Response of Seedling Bird Vetch (*Vicia cracca*) to Six Herbicides

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Bird vetch is a perennial Eurasian plant which, unlike many exotic weed species, can invade low fertility areas that have not been disturbed. It also is common in pastures, woodland, and tall forb communities. Bird vetch is expanding along Alaskan roadsides, in urbanized areas, and in low density forests. A greenhouse study was conducted to determine efficacy of six herbicide treatments applied at reduced rates in 2005 and again in 2006 for bird vetch seedling control. Bird vetch seedlings were tolerant of reduced rates of chlorsulfuron and 2,4-DB; however, complete control was achieved with rates of clopyralid, dicamba plus diflufenzopyr, triclopyr, and 2,4-D that were a fourth to an eighth of the full registered rate. These results will be important for developing effective, low-cost methods for controlling bird vetch in Alaska, especially on the outer margins of infestations.

Nomenclature: Chlorsulfuron; clopyralid; dicamba; diflufenzopyr; triclopyr; 2,4-D; 2,4-DB; bird vetch, *Vicia cracca* L. VICCR.

Key words: Alaska, exotic weeds, greenhouse, weed control.

Bird vetch is a weak stemmed, climbing perennial legume that can spread vegetatively from buds on roots (Aarssen et al. 1986) as well as spreading by seed. Bird vetch is native to parts of Europe and Asia, but has spread across the Northern United States and Canada (Gleason and Cronquist 1963) since its first report in 1860 at Prescott, Ontario (Aarssen et al. 1986). Bird vetch is a plant common to hedgerows, roadsides, and grasslands in Great Britain (Cadbury et al. 1971), and it is found along roadsides, in meadows, pastures, perennial horticulture crops, and arable fields in Canada (Aarssen et al. 1986). Bird vetch was planted in Alaska in 1909 at the Rampart Experiment Station north of the Yukon River (65.50° N, 150.16° W) and later at the Fairbanks and Palmer Experiment Stations to determine forage value (Klebesadel 1980). From there bird vetch has spread into disturbed and undisturbed areas in Alaska (http://akweeds.uaa.alaska.edu/). As the bird vetch infestation has expanded, concerns about its impact on the environment and efforts to control it have increased.

Bird vetch has a relatively large seed weighing 12 to 25 mg and measuring up to 3 mm in length with a hard seed coat (Aarssen et al. 1986; Ortega-Olivencia and Devesa 1997; Thompson et al. 1993; Van Assche et al. 2003). This seed coat imparts a physical dormancy that typically restricts germination the first year after production (Hill et al. 1989; Roberts and Boddrell 1985; Van Assche et al. 2003). The hard seed coat is softened naturally when exposed to temperatures alternating between 10 and 20 C in a moist environment (Van Assche et al. 2003). Bird vetch germinates later in the spring than other legume species, emerging from April to June in Great Britain and Belgium (Roberts and Boddrell 1985; Van Assche et al. 2003). Scarification, either mechanical or with sulfuric acid (1 hr), weakens the seed coat and increases germination to over 80% (Ortega-Olivencia and Devesa 1997). Despite physical dormancy, bird vetch seed viability drops off considerably after five years (Roberts and Boddrell 1985), which has positive implications for management of seed banks.

Bird vetch is thought to be typical of plant species that are common to woodland, hedgerows, or tall forb communities (Grime et al. 1988; Westoby et al. 1996) because its large, round, short-lived seed falls through a pasture canopy to the ground and its seed reserves support enough height growth for the plant to grow through the pasture canopy to sunlight. In a four-year study in Nova Scotia, bird vetch increased from 3 to 9% of the overall vegetation in a faba bean (*Vicia faba* L.) field where total plant biomass remained constant (Hill et al. 1989). Contrary to the general trend of greater establishment and persistence of invading species in disturbed and/or high fertility environments, a five-year plant invasion study conducted in England documented the ability of bird vetch to establish in low fertility and disturbance environments (Thompson et al. 2001) similar to sites invaded in Alaska. Additionally, in these low fertility and low disturbance environments, bird vetch was able to establish independently of the number of gaps in the existing vegetation (Burke and Grime 1996). In a study in Switzerland, seven invasive legume species were sown in April into monocultures of 27 other species (Turnbull et al. 2005). Five months later bird vetch was the dominant invader in nonleguminous broadleaved plots compared with grass or leguminous broadleaved plants in 48 compared with 19 or 17 percent, respectively, of the total plots of each functional group.

The use of herbicides might be an effective method of reducing bird vetch populations in Alaska. Postemergence application of clopyralid successfully controlled bird vetch, whereas chlorsulfuron, 2,4-D, and dicamba provided marginal control, and the plant was tolerant of bentazon, bromoxynil, 2,4-DB, imazethapyr, and thifensulfuron (Aarssen et al. 1986; Ivany 2001). Triclopyr and diflufenzopyr plus dicamba are herbicides that are registered for broadleaf control in pastures and non-crop areas with potential for control of bird vetch. Additionally, triclopyr can control many shrub species which are a problem on Alaskan roads because they attract moose and block vehicle line of sight (L. Johnson, Alaska Department of Transportation, personal communica-

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tion). Increased herbicide half lives in the cold soils of Alaska have been measured for several herbicides (Conn and Cameron 1988; Conn and Knight 1984) due to the soil environment being colder for longer periods and having underlying permafrost. Targeting seedlings and early emerging plants while using reduced rates of herbicides might alleviate the potential problems associated with increased herbicide half lives on susceptible crop or native plant species. Therefore, the objective of this research was to determine the effectiveness of six herbicides (chlorsulfuron, clopyralid, dicamba plus diflufenzopyr, triclopyr, 2,4-D, and 2,4-DB) to control bird vetch seedlings at reduced rates.

Materials and Methods

An experiment was conducted in 2005 and 2006 in a USDA—Agricultural Research Service greenhouse located at the University of Alaska Fairbanks Matanuska Experiment Farm near Palmer, AK. The greenhouse was maintained at 15 to 20 C with supplemental lighting in a 12/12 h day/night cycle. Supplemental lighting was not available for the first 4 wk in 2005. Bird vetch seed that was collected at the University of Alaska Agricultural and Forestry Experiment Station in Fairbanks in the autumn of 2005 was used for the experiment both years. To break seed coat physical dormancy, seeds were soaked in concentrated sulfuric acid for 1 hr and rinsed with water before planting. A sterilized potting soil[1] was used in 2005 and an artificial potting mix[2] was used in 2006. An assumption was made that the potting mix would not significantly alter plant response to the herbicides because the herbicides chosen were all applied postemergence. Three seeds were planted in each 60 ml pot. Plants were watered daily and thinned to one seedling per pot 2 to 3 wk after planting. Herbicides were applied at the two- to three-leaf stage using a handheld variable-rate log-step sprayer[3] with a flat fan nozzle[4] delivering 200 L/ha with 250 kPa. Prior to spraying on application day, ten representative plants were harvested at the soil level, dried at 60 C for 4 d, and weighed to determine initial dry weights. Two wk after treatment, all plants were harvested at the soil level, dried at 60 C for 4 d, and weighed. Dry matter accumulation after spraying was determined by subtracting the average initial weights from final weights for each experiment. At harvest, treated plants were visually rated for control compared to the control plants using a 0 (no difference from control) to 100 (complete death) percent scale.

Both experiments were conducted using a randomized complete block design with four replications. Control plants were sprayed with water and were included for each herbicide used to control for any residual herbicide in the spray equipment. Application rates ranged from half the recommended field use registered rate to one-sixteenth of that rate, except for chlorsulfuron, which ranged from half to an eighth of the full registered rate (Table 1). Four pots of bird vetch plants were used in each replication in 2005. In 2006, the number of pots used was increased to ten per replication.

Dry weight data for each replication were averaged and analyzed using the general linear models of SAS (2004). Data were determined to be normally distributed using a UNIVARIATE procedure on model residuals with the Shapiro-Wilk statistic of SAS. There were no differences at similar herbicide doses between the two experiments so all data were combined. Each herbicide was analyzed separately. A least significant difference means test (Fischer's protected) was used when the *F*-test probability was $<$ 0.05 to identify differences among the dose responses.

Table 1. Effect of herbicides on dry matter accumulation and visual injury of bird vetch seedlings in greenhouse experiments.

Herbicide	Rate g ai/ha	Plant weight[a] mg	SE ±mg	Control[b] %
Chlorsulfuron	0	9.3a	1.0	0
Chlorsulfuron	2.2	12.0a	2.0	10
Chlorsulfuron	4.4	7.3a	1.8	20
Chlorsulfuron	8.8	6.5a	1.8	20
2,4-DB	0	13.0a	2.0	0
2,4-DB	53	19.0a	2.6	0
2,4-DB	110	15.0a	3.1	0
2,4-DB	210	13.0a	1.3	20
2,4-DB	420	12.0a	2.2	20
Clopyralid	0	14.0a	1.2	0
Clopyralid	13	7.9b	1.9	50
Clopyralid	26	3.9c	0.6	80
Clopyralid	53	2.9c	0.5	100
Clopyralid	105	1.4c	0.3	100
Dicamba + Diflufenzopyr	0	13.0a	3.5	0
Dicamba + Diflufenzopyr	1.6 + 0.7	12.0a	1.6	50
Dicamba + Diflufenzopyr	3.3 + 1.3	7.4ab	2.1	50
Dicamba + Diflufenzopyr	6.5 + 2.6	5.6b	1.2	100
Dicamba + Diflufenzopyr	13 + 5.3	4.6b	1.0	100
Triclopyr	0	11.0a	1.8	0
Triclopyr	79	7.9a	1.6	40
Triclopyr	160	3.0b	0.3	80
Triclopyr	320	2.6b	0.4	100
Triclopyr	630	0.4b	0.2	100
2,4-D	0	22.0a	5.0	0
2,4-D	100	6.2b	0.5	25
2,4-D	200	6.2b	0.5	50
2,4-D	400	3.8b	0.6	100
2,4-D	800	3.9b	0.8	100

[a] Means within a herbicide followed by the same letter are not significantly different according to a Fischer's protected LSD at P = 0.05.

[b] On a scale where 0 = no apparent injury and 100 = all plants dead.

Results and Discussion

Reduced rates of chlorsulfuron and 2,4-DB did not retard growth or kill bird vetch seedlings (Table 1). As the clopyralid rate increased, bird vetch growth decreased, with complete control observed at the two highest rates (105 and 53 g/ha). The two lowest rates of the combination of dicamba plus diflufenzopyr (1.6 + 0.7 and 3.3 + 1.3 g ae/ha, respectively) did not reduce growth of bird vetch seedlings compared to nontreated plants. However, at the two highest rates of dicamba plus diflufenzopyr (6.5 + 2.6 and 13 + 5.3 g ae/ha, respectively) growth was reduced and all plants were controlled. The lowest dose of triclopyr (79 g ae/ha) did not reduce the growth of bird vetch seedlings, compared to nontreated plants. However, the three highest doses of triclopyr (160, 320, and 630 g ae/ha) did reduce growth with complete control at the two highest doses. All doses of 2,4-D (100, 200, 400, and 800 g ae/ha) reduced the growth of bird vetch seedlings with complete control at the two highest doses compared to nontreated plants.

Aarssen et al. (1986) measured complete control of 3- to 4-wk-old greenhouse-grown bird vetch with 120 g/ha clopyralid, and decreased control with 350 g/ha 2,4-D, 20 g/ha chlorsulfuron, and 1,100 g/ha 2,4-DB, respectively. In a greenhouse experiment, Ivany (2001) reported 33% and 8% control of 3- and 6-wk-old bird vetch with 500 g/ha of 2,4-D amine based on visual observation. In this study, bird vetch seedlings were tolerant of reduced rates of chlorsulfuron, and 2,4-DB. However, bird vetch seedlings were controlled by clopyralid, dicamba plus diflufenzopyr, triclopyr, and 2,4-D that were below full registered rates and should be candidates for field testing.

Clopyralid, dicamba plus diflufenzopyr, triclopyr, and 2,4-D might be effective for control of bird vetch in Alaskan pastures. Triclopyr and 2,4-D also could have potential for vetch control along roadsides and in Conservation Reserve Program lands, where there is the potential added benefit of shrub control, whereas shrub control from these herbicides would be an undesirable impact on other land uses. There is a potential for off-target impacts on desirable native forbs and drift into waterways from any of these herbicides. The possibility of effective bird vetch seedling control with reduced rates of clopyralid, dicamba plus diflufenzopyr, triclopyr, and 2,4-D could help with the interior Alaska concern for the potential of extended soil residuals (Conn and Cameron 1988; Conn and Knight 1984).

Although bird vetch populations are expanding in Alaska (http://akweeds.uaa.alaska.edu/), many are in small discrete patches. In larger urban areas such as Fairbanks, Palmer, and Anchorage, management of bird vetch to reduce its rate of expansion might be the only option available. In less disturbed areas, where patches of bird vetch are less than a hectare in size, it might be possible to eradicate this species (Auld and Tisdell 1986). These established patches of bird vetch might need maximum registered rates of herbicides such as clopyralid, triclopyr, or dicamba+diflufenzopyr to kill mature plants, whereas the peripheral buffer zone, where seed might have been dispersed (Auld et al. 1982), can be treated with a reduced herbicide rate to kill emerging seedlings. Because of the short five-year seed bank life, annual follow-up treatments with a reduced herbicide rate over the established patch and the peripheral buffer zone could result in eradication.

Sources of Materials

[1] Sterilized potting soil, Ann's Greenhouses, 780 Sheep Creek Rd, Fairbanks, AK 99709.

[2] Artificial potting mix, Premier Horticulture Incorporated, 127 South 5th Street, No. 300, Quaker Town, PA 18951.

[3] Variable-rate log-step sprayer, R & D Sprayers, 419 Highway 104, Opelousas, LA 70570.

[4] Flat fan nozzle, 8002 VS nozzle, Tee-Jet Spraying Systems Co., Wheaton, IL 60187.

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