

BASAL STREAMLINE SPRAYS FOR HARDWOOD RESPROUT CONTROL: HERBICIDES, CONCENTRATIONS, AND STREAKS PER STEM. J.H. Miller, Southern Research Station, USDA Forest Service, Auburn University, AL 36849.

ABSTRACT

Basal streamline sprays were tested to control sweetgum, water oak, and southern red oak that ranged from 0.5-2 inches groundline diameter. Primary test herbicides and mixtures were triclopyr (Garlon 4) at 20 and 40 percent mixed with 10 percent d-limonene (Cide-Kick) and the remainder diesel; and imazapyr (Chopper) at 5 and 10 percent mixed in only diesel. Primary herbicide mixtures were applied with three doses: a) to one stem side using one streak, b) to one side using two streaks, and c) to two sides using two streaks per side. Secondary test herbicides were picloram + triclopyr (Access) at 10 and 20 percent mixtures and fluroxypyr (Dowco 433 or Starane) at 24 and 48 percent mixtures with 10 percent d-limonene and the remainder diesel. Secondary herbicides were tested only using two streaks to one side. All applications were in April. Individual rootstocks were the experimental units and assessment was 18 months after application. Increasing doses of primary herbicides resulted in increasing control. Both triclopyr and imazapyr at the highest concentrations and doses yielded greater than 80 percent crown volume reduction for sweetgum and the oaks. Rootstock control was greatest for the highest concentration-doses as well. Treatments to one stem side were most effective with imazapyr at the high concentration. Southern red oak was the most difficult species to control. In general, the secondary herbicides were less effective than the primary herbicides.

INTRODUCTION

Basal streamline is an application option for selectively controlling small woody stems less than 2 to 3 inches in groundline diameter (1, 5, 6, 13, 14). Basal streamline applications are especially useful for controlling sprouting clumps of hardwoods and shrubs, in particular red maple (*Acer rubrum* L.) This method is costly as currently applied however, compared to foliar directed sprays (4, 7). Both directed sprays and basal streamline treatments have limitations on target plant size and basal streamline has poorly defined seasons of effective application. For further development of basal streamline treatments, refinements are needed in herbicide selection relative to target species, timing, concentrations of mixtures, carriers, and application methods to improve efficacy and reduce costs. Much recent research has focused on carriers (4, 9, 10, 11), mainly tested as low-volume basal sprays, but few studies have examined altered application methods for streamline (2) and further testing of alternative herbicides appears warranted.

The objectives of this research were:

1. To examine the number of stem spray streaks required for satisfactory woody stem control for the more commonly-used herbicides using standard and test herbicide concentrations. Currently the application of two streaks of herbicide on two stem sides is the operational recommendation (5) and lesser numbers of sides is the focus of this test.
2. To compare control characteristics of commonly-used herbicides to a lesser-used labeled herbicide (Access) and a promising test herbicide (Starane).

This study was part of a larger investigation of application timing (8).

METHODS

This research was established on a Piedmont site with Gwinnett sandy loam soils in east central Alabama, near Auburn. The site had been rootraked 2.5 years earlier and loblolly pine (*Pinus taeda* L.) seedlings had been planted. Test hardwood species were sweetgum (*Liquidambar styraciflua* L.), water oak (*Quercus nigra* L.), and southern red oak (*Quercus falcata* Michaux) that ranged in size from 0.5-2 inches groundline diameter. These are three of the most common competing hardwood species in the region. Primary test herbicides and mixtures were Garlon 4 (62 percent triclopyr ester) at 20 and 40 percent (volume: volume) mixed with 10 percent Cide-Kick (100 percent d-limonene and emulsifiers) and the remainder diesel; and Chopper (28 percent imazapyr) at 5 and 10 percent mixed in only diesel. Garlon 4 at 40 percent exceeds the current maximum label recommended concentration of 30 percent and Chopper at 5 percent is less than the minimum label recommended concentration of 6 percent. The other two test concentrations for each product are within current label recommendation. Chopper is currently labeled for forest site preparation and Garlon 4 is labeled for conifer release, and both for managing wildlife openings. Garlon has no soil activity, while Chopper does.

Secondary test herbicides were Access (32 percent triclopyr and 17 percent picloram) at 10 and 20 percent mixtures and Starane (Dowco 433) (30 percent fluroxypyr ester) at 24 and 48 percent mixtures with 10 percent Cide-Kick and the remainder diesel. Access has soil activity and Starane does not. Access is currently labeled for forest site preparation, while Starane remains a test product. Access' label recommendations are for low volume basal applications at 20 and 30 percent mixtures with full lower-stem cover, not the streamline being tested here.

All applications were made using a CO₂ sprayer at 20 psi and a handgun equipped with a straight-stream nozzle (a Spraying Systems Co. 0002 for Chopper and a 0001 for the other herbicides). Applications were made between 6-12 inches of the soil surface and below major branches. Gardiner and Yeiser (2) reported that higher positioning of streaks generally resulted in less crown reduction because lower branches survived and epicormic branching occurred following March applications.

The primary herbicide-concentration mixtures were applied with the following test methods: a) to one stem side using one spray streak, b) to one side using two streaks, and c) to two sides using two streaks per side--an assumed 1X, 2X, and 4X dose, respectively. The secondary herbicides were tested using only two streaks to one side. To make these treatments the applicator stood 3-4 ft from the target rootstock and sprayed with a constant left to right motion and then back again if two streaks were required. For treating a second side, the applicator took two steps forward and applied the other two streaks at a point 90° around the stem (rootstock) center. This two-side method is the current operational recommendation (5). Multi-stemmed or single-stemmed rootstocks were tagged and randomly assigned treatments or left as untreated check plants. Twenty rootstocks per species were in each treatment replication, including the checks. All rootstocks were a minimum of 6-ft apart, with no evidence of a common root system.

Rootstocks were measured at the time of treatment and again 18 months after treatment (MAT) as the final assessment in September. Measurements were number of stems in the rootstock, crown height, maximum crown diameter, and right-angle crown diameter. After-treatment crown measurements were made to normal-sized (non-stunted) leaf tips and included basal resprouts. Rootstock control was judged by breaking stems progressively from the top down to groundline or by cutting away the lower bark on larger stems. The degree of *rootstock reduction* was calculated as the percent of treated rootstocks completely controlled that showed no resprouting. *Crown volume reduction* (CVR) was calculated using the total height and average of the two crown diameters, for both the treated and check trees, to calculate the volume of cylinders. Linear regressions were calculated with the check-tree data describing the relationship between initial crown volume and the crown volume at end of the 18 month period (3). These equations for each species were used to calculate a *projected crown volume* for each treated rootstock. CVR was then calculated as follows: $CVR = (\text{Projected crown volume} - \text{Final crown volume}) \div (\text{Projected crown volume})$. Thus, CVR takes into account the amount of growth that would have occurred during the period between the initial and final measurements.

A completely randomized design was used with the number of replications equaling the number of test plants per treatment--usually twenty if all were relocated. All percentage values were transformed using the arcsine square root before analysis. An analysis of variance (ANOVA) was used and the model included herbicide, concentration, and dose as the independent variables. The three doses were as follows: (a) 1 streak on 1 side, (b) 2 streaks on 1 side, and (c) 2 streaks on 2 sides. Mean separation was with Tukey's HD analysis. A level of "effective" treatment is considered to be above 80 percent for both crown volume reduction and rootstock reduction. This is a conservative level considering that this would be 80 percent of the projected crown volume that would occur over two growing seasons.

RESULTS AND DISCUSSION

Streaks per stem side

Basal streamline applications of both Garlon and Chopper herbicides at the highest concentrations and doses yielded greater than 80 percent crown volume reduction for sweetgum, water oak, and red oak with these April applications (Table 1). Lower concentrations and doses also yielded effective control (>80 percent CVR) of water oak and with Garlon on sweetgum, but not for southern red oak. Garlon at 20 percent and 2 streaks on 2 sides was effective on both sweetgum and water oak, with 77 percent control of southern red oak. Others have noted difficulty with basal-spray control of species within the red oak group (2, 12, 13, 14).

Chopper at 10 percent on water oak exceeded 80 percent CVR when applied as 1 or 2 streaks on 1 side as well as the 2 streaks on 2 sides. Chopper at 5 percent resulted in a CVR of 93 percent for water oak when applied at 2 streaks on 2 sides, while CVR's of 79 percent were achieved by Chopper at 10 percent applied on sweetgum at both 1 and 2 streaks on 1 side. The significant interactions for sweetgum and water oak necessitates examining the graphical summaries shown in Figure 1 (and southern red oak is included) and invalidates the ANOVA and Tukey HD tests for these species. For red oak the herbicides performed equally overall with the low concentration of Chopper showing significantly less control than the high concentrations of both herbicides.

Only one treatment resulted in greater than 80 percent RR on the three species, which was Garlon on sweetgum at the highest concentration and dose combination (Table 1). Seventy to eighty percent RR was achieved on water oak with both herbicides at the highest concentrations and doses and on sweetgum with Chopper at the high rate. Southern red oak was the most resistant to rootstock control of the three species.

The April timing was found to be comparable to other effective timings (i.e., the February timing) in the overall study in regards to CVR but less effective for RR (8).

New vs old herbicides

In general, the herbicides Access and Starane were less effective than Garlon and Chopper at these test concentrations and with treating only one stem side with two streaks (Table 2). The exception was Access control on southern red oak. Access treatments provided the greatest control of southern red oak in this group of treatments with both concentrations performing equally. Statistically, the Access control was comparable to the Garlon and Chopper treatments. Very low levels of rootstock reduction were produced by all the treatments, with the highest being 70 percent of treated sweetgum rootstocks by the high rate of Garlon. Similar conclusions with Starane were reported by Yeiser and Reed (14) when treating sweetgum and southern red oak, while effective CVR's were found for red maple and hickory (*Carya* spp.). Burch et. al.(1) found that increasing rates of Starane resulted in decreased CVR's when testing larger stem sizes.

CONCLUSIONS

These conclusions can be drawn from these findings:

1. For Garlon basal streamline, a reduction in dose from 2 streaks on 2 sides to 2 streaks on 1 side will require a higher concentration than the label-minimum recommendation of 20 percent for effective treatments. Gardiner and Yeiser(2) reported that increasing the number of treated sides did not improve CVR's for 1-inch stems, but yielded significant increases for 2- and 3-inch stems, although control decreased greatly with increasing stem diameter regardless of sides treated. Garlon has no soil activity and can be used in the proximity of nontarget woody stems.
2. For Chopper with the higher concentration (10 percent), effective crown reduction was achieved with 2 streaks on 1 side with water oak and sweetgum. The lower concentration only performed adequately on water oak in crown volume reduction but still inadequately in rootstock reduction. Chopper has soil activity and cannot be used within the rooting zone of susceptible nontarget plants.
3. The highest concentrations and doses were required to achieve greater than 70 percent rootstock reductions with sweetgum and water oak. Rootstock reductions of less than 45 percent were found with any concentration-dose of test herbicides on red oak.
4. The April timing resulted in crown reductions comparable to other timings as found in the overall study, but the levels of rootstock control were unsatisfactory.
5. The comparisons including Access and Starane found that Access was only effective with southern red oak and only for crown reduction. Neither showed enhanced rootstock control over the commonly-used herbicides.

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Table 1. Percent crown volume reduction and rootstock reduction 18 months after treatment with basal streamline applications comparing herbicides, concentrations, stem-sides treated, and number of treatment streaks per side.

| Dose(D) Sides Streaks | | Herbicide (H) and Concentration Percent (C) | | | | | | | | | | |
|--------------------------|------------------------|---|------------|---------|------------|------------------|---------------------------|---------------------|----|-----------|----|------|
| | | Crown Volume Reduction | | | | | | Rootstock Reduction | | | | |
| | | Garlon 4 | | Chopper | | Mean | Interactions ¹ | Garlon 4 | | Chopper | | Mean |
| 20 | 40 | 5 | 10 | 20 | 40 | | | 5 | 10 | | | |
| Sweetgum | | | | | | | | | | | | |
| 1 | 1 | 40 | 42 | 33 | 79 | 49c ² | HxC** | 5 | 5 | 0 | 20 | 8 |
| 1 | 2 | 69 | 90 | 37 | 79 | 70b | HxD** | 21 | 70 | 0 | 40 | 33 |
| 2 | 2 | 88 | 96 | 61 | 99 | 87a | CxD ns | 53 | 84 | 24 | 70 | 58 |
| | | 63B | 76AB | 44C | 86A | 69 | | 26 | 53 | 8 | 43 | 31 |
| | herbicide means | | 71A | | 66A | | | 39 | | 26 | | |
| Water Oak | | | | | | | | | | | | |
| 1 | 1 | 37 | 46 | 51 | 81 | 58c | HxC ns | 0 | 10 | 5 | 10 | 6 |
| 1 | 2 | 63 | 77 | 69 | 91 | 77b | HxD** | 20 | 42 | 5 | 40 | 27 |
| 2 | 2 | 94 | 94 | 93 | 99 | 95a | CxD ns | 62 | 74 | 30 | 75 | 60 |
| | | 65B | 72B | 71B | 90A | 77 | | 27 | 42 | 13 | 42 | 29 |
| | herbicide means | | 69B | | 81A | | | 35 | | 28 | | |
| Southern Red Oak | | | | | | | | | | | | |
| 1 | 1 | 55 | 54 | 40 | 64 | 59c | HxC ns | 0 | 5 | 10 | 14 | 7 |
| 1 | 2 | 68 | 75 | 59 | 74 | 74b | HxD ns | 0 | 24 | 23 | 24 | 18 |
| 2 | 2 | 77 | 94 | 67 | 85 | 83a | CxD ns | 16 | 42 | 25 | 36 | 30 |
| | | 67AB | 74A | 55B | 74A | 72 | | 5 | 24 | 19 | 25 | 16 |
| | herbicide means | | 70A | | 64A | | | 15 | | 22 | | |

¹Interaction significance levels indicated as *=.05 level; **=.01 level; and ns=non significant.

²Means in a column within a species with different letters are significantly different at the 0.05-level as determined by Tukey's mean separate test.

Table 2. Percent crown volume reduction (CVR) and rootstock reduction (RR) 18 months after treatment with basal streamline applications to one stem side using two streaks, comparing herbicide and two concentrations (percent).

| Species | Response | Garlon 4 | | Chopper | | Access | | Starane | |
|------------|----------|--------------------|------|---------|------|--------|------|---------|------|
| | | 20 | 40 | 5 | 10 | 10 | 20 | 24 | 48 |
| Sweetgum | CVR | 69abc ¹ | 90a | 37c | 79ab | 57abc | 47bc | 41c | 53bc |
| | RR | 21 | 70 | 0 | 40 | 33 | 10 | 11 | 35 |
| Water Oak | CVR | 63bc | 77ab | 69abc | 91a | 42cd | 35d | 39cd | 48cd |
| | RR | 20 | 42 | 5 | 40 | 10 | 0 | 0 | 0 |
| S. Red Oak | CVR | 68ab | 75a | 59ab | 74a | 76a | 77a | 18bc | 38c |
| | RR | 0 | 24 | 22 | 24 | 20 | 24 | 10 | 0 |

¹Means in a row followed by the same letter are not significantly different at the 0.05 level.

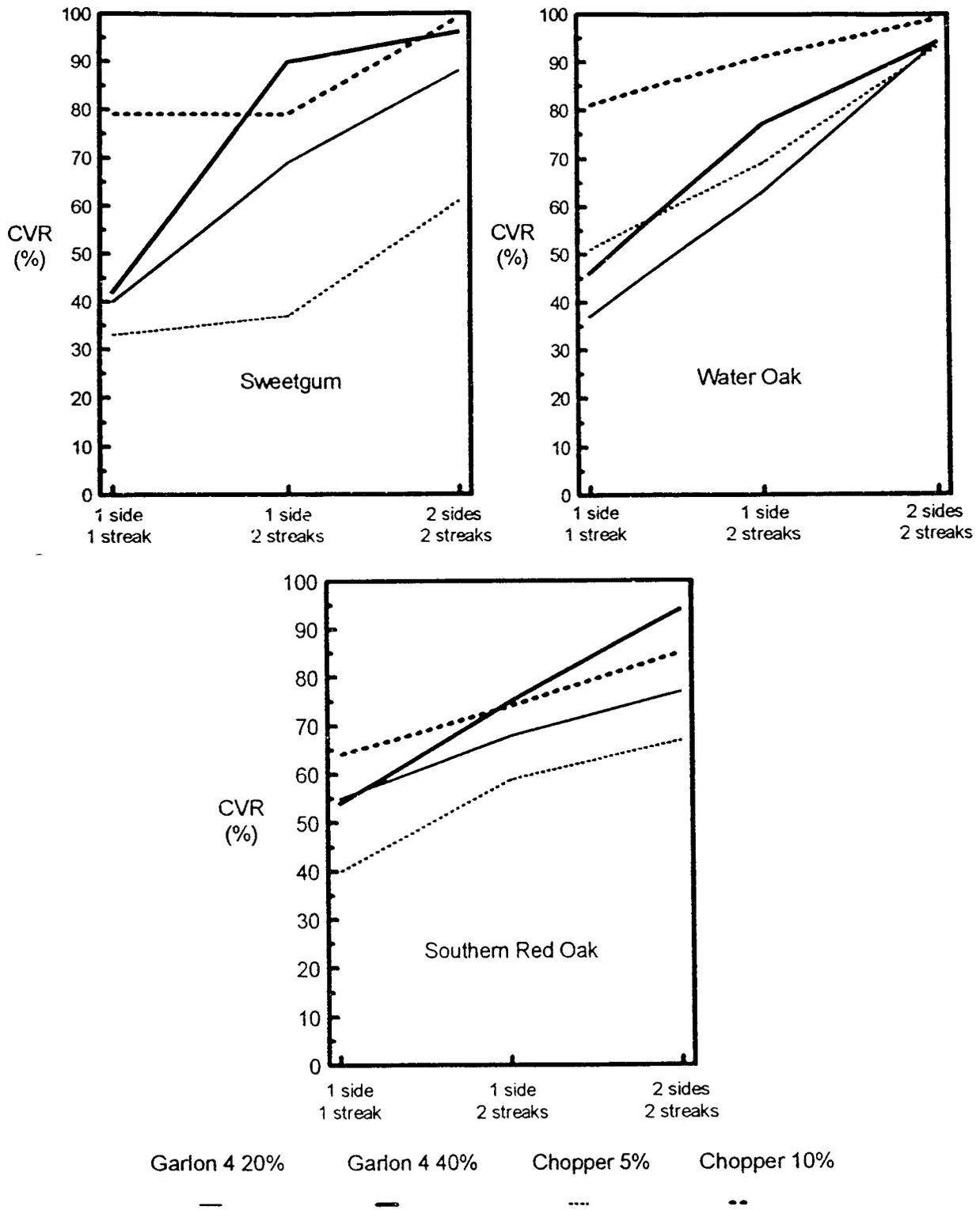


Figure 1. Percent crown volume reduction (CVR) 18 months after treatment with basal streamline applications comparing herbicides, concentrations, stem-sides treated, and number of treatment streaks per side.