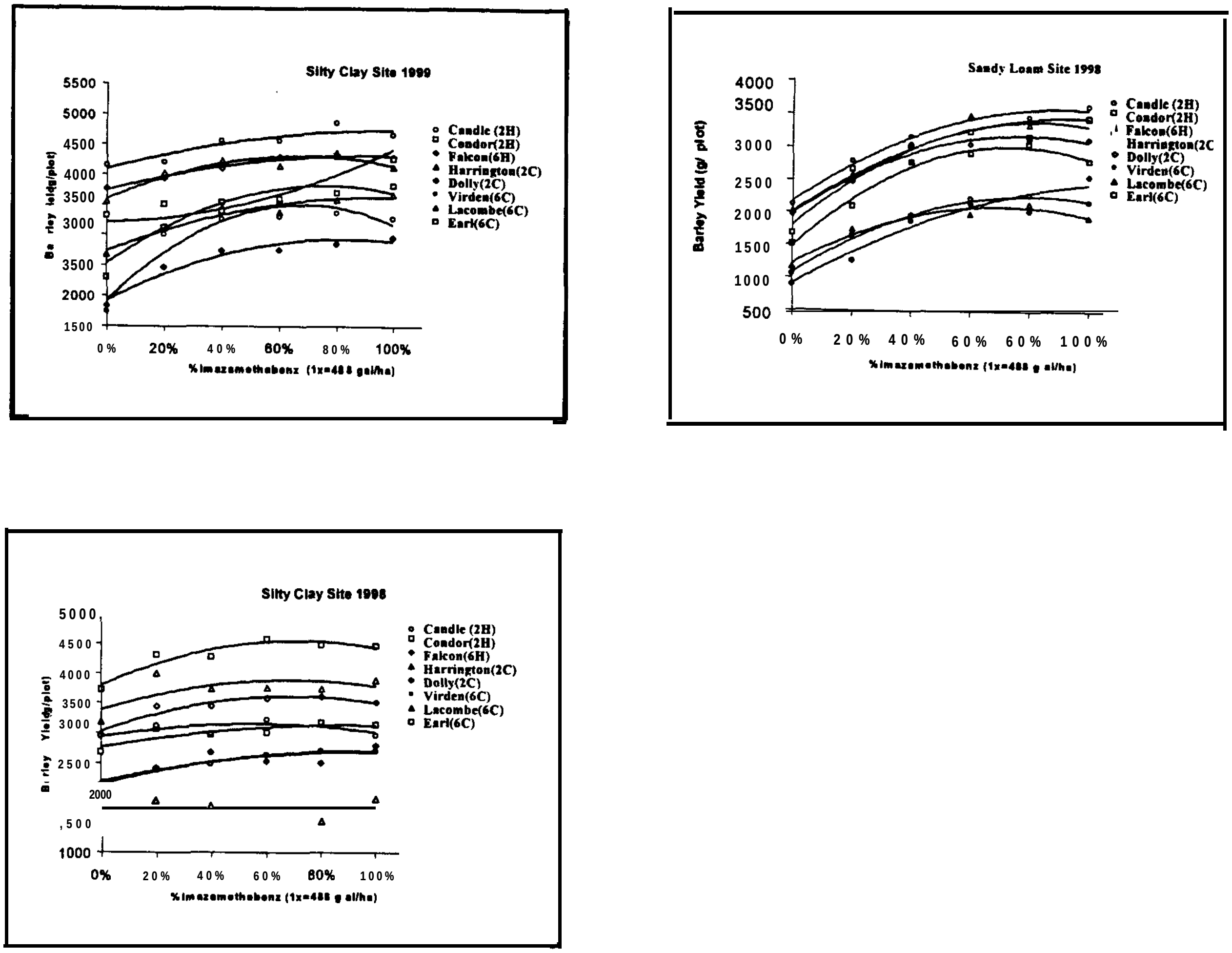

Figure 2. Yield of eight barley cultivars during a two year period and two sites at varying concentrations of imazamethabenz.

Table 2. Percent imazamethabenz rate at which no yield gain occurred in eight barley cultivars at two sites for two years.

Variety	Silty Clay Site 1999	Silty Clay Site 1998	Sandy Loam Site 1998	Competitive Rank
Virden	40%	0-20%	40%	1
Lacombe	20%	20-40%	60%	2
Harrington	100%	0-20%	40%	4
Condor	20%	20-40%	60-80%	3
Dolly	40%	40-60%	60-80%	5
Earl	100%	40-60%	80-100%	8
Falcon	40%	40-60%	80-l 00%	7
Candle	40%	40-60%	60-80%	6

Discussion

Depending on the cultivar, imazamethabenz rates could be reduced without reductions in barley yield or increased wild oat seed return. In other words, reducing the herbicide rate did not result in reduced weed control. Some cultivars like Harrington were low yielding, however, they suppressed wild oat seed production. Conversely, cultivars like Earl were high yielding, however, they did not suppress wild oat seed production. Therefore, when weed pressures are high, cultivars that suppress wild oat seed production at reduced rates should be chosen. Conversely, cultivars with increased yield at reduced herbicide rates may be used when weed populations are at low densities.

Reducing herbicide rates with competitive cultivars should be used only as part of an Integrated Weed Management (IWM) strategy. Competitive cultivars should be used in conjunction with other practices like fertilizer banding, narrow row spacing, increased seeding rates, and timely herbicide application to reduce reliance on herbicides. With proper management strategies competitive cultivars could allow for reductions in herbicide usage without sacrificing weed control or barley yield.

Identifying the traits that contribute to cultivar competitiveness should be paramount so that information can be given to breeders who could then breed for competitiveness. Exploiting the morphological and physiological traits that confer cultivar competitiveness is an important step in an Integrated Weed Management (IWM) strategy, where producers can reduce herbicide rates without reducing weed control or crop yield.

Acknowledgements

Weed Ecology Field Crew

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