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# Soil Spot Herbicides for Single-Stem Hardwood Control[1]

James H. Miller, *USDA Forest Service, Southern Forest Experiment Station, the George W. Andrews Forestry Sciences Laboratory, Auburn, AL 36849.*

*ABSTRACT. Soil spot treatments of undiluted Velpar® L and a concentrated mixture of Spike® 80W were applied around test trees of five hardwood species. The test rates were 2, 4, and 6 ml of herbicide/in. of dbh applied to the soil within 3 ft of each tree. Hardwood topkill was assessed after two growing seasons. The 4-ml rate of Velpar L was required to achieve 80% or greater average topkill of sweetgum (Liquidambar styraciflua) and water oak (Quercus nigra) on loamy soils, while a 6-ml rate was needed to exceed 80% topkill of dogwood (Comus f lorida). Spike 80W gave about 80% topkill of both water oak and dogwood at the 2-ml rate but was ineffective on sweetgum. Only Spike 80W at the 6-ml rate yielded greater than 70% average topkill of boxelder (Acer negundo) and hophornbeam (Ostrya virgin&a). Nearby hardwoods of susceptible species within 3 ft of treated trees were also killed, extending the cost-effectiveness of these hardwood control treatments.*

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Herbicide injection has been used for the past 35 years in the South to control individual hardwoods (Peevy 1951). This versatile procedure can be used for site preparation, timber stand improvement (TSI), and both pine and hardwood release. The original low cost of this treatment made it an attractive method- of hardwood control for many forest landowners. However, treatment costs are increasing as laborers become scarce and better paid. Also, injection with either the tube- or hatchet-type injectors is an arduous task, one that can be done only by a strong person in excellent physical condition. Full injectors that must be repeatedly swung into trees can weigh up to 16 lb. Less physcially demanding procedures having comparable effectiveness to injection are needed, possibly ones that would gain wider acceptance and application by private forest landowners.

One possible alternative that has developed in the last few years is spot applications of a soil-active herbicide to the soil surface immediately around target stems. Velpar L, a 25% active ingredient (a.i.) liquid formulation of hexazinone (DuPont), was labeled. in 198 1 for undiluted basal soil treatments for controlling hardwoods on forest lands. An exact-delivery hand gun for applying this herbicide, known as the *spotgun,* was made available for purchase. Undiluted spots of Velpar L are applied within 3 ft of hardwood stems at rates of 2 to 4 ml/in. of dbh. Since its introduction, this and related procedures have grown rapidly in use for site preparation, TSI, and pine release.

Loblolly pine (*Pinus taeda*) has shown good tolerance to hexazinone herbicides (Fitzgerald and Fortson 1979, Campbell 1982). If properly applied, specified rates can be used in newly established or existing loblolly pine stands with only minimal mortality. Some selectivity in hardwood control has also been noted (Lowery 1984) that may lead to the development of prescriptions for selective hardwood release as well.

Earlier research has shown that soil spots of Velpar L were as ef-

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Discussion of herbicides in this paper does not constitute recommendation of their use or imply that uses discussed here arc registered. If herbicides are handled, applied. or disposed of improperly, there is potential for hazards to the applicators, off-site plants, and environment. Herbicides should be used only when needed and should be handled safely. Follow the directions and heed all precautions on the container label.

Use of trade names is for the reader's information and convenience and does not constitute official endorsement or approval by the U.S. Department of Agriculture to the exclusion of any other suitable product.



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fective for controlling sweetgum as injection with Tordon® 101R, a commonly-used injection herbicide (Miller 1984). The study reported here was conducted to compare the effectiveness of Velpar L spot treatments on five hardwood species with the effectiveness of Spike 80W, another soil-active herbicide that may be suitable for forestry use. Spike 80W is an 80% a.i. wettable powder of tebuthiuron (Elanco Products Company); it is labeled for soil spot applications on noncroplands only.

## METHODS

### Study sites

A mature stand of old-field loblolly pine with a major component of mixed hardwoods in the east-central Alabama Piedmont was one study area. Soils were an eroded Cecil series having surface and subsurface textures that varied from sandy loam to clay loam. The three test hardwood species at this location were sweetgum, dogwood, and water oak. Sweetgum and water oak trees selected for testing ranged from 4 to 12 in. dbh and dogwoods from 3 to 7 in. dbh. Two other study areas were located near Vicksburg, Mississippi. Boxelder, 2 to 22 in. dbh, was the test species on an island at the edge of the Mississippi River. Here the soil was a Robinsonville-Crevasse Association having a sandy-loam texture. Eastern hophornbeam, 3 to 12 in. dbh, was the test species on loessial bluffs near the Mississippi River on soils of the Memphis-Natchez Association having a silt-loam texture that extended to a depth greater than 50 ft. All test trees were more than 30 ft apart.

### Experimental design

A completely randomized experimental design was used with 6 treatments and an untreated check. Fifteen trees per species were treated at each rate for a total of 525 test trees. Undiluted Velpar L was applied using label specifications at 2 and 4 ml/in. of dbh and at one higher rate, 6 ml for each inch of dbh. A mixture of 3.6 lb of Spike 80W in 1 gal of water was also tested at *2.4,* and 6 ml/in. of dbh. A delivery rate of 2 ml/spot was used for ail treatments. Thus, increasing rates also meant an increase in the number of spots. Spots were equally spaced around the trees within 1 ft of boles less than 6 in. dbh and within 3 ft of larger trees. The diameter of each tree was measured and recorded along with the number of spots applied. Treatments were applied during the last week of April or the first week of May. All three study locations had wet periods before treatments amounting to 4 in. of rainfall within 3 weeks. During the 3 weeks after application, 1.5 in. of precipitation fell in Alabama and 2 in. in Mississippi. (The exact amount of rainfall required to adequately activate soil spots has not been determined.)

### Analyses

Percent topkill was visually estimated in 5% increments at the end of the second growing season, in August 1983. Resprouting was also noted at that time. At the Alabama study location, nearest-neighbor pines and hardwood trees within 15 ft of treated trees were identified at the beginning of the study, and percentage of topkill for these nontarget trees was also recorded in August of the second growing season. Duncan's multiple range test was calculated, by species, on percentage of topkill to test for treatment differences using arcsine transformed percentage values. The percentage of complete stem control of hardwoods, and nearest-neighbor pines at the Alabama location, were tabalated for presentation. Because of the experimental design, statistical analysis of this data was not possible.

## RESULTS AND DISCUSSION

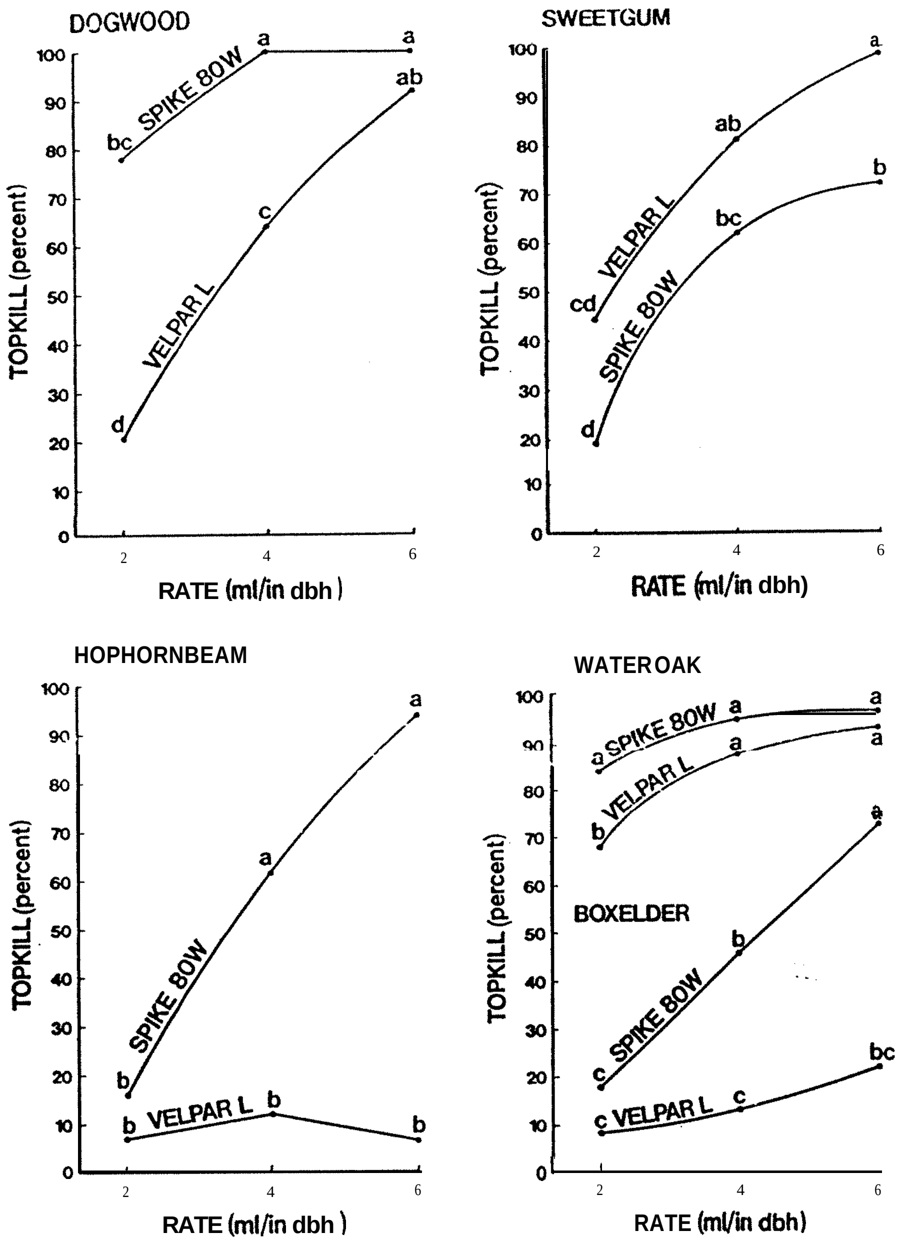
### Topkill and resprouting

Sweetgum topkill increased with increasing rates of both Velpar and Spike (Figure 1), but only Velpar at the 4- and 6-ml rates provided more than 80% topkill. Figure 1 shows that while Spike was causing increasing topkill with increasing rates, topkill was increasing at a decreasing rate. Thus, an 80% topkill with Spike would probably require more than an 8-ml rate. Dogwood was much more susceptible to Spike, with 100% topkill at rates starting at 4 ml. Only the 6-ml rate of Velpar gave comparable (0.05 level) topkill to the two higher rates of Spike. The highest labeled rate of Velpar (4 ml per in) provided only 64% topkill for dogwood. As stated on the Velpar label, greater control may be expected on sandier textured soils with low organic matter, which were not included in this study.

The most comparable control with the two herbicides was in the topkill of water oak. All rates, except the 2-ml rate of Velpar, gave greater than 80% topkill. Both herbicides were at the top of the dose-response curve (Figure 1), with additional herbicide causing less and less response.

Both boxelder and hophornbeam showed simiir responses to these two herbicides. Both species were more effectively controlled with Spike, while Velpar gave little control at the test rates. To achieve greater than 80% topkill for boxelder would require at least a 7-ml rate, if the response curve continued in a linear manner. With hophornbeam, only the 6-ml rate of Spike gave topkills exceeding 80%. None of the test rates of Velpar differed significantly from the untreated checks.

Table I shows a tabulation of the percentage of trees with greater than 90% topkill and the percentage of these trees that subsequently resprouted. Sweetgum was the species that most frequently resprouted. Even at the 6-ml Velpar rate, all treated trees showed greater than 90% topkill, but 73% of these resprouted. None of the test rates provided enough control to stop sprouting on treated sweetgums. Dogwood also commonly produced basal sprouts after treatment, especially with Velpar, but the 6-ml rate of




*treated with Velpar L and Spike 80 W at three rates. By species, points with the same letter code are not significantly different at the 0.05 level as determined by Duncan's multiple range test.*

Spike did reduce the frequency of sprouting. Water oak showed less tendency to sprout after treatments, while boxelder and hophornbeam showed no resprouting.

### *Soil properties influencing herbicide effectiveness*

The effectiveness'of soil-applied herbicides are influenced by soil properties (Bailey and White 1970). The amount of time these herbicides remain in the soil and are available for plant uptake is dependent on the degree of soil adsorption, desorption and degradation rates, and leaching losses.

As soil organic matter and clay content increase, the effectiveness of Velpar (Minogue et al. unpublished) and Spike (Duncan and Scifres 198 1) decrease. Minogue et al. also reported that hardwood control with Velpar pellets decreases as the silt content and cation exchange capacity increases. This is because leaching losses are greatest in sandy soils with low organic matter (Norris 198 1, Weber and Whitacre 1982) and adsorption, resulting in inactivation, is greatest in organic or clay soils. Resident time expressed as half-life (the length of time when half the herbicide is loss from the solum) has been estimated in the field for southern soils as 1½ to 6 weeks for Velpar (Neary et al. 1983, Sung et al. 1981). Phytotoxic levels of Spike have persisted for more than 2 years in Texas and Georgia soil (Bovey et al. 1982, Silvey et al. 1986). Neary et al. (1983) reported that Velpar levels in Pied-

Table 1. Percent of treated hardwoods with greater than 90% topkill after two growing seasons and percent of these that resprouted.

| | | Sweetgum | | Dogwood | | Water oak | | Boxelder | | Hophorn-beam | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Herbicide | Rate/in. dbh | topkill >90% | resprout | topkill >90% | resprout | topkill >90% | resprout | topkill >90% | resprout | topkill >90% | resprout |
| | *ml* | Percent | | | | | | | | | |
| Velpar L[1] | 2 | 20 | 100 | 13 | 0 | 46 | 0 | 7 | 0 | 7 | 0 |
| | 4 | 73 | 80 | 40 | 50 | 73 | 9 | 7 | 0 | 7 | 0 |
| | 6 | 100 | 73 | 87 | 85 | a7 | 0 | 20 | 0 | 20 | 0 |
| Spike 80W[2] | 2 | 13 | 50 | 66 | 20 | 80 | 8 | 13 | 0 | 7 | 0 |
| | 4 | 53 | 50 | 100 | 47 | 93 | 14 | 33 | 0 | 53 | 0 |
| | 6 | 67 | 80 | 100 | 27 | 93 | 7 | 66 | 0 | 93 | 0 |
| Check[3] | — | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 |

[1] Undiluted; 25% a.i./gal liquid formulation.
[2] Solution consisting of 3.6 lb in 1 gal water.
[3] Untreated trees for comparison.

mont soils can be greatest, and persist the longest, on mid- and toe-slopes because of shallow leaching of the herbicide from upper slope positions. Thus control may be greatest on the mid- and toe-slopes, although field observations have 'found poor control on toe-slope and stream margins in the Piedmont and Coastal Plain (Miller 1984).

### Neighboring hardwoods and pines

Both herbicides completely controlled 29% to '73% of nearest-neighbor hardwoods within 15 ft of treated trees (Table 2). The percentage of control generally increased with increasing rate, except at the highest rate of Velpar. Small hardwoods less than 3 in. dbh within 3 ft of a treated tree were consistently killed, but trees up to 15 ft away could also be killed, regardiess of size. This additional hardwood control means that only the larger trees need to be treated with Velpar, and most smaller trees within 3 ft will also be controlled by this treatment.

At the labeled rates of Velpar (2 to 4 ml/in. dbh), the nearby pines in the mature stand were not appreciably affected. However, at the 6-ml rate of Velpar, a substantial 25% loss occurred. Mortality only occurred when the pine tree was within 8 ft of the treated hardwood. Spike killed more than 25% of the pines at all test rates. At the 2- and 4-ml rates of Spike, pine mortality occurred when pine trees were within 10 ft of treated trees and within 12 ft at the 6-ml rate. A 12-ft zone of activity was also identified when spots of Spike were applied in a mature pine-hardwood stand on loamy sand soils (Miller 1984).

Table 2. Percent of nearest-neighbor hardwoods and pines, within 15 ft of treated trees, that were completely controlled.

| Herbicide | Rate/in. dbh | Hardwood Dead | Hardwood No. | Pine Dead | Pine No. |
|---|---|---|---|---|---|
| | ml | Pct | | Pct | |
| Velpar L | 2 | 34 | 45 | 5 | 22 |
| | 4 | 51 | 44 | 0 | 22 |
| | 6 | 49 | 44 | 25 | 20 |
| Spike 80W | 2 | 29 | 45 | 11 | 18 |
| | 4 | 58 | 45 | 28 | 18 |
| | 6 | 73 | 45 | 39 | 23 |
| Check | | 0 | 42 | 2 | 45 |

### Costs

Herbicide costs for each of the test treatments are presented in Table 3. Labor costs were estimated using a timing study on 635 stems that were both spot-treated and injected by three different men. These cost estimates do not include rest periods, long-term productivity, or overhead expenses. Timings from two types of spotguns and two types of injectors were averaged. The cost of spot applications using the 4-ml rate of Velpar L were more than 3 times that of injection treatments. Though spot treatments were normally applied up to 2.5 times faster than injection, the herbicide cost was the major expense. However, other factors may favor spot applications. In addition to being far less strenuous, worker safety is probably improved with spot treatments because sharp swinging tools are not involved. Worker fatique is certainly more prevalent with the injection method; thus, long-term productivity would probably be enhanced by using the spot application method.

Table 3. Costs of treating a 6-in. dbh hardwood tree by injection and spot treatments.

| Treatment | Rate/in. of dbh | Herbicide cost | Labor cost[1] | Treatment cost |
|---|---|---|---|---|
| | (ml) | ($) | | |
| Injected with Tordon 101R[2] | 1 | 0.05 | 0.03 | 0.08 |
| Velpar L | 2 | 0.14 | 0.01 | 0.15 |
| | 4 | 0.28 | 0.01 | 0.29 |
| | 6 | 0.42 | 0.01 | 0.43 |
| Spike 80W | 2 | 0.20 | 0.01 | 0.21 |
| | 4 | 0.40 | 0.01 | 0.41 |
| | 6 | 0.60 | 0.01 | 0.61 |

[1] Labor Pay was $3.35/hr, and only production time was considered in this cost; does not include overhead expenses.

[2] Commonly used injection herbicide (Dow Chemical Co.), containing 5.4% pidoram and 20.9% 2,4-D amine as active ingredients.

## CONCLUSIONS

To control sweetgum, water oak, and dogwood on fine-textured soils of the Piedmont with spot applications of Velpar L, the highest labeled rate of 4-ml/in. of dbh should be used. Considerable resprouting of sweetgum and dogwood can be expected. Treatments using this rate for TSI or preharvest site preparation in mature loblolly pine stands should be safe for the pines. Surrounding smaller hardwoods may also be controlled when treating only the larger hardwoods, which will increase worker productivity and the cost-effectiveness of the treatment. Higher rates of Velpar should not be used when pines are present. Spot treatments may cost about 3 times more than injection treatments on these sites, but the operation would be performed more quickly and with less physical effort. Velpar L is not effective for controlling boxelder or hophornbeam on sites similar to those tested in this study. Also, control effectiveness may decrease on lower slopes and around streams. The use of Spike 80W may be a potential spot treatment for the control of eastern hophornbeam on silty loam soil, pending forestry labeling. But Spike 80W should not be used in pine stands because severe pine mortality could occur. □

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