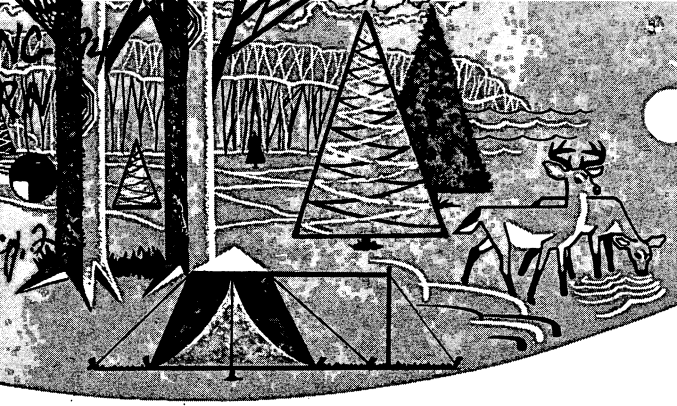

RESEARCH NOTE NC-94

NORTH CENTRAL FOREST EXPERIMENT STATION, FOREST SERVICE—U.S. DEPARTMENT OF AGRICULTURE
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Picloram in Spaced Stem Injections to Control Lake States Hardwoods[1]

ABSTRACT. — Picloram (4 amino-3, 5, 6-trichloropicolinic acid), manufactured under the name of Tordon, controls most pole-size and smaller hardwoods in the Lake States by stem injections spaced up to 6 inches apart.
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Most pole-size hardwoods in the Lake States can be killed by stem injections of picloram spaced up to 6 inches apart.[2] Treatments are equally effective during both dormant and growing seasons. The oral toxicity of picloram to mammals is in the range of ordinary table salt (Lynn 1965). Field use of salt and ester formulations has not resulted in any known damage to wild fish or bird populations (Kenaga 1969).

METHODS

Beginning in March 1963, Tordon 22K,[3] the first picloram herbicide available, was tested for effectiveness in spaced stem injections. Tordon 22K contains 2 pounds acid equivalent per liquid gallon of picloram as the potassium salt, but is not currently available in commercial quantities. Another picloram herbicide, Tordon 101 Mixture, was tested beginning in October 1963. This formulation, which is available commercially, contains 0.54 pounds of picloram plus 2 pounds of 2,4-D per liquid gallon, both as triisopropanolamine salts.

The injection treatments were tested at three times of the year: (1) the peak of the growing season, immediately after full leaf development (mid-June in southern Michigan), (2) the late growing season (September or early October, before first frost), and (3) the dormant season (early March).

The stem injections were made in slots cut with a 2-inch chisel to a depth of ½ inch or more, at spacings of 2, 4, and 6 inches (edge to edge). Injections generally were made 3 to 4 feet above the ground, although some were at 5 to 6 feet.

[1] *John L. Arend (formerly Silviculturist for the Station, now retired) tested the herbicides and compiled the basic data.*

[2] *Picloram (4 amino-3,5,6-trichloropicolnic acid) is marketed in various formulations as Tordon, registered trademark of the Dow Chemical Company, Midland, Michigan.*

[3] *Mention of trade names does not constitute endorsement by the USDA Forest Service.*

A range of herbicide volumes for each spacing was used to determine the minimum effective dosage. Undiluted volume per injection ranged from ¼ ml. to 2 mls. for Tordon 22K and from ½ ml. to 8 mls. for Tordon 101 Mixture. The herbicides were applied with an automatic 2 ml. pipette. A water dilution consisting of ¼ ml. Tordon 22K and ¾ ml. water was also tested to see if the larger volume would be more effective in covering the 2-inch wide injections. Tordon 101 Mixture, which has a much higher viscosity than Tordon 22K, was also diluted 50 percent by volume with water for winter applications. Each combination of herbicide dosage, spacing, and season was tested on a minimum of five randomly selected sample trees.

The first treatments in March and June 1963 were tried on both northern red oak (*Quercus rubra* L.) and white oak (*Quercus alba* L.). Trees were mostly pole size, although a few were small sawtimber size. Because initial results showed northern red oak more difficult to kill than white oak, later treatments were confined primarily to northern red oak. In addition, stem injection treatments were also tried on other hardwoods to compare their resistance to that of northern red oak. These species included hickory (*Carya* spp.), red maple (*Acer rubrum* L.), American beech (*Fagus grandifolia* Ehrh.) eastern hophornbeam (*Ostrya virginiana* (Mill.) K. Koch), white ash (*Fraxinus americana* L.), boxelder (*Acer negundo* L.), sugar maple (*Acer saccharum* Marsh.), black cherry (*Prunus serotina* Ehrh.), American elm (*Ulmus americana* L.), bigtooth aspen (*Populus grandidentata* Michx.), and serviceberry (*Amelanchier* spp.).

Treatments comparing species resistance were tried on 10 to 100 trees of each species ranging from pole size to 26 inches d.b.h. In these trials, trees were selected that would be difficult to kill, such as members of sprout clumps and forked trees, to test the effectiveness of the prescription rates that were effective on red oak. Only white ash and sugar maple showed a greater resistance to picloram than northern red oak.

Table 1. — *Effects of undiluted Tordon 22K applied by spaced stem injections to northern red oak and white oak*

Spacing between injections (Inches)	Volume per injection	Average volume per tree	Trees treated	Range in d.b.h.	Trees killed by Aug. 1965
	Mls.	Mls.	Number	Inches	Percent
MARCH 1963					
2	1/4	1.5	10	6-10	100
	1/2	2.7	10	5-9	100
	1	5.1	10	5-11	100
4	1/4	1.0	10	5-10	40
	1/2	1.6	10	5-9	80
	1	3.7	10	4-11	100
	2	7.3	10	4-11	100
6	1/4	0.7	10	5-10	30
	1/2	1.4	10	5-10	80
	1	3.1	10	6-10	100
	2	4.8	10	5-8	80
JUNE 1963					
2	1/4	1.4	15	5-10	100
	1/2	3.1	15	4-16	100
	1	6.7	15	5-12	100
4	1/4	1.0	10	5-10	80
	1/2	2.1	15	5-12	90
	1	4.4	15	4-13	100
	2	11.8	5	9-12	100
6	1/4	0.7	10	5-10	30
	1/2	1.4	15	5-10	80
	1	3.0	15	5-10	100
	2	7.9	5	6-14	100
OCTOBER 1963					
2	1/4	1.7	5	8-10	100
	1/2	4.1	5	6-14	100
	1	8.0	5	8-11	100
4	1/2	2.4	5	7-12	80
	1	4.1	5	6-10	100
	2	8.1	5	6-11	100
6	1/2	1.4	5	5-9	80
	1	3.3	5	7-10	100
	2	7.3	5	8-12	100

RESULTS AND DISCUSSION

Tordon 22K

One-fourth ml. of undiluted Tordon 22K per injection at 2-inch spacing was adequate to kill northern red oak and white oak during all seasons (table 1). However, ¼ ml. at 4-inch spacing killed only 80 percent of the trees and at 6-inch spacing only 40 percent. In contrast, the water dilution containing ¼ ml. Tordon 22K killed all the trees at all three spacings.

When a single stem in a hardwood sprout clump was injected with Tordon 22K, one or more of the untreated stems often died during the third growing season. This did not occur with stem injections using Tordon 101 Mixture. Newton and Holt (1967) found stem-injected Tordon 22K to be effective in killing Douglas-fir, but in dense stands the adjacent untreated trees also died — apparently because of root grafts with the treated trees.

Tordon 101 Mixture

This formulation was effective on oak and other pole-size hardwoods with about twice as much volume per injection as with Tordon 22K (table 2).

Table 2. — *Effects of Tordon 101 mixture applied by spaced stem injections to northern red oak*

Spacing between injections (Inches)	Volume per injection	Average volume per tree	Trees treated	Range in d.b.h.	Trees killed by Sept. 1967
	Mls.	Mls.	Number	Inches	Percent
OCTOBER 1963[1]					
2	0.5	3.6	5	6-11	60
	1.0	7.7	5	9-10	100
	2.0	14.7	5	7-14	100
2	1.0	4.5	5	6-11	60
	2.0	10.1	5	9-10	100
	4.0	18.4	5	7-10	100
4	2.0	7.8	5	7-14	80
	4.0	14.7	5	10-15	100
	8.0	39.4	5	6-11	100
JUNE 1964[1]					
2	0.5	3.2	5	6-12	100
	1.0	6.9	5	7-10	100
	2.0	16.9	5	8-18	100
4	1.0	5.3	5	9-12	40
	2.0	10.6	5	6-12	100
	4.0	18.6	5	7-12	100
6	2.0	7.0	5	7-11	80
	4.0	15.6	5	8-11	100
	8.0	31.7	5	6-18	100
MARCH 1966[2]					
2	0.5	2.9	10	6-9	80
	1.0	5.6	5	6-8	100
	2.0	14.8	7	7-11	100
4	1.0	5.0	5	7-12	80
	2.0	8.9	10	6-11	100
	4.0	17.2	10	6-10	100
6	2.0	7.2	5	6-12	80
	4.0	14.9	10	7-11	100
	8.0	29.8	10	5-14	100

1/ Undiluted quantities for the October and June treatments.
2/ Diluted 50 percent by volume with water for the March treatments.

However, large-crowned sugar maples were not killed by stem injections spaced 2 and 4 inches apart if made during the dormant season. The ground vegetation around the base of these treated maples often was killed for a radius of several feet, indicating that some herbicide was washed down the stems by rain possibly after copious sap flow during the dormant season.

Tordon 101 Mixture, which tends to be thick and syrupy in cold temperatures, flowed freely when diluted 50 percent by volume with water. Kill of red oaks following March injections with the diluted solution was roughly equal to that following June and October injections with the undiluted Tordon 101 Mixture (table 2). Thus the diluted injections, containing only half as much Tordon 101 Mixture, were about as effective as the undiluted injections. It appears that the cost of controlling hardwoods with this herbicide can be greatly reduced by diluting it properly.

Stem Damage from Sapwood Injections

Stems of oaks killed by spaced stem injections of picloram showed similar but more extensive damage than caused by 2,4,5-T amine (Arend 1967). No important tangential damage to the xylem was observed between injection points. A slightly wider portion of the sapwood was killed on each side of the injection than with 2,4,5-T; however, the area narrowed more quickly above the injection. In addition, phloem translocation of picloram apparently exceeds that of 2,4,5-T amine.

The stems of several sugar maple trees, both killed and unkilled from injections of Tordon 101 Mixture spaced 2 and 4 inches apart, were examined 2 years after the treatments. The sapwood, cambium and phloem were dead for at least 2 feet directly above and below the 2-inch wide injections in both the living and dead trees. This limited stem damage resulted in the death of trees with small, suppressed crowns, but only an occasional branch or small portion of the crown died on trees with large, vigorous crowns. The damage to the sapwood of maples was shallow — rarely exceeding 1 inch in depth — suggesting more limited radial translocation of the injected herbicide than in oak.

The limited radial damage in the sapwood may help explain why sugar maples continue to live for years after they have been treated with complete chemical frill girdles. The outer sapwood is killed only to about the depth of the injections.

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PESTICIDE PRECAUTIONARY STATEMENT

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife — if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.