4. THE SELECTIVE EFFECT OF METSULFURON AND SETHOXYDIM ON SHRUBS, GRASSES AND SEDGES

4.1. ABSTRACT

I tested two herbicides for selective control of established perennial dicots (mostly shrubs) and monocots (grasses and sedges) in native prairie. Metsulfuron applied in four pulses (total 0.2325 kg a.i. ha^{-1}) reduced aboveground dicot mass from 559 to 53 g/m^2 and increased monocot mass from 56 to 87 g/m^2. Sethoxydim applied in three pulses (total 10.433 kg a.i. ha^{-1}) reduced aboveground monocot mass from 40 to 17 g/m^2 without affecting dicot mass. Remaining monocots consisted mostly of sedges (*Carex* sp.). The herbicides were highly selective but high amounts were needed to control established vegetation.

4.2. INTRODUCTION

Selective herbicides are useful when desired and undesired plants grow closely together, e.g., for the removal of established shrubs from pasture without damaging the grass sward (Bowes & Spurr 1996), for the removal of grasses from prairie shelter belts (L. Alspach, P.F.R.A., pers. comm.) or for tree plantations to reduce competition from grasses (Woods et al. 1992). Selective herbicides are a good alternative when undesirable plants would colonize soil disturbed by mechanical removal (Fairbank et al. 1990, Richardson et al. 1990). High selectivity of herbicides is also advantageous where spray drift might affect natural vegetation or non-target crops (chapter 3, p. 67).

Metsulfuron is a post-emergence systemic herbicide developed for control of herbaceous broadleaf weeds in grain crops (Ahrens 1994). It can be taken up by both roots and leaves and has been used successfully to eliminate several woody species in grassland (Derr 1989, McDaniel et al. 1991, Bowes & Spurr 1996). However, control of woody species in un-disturbed vegetation (Derr 1989, McDaniel et al. 1991) may require more metsulfuron than what is necessary in recently disturbed vegetation (Bowes & Spurr 1996). As a consequence, more metsulfuron may have a more deleterious impact on established grasses.

Sethoxydim is a post-emergence contact and systemic herbicide developed for control of grasses in broadleaf crops such as canola, flax, and legumes (Ahrens 1994). It is taken up primarily through the foliage. The effect of sethoxydim on woody species has not been studied so far.

I examined the effectiveness of metsulfuron and sethoxydim for selective control of dicots (mostly shrubs) and monocots (grasses and sedges) in undisturbed mixed-grass prairie.

4.3. METHODS

The study was conducted 120 km south of Regina, Saskatchewan, Canada (49° 20'N, 104° 40'W), in natural mixed-grass prairie (Coupland 1950, Looman 1980). I applied two treatments of herbicide (applied vs control) in factorial combination with two treatments of target growth form (shrubs vs grasses) to four plots in each of two habitats. Habitat was either mixed-grass prairie (*Stipa comata*, *Bouteloua gracilis*, *Agropyron* spp.) with sparse growth of snowberry (*Symphoricarpos occidentalis*, 5-15% cover) or snowberry brush (95% cover) with grasses and sedges (5-10% cover) underneath the canopy. The plots (2 m × 2 m) were established in the first week of May 1996 by trenching to a depth of 15 cm to confine roots within plots. In each habitat, one plot was treated with metsulfuron to kill dicots (i.e., snowberry), one plot was treated with sethoxydim to kill perennial monocots (i.e., grasses and sedges), and two plots received no herbicide (one as a control for dicots and one as a control for monocots). The experimental design was completely replicated at five sites within a 1 km^2-area. Thus, my experiment was a blocked-factorial design with the three factors herbicide, growth form, and habitat and blocked on sites. Plots were randomly assigned to herbicide × target growth form combinations within each habitat.

I used 7.5 g a.i./ha of metsulfuron methyl (*Ally*, DuPont, Canada) on May 27, and 75 g a.i./ha on June 11, June 26, and July 20, 1996 to kill dicots. I used 0.497 kg a.i./ha of sethoxydim (*Poast*, BASF, Canada) on June 15, and 4.968 kg a.i./ha on June 26 and July 20, 1996 to kill perennial monocots. Since I was mostly interested in the effect of sethoxydim on perennials, I used 45.6 g a.i./ha of clethodim (*Select*, Rhône-Poulenc, Canada) on May 27 to kill annual monocots so their biomass would not be included with the perennials' after harvest in the fall. Metsulfuron and sethoxydim concentrations were increased after the first application because the initial concentrations appeared to be ineffective based on visual inspection 2-3 wk after application. Herbicide treatments were repeated until mortality was >90%, resulting in three applications of sethoxydim and four applications of metsulfuron.

Metsulfuron was mixed with 1.5 m^3 water/ha and applied uniformly with a 12-L backpack sprayer from above the bush canopy. Snowberry forms a dense canopy above the monocots, therefore, clethodim and sethoxydim were applied underneath the bush canopy. To ensure uniform coverage I mixed clethodim and sethoxydim with 7.5 m^3 water/ha. All herbicides were mixed with a surfactant (sodium hexametaphosphate) at 2 g/L and blue food colouring to control spray coverage.

Standing crop of the target growth form and the remaining vegetation (non-targets) within each plot was harvested from one 0.15 m × 1.0 m subplot, 1 m from a plot edge during August 28-29, 1996 and dried at 75° C to constant mass.

I determined the effect of each herbicide on standing crop of targets with an analysis of variance for blocked-factorial designs (Lorenzen & Anderson 1993). Factors were site (random effect), habitat, herbicide, and growth form (fixed effects). To determine the effect of each herbicide on the remaining vegetation I used remaining standing crop as dependent variable.

4.4. RESULTS

Averaged over habitats, metsulfuron significantly reduced dicot standing crop to 9% of that in control plots (Fig. 4.1a), but sethoxydim did not significantly reduce monocot standing crop (Fig. 4.1b, herbicide × growth form interaction: $F_{1,4} = 9.57$, $P = 0.04$). The habitat × herbicide and habitat × herbicide × growth form interactions were not significant, suggesting that the herbicides had similar effects in both prairie and brush habitat. Shrub removal significantly increased the standing crop of grasses (Fig. 4.1a; a-priori means contrasts: t = 4.85, $P = 0.02$), but the removal of grasses had no effect on the stand-

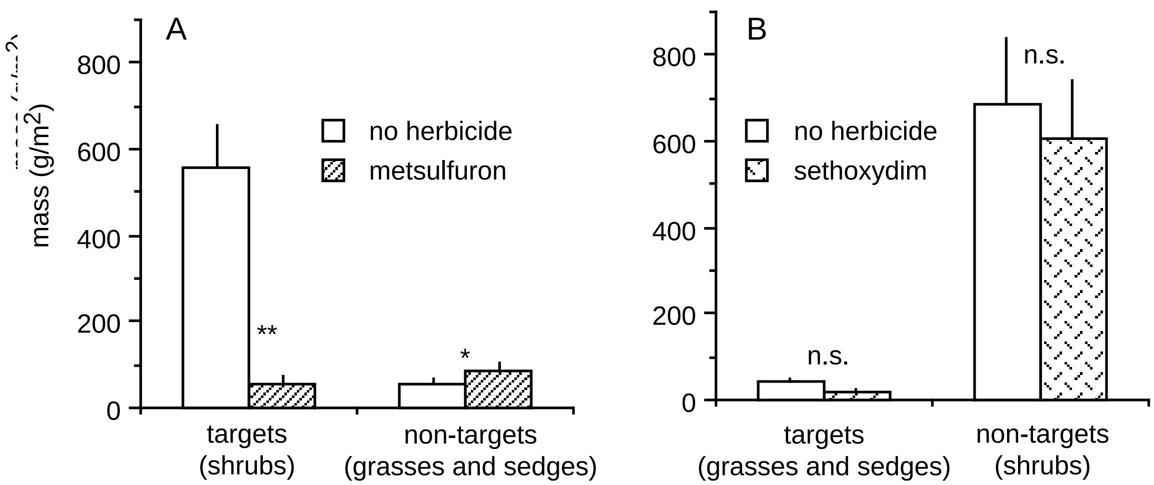

FIG. 4.1. Effect of metsulfuron (a) and sethoxydim (b) on standing crop of target and non-target growth forms. Bars represent means averaged over habitat treatments and sites, error bars indicate 1 SE (n = 10). Asterisks show significant differences between sprayed and unsprayed treatments (a-priori means contrasts, n.s.: $P > 0.05$, *: $P \leq 0.05$, **: $P \leq 0.01$).

ing crop of shrubs (Fig. 4.1b), resulting in a significant herbicide × growth form interaction ($F_{1,4}$ = 24.4, P = 0.008).

4.5. DISCUSSION

Both herbicides were selective in the sense that they tended to reduce the mass of the target growth form without reducing the mass of non-target growth forms (Fig. 4.1). The amounts of herbicides required to achieve this level of control, however, were up to 30 times higher than recommended doses and much higher than the amount used by Bowes & Spurr (1995) to achieve 100% mortality in similar vegetation and the same geographical region. The large difference between Bowes & Spurr's and my experiment is consistent with high variability of metsulfuron potency in bioassays on *Brassica rapa* (Streibig et al. 1995). Higher doses of metsulfuron may be required to control shrubs in undisturbed vegetation (Derr 1989, McDaniel et al. 1991, Bowes & Spurr 1996). Timing of application seems important for degree of shrub control, but differs among species (Derr 1989, McDaniel et al. 1991). I started spraying as soon as shrub leaves expanded, which may have been too early. Shrubs consisted mostly of snowberry, a clonal plant with tillers connected by an extensive rhizome system (Pelton 1953). Sprayed snowberry tillers may have obtained resources through roots below 15 cm soil depth from undamaged tillers outside the plot. Therefore it may be more effective to apply treatments to the whole clone.

Monocots were not significantly reduced by sethoxydim even though I applied 21 times the recommended dose (Fig. 4.1b). About 90% of the remaining plant mass were sedges (*Carex* spp.). The abundance of sedges appeared to have increased after the herbicide application from initially 10-15% cover in prairie. The effect of sethoxydim on sedges could not be quantified because sedges were not sampled separately from grasses. The high selectivity of sethoxydim in favour of sedges could be applied to stop invasion of exotic grasses into northern natural sedge communities (Wein et al. 1992).

The removal of shrubs increased monocot mass (Fig. 4.1a). The enhanced growth of grasses after shrub control is likely due to reduced competition for nitrogen and light (Harrington & Johns 1990, McDaniel et al. 1991, Van Auken et al. 1992, Wilson 1993b, chapter 5). The reduction of grass standing crop to 42% of its initial mass, however, did not affect shrub mass (Fig. 4.1b, see Felker et al. 1984, Aerts et al. 1991, Woods et al. 1992). This may indicate that shrubs in my experiment were little affected by grass competition.

The low impact of sethoxydim and metsulfuron on non-target growth forms make these herbicides suitable for selective control where mechanical damage or soil disturbance should be avoided. However, the amount of herbicide needed for effective control may vary strongly among locations and years, and treatments may have to be applied to the whole shrub clone.