Effect of Fertilizer Nitrogen on Crop-Weed Interactions in Montana Cereal Production

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Fertilizer Facts

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Introduction

Weeds compete with crops for available resources including nitrogen (N), reducing the N use efficiency. Herbicides are the major technology for weed control in cereals and there is increasing concern about herbicide failures. We quantified barley-weed competition under different N levels, and the relationship between soil N and herbicide performance.

Methods

For objective 1, field studies were conducted in 2011- 2013 on irrigated malt barley (Metcalf). Treatments were three target available N rates – 50, 100, and 150 lb N/acre, three barley seeding rates – 34, 68, and 136 lb/acre, and four weed interference treatments – season-long weedy check, season-long weed free, weeds removed at 3-4 leaf stage of barley (recommended timing of herbicide application), and weeds removed at 8-l0 leaf stage of barley (late application of herbicide). Soil nitrate-N was determined and N fertilizer rates adjusted with urea broadcast and incorporated before crop planting. Major broadleaf weeds present at the test site were common lambsquarters, wild buckwheat, kochia, and redroot pigweed.

For objective 2, a greenhouse study with individually potted plants was used to test herbicides commonly used for weed control in wheat/barley or chem-fallow systems. We had two N rates with ammonium nitrate as the source – low (50 lb N/acre) and high (150 lb N/acre), and five herbicide doses – 0 (control), ⅛, ¼, ½ and the full recommended rate. Herbicides were applied at the 4-5 leaf stage of weeds. Visual control ratings (scale of 0 being no control to 100 being plant death) and shoot dry weights were recorded 21 days after application. A regression model was used to estimate the effective dose to obtain 50% control (ED_{50}).

Results

Averaged across years and seeding rates, barley plant height increased with increasing N rate (Table 1). Barley biomass at anthesis did not differ between 50 and 100 lb N/acre, but yield was higher at 100 lb N/acre. Further increasing N to 150 lb N/acre increased barley biomass, but did not further increase yield. In plots with 50 lb N/acre, there was more than three times greater weed biomass when weed removal was delayed from the 3-4 leaf to the 8-10 leaf stage of barley (Table 2). In contrast, no difference in weed biomass was observed between 3-4 leaf and 8-10 leaf weed removal timings with 100 or 150 lb N/acre. These results suggest that weeds were at a competitive advantage to the barley crop at the low N rate of 50 lb N/acre, whereas barley was more competitive at higher N rates.

Results from the greenhouse study suggest that the influence of N rate on herbicide efficacy varies with weed species and herbicide. Based on the doses necessary to obtain 50% control, 1.5-, 1.25-, and 1.5-fold higher doses of Achieve®, Puma®, and Roundup®, respectively, were needed to control wild oat grown in 50 than in 150 lb N/acre soil (Figure 1A). N rate did not influence the effect of Axial®, Assert®, Discover®, Avenge®, and Liberty® herbicides on wild oat control. Kochia required 1.3- and 1.5-times higher

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doses of Ally® and Affinity®TankMix, respectively, when grown in 50 than in 150 lb N/acre soil (Figure 1B). N rate did not influence the effect of Bronate Advanced® and Liberty® herbicides on kochia control. The observed N response with some of these herbicides might be due to involvement of N in the biochemical or physiological plant pathways these herbicides target.

Table 1. Effect of N rate on barley height, biomass, and yield, averaged over 2011-2013. Different letters indicate significant differences with 95% probability.

Nitrogen (lb N/acre)	Height (inches)	Biomass (g/ft row)	Yield (bu/acre)
50	22 c	49 b	73 b
100	23 b	50 b	79 a
150	24 a	56 a	82 a

Fertilizer Facts

- At 50 lb N/acre, weeds should be controlled as early as the 3-4 leaf stage of barley to prevent yield reductions.
- N rates greater than 100 lb N/acre are needed to increase barley crop competitiveness.
- Herbicide control failure is more likely to happen in low than high N soils.
- The effect of soil N on herbicide efficacy varies with weed species and herbicide.

Table 2. Weed removal timing and N rate interaction on weed biomass, averaged over 2011-2013. Different letters indicate significant differences with 95% probability.

	50 lb N/acre	100 lb N/acre	150 lb N/acre
Weed removal timing	**Weed biomass (lb/acre)**		
Season-long weed free	0 c	0 c	0 c
Weeds removed at 3-4 leaf barley	384 c	480 bc	480 bc
Weeds removed at 8-10 leaf barley	1248 b	960 b	864 b
Season-long weedy check	7680 a	5472 a	4800 a

Acknowledgement:

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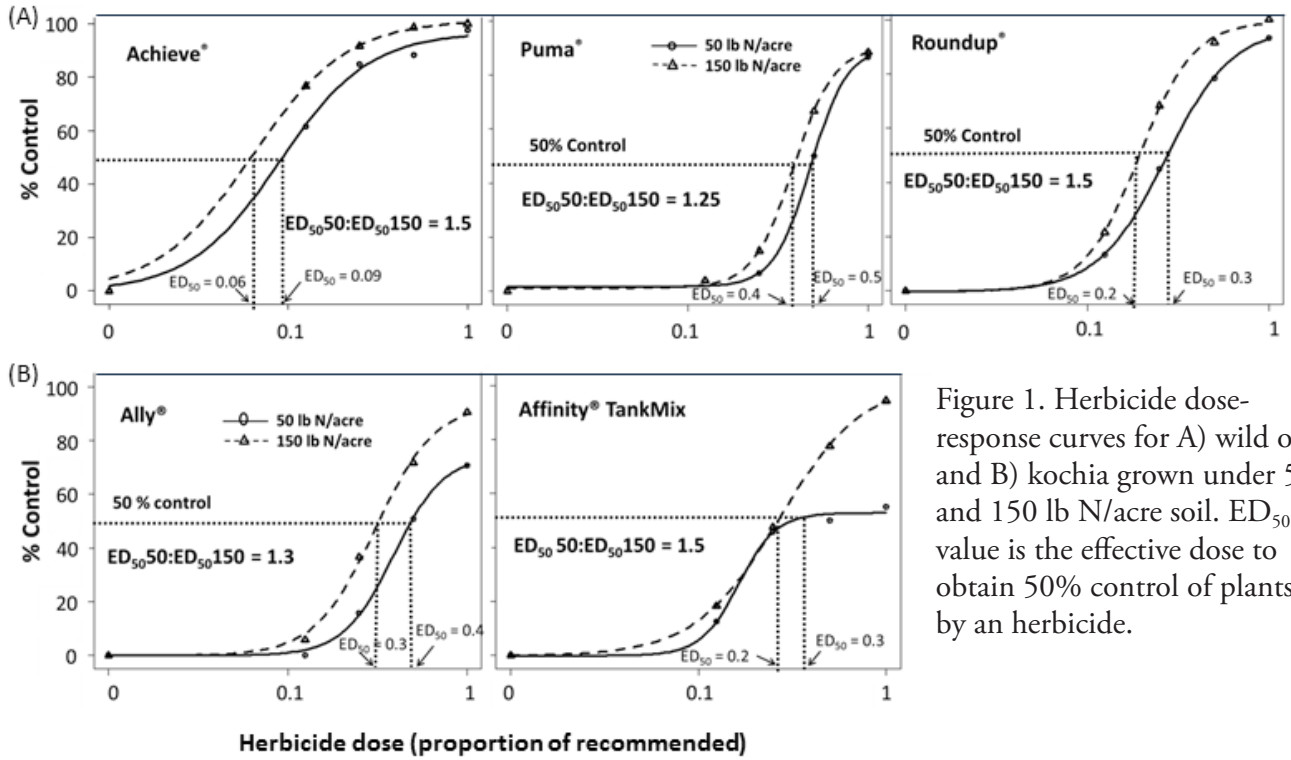

Figure 1. Herbicide dose-response curves for A) wild oat and B) kochia grown under 50 and 150 lb N/acre soil. ED_{50} value is the effective dose to obtain 50% control of plants by an herbicide.

Edited by Clain Jones, Extension Soil Fertility Specialist, and Kathrin Olson-Rutz, Research Associate