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Prepared by Major W.C. Taylor, CLO (CBR)

CDW: 2514-3-4 (CBR) LOG

7 Aug 66

VEGETATION CONTROL - CFB GAGETOWN

AIM

1. The aim of this brief is to outline the US participation in vegetational control at CFB Gagetown.

BACKGROUND

2. DEC 63

During a visit to Canada in Dec 63 Colonel C.S. Casto, the Commander of the Biological Laboratories at Fort Detrick, learned of the problems the Canadian Army was having in controlling grass and seedling growth, and timber regrowth, at Gagetown (See Annex A). Colonel Casto made an informal offer to Canada of technical assistance and defoliant chemicals. This offer was subject to the approval of Colonel Casto's superiors. He suggested that Canada write to the US authorities giving details of the problem and requesting advice and assistance. It was agreed that both countries would benefit from such a cooperative venture. Specifically Canada would benefit from the technical advice which could be given by US experts. This advice would mainly consist of constructive criticism of the methods and herbicides used by civilian contractors in the past and recommendations and suggestions for better procedures and chemicals which could be incorporated in specifications and contracts for future years. The US would benefit by being given the use of large tracts of first and second growth timber in an environment similar to that of the northern United States where new herbicides, which had never been employed in this type of climatic zone, could be tested.

3. FEB 64

As a result of Colonel Casto's offer and suggestions, a letter was sent from the Director of Works, Army Headquarters in Feb 64, to The Canadian Army Staff (Washington), outlining the problem and giving specific information about types of foliage, sizes of areas, climate, etc. This information was sent to Colonel Casto with a request for his comments and recommendations.

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4. MAR 64

In Mar 64, the Commanding General, Edgewood Arsenal, authorized the Biological Laboratories to assist Canada as required. Fort Detrick at that time was a subordinate agency to Edgewood Arsenal and thus came under command of the Commanding General, Edgewood Arsenal.

5. APR 64

In Apr 64, experts from Fort Detrick visited Gagetown, viewed the area, and discussed the problem with senior officers at Gagetown. They were able to study the invitation-to-tender being put out for brush control for the Summer of 1964 and were able to make various constructive suggestions as to how the specifications could be improved. Some of these suggestions are detailed at Annex B. Due to workload the scientists from Fort Detrick were unable to assist any further that year.

6. SUMMER 1964

The program, amended as suggested by the people from Fort Detrick, could not be implemented in 1964 due to nonavailability of suitable aircraft. However it was planned to carry out this improved program in the Summer of 1965. Herbicidal application in the Summer of 1964 was carried out by a civilian contractor in a program parallel to that of 1963. This latter project was assessed in Mar 64 by the Gagetown Forestry Staff as 90% effective. Results of the 1964 brush control project have not been made available to this office, but unofficially the Fort Detrick scientists felt that it was not particularly successful. This conclusion was based on their conversations with people at Gagetown, and a view of the results during their visits to Gagetown in Mar and Sep 65. Thus the contract for 1963 was judged to be 90% effective while that of 1964 possibly was much less successful although the two programs were very similar. This would indicate a discrepancy somewhere, either in know-how, chemicals used, the timing of the program, or a combination of factors.

7. FALL 1964

In the Fall of 1964 an offer of the use of areas at Gagetown for the following year for defoliation trials was received from the Canadian Government. A proposed visit to Gagetown by Fort Detrick personnel in Sep 64 to assess the results of the contractor's spray project of that summer and to discuss the program for 1965 could not be arranged due to prior commitments at Gagetown and heavy workloads on the part of the personnel at Fort Detrick.

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8. MAR 65

However in Mar 65 the Project Officers from Fort Detrick again visited Gagetown. A trial program was organized with Canada supplying several hundred acres of growth that would not be disturbed for at least one year after the spray trial. In addition Canada was to provide vehicles, drivers, labor parties, aircraft, and rations and quarters. Fort Detrick was to provide several herbicides to be tested at different concentrations on various types of virgin timber and second growth brush to determine which was the most effective in the North Temperate Zone. At that time there were approximately 27 chemicals suggested for testing. The test plan called for a US Army helicopter to do the spraying and each chemical was to be allotted a test patch. The test was to take place in mid Jun 65.

9. MAY 65

However on 20 May 65, prior to the program being implemented, it was ordered cancelled by US authorities due to the cost which was to be incurred. This decision was reversed in Mar 66 and plans again were formulated to carry out the trial in the Summer of 1966.

10. SUMMER 1965

In the late Spring 1965 Camp Gagetown officials again contracted with a civilian contractor to provide Gagetown with brush control. The contract was awarded to Dow Chemical Company who sprayed approximately 4700 acres of second growth brush with Tordon 101 (See Annex C) from a Hughes 269A helicopter. Sprays were made up in the ratio of one gallon Tordon to 11½ gallons of water with a thickening agent to prevent drift, and were applied at the rate of 10 gallons total measure per acre during the period 1 to 15 Jul 65. When viewed in late Sep, hardwoods such as maple and alder had turned brown but conifers were not much affected -- there were examples of trees growing side-by-side of the same size and species, and sprayed at the same time with the same quantity of spray, with one beginning to yellow and the other unaffected.

11. Once again it was the opinion of the Detrick scientists that rates of application were too light and had come too late in the year. Also Tordon is slow acting and, while it has an effect on a wide variety of species, it does not kill all species.

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12. Of the area sprayed approximately one-fifth was accidentally set afire after it was sprayed. There were complaints from the firefighters that the smoke from the fire was unusually irritating. It was not determined if this was caused by the Tordon or the thickening agent. However the fire proved the effectiveness of after burning an area. All vegetation including grass, hardwood trees, and conifers, was dead with no resprouting expected. A hot fire such as this one was would kill any latent buds on the trees and most seeds in the top two inches of soil.

13. US HERBICIDAL TRIAL - JUN 66.

In Jun 66 the trial was conducted. Spraying by a US H34 helicopter equipped with HIDAL spray equipment began on 14 Jun and was completed on 16 Jun. Sixteen two-acre plots were sprayed with the following compounds (See Annex C): Purple, Orange, M2993, Phytar 160, Phytar 560, Tordon 101, Tordon 22K, Diquat, and various combinations of these. Thirty-six small plots of 400 square feet each, were sprayed with a "cherry picker" spray rig and nine plots of pelletised soil sterilants were hand applied. The area treated can be located on the map of Cam Gagetown, composite sheet, Edition 6, ASE 24, TR-63. The general area was along a trail leading from the western boundry of the camp (map reference 9055), East-North-East to Gillan's Corner (map reference 9956). The helicopter and photo aircraft used the Hainesville Airstrip (map reference 9153). It is understood that some of the plots were showing effects of the herbicides within hours after treatment.

14. It is anticipated that inspection trips will be made to Gagetown by the personnel from Fort Detrick in Jul and Aug 66, and in late Aug - early Sep a request has been submitted for authority for a number of senior US Army and US Air Force officers to visit Gagetown to view the results which should be most evident by then.

15. A list of personnel, both US and Canadian, involved in the project since 1964, is attached as Annex D.

COMMENT

16. US interest in this trial is intense, especially with the operational personnel, both Army and Air Force. Canadian interest appears to be quite slight and limited to those people concerned with the clearing of training and range areas.

17. The US interest is understandable. A great amount of effort has been expended to find some means of destroying the jungle canopy in South-east Asia. Apparently, after some initial bad publicity, chemicals in the

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form of desiccants, defoliants, and plant growth regulators were found to be effective. Because of this, interest naturally was generated in their effects on plants in a North American - European climatic zone. Difficulty in finding suitable areas make the idea of performing tests at Gagetown doubly attractive.

18. The Canadian attitude is also understandable. Brush control has not come to the attention of the operational people as yet for Canada's military planners probably are more concerned with operations in the Temperate Zone where foliage is not a great problem. Lack of interest can also be attributed to the fact that, at Gagetown alone, brush control involves 50,000 acres whereas the trial in Jun 66 took in a mere 35 acres or so. As a result even the RCE personnel involved possibly feel that the trial is rather removed from their problems.

CONCLUSION

19. However, it is suggested that the original benefits of this cooperative venture have, or will have, been obtained. The United States has its test data on a variety of chemicals used in the Temperate Zone; and Canada will have the advice of experts as to how a better brush control program, using civilian contractors, can be obtained.

ANNEX A
TO: CDW: 2514-3-4 (CSR) 406
DATED: 2 Aug 66

BRUSH CONTROL PROBLEM - CTR GAGETOWN

1. Of the approximately 250,000 acres comprising Camp Gagetown, about 50,000 acres only are cleared. This cleared area can be classified under one of four categories:

a. Cleared with stumps remaining (tank, artillery, and infantry weapons ranges) -- approximately 15,000 acres.

b. Clear with stumps removed (maneuver area) -- 25,000 acres.

c. Former farmland (bivouac areas) -- 10,000 acres.

d. Roads -- 150 miles

The cleared areas are not continuous but consist of open sites surrounded by forests. The sites vary in size from less than 100 acres to greater than 10,000 acres. Control depends largely on the use to which each area is put. The problem of fires on the ranges is predominant while many of the maneuver areas can be hand cleared as required and thus do not present as great a concern.

2. Control measures in the past have been as follows:

a. Large clearings (tank and artillery ranges) -- periodic aircraft herbicidal spray approximately every two years.

b. Small clearings (infantry weapons ranges) -- herbicide spray by hose and gun equipment.

c. Maneuver areas - hand cutting. No herbicide treatment as yet.

d. Farmland (bivouac areas) -- controlled burning.

e. Roadsides -- periodic herbicide spraying and handcutting.

3. The herbicide spraying has been performed by civilian contractors who have used a variety of commercial herbicides such as: ammonium sulfamate, 50/50 mixture of the iso-octyl esters of 2,4-D (2,4-dichlorophenoxyacetic acid) and 2,4,5-T (2,4,5-trichlorophenoxyacetic acid). It is understood that the success of these annual treatments has varied.

ANNEX B
TC: CDW: 2514-3-1 (CAR) 406
DATED: 1 Aug 66

SUGGESTED IMPROVEMENTS AND CONSTRUCTIVE COMMENTS TO HELP PROVIDE A MORE EFFICIENT CIVILIAN CONTRACTORS HERBICIDAL SPRAYING PROJECT - CFB GAGETOWN

1. Define what was desired in brush control and leave the contractor more flexibility as to how it should be accomplished.

2. Use diesel oil only as a diluent rather than 80/20 water/diesel oil, and reduce mixed volume applied from five gallons per acre to one or two gallons per acre. The diesel oil as diluent should give a better effect where rainy weather can be anticipated soon after application.

3. Use the more volatile n-butyl esters of 2,4-D and 2,4,5-T rather than the iso-octyl esters.

4. Inwind flights should be used where the foliage is particularly dense, rather than crosswind applications to enable the spray to penetrate the canopy.

5. A program should be planned on a continuing basis year by year where an area would be cleared initially and then sprayed in subsequent years to suppress second growth. New areas could then be included each year over a period of time. As clearing is the expensive process the cost could then be spread over a time frame. The subsequent application of herbicides following clearing would definitely keep the vegetation under control and is the most economical method of control.

6. The cutting of unsprayed hardwood growth should be discontinued otherwise resprouting of stumps, unless sprayed or painted, will create more problems than the initial growth.

7. If a continuing planned program as recommended above is contemplated, and Bell, Hughes or Hiller helicopters are available, the purchase of suitable spray equipment is recommended. Two US corporations are named as suppliers:

a. Agricultural Aviation Engineering Company
1040 DiGuilo Avenue
Santa Clara, California

b. Transland Aircraft
Terrance, California

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This equipment costs about $3,000 and is easily mounted and removed as required.

8. Some other factors which may have contributed to a degree of lack of success in the past are:

a. Use of aqueous solutions (mentioned above)

b. Sprays delivered under other than inversion conditions

c. Droplet sizes too large

d. Too much air turbulence

e. Sprayed too late in season

f. Sub-lethal depoeits only

ANNEX C
TO: CDW: 2514-3-4 (CBR) 406
DATED: 4 Aug 66

COMPOUNDS SPRAYED IN CANADA - 1966

1. Purple - no diluent (50% n-butyl ester 2,4-D + 30% n-butyl ester 2,4,5-T + 20% iso-butyl ester 2,4,5-T).
2. Purple + oil.
3. Orange - no diluent (50-50 mixture n-butyl esters 2,4-D and 2,4,5-T).
4. Orange + oil.
5. 70% 2,4-D + 30% 2,4,5-T - no diluent (n-butyl esters).
6. 70% 2,4-D + 30% 2,4,5-T + oil.
7. M-2991 + oil 4 lb 2,4,5-T + 1 lb iso octyl ester Tordon per gal.
8. Phytar 160 (no diluent) sodium cacodylate without surfactant.
9. Phytar 160 - water.
10. Phytar 560 (no diluent) sodium cacodylate with surfactant.
11. Phytar 560 + water.
12. Tordon 101 + water (4-amino-3,5,6-Trichloro picolinic acid).
13. Tordon 101 + Phytar 160.
14. Tordon 22K + water.
15. Tordon 22K + Diquat.
16. Tordon 22K + Phytar 160.
17. Diquat (1,1' Ethylene-2,2'-dipyridilium dibromide)

ANNEX D
TO CDW: 2514-3-4 (C3F) 406
DATED 2 Aug 66

PERSONS INVOLVED IN VEGETATIONAL CONTROL - CPU CAGETOWN

APR 64 - JUL 66

This Annex has been removed in order to protect individuals involved.

TRIALS OF HERBICIDES FOR BRUSH CONTROL AT BASE GAGETOWN

by

J. C. Baynton

FOREST RESEARCH LABORATORY
FREDERICTON, NEW BRUNSWICK
INTERNAL REPORT M-46

FORESTRY BRANCH
DEPARTMENT OF FISHERIES AND FORESTRY
APRIL, 1969

11 of 28

Not for Publication

Trials of Herbicides For Brush Control at Base Gagetown

by

J. C. Boynton

FOREST RESEARCH LABORATORY

FREDERICTON, NEW BRUNSWICK

INTERNAL REPORT M-46

Forestry Branch

April, 1969

INTRODUCTION

In 1966 and 1967, the Forestry Branch in co-operation with the Department of National Defence (DND) conducted trials of several herbicides applied by helicopter to second-growth stands of conifers and hardwoods at Base Gagetown. By careful application of known quantities of herbicide to small test areas, it was hoped to identify the kinds and concentrations of herbicide required to give effective control of the various species commonly found in the Base Gagetown training area. The author established the test plots, supervised the spraying which was performed under contract with DND, and collected the data presented in this report.

The trials were conducted in an area north of the Enniskillen Road from which the forest cover had been removed in 1955. By 1966, in spite of aerial spraying with phenoxy herbicides in 1956 and 1958 the area supported a fairly dense sapling stand of trembling and largetooth aspen[1], red maple, black and white spruce, and balsam fir, with lesser amounts of white birch, wire birch, white ash, white pine, and several shrub species of which wild raisin was most abundant. Since the main components of the stand are found in all parts of the military training area, and all have proved to be more-or-less resistant to the phenoxy herbicides previously used in the brush control program, discussion will be confined to three species - groups namely aspen, red maple, and spruce-fir.

TREATMENTS AND PLOT LAYOUT

In 1966, three concentrations of each of three herbicides were applied, mixed with water, at the rate of 10 gal[2] total spray volume per acre.

Herbicide[a]	Low Rate	Medium Rate	High Rate
D/T	3 lb. a.e.[b]	6 lb. a.e.	9 lb. a.e.
D/TP	3 lb. a.e.	6 lb. a.e.	9 lb. a.e.
Tordon	1 gal (US)	2 gal (US)	6 gal (US)

[a] The herbicides are more fully described in Appendix 1.

[b] a.e. = acid equivalent.

The Tordon spray was thickened by the addition of the particulating agent "Norbak" as required by the manufacturer. The high rate of Tordon was intended

[1] Nomenclature follows that in "Native Trees of Canada" (6th Ed., 1963). Can., Dep. Forest., Ottawa

[2] Imperial gallons unless otherwise specified.

to be 4 gal (US)/acre but due to faulty calibration, spray was applied at 15 gal total volume per acre instead of the usual 10 gal.

Each treatment was applied to one plot in each of four randomized blocks. Plots were one spray swath (about 40 feet wide) by 200 feet long. Adequate isolation strips separated plots and blocks and no signs of contamination were observed. Spraying was carried out on the morning of 31 July.

In 1967, the 1966 treatments were repeated (with Tordon being applied at the correct rate) and the following treatments were added:

Herbicide	Low Rate	Medium Rate	High Rate
Decamine	3 lb. a.e.	6 lb. a.e.	9 lb. a.e.
D/T + TCA	(D/T 3 lb. a.e. (TCA 10 lb.	6 lb. a.e. 15 lb.	9 lb. a.e. 25 lb.
TOR	6 lb. a.e.	12 lb. a.e.	18 lb. a.e.

Each treatment was applied to one plot in each of three randomized blocks. Plot size was the same as in 1966. Spraying began on the evening of 27 June and was completed the following morning.

COLLECTION OF DATA

The 1966 plots were examined on July 1967 and a careful count of dead, damaged, and undamaged stems was made on a strip 6.6 feet wide and 132 feet long laid out along the centre line of each sprayed plot. Stems were tallied in two size classes (under 3 feet high and over 3 feet high) and four damage classes (dead, severely damaged, lightly damaged, and undamaged). Each stem in a clump of hardwood sprouts was tallied separately.

In July 1968, the 1967 plots were measured. The following changes in procedure were made:

(a) Stems were not separated by size

(b) Only three damage classes were recognized. Stems were classed as "damaged" only when the height had been reduced by killing of the leader or had been checked by killing of the terminal bud. Even if severely defoliated a stem which continued to increase in height was not considered to be damaged.

(c) To overcome the difficulty encountered in the interpretation of the 1967 tally, in which the numerical representation of some species was sometimes insufficient to indicate the effects of treatment, when there were less than 20 stems of a given species on the 132 x 6.6 feet sub-plot, a larger area was examined until that number was reached, or until the whole of the sprayed plot had been examined. In the latter event any shortage still remaining was made up, when possible, by counting more than 20 stems on the corresponding plots in other blocks.

(d) When, on the other hand, 20 stems had been tallied before the whole of the sub-plot had been examined, the tally stopped if it seemed that the distribution of stems by damage classes was clearly indicative of the extent of damage caused, e.g. if all 20 stems fell in the same class, and stems in other classes could not be seen on the remainder of the sprayed plot.

(e) Because even one living stem in a clump of hardwood sprouts indicates that the root system has not been killed, tallying individual stems can give misleading results. For hardwoods, therefore, the clump rather than the single stem was adopted as the tally unit. For a clump to qualify as either "dead" or "undamaged" every stem in the clump had to be in that class. "Damaged" clumps could, of course, contain stems in all three classes.

These changes mean that detailed comparison between the 1966 and 1967 spray plots are impossible and, where it was considered necessary to compare results of the two trials, the 1966 plots were remeasured using the 1968 technique. It is perhaps unfortunate that these changes also limit the usefulness of the results to persons interested in a selective type of brush control. For example, damage to conifers shown here as very low might in fact be so severe as to cause appreciable loss in value in a Christmas Tree plantation. It must be born in mind that the objective of the trials was to discover suitable treatments for long-term control of all species.

RESULTS

The amount of damage caused to a given species by a given treatment varied, sometimes rather widely, from one plot to another. Some of the probably causes are differences in soil moisture, chance variations in rate of application within the plot due to changing air currents, and differences in the relative height of neighbouring stems. Some plots did not yield data due to the absence of a species from those plots. Accordingly it is necessary to average the data for all plots which received the same treatment. In the following discussion, three species groups are dealt with separately. Aspen includes trembling aspen and largetooth aspen. Spruce and fir are combined because preliminary analysis failed to reveal any difference in their reaction to any treatment.

Aspen

1966 Trial

The two pheroxy herbicides appeared to be about equally damaging and even though they are much less effective in killing aspen than is Tordon (Table 1), they caused appreciable mortality and a great deal of defoliation. Trends are not clearly established, though the percentage of stems showing only light damage at the low rate of application suggests that this treatment was approaching the lower limit of effectiveness. Increasing the concentration above the medium rate (6 lb. a.e.) did not, in this trial, increase the effectiveness.

Tordon is evidently a very efficient killer of aspen. At the lowest rate used, only one stem was not killed and it was severely damaged. When the plots were remeasured in 1968, it was found that all stems on the low rate plots were dead, indicating that an even lower rate of herbicide might be used when an immediate kill is not required.

Table 1. Effect of Three Herbicides, Each at Three Rates, on Aspen. 1967 Tally of 1966 Application

Treatment		Distribution of stems by damage classes							
		Dead		Severe		Light		Undamaged	
		No.	%	No.	%	No.	%	No.	%
D/T	L	36	33	55	50	17	15	2	2
	M	11	18	47	77	3	5	0	0
	H	19	28	40	60	8	12	0	0
D/TP	L	14	19	46	61	15	20	0	0
	M	64	40	88	56	6	4	0	0
	H	19	40	27	56	2	4	0	0
Tordon	L	18	95	1	5	0	0	0	0
	M	73	100	0	0	0	0	0	0
	H	77	100	0	0	0	0	0	0

1967 Trial

In the 1967 trial, the D/T treatment caused roughly twice the

mortality obtained in 1966, while the D/TP was somewhat less effective than in the previous trial (Table 2). Tordon was again the most effective killer of aspen; this time 9% of the stems remained alive at the low rate, but these stems will probably die within 1 year.

Of the three additional treatments, Decamine at the medium rate gave results comparable to the other phenoxy treatments, but neither the low nor the high rate caused much mortality. The addition of TCA to the D/T mixture appeared to make it somewhat more effective, though the highest kill was still less than was caused by the low rate of Tordon. TOB at the low rate was very disappointing, and even at the higher rates its performance was still unsatisfactory.

Table 2. Effect of Six Herbicides, Each at Three Rates, on Aspen. 1968 Tally of 1967 Application

Treatment		Distribution of clumps by damage classes					
		Dead		Damaged		Undamaged	
		No.	%	No.	%	No.	%
D/T	L	25	62	15	38	0	0
	M	27	46	31	54	0	0
	H	16	73	6	27	0	0
D/TP	L	15	25	45	75	0	0
	M	18	30	42	70	0	0
	H	16	33	33	67	0	0
Tordon	L	51	91	5	9	0	0
	M	49	100	0	0	0	0
	H	4	100	0	0	0	0
Decamine	L	6	10	53	88	0	0
	M	25	49	25	51	0	0
	H	8	17	39	83	0	0
D/T+TCA	L	32	67	16	33	0	0
	M	39	70	17	30	0	0
	H	45	85	8	15	0	0
TOB	L	2	3	57	95	1	2
	M	16	42	22	58	0	0
	H	10	25	30	75	0	0

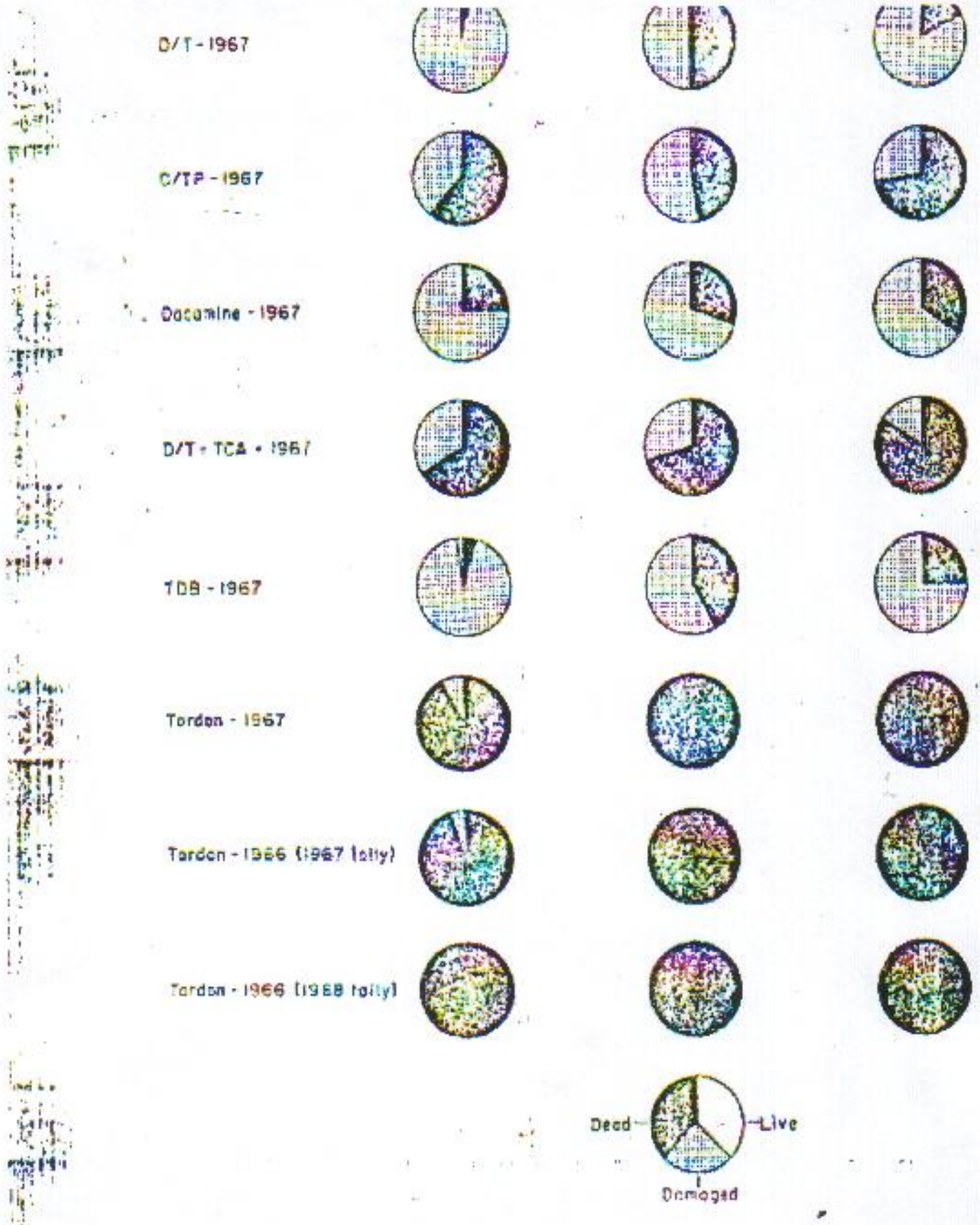

Figure 1. Effect of herbicides on trembling and largetooth aspen.

Red Maple

1966 Trial

It is immediately apparent that red Maple is much more resistant than aspen to all three herbicides (Compare Tables 1 & 3). Only Tordon caused any appreciable mortality; the high rate gave the best kill, but the medium rate was almost as good. Certainly the 5% increase in mortality would not warrant tripling the dose. Doubling the amount of herbicide, from 1 to 2 gal, more than doubled the mortality and is therefore justified.

Table 3. Effect of Three Herbicides, Each at Three Rates, on Red Maple. 1967 Tally of 1966 Spraying

Treatment		Number of stems by damage class							
		Dead		Severe		Light		Undamaged	
		No.	%	No.	%	No.	%	No.	%
D/T	L	4	3	24	17	101	60	16	11
	M	9	5	78	46	60	36	21	13
	H	2	1	53	24	142	64	26	11
D/TP	L	0	0	32	21	101	67	18	12
	M	1	1	6	5	77	60	44	34
	H	14	9	34	21	101	61	15	9
Tordon	L	70	40	46	60	0	0	0	0
	M	126	88	17	12	0	0	0	0
	H	159	93	12	7	0	0	0	0

While Tordon at the medium and high rates greatly reduced the height and density of the red maple sprouts the effect may be of short duration. As suggested earlier, even though 90% of the stems were killed, every clump may have one or more live stems indicating that the root system has not been killed, and new sprouts may soon replace the dead ones.

1967 Trial

Tallying entire clumps rather than single stems has of course had the effect of reducing the tally in both the "dead" and "undamaged" classes (Compare Tables 3 & 4). Only Tordon at the medium and high rates and D/T+TCA

at the high rate caused appreciable mortality, and even the high rate of Tordon gave much less than total control, leaving 34% of the clumps with living stems and, therefore, living root systems.

Table 4. Effect of Six Herbicides, Each at Three Rates, on Red Maple. 1968 Tally of 1967 Spraying

Treatment		Distribution of clumps by damage class					
		Dead		Damaged		Undamaged	
		No.	%	No.	%	No.	%
D/T	L	1	2	58	96	1	2
	M	0	0	60	100	0	0
	H	0	0	60	100	0	0
D/TP	L	1	2	59	98	0	0
	M	1	3	37	98	0	0
	H	2	3	58	97	0	0
Tordon	L	7	11	55	89	0	0
	M	10	23	33	77	0	0
	H	38	66	20	34	0	0
Decamine	L	0	0	41	68	19	32
	M	0	0	41	67	20	33
	H	1	2	37	90	3	8
D/T+TCA	L	1	3	25	87	3	10
	M	3	6	57	93	1	2
	H	22	26	60	74	0	0
TOB	L	1	2	59	95	2	3
	M	0	0	60	100	0	0
	H	0	0	59	98	1	2

Decamine was the least effective of all the herbicides used in this trial, and D/TP which has been claimed to be more effective than D/T against maple and other hard-to-kill species did not live up to its reputation in this test. TOB was no better than the phenoxy esters.

(7) At the high rate, D/T+TCA was much more effective than D/T alone.

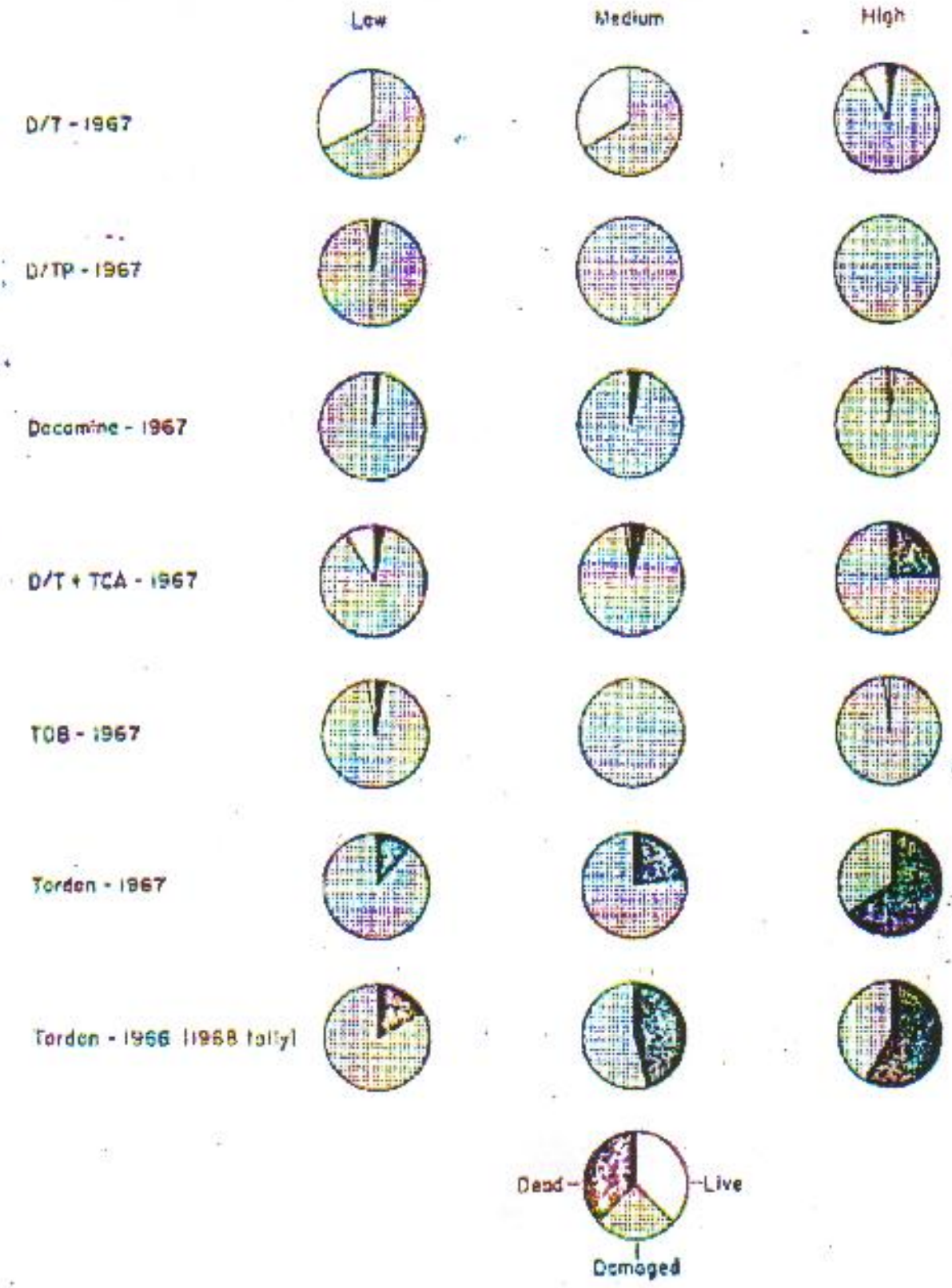

Figure 2. Effect of herbicides on red maple.

For situations where 25% mortality of red maple clumps indicates a satisfactory degree of control, 9 lb. of D/T plus 25 lb. of TCA per acre gave about the same results as 2 gal of Tordon. Comparing D/T alone with D/T+TCA, it would appear to be the TCA component which is responsible for the maple mortality (Table 4). Thus 3 lb. of D/T plus 25 lb. of TCA might give the same results at lower cost.

To obtain comparable data for the 1966 Tordon plots they were re-tallied (by clumps) in July 1968. The results for the 1965 and 1967 treatments were:

Rate (Gal)	Percentage mortality	
	1966 plots	1967 plots
1	17	11
2	46	23
4	-	66
6	59	-

At the 1- and 2-gal rates, mortality is higher on the 1966 plots. This agrees with observations which indicate continued mortality during the second year after spraying with Tordon. The fact that the mortality recorded 1 year after spraying with 4 gal of Tordon is greater than that recorded 2 years after spraying with 6 gal is a contradictory result for which no explanation can be offered. The only firm conclusion which can be drawn from these trials is that even at the high rates of 4 and 6 gal/acre Tordon, although it kills a large number of stems, cannot be relied upon to give long-lasting control of this species.

Spruce and Fir

1966 Trial

Since phenoxy herbicides have very little effect on conifers, only the data for the Tordon plots are presented here (Table 5). It was observed that the D/T treatments caused a certain amount of needle cast, but no damage could be seen 2 years after spraying.

Table 5. Effect of Tordon, at three Rates, on Spruce and Fir, 1967 Tally of 1966 Spraying

Treatment		Number of stems by damage class							
		Dead		Severe		Light		Undamaged	
		No.	%	No.	%	No.	%	No.	%
Tordon	L	41	33	36	29	44	35	4	3
	M	41	42	29	30	22	23	5	5
	H	241	78	46	15	19	6	3	1

This tally, 1 year after spraying, shows a clear trend of increasing mortality with increasing dosage, reaching the maximum of 78% at the 6-gal rate. It thus appears that the desired degree of control can be approached, if not attained, if enough herbicide is used.

1967 Trial

Only three of the 1967 treatments caused any mortality of conifers, so data for the other treatments are not shown. In this trial, Tordon gave results comparable to those obtained 1 year earlier--somewhat lower at the low rate, considerably better at the medium rate, and slightly better at the high rate. This last result is unexpected, because the trend is clearly toward better kill with higher dosage, and yet the high rate in 1966 contained 6 gal compared to 4 gal in 1967. This suggests that dosages above 4 gal cannot be relied upon to give a higher mortality.

TDB was generally superior to D/T+TCA, but the high rate of TDB was less effective than the medium rate of Tordon.

The 1968 remeasurement of the 1966 Tordon plots shows that, as with red maple and aspen, mortality increased in the second year after spraying (Table 7). The whole increase is attributed to the death of stems classed as "severely damaged" in 1967. Conversely, some of the stems classed as lightly damaged in 1967 improved in appearance to the point where they were classed as undamaged in 1968.

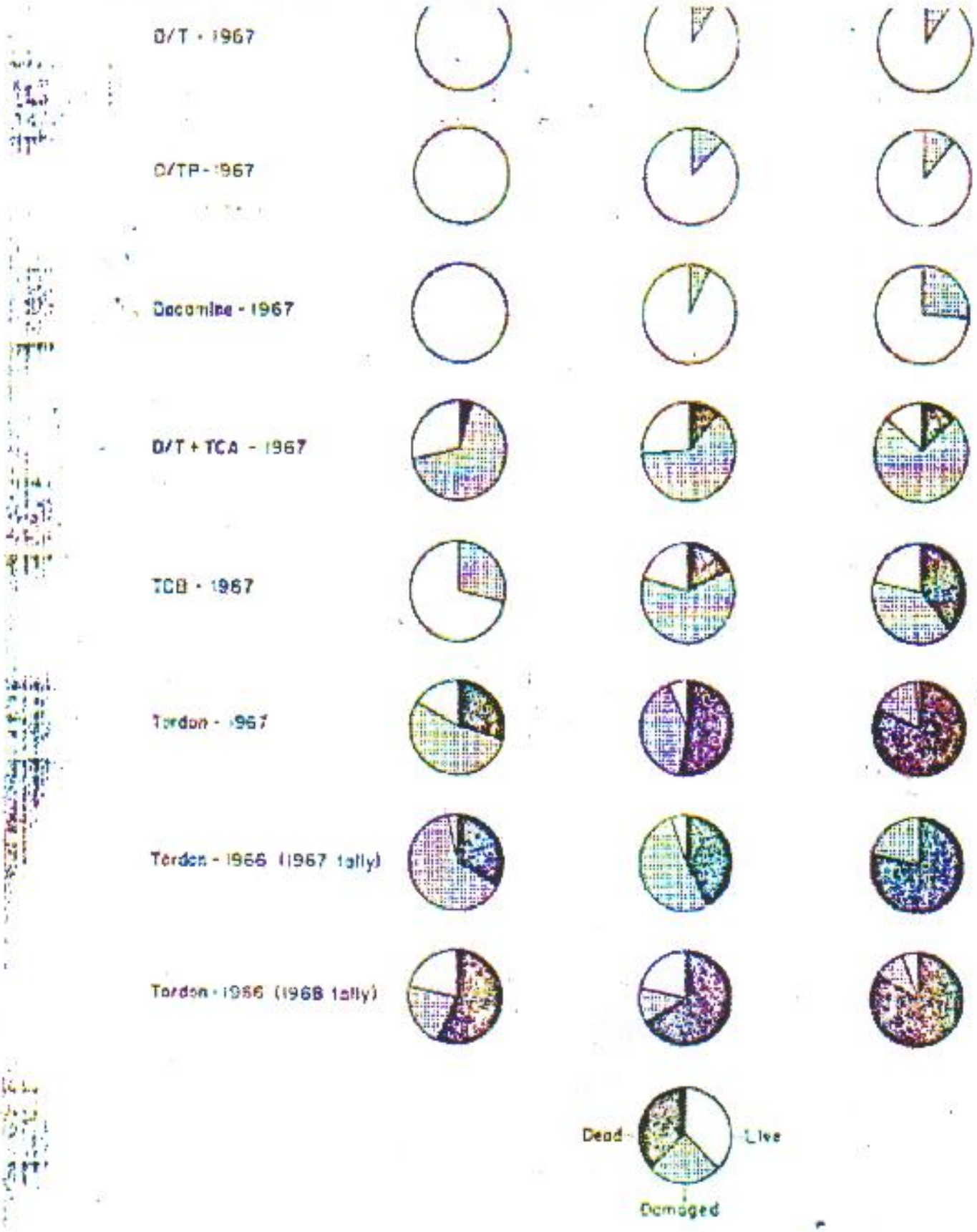

Figure 3. Effect of herbicides on spruce and fir.

Table 6. Effect of Three Herbicides, Each at Three Rates, on Spruce and Fir. - 1968 Tally of 1967 Spraying

Treatment		Number of stems by damage class					
		Dead		Damaged		Undamaged	
		No.	%	No.	%	No.	%
Tordon	L	23	29	42	54	13	17
	M	43	52	35	42	5	6
	H	100	82	21	17	1	1
D/T+TCA	L	3	4	51	67	22	29
	M	6	12	31	62	13	26
	H	13	13	73	13	14	14
TOB	L	0	0	17	28	43	72
	M	17	18	58	61	20	21
	H	19	38	20	40	11	22

Table 7. Change in Percentage Mortality of Spruce and Balsam Fir on Plots Sprayed in 1966

Treatment		1967 tally	1968 tally
Tordon	L	33	56
	M	42	66
	H	78	83

Conclusions

1. Where any of the three resistant species groups occurs, only Tordon of the six chemicals tested will give anything approaching complete, long-term control.

2. In increasing resistance to Tordon, the species groups rank as: Aspen, Spruce-Fir, Red Maple.

3. For Aspen, a concentration of Tordon between 1 and 2 gal (US)/acre will give 100% kill in the first year. Spruce and fir seem to require 4 gal (US) to give a first-year kill of about 80%; further mortality will probably occur in the second year. For red maple, neither the 4 gal nor the 6 gal rate has killed

more than 65% of the sprayed clumps (first-year kill with the 4 gal treatment). Moreover, it is possible that some of the clumps which appeared to be dead 1 year after spraying may sprout again and offset second-year mortality.

4. These trials provide no evidence to indicate that increasing the concentration of Tordon above 4 gal/acre will provide a better kill, though the possibility is not ruled out since the 4 and 6 gal rates were used in different years and weather conditions may have influenced the results.

Appendix I

Description of the herbicides used in the 1966 and 1967 trials

Herbicide	Description
Dacamine	"Dacamine 2D/2T", a formulation containing equal parts of diamine salts of 2, 4-D and 2,4,5-T, total acid equivalent 76.8 oz/gal.
D/T	A mixture of equal parts of low volatile esters of 2,4-D (dichlorophenoxyacetic acid) and 2,4,5-T (trichlorophenoxyacetic acid).
D/TP	A mixture of equal parts of low volatile esters of 2,4-D and 2,4,5-TP (trichlorophenoxypropionic acid). Common names for 2,4,5-TP are "Silvex", "Kuron", and "Fenoprop".
TCA	Trichloroacetic acid.
TDB	A water-soluble amine formulation containing 19.2 oz of 2,4-D, 9.6 oz. of 2.4,5-T and 19.2 oz. of trichlorobenzoic acid per imperial gal.
Tordon	"Tordon 101", a formulation containing 2 lb. of 2,4-D and 0.54 lb. of picolinic acid per gal (US).

Appendix II

1. Approximate Cost of Herbicides

Herbicide	Dollars/lb. a.e.
2,4-D (Esteron 6-E, $ 6.00/gal)	1.00
2,4-D/2,4,5-T (Esteron 3-3E, $ 10.00/gal)	1.67
2,4,5-TP (Kuron, 12.20/gal)	2.50
Dacamine (Dacamine, 2D/2T, $ 8.00/gal)	1.66
TCA ($ 0.50/lb.)	
TDB ($ 7.50/gal)	2.50
Tordon 101 ($ 15.00/U.S. gal)	

2. Approximate costs (dollars per acre) of treatments

Herbicide	Rate		
	L	M	H
		dollars	
D/T	5.00	10.00	15.00
D/TP	5.25	10.50	15.75
Dacamine	5.00	10.00	15.00
D/T+TCA	10.00	17.50	27.50
TDB	15.00	30.00	45.00
Tordon	15.00	30.00	60.00 (4 gal) 90.00 (6 gal)