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**CHEMICAL DEFOLIATION
OF NORTHERN TREE SPECIES**

**Kenneth D. Demaree
Allen R. Haws**

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ABSTRACT

In June 1966, aerial spray tests were conducted at Base Gagetown, New Brunswick, Canada, by personnel of the Plant Sciences Laboratory, Fort Detrick, Maryland, in collaboration with the Canadian Ministry of Defence.

In 1967, 37 densely wooded plots were sprayed at Base Gagetown as a continuation of the work started in 1966.

Fifteen herbicides were applied by helicopter on duplicate 3-acre plots in a volume of 3 gallons per acre. Because of a late spring, trees were in a very tender growth stage.

ORANGE caused the most severe desiccation within 5 to 12 days. Other treatments causing severe, fast browning were: Tordon 22K + diquat, paraquat, and diquat.

Abscission (defoliation) was generally poor due to the tenderness of the leaves and the cool weather.

A mixture of Tordon 22K + paraquat caused 42% defoliation of all species by the end of the growing season. Other treatments producing nearly as much defoliation as the Tordon 22K + paraquat mixture were: Tordon 22K + diquat, Tordon 22K, paraquat, and ORANGE.

I. INTRODUCTION

In 1964, the Canadian Ministry of Defence requested personnel of Crops Division to visit Base Gagetown to advise representatives of the Canadian Army on problems of vegetation control. During this visit, Chemical Branch, Crops Division made arrangements to use large tracts of wooded areas for the evaluation of various herbicides. The work was started in the summer of 1966 and continued through 1967.

Base Gagetown, the area chosen for this work, is located between Fredericton and St. John in New Brunswick. Base Gagetown contains 427 square miles, 80% of which is heavily forested. The terrain ranges from swamp to high hills.

This area was one of six locations in North America that the Plant Sciences Laboratory used in 1967 for experiments on rapid-acting defoliants. This northern area was chosen because of species and climate not found in the other areas.

II. MATERIALS AND METHODS

A. SITE

The test area selected for 1967 contained a mixture of evergreens and broadleaf deciduous forests and was located on Rippon Road, east of Broad Road. Rippon Road runs in a general east-west direction. The test area was located approximately 10 miles from the nearest border of the reservation, therefore a like distance from the nearest croplands.

Predominant species in this area were:

<u>Scientific Name</u>	<u>Common Name</u>
<u>Abies balsamea</u>	balsam fir
<u>Acer rubrum</u>	red maple
<u>Alnus incana</u>	speckled alder
<u>Betula populifolia</u>	gray birch
<u>Fagus grandifolia</u>	American beech
<u>Larix laricina</u>	American larch
<u>Picea glauca</u>	white spruce
<u>Pinus strobus</u>	white pine
<u>Populus tremuloides</u>	quaking aspen
<u>Viburnum spp.</u>	viburnum

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B. PLOT LAYOUT

Fifty plots, each 200 by 660 feet with a 200-foot buffer zone between adjacent plots, were laid out on both sides of Rippon Road.

C. CHEMICALS

The majority of the herbicides used in this test were commercially available; however, some were compounds prepared specifically for this test. The original plan was to spray duplicate plots at 3, 6, and 10 gallons per acre of each compound. Due to unfavorable weather conditions, only treatments at 3 gallons per acre were applied between 21 and 24 June 1967.

The compounds used were:

<u>Common Name</u>	<u>Trade Name</u>	<u>Chemical Identity</u>
2,4-D		2,4-dichlorophenoxyacetic acid, <u>n</u> -butyl ester
Penta HCA + T	Timbertox #10	pentachlorophenol hexachloroacetone + 2,4,5- trichlorophenoxyacetic acid
Dinitro Cacodylic acid	Dow General Phytar 560G	4,6-dinitro- <u>o</u> - <u>sec</u> -butylphenol sodium cacodylate
Paraquat	Ortho Paraquat	1,1'-dimethyl-4,4'-dipyridinium dibromide
Diquat	Ortho Diquat	1,1'-ethylene-2,2'-dipyridinium dibromide
Picloram	Tordon 22K	4-amino-3,5,6-trichloropicolinic acid, potassium salt
ORANGE		50-50 mixture of <u>n</u> -butyl esters of 2,4-D and 2,4,5-T
Benzoic acid	Trysben 200	dimethylamine salt of 2,3,6- trichlorobenzoic acid
WHITE	Tordon 101	0.54 lb. picloram + 2 lb. 2,4-D per gal
Picloram ester	M-3142	isooctyl ester of picloram, 4 lb./gal
Picloram + dalapon	M-3189	picloram-dalapon, 1.5 + 5.5 lb./gal mixture

In addition, the combinations (Tordon 22K plus diquat) and (Tordon 22K plus paraquat) were used.

D. APPLICATION, EQUIPMENT, AND OPERATION

Plots were sprayed by a Bell G-2 helicopter operated on contract by Okanagan Copters Ltd. of Vancouver, British Columbia. The helicopter was fitted with two 40-gallon saddle tanks and a 24-foot boom with nozzle spacings every 6 inches along the boom. The system was calibrated to deliver 3 gallons per acre with a pump pressure of 40 pounds per square inch. Flying at 40 knots and an altitude of 10 to 15 feet above the tops of the trees resulted in a spray swath of 50 feet.

Application flight lines were flagged only at the road end of the plots because the impenetrability of the forest made it impractical to mark the back ends. Thus, it was necessary to fly all passes on a compass bearing, determining the distance covered by flight speed and elapsed time. Calibration flights were made to establish time in seconds to cover 660 feet of plot length at an air speed of 40 knots.

E. WEATHER CONDITIONS

Because of unfavorable weather conditions, only applications at 3 gallons per acre were applied between 21 and 24 June 1967. The test was delayed 1 week because of unusually cold weather and a late snow prior to the applications. A further delay of 2 weeks would have been desirable to allow the leaves of maple, birch, aspen, and beech more time to mature. However, because of a previously arranged schedule, further delay was impossible.

F. EVALUATION METHODS

Evaluations for abscission and desiccation were made 1, 10, 30, 60, and 90 days after spraying. Ratings were made visually on a 0 to 5 scale with 0 = no effect and 5 = 100%. Evaluations for regrowth were made on the same 0 to 5 scale beginning 30 days after spraying.

III. RESULTS

A. DESICCATION

Among the broadleaf species present, desiccation was severe and rapid with all but a few treatments, principally Tordon and Trysben. ORANGE at 26 pounds per acre caused the most severe browning.

On conifers, paraquat and diquat were the most rapid-acting desiccants. A mixture of diquat and Tordon 22K, at 3 pounds per acre active ingredient each, was more rapid than either diquat or paraquat alone at the 6 pounds per acre rate.

Listed in Table 1 are all treatments that produced 70% or more desiccation within 5 to 12 days.

TABLE 1. CHEMICALS AND RATES CAUSING DESICCATION

Chemical	Rate, lb./acre	Desiccation, %	
		5 to 7 Days	9 to 12 Days
ORANGE	26	85	95
Tordon 22K + Diquat	3 + 3	80	90
Paraquat	6	80	80
Tordon 22K + Diquat	2 + 2	80	85
Diquat	6	75	90
Tordon 22K	3	75	80
2,4-D	26	70	85
Penta	12	70	75
Dinitro	6	70	75

B. ABSCISSION

Leaf fall was generally poor in this trial and did not reach maximum until 90 days after spraying. Leaf fall occurred in most of the conifers as well as most of the hardwood species. Treatments producing 20% or more defoliation after 90 days are shown in Table 2.

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TABLE 2. CHEMICALS AND RATES CAUSING DEFOLIATION

Chemical	Rate, lb./acre	Abscission, %
Tordon 22K + Paraquat	3 + 3	42
Tordon 22K + Diquat	3 + 3	40
Tordon 22K + Paraquat	2 + 2	38
Tordon 22K	4.5	36
Paraquat	6	32
Tordon 22K	3	30
ORANGE	26	28
HCA + T	6 + 6	26
2,4-D	26	24
M-3142	6	20
Diquat	6	20
Tordon 22K + Diquat	2 + 2	20

IV. DISCUSSION

A. DESICCATION

Because the leaves on all broadleaf deciduous species were tender and immature, desiccation or browning was very rapid. Although numerical evaluations were not made so early, desiccation on some plots was noticeable within a few hours after spraying. If a plot was sprayed in the morning, wilting could be observed by evening of the same day.

ORANGE, a mixture of the *n*-butyl esters of 2,4-D and 2,4,5-T, is usually considered one of the slower-acting herbicides, but because of the tenderness of the leaves, it was very fast acting at this location. Percentage kill of the trees will be determined in 1968.

In 1967 tests in the southern United States, dinitro appeared to be one of the most rapid-acting desiccants, but in the Canadian location with northern climatic conditions and species, dinitro was relatively slow in its action. Cooler temperatures may have contributed to this slower action. Penta was similar to dinitro in its relatively slow desiccant action under these circumstances.

Paraquat and diquat acted rapidly on all species, but were particularly effective on conifers. However, a mixture of diquat and Tordon 22K at 3 pounds per acre active ingredient each was more rapid than either paraquat or diquat alone at the 6 pound per acre rate.

Regrowth occurred very rapidly on some plots, particularly those sprayed with paraquat, diquat, penta, or dinitro. Regrowth was generally apparent on those plots beginning at the 60-day evaluation.

5. ABSCISSION

Abscission or defoliation occurred in most of the conifers as well as most of the hardwood species. Fir and spruce were more resistant to leaf shed than pine, hemlock, or larch. Spruce was highly variable in its response to herbicides. One tree would shed its needles readily while another adjacent tree, presumably receiving the same amount of spray, might show no defoliation.

A mixture of slow-acting Tordon 22K and fast-acting paraquat caused the greatest amount of defoliation of any treatment by the end of the growing season. This mixture defoliated a wider spectrum of plant species than either compound used alone at similar rates.

Trysben 200, one of the chlorine-substituted benzoic acids, affects spruce in a peculiar manner. Instead of the needles on the outermost branch tips falling first as with most herbicides, the needles nearest the main trunk fall first, the outermost needles falling last. This produces an unusual appearance of mostly bare branches with tufts of needles on the tip of each branch.

V. SUMMARY

Thirty-seven densely wooded plots were sprayed at Base Gagetown, New Brunswick, Canada, in 1967. Each plot was 200 by 660 feet or approximately 3 acres. Fifteen herbicides, mostly commercial, were applied by helicopter on duplicate plots each in a volume of 3 gallons per acre.

ORANCE, a mixture of 2,4-D and 2,4,5-T, at 26 pounds per acre caused the most severe browning within 5 to 12 days.

A mixture of Tordon 22K and paraquat caused the greatest amount of defoliation of all species.

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