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Glyphosate
Controls Hardwoods in West Virginia

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Abstract

Applications of Roundup, a glyphosate, by mistblower were effective in controlling hay-scented fern, blackberries, and some tree, shrub, and herbaceous species on an experimental watershed in West Virginia. Damage to planted Norway spruce was slight at rates of 1, 2, and 3 qt/acre (0.75, 1.50, and 2.25 lb/acre of the acid glyphosate). A variety of hardwood species were killed following injections of 20 or 50 percent solution of Roundup at a rate of 1.5 ml per incision. The cuts were spaced at 1.5 inches, edge to edge, around the stem near groundline. Resprouting of the treated hardwoods was minimal after 2 years.

Introduction

The banning of 2,4,5-T and restrictions on the use of other phenoxy-based herbicides has drastically curtailed the use of these chemicals in forestry practices. Roundup[1], a water-soluble compound that contains 3 lb/gal of the acid glyphosate (Isopropylamine salt of N-(phosphonomethyl) glycine) may be an effective substitute for 2,4,5-T in some forestry applications.

Roundup is registered for use in certain forestry operations including site preparation and direct foliage spraying on undesirable vegetation. It can be used for conifer release but this use is not recommended in several southern states.

Norway spruce and Scotch pine have shown a profound tolerance to glyphosate during the mature growth stage, and less tolerance during shoot elongation (Lund-Hoie 1975, 1976). In Norway, target species appeared more sensitive to autumn application. In western Oregon, Douglas-fir, grand fir, noble fir, and ponderosa pine were not affected by foliar applications of Roundup applied at 1 qt or less per acre (Newton 1977). Best results were obtained just before leaf abscission. Also, injections of 1 ml per 6 inches of diameter were effective on western hardwoods treated in late summer.

In the East, applications of 1 qt/acre of Roundup on the Allegheny Plateau in Pennsylvania controlled the development of hay-scented fern, New York fern, short-husk grass, bracken fern, wild oat grass, rough-stemmed goldenrod, and flat-topped aster for 3 years. One year after application, survival and growth of planted and natural black cherry seedlings on the plots were not affected[2].

The objectives of this study were (1) to determine the tolerance of planted Norway spruce and natural vegetation to different rates of Roundup applied at different times with a mistblower, (2) to determine the effectiveness of injections of Roundup in killing hardwood saplings larger than 1-inch dbh and large cull beech trees. Testing was done in West Virginia on the Fernow Experimental Forest and on the Cheat Ranger District, Monongahela National Forest.

[1] The use of trade, firm, or corporation names in this paper is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.

[2] Horsley, Stephen B. Effectiveness of herbicides in controlling ground covers in orchard stands and woodlands. In preparation.

Figure 1.—General condition of spruce before treatment.

Methods

The dominant species of vegetation on the Norway spruce area before treatment were hay-scented fern and blackberry, which accounted for about 60 percent of the ground cover. Small saplings, mostly red maple, sweet birch, sassafras, sourwood, and downy serviceberry, were intermingled with greenbrier, azalea and were underlain by patches of haircap moss. The spruce ranged in height from about 1 to 3 feet; most were partially or completely overtopped (Fig. 1). Aerial spraying of the area with 2,4,5-T 3 years earlier provided only short-term control of the blackberries and hardwoods; control of the hay-scented fern was minimal. At the time of these tests, the average height of the regrowth was between 3 and 6 feet.

Application by Mistblower

Roundup was applied to 1/5-acre plots with a mistblower at rates of 1, 2, and 3 qt/acre (0.75, 1.50, and 2.25 lb/acre) on August 15, September 1, and September 15, 1978. The amount of Roundup required for the three application rates was mixed with enough water to prepare 3 gal of mixture to ensure complete and uniform coverage. The final evaluation of the mistblown area was made in the late summer of the second growing season. A subjective evaluation was made by rating species controlled in 8 milacre plots in each 1/5-acre plot. Hardwoods were considered controlled if crown foliage was less than 20 percent. Hay-scented fern, blackberries, greenbrier, and haircap moss were considered controlled if the amount of the plot they occupied was reduced by 80 percent or more. Damage to spruce also was noted.

Tree Injection

The injection areas had been planted with 2-0 eastern white pine 8 years earlier following clearcutting of the overstory hardwoods. At the time of release, the pines were 2 to 3 feet tall, sparsely needled, and overtopped by seedling- and sprout-origin hardwood stems 15 to 20 feet tall. We used 20 and 50 percent solutions of Roundup and injected approximately 1.5 ml of solution into each cut. Trees were injected in mid-September or mid-November. Cuts were spaced at 1.5 inches, edge to edge, around the circumference of the tree a few inches above groundline. The same procedure was used to treat 24 cull beech trees 8 to 24 inches in diameter at breast height, except that 2 ml of 20 percent solution was injected into each incision.

Injected hardwood stems were examined in September of the second growing season after treatment. The species, number of stems injected, and number of injected dead stems were recorded. Release effect on white pine was noted in change of needle color and apparent vigor of seedlings.

Results

Release of Norway Spruce

The effects of mistblowing were evident within 2 to 3 weeks after treatment; this was earlier than had been anticipated. Observations 2 years after treatment did not differ from those 1 year after treatment. In general, at all rates and times of application, most of the woody species, hay-scented fern, and blackberries were controlled (Table 1). However, overall control of the woody species seemed to be slightly better at the two heavier rates.

The most resistant species of vegetation were greenbrier, cucumbertree, and haircap moss (Table 1). They appeared little affected for all levels of Roundup. Species that showed intermediate

Table 1.—Sensitivity of various species of vegetation to mistblown Roundup at rates of 1.50 and 2.25 lb/acre of the acid glyphosate applied August 15, September 1, and September 15

Killed[a]	Intermediate resistance[b]	Resistant[c]
Devil's walking-stick	Sourwood	Greenbrier
Red maple	White ash	Norway spruce
Blackberry	Flowering dogwood	Cucumbertree
Hay-scented fern	Clubmoss	Haircap moss
Azalea		
Sweet birch		
Chestnut oak		
Sassafras		
Pin cherry		
Bigtooth aspen		
Black cherry		
Black locust		
Yellow-poplar		
Northern red oak		
Downy serviceberry		
Bracken fern		
Broom sedge		
St. John's-wort		

[a] After 2 years, no foliage or any sprouting from base of dead stems.
[b] Crowns partially killed; second-year foliage deformed and sparse.
[c] After 2 years, foliage appeared normal and healthy.

resistance to Roundup were sourwood, white ash, flowering dogwood, and clubmoss. These species still had some foliage, but most were deformed and the foliage was scattered. Sourwood trees sprouted at the base but the sprouts were deformed.

Norway spruce appeared only slightly sensitive to Roundup. In the first year we observed only four trees with needle damage; by the second year, the symptoms were even less pronounced, or had disappeared. The damaged spruce were on the areas treated with 2 and 3 qt/acre.

Treatment remained effective for at least 2 years. While some herbaceous plants, grass, and young blackberries have become reestablished on the area, we do not feel that they are serious competitors to the spruce. In effect, the Roundup has set back plant succession to the grass-herbaceous stage.

Figure 2.—Typical red maple clump injected with Roundup.

Autumn bent grass is now the most prevalent species on these plots.

Effects of Tree Injection

Injection proved effective in killing hardwoods 1.0 inch or more in diameter that had overtopped planted white pine. There was no difference in the kill rate at injections of 20 or 50 percent solution, nor was there any difference in kill between application dates. The kill rate was best when the prescribed method was followed. When spacing exceeded 1.5 inches, only part of the tree crown was killed in some instances. On stumps with a large number of sprouts, especially red maple, control was excellent when the stumps were treated as prescribed (Fig. 2).

The response of white pine to injection was highly visible 2 years after treatment. Before injection, the pines were yellowish green, mostly crooked, very slow growing, and sparsely needled. Two years after release, the pine foliage was much more dense and foliage was a bluish green. The effect on height growth of pine was not measured per se, but observations indicated that second-year internodes generally were longer than in the previous year.

The effect of Roundup injection on various hardwood species is shown in Table 2. Dogwood was the most resistant of the species treated. We observed sprouting on one sourwood clump, but the sprouts were small and the leaves were deformed. After 2 years, we did not observe basal sprouting on any of the other species injected.

After 1 year, 54 percent of the injected large cull beech trees had dead crowns. During the second growing season, 75 percent of the treated trees were leafless and the trees appeared dead (Table 3). Of the remaining trees, crown kill ranged from 50 to 80 percent.

Table 2.—Effectiveness of injections of Roundup in killing sapling hardwood trees

Species	Number observed injected	Number observed dead
Sassafras	135	133
White oak[a]	11	11
Sourwood[a]	109	109
American chestnut	22	22
Red maple[a]	121	117
Black locust	14	14
Blackgum	19	19
Flowering dogwood	29	19
Chestnut oak[a]	59	59
Downy serviceberry	4	4
Witch-hazel[a]	4	4
Yellow-poplar[a]	10	10

[a] Mostly sprouts.

Table 3.—Effect of Roundup injection on large cull beech trees 2 years after treatment

Dbh class	Number of trees	Number of dead crowns
8	1	1
12	4	4
14	3	2
16	7	4
18	5	4
20	1	1
22	1	1
24	2	1
	—	—
Total	24	18

Discussion

Norway spruce was slightly sensitive to Roundup at the two higher rates used in these preliminary tests. Although some needle burn was observed on a few trees the first year, most of the symptoms had disappeared by the end of the second growing season. Blackberries and hay-scented fern were 100 percent controlled for at least 2 years on the test area, and control of many woody species was adequate.

This study showed that foliar application of Roundup was effective from August 15 until September 15. Earlier or later dates may be effective, but these were not tried. Lund-Hoie (1975, 1976) and Newton (1977) reported good results from application several weeks before leaf abscission.

One of the study objectives was to determine an effective rate and time for foliar spraying of the entire watershed. The test plots provided this information and on September 6, 1980, the watershed was helicopter sprayed with 10 gal/acre of 5 percent Roundup solution (2 qt Roundup per acre). Treatment effects will be monitored annually to provide additional data on sensitivity of various species and growth response of Norway spruce.

These tests also demonstrated that unwanted hardwoods can be controlled by injections with Roundup. For example, release from competing hardwoods usually is necessary to reestablish a white pine component in hardwood stands. By using injectors, the percentage of white pine in the new stand can be controlled.

The use of 1 ml of undiluted glyphosate (Mon-0139) at 4 lb active material/gal and incisions at 7 inches was effective in killing sweet gum and blackjack oak in the south (Mann and Haynes 1978; Mann 1979). A 1:1 mixture of Tordon 101 and glyphosate (Mon-0139) was effective in controlling hickory.

In our region, more work is needed to determine the best spacing of incisions and the optimum concentrations of different herbicides and mixtures for various species. Frequently, we wish to control many species of hardwoods not only for conifer release but also to release hardwood crop trees in young stands. The effectiveness of Roundup in controlling sprouting from treated hardwoods is of major importance in crop-tree release work.

The season of the year when injection is most effective on different tree species needs to be better defined. We know from experience with other water-soluble herbicides that injection is not effective on trees such as maples and birches during periods of strong sap flow. Newton and Smith (1976), working with Silvisar 510 and 550, recommended that treatment of maples, beeches, and birches be avoided from January to May. Injection during the dormant season, however, usually is desirable from the standpoint of workloads. It is generally easier to get around in the woods during the dormant season, and the bases of the trees to be treated are not obscured by other plants.

The results of this preliminary study indicate that Roundup has potential uses in central Appalachian forests. The effectiveness of Roundup on a wide spectrum of species, its water solubility, selectivity on some conifers, and reportedly rapid breakdown and immobilization in the soil enhance this potential.

Acknowledgment

We thank the personnel of the Cheat Ranger District, Monongahela National Forest, particularly David Welsch and Mike Ledden, for their assistance in locating suitable areas and their help with the installation of the study.

List of Species Mentioned in this Paper

Common Name	Scientific Name
American beech	*Fagus grandifolia* Ehrh.
American chestnut	*Castanea dentata* (Marsh.) Borkh.
Bigtooth aspen	*Populus gradidentata* Michx.
Blackgum	*Nyssa sylvatica* Marsh.
Black locust	*Robinia pseudoacacia* L.
Cherry	
Black	*Prunus serotina* Ehrh.
Pin	*Prunus pensylvanica* L. f.
Cucumbertree	*Magnolia acuminata* L.
Douglas-fir	*Pseudotsuga menziesii* (Mirb.) Franco
Downy serviceberry	*Amelanchier arborea* (Michx. f.) Fern.
Fir	
Grand	*Abies grandis* (Dougl. ex. D. Don) Lindl.
Noble	*Abies procera* Rehd.
Flowering dogwood	*Cornus florida* L.
Maple	
Red	*Acer rubrum* L.
Sugar	*Acer saccharum* Marsh.
Norway spruce	*Picea abies* (L.) Karst.
Oak	
Blackjack	*Quercus marilandica* Muenchh
Chestnut	*Quercus prinus* L.
Northern red	*Quercus rubra* L.
Pine	
Eastern white	*Pinus strobus* L.
Ponderosa	*Pinus ponderosa* Dougl. ex Laws
Scotch	*Pinus sylvestris* L.
Sassafras	*Sassafras albidum* (Nutt.) Nees
Sourwood	*Oxydendron arboreum* (L.) DC.
Sweet birch	*Betula lenta* L.
Sweet gum	*Liquidoumbar styraciflua* L.
White ash	*Fraxinus americana* L.
Yellow-poplar	*Liriodendron tulipifera* L.

Shrubs and Herbaceous Vegetation

Aster	*Aster umbellatus* Mill.
Azalea	*Rhododendron nudiflorum* (L.) Torr.
Blackberry	*Rubus* spp.
Broom sedge	*Andropogon virginicus* L.
Clubmoss	*Lycopodium* L. spp.
Devil's walking-stick	*Aralia spinosa* L.
Fern	
Bracken	*Pteridium aquilinum* (L.) Kuhn
Hay-scented	*Dennstaedtia punctilobula* (Michx.) Moore
New York	*Dryopteris noveboracensis* (L.) Grory
Goldenrod	*Solidago* spp.
Grass	
Autumn bent	*Agrostis perennans* Walt. Tuckerm.
Wild oat	*Danthonia compressa* Aust.
Greenbriers	*Smilax rotundifolia* L.
Haircap moss	*Polytrichum commune*
St. John's-wort	*Hypericum punctatum* Lam.
Witch-hazel	*Hamamelis virginiana* L.

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Caution

Pesticides used improperly can be injurious to man, animals, and plants. Follow the directions and heed all precautions on the labels.

Store pesticides in original containers under lock and key—out of the reach of children and animals—and away from food and feed.

Apply pesticides so that they do not endanger humans, livestock, crops, beneficial insects, fish, and wildlife. Do not apply pesticides when there is danger of drift, when honey bees or other pollinating insects are visiting plants, or in ways that may contaminate water or leave illegal residues.

Avoid prolonged inhalation of pesticide sprays or dusts; wear protective clothing and equipment if specified on the container.

If your hands become contaminated with a pesticide, do not eat or drink until you have washed. In case a pesticide is swallowed or gets in the eyes, follow the first aid treatment given on the label, and get prompt medical attention. If a pesticide is spilled on your skin or clothing, remove clothing immediately and wash skin thoroughly.

NOTE: Some States have restrictions on the use of certain pesticides. Check your State and local regulations. Also, because registrations of pesticides are under constant review by the Environmental Protection Agency, consult your local forest pathologist, county agricultural agent, or State Extension specialist to be sure the intended use is still registered.

Wendel, G. W.; Kochenderfer, J. N. Glyphosate controls hardwoods in West Virginia. Broomall, PA: Northeast. For. Exp. Stn.; 1982; USDA For. Serv. Res. Pap. NE-497. 7 p.

Applications of Roundup, a glyphosate, by mistblower were effective in controlling hay-scented fern, blackberries, and some tree, shrub, and herbaceous species on an experimental watershed in West Virginia. Damage to Norway spruce was slight at rates of 1, 2, and 3 qt/acre (0.75, 1.50, and 2.25 lb/acre of the acid glyphosate). A variety of hardwood species was killed following injections of 20 or 50 percent solution of Roundup at a rate of 1.5 ml per incision. The cuts were spaced at 1.5 inches, edge to edge, around the stem near groundline. Resprouting of the treated hardwoods was minimal after 2 years.

ODC 414.13:414.22:414.26:174.7 *Picea abies* L. + 174.7 *Pinus strobus* L.

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