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RH: Herbicide Application . Warson et al.

Maintaining Early-Successional Habitats Using A Metal Wick Herbicide Applicator

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Abstract: Maintenance of early-succession plant communities can be problematic because hardwood and pine tree species tend to colonize and dominate. Controlling hardwoods and pines requires frequent use of prescribed fire or mechanical control unless herbicides are used. Broadcasting herbicides can be expensive and effects on non-target species may be considered an unacceptable risk. Therefore, we tested the efficacy of an aluminum wick, herbicide applicator, the Weed Sweep®, for control of hardwood and pine saplings, 1994-1996. We compared spring and fall applications in one trial and in a second trial tested two herbicide mixes, glyphosate mixed with either trichlopyr or imazapyr. Herbicides plots had 78% fewer sapling stems/ha than control plots ($P < 0.006$). May applications of glyphosate/imazapyr provided greater control of hardwoods but lower control pines than September applications ($P < 0.05$). Also, glyphosate/imazapyr provided greater control of hardwoods than glyphosate/trichlopyr ($P < 0.05$). Percent ground cover by forbs, grass, and legumes and total number of species in the ground story did not differ between treatment and and control plots. Our results indicate that a higher rate may be needed to achieve more consistent control of slower growing genera, such as *Carya* and *Quercus*. However, this technique may be valuable to managers needing an inexpensive alternative to mechanical methods for controlling hardwood resprouts and young pines and require a herbicide application technique more environmentally-sensitive than broadcast spraying.

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Many early-successional wildlife species are declining (Brennan 1991, Peterjohn et al. 1995), so maintenance of grass-forb-shrub communities is an important management issue (Askins 1994). For example, managing strips of early-successional vegetation along edges of crop fields is recommended for bobwhite quail (Puckett et al. 1995). Managers rely on prescribed fire and mechanical treatments to manage tree saplings in upland pines forests, agricultural ditch banks and power line right of ways. Frequent use of mowing to reduce stature of brush and saplings has negative consequences for many wildlife species (Puckett et al. 1995). Long-term, mowing encourages hardwood root sprouts and reduces diversity of plant species in the ground story (Horn 1995, Geyer et al. 1994, Johnstone 1990, Bramble et al. 1990, Bramble et al. 1991). Another situation where hardwood resprouts cause management problems is maintenance of open, park-like, pine forests. While managers use freqent fire to kill hardwoods, fuels may not permit fires at a frequency necessary to kill hardwoods (Glitzenstein et al. 1995); so managers are forced to use expensive mechanical methods. Herbicides are an alternative to mechanical control of hardwood resprouts and pines. While herbicide use has reduced long term maintenance costs on right-of-ways (Johnstone 1990), most application methods are costly on a per area basis (Nowak et al. 1993). Also, broadcast applications of herbicides may kill non-target plant species.

Therefore, we tested the effectiveness of a metal herbicide wick, the Weed Sweep®, for hardwood and pine sapling control. This tractor-mounted, metal wick scratches the bark of saplings, exposes the cambium, and applies concentrated herbicide to plants it grazes. Because herbicide is not sprayed, we hypothesized it should not effect plant species composition or diversity in the short-term. We determined percent control of hardwoods and pines in plots on 2 power line ROWs that have been mowed on a 3 year rotation. We determined control of hardwood and pine saplings from glyphosate/imazapyr (Accord®/Arsenal®) and compared efficacy of spring and fall applications. In a separate trial we compared control of tree saplings provided by glyphosate/trichlopyr (Accord®/Garlon® 3A) and glyphosate/imazapyr. Finally, we measured plant species diversity on plots with and without herbicide treatment.

METHODS

Description of the Weed Sweep®

The functional unit of the Weed Sweep® (Reddick Equipment Co., Williamston, North Carolina) was constructed of 30.5 cm wide channel aluminum bar. Attached to the bar's ventral surface was a sheet of composite plastic with many small holes. Undiluted chemical was pumped to the bar via soaker hose. In use, herbicide not removed by vegetation was held in small holes by capiillary action. Aluminum teeth located on the bar's leading edge scratches vegetation permitting herbicide to enter the cambium layer. Two bars, one front- and one side-mounted, were fixed at a 30° forward angle. The side-mounted bar had a break-away mechanism consisting of a tension spring and shear-bolt and was capable of being lowered to an angle of 45° below horizontal and raised to 90° above horizontal. Height was adjusted from approximately 20 cm to 2 m above ground surface. Total wiping width was 5.18 m.

Herbicide Treatments

We conducted 2 experiments to determine effects of season of application and hericide tank mix on efficacy of controlling tree saplings. Both experiments use a randomized block design with 3 replications per block. For spring vs. fall herbicide application experiment, 12, 15 m X 15 m plots were placed on 2 electric transmission line rights-of-way (ROW). Herbicides were applied to randomly selected plots during the first week in September, 1994 (fall application) the last week of May 1995 (spring application). A tank mix of 1892 ml glyphosate, 473 ml imazapyr, and 236 ml surfactant was used. Application rates for both fall and spring sweeps were approximately 3.25 L/ha. Active ingredient rate was 1560 g/ha glyphosate and 780 g/ha imazapyr.

We applied herbicide to 12 additional plots to compare control rates of glyphosate/imazapyr and glyphosate/trichlopyr in July, 1995. Glyphosate/imazapyr was applied as in the first trial. The second tank mix contained 1892 ml glyphosate, 473 ml trichlopyr, and 236 ml surfactant. This herbicide combination also was applied at 3.25 L/ha. Active ingredient rate was 1560 g/ha glyphosate and 1170 g/ha trichlopyr. A nonionic surfactant was added to all tank mixes. A ground speed of 5 km/hr was maintained for all applications. The wiping surface was kept at 66 cm above ground level during herbicide applications.

Vegetation Measurements

Plots wiped fall 1994 were evaluated in May 1995 after trees had fully leafed out approximately eight months post-treatment. Plots wiped during spring 1995 and plots receiving glyphosate/imazapyr vs. glyphosate/trichlopyr applications in July 1995 were not evaluated until May 1996 after full tree leaf-out, approximately 10 months post-application.

For treatment comparisons, all individual stems ≥ 66 cm were identified to genus and recorded as dead or alive for each plot. Live stems were classified as those with green leaves and signs of bud activity, or stems showing green active cambium when cut. Effectiveness for each treatment was represented by kill rate calculated by dividing number of dead stems by total number of stems for each species/genus. In May, 1996, we subsampled all plots to compare sapling stem density between spring/fall plots and herbicide combination plots to control plots. We counted live stems in two, 4m diameter circles per plot to estimate stems/ha.

Ground story vegetation sampling was conducted from the last week in August 1995 to the second week of October 1995. Treatment plots were subsampled by selecting four random distances (starting points) along a plot side. At each starting point, 5 equally spaced plots were placed along a transect running perpendicular to the plot side for a total of 20 subsamples per plot.

Herbaceous canopy coverage was calculated using a modified Daubenmire plot. The sampling device consisted of a 50 X 50 cm. frame containing a gridwork of 400, 2.54 X 2.54 cm squares. Average values for 3 vegetation coverage categories (% grass, % forb, and % legume) and an overall % cover were used to compare changes in vegetation in response to herbicide treatments. All species occuring in each subsample square were recoreded

Statistical Analysis

Percent control values for tree species for each plot were used to test for treatment differences using a two-way analysis of variance (ANOVA) (SAS Institute, Cary, NC). If needed, subsamples were averaged for each plot to avoid psuedoreplication. Tests of equal variance were performed on all data using JMP which includes Brown-Forsythe, Levene, and Bartlett tests for equal variance. If variances were unequal, a Welch ANOVA test allowing for unequal variances was used to detect treatment differences. Data were also tested for normality using a Shapiro-Wilk W test (JMP). Small sample sizes made determining normality difficult. As a precaution the nonparametric Kruskall-Wallis rank sum test also was used.

RESULTS

Sixteen genera received herbicide treatments. Seven commonly occurring genera/species were (listed in order of decreasing stem density) pine (mostly loblolly, *Pinus taeda* L.), sweetgum (*Liquidambar styraciflua* L.), winged sumac (*Rhus copallina* L.), oak species (*Quercus* sp., mostly *Q. falcata* Michx., *Q. nigra* L., *Q. phellos* L., and *Q. marilandica* Muenchh.), red maple (*Acer rubrum* L.), pignut hickory (*Carya glabra* Mill), and common persimmon (*Diospyros virginiana* L.).

Herbicide treatments provided effective control of woody vegetation. Spring/fall treatment plots (ROW1: _ = 2133 stems/ha SE=933, ROW2: _ = 2400 stems/ha SE=693) and herbicide combination treatment plots (ROW1: _ = 4266 stems/ha SE=1091, ROW2: _ = 2400 stems/ha SE=1200) did not differ in stem density ($P > 0.05$) but had significantly lower stem densities than control plots (ROW1: _ = 14,133 SE=3839, ROW2: _ = 10,933 SE=7119) ($P < 0.006$).

Glyphosate/imazapyr (G/I) controlled most species better than glyphosate/trichlopyr (G/T) (Table 1). Generally, pines and slower growing hardwoods (oaks and hickories) had lower control rates than rapidly growing species (red maple, sweetgum, and winged sumac).

All species were not present in all plots for each treatment. Thus, statistical analysis for treatment effects were performed on three species and three groups of species; common persimmon, sweetgum, winged sumac, pines, oaks, and hardwoods in general. Control rates for sweetgum and hardwoods were significantly higher for G/I ($P= 0.026$ and 0.01 respectively) (Table 2). Pine control rates were nearly significantly different ($P= 0.0745$). Blocking factor, (i.e., ROW), was significant for sweetgum ($P = 0.0467$), oak ($P = 0.0497$), and hardwoods ($P = 0.0038$) with higher control rates occurring on ROW 2.

May applications controlled most hardwood species better than September treatments (Table 3). Control rates for pines were low for both treatments on ROW 1 and spring application on ROW 2. Fall application gave the best pine control (50%, $n = 66$) of all herbicide applications. On average, control rates for faster growing hardwoods (red maple, sweetgum, and winged sumac) were slightly higher than control rates for slower growing species (hickories and oaks).

Similar to the herbicide combination treatments, not all species/groups were present in every treatment plot. Again, only a four species/groups (pine, sweetgum, oak, and winged sumac) and the pooled group hardwoods could be statistically analyzed for treatment effects. Spring application resulted in significantly better control for sweetgum and hardwoods ($P = 0.0157$). Treatment effect was significant for pine ($P = 0.0004$) with better control using fall application

(Table 4).

Vegetation Characteristics

A total of 197 species comprised of 115 genera were recorded. Common grass species included broomsedge (*Andropogon virginicus* L.), three-awn grass (*Aristida* sp.), poverty grass (*Danthonia* sp.), *Dichanthelium* sp. and Beardgrass (*Gymnopogon brevifolius*). Common forbs included Boneset/Throughwort (*Eupatorium* L. sp.), common cinquefoil (*Potentilla canadensis* L.), blackberry (*Rubus* sp.), goldenrods (*Solidago* sp.), *Bidens aristosa* Michaux., trumpet creeper (*Campsis radicans* L), poison ivy (*Rhus toxicodendron* L.), greenbrier (*Smilax* sp.), Japanese honeysuckle (*Lonicera japonica* Thunberg) and muscadine grape (*Vitis rotundifolia* Michaux.). Lespedezas most common included *Lespedeza procumbens* Michaux., *L. repens* Barton, *L. virginiana* Britten, and *L.cuneata* Michaux.

Numbers of species were significantly greater for ROW 2 (= 57.6, SE = 2.47) than ROW 1 (_ = 49.6, SE = 1.87) (K-W ^{2} = 7.23, 1 df, P = 0.0072), but there was no significant difference in number of species among plots herbicide treated and control plots. Control plots had an average of 54.2 (SE = 3.9) species compared to 57.2 (SE = 1.8) and 50.5 (SE = 2.1) for plots treated spring or fall and with different herbicide combinations, respectively. There were no significant difference in percent forbs, legumes, grasses or overall plant cover between treatment plots and control plots ($P > 0.05$).

DISCUSSION

This study was our first attempt to manage hardwood and pine tree species using the Weed Sweep®. However, even at the relatively low rates applied, control achieved was similar to other types of herbicide applications. Pitt et al. (1993) found that glyphosate treatments at doses > 0.5 times the label maximum rates reduced woody cover by 77% relative to untreated areas. Johnstone (1990) reported 90% control of undesirable plant species with a fall application of glyphosate. Geyer et al. (1994) showed that a fall application of imazapyr/picloram provided approximately a 50% tree control. Nowak et al. (1992) showed an 87% decrease in undesirable woody stem densities using a selective stem foliar treatment with a trichlopyr/picloram tank mix over a three year period (second conversion maintenance cycle).

One major advantage herbicide wiping has over other mechanical and chemical methods is cost effectiveness. Abrahamson et al. (1991) showed stem foliar treatment costs ranged from 815 to 1037 dollars/ha ($330 - $420 per acre) and basal treatment costs ranged from 1359 to 1705 dollars/ha ($550 - $690 per acre) for areas with stem densities of 3200 to 17000 stems/ha. Johnstone (1990) showed that herbicide treatment costs decreased from $642 per hectare ($260 per acre) to $247 per hectare ($100 per acre) with better planning and reduced brush density, and that mechanical mowing costs were $197 per hectare ($80 per acre) in 1980 for one-year-old brush and $370 per hectare ($150 per acre) in 1987 for three-year-old brush. This was similar to Carolina Power & Lights mowing costs which ranged from $148 - $247 per hectare ($60-$100 per acre) (Pers. Commun. Doug Meier CP&L Transmission Forester). Herbicide wiping costs were estimated to be $94 per hectare ($38 per acre) (Anderson et al. 1997). Based on the control ratings observed in this study and the cost effectiveness, herbicide wiping technique may be more cost effective than other chemical methods used in ROW vegetation management.

We believe this technique has merit for many situations in wildlife management where control of hardwood resprouts is a long-term management problem. These include ROW maintenance, controlling trees in fallow fields, hardwood resprouts in open upland pine habitats, and removing hardwoods from edges of agricultural fields or in drainage ditches. Benefits to wildlife would depend on management goals and use. In an on-going study, the Weed Sweep® is being used to remove hardwoods from field borders and the edges of drainage ditches to avoid mowing and maintain year-round habitat for northern bobwhite quail (P.T. Bromley, unpubl. data). Where prescribed burning is difficult, for ecological or legal reasons, this technique may offer relatively inexpensive control of hardwoods without undesirable effects on other groudstory vegetation.

We observed very little herbicide dripping from the Weed Sweep. Kill of non-target plants was limited to situations where non-targets touched the bar and when herbicide was carried by tractor tires after running over treated brush. Also, some forbs immediately surrounding the root collar of trees treated with imazapyr were killed,. However, these situations occurred infrequently. Therefore, we believe this technique may have utility in situations where managers need to selectively remove undesirable woody vegetation overtop of sensitive or rare grass/forb communities.

Choice of herbicide used to control undesirable woody vegetation is important. The herbicides chosen must provide good control at cost-effective application rates. Also, different herbicides control some woody plant species better than others due to plant factors (translocation patterns, waxy cuticles, etc.) and by a herbicide's mode of action (Green et al. 1992). Glyphosate, imazapyr, and trichlopyr were chosen for this study because these three herbicides are commonly used in controlling undesirable woody species in forestry and utility ROW applications (Johnstone 1990, Nowak et al. 1992, Pitt et al. 1993, Nowak et al. 1993, Horn 1995). Also, these three herbicides are considered environmentally safe (Horn 1995).

The herbicides in combination with the Weed Sweep® in this study provided good control for most species treated. As anticipated, control rates varied greatly for some species treated. This variation may be partially accounted for by low stem densities for many of the species treated in one or more of the plots. Variability in control rates also may have been caused by the low application rates. Pitt et al. (1993) found reduced application rates gave acceptable levels of control but, the consistency of the levels of control suffered. Anderson et al. (1997) achieved higher control rates and greater consistency with double the application rates used in this study.

Lack of overall pine control may be a concern for some management problems, such as ROW maintenance as neither tank mix provided adequate pine control. Green et al. (1992) found similar results studying glyphosate absorption and translocation in four woody species including loblolly pine.

The glyphosate/imazapyr tank mix provided good control for both spring and fall applications. However, spring control was slightly better for most species and significantly better for sweetgums and grouped hardwood. This finding seems logical based on the fact that in early spring leaves are growing rapidly and producing and moving photosynthate out to the rest of the plant . Green et al. (1992) showed some woody plants may translocate glyphosate out of the roots and back to the leaves. If this translocation to the leaves is occurring during the fall, then glyphosate could potentially be lost during leaf senescence and would be unavailable to control regrowth the following spring.

Data for this project were collected over a period of only 2 years and are representative of North Carolina Piedmont soils and typography. More research using the herbicide wiping method is needed and for longer periods of time to verify our results. However, the findings of this study suggest the combination of effective control of undesirable woody vegetation throughout the growing season and low application costs potentially could make herbicide wiping a valuable technique for managing early-successional vegetation.

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