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# TECHNICAL MEMORANDUM 46

## FIELD SCREENING OF DESICCANTS AND DEFOLIANTS

APRIL 1964

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UNITED STATES ARMY  
BIOLOGICAL LABORATORIES  
FORT DETRICK

U.S. ARMY BIOLOGICAL LABORATORIES  
Fort Detrick, Frederick, Maryland

TECHNICAL MEMORANDUM 46

FIELD SCREENING OF DESICCANTS AND DEFOLIANTS

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Crops Division  
DIRECTOR OF BIOLOGICAL RESEARCH

Project 1C522301A06101

April 1964

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### FOREWORD

The author wishes to express his appreciation to Mr. Robert Winder of Fort Ritchie and to Mr. Robert Shipley of Fort Meade for granting permission to use wooded areas and plots for experimental purposes, also to Mr. J. Ray Frank, Ralph E. Buschmann, and Robert F. Morneweck for their help in spraying and observing effects of treatments.

### ABSTRACT

Chemical compounds showing herbicidal or defoliating activity were sprayed on 108 individual trees and on 24 plots. A combination of Tordon and Diquat sprayed at ten pounds per acre gave the best results on individual trees. Cacodylic acid sprayed at ten pounds or more per acre was the most effective on plots, and at 40 pounds per acre caused some defoliation of Pinus virginiana.

### DIGEST

Chemical compounds showing herbicidal, desiccating and/or defoliating activity were sprayed alone and in combination on 108 individual trees and on plots of 150 square feet at rates of 10, 25, 40, 55, 70, 85, and 100 pounds per acre.

Five compounds when used alone at ten pounds per acre showed the following herbicidal activity:

Tordon killed elm, locust, and maple.

2,4-D (butyl ester) killed locust.

"Orange" (mixture of butyl esters of 2,4-D and 2,4,5-T) killed elm, locust, maple, and chestnut oak.

Diquat killed elm, locust, and maple.

Endothal killed maple.

When Tordon was used in combination with other compounds at a rate of five pounds per acre of each compound, the following activity was observed:

Tordon plus 2,4-D was no more effective than Tordon alone.

Tordon plus the mixture of 2,4-D and 2,4,5-T was slightly more effective than Tordon alone.

Tordon plus Diquat was the most effective of all combinations. It killed ash, elm, locust, maple, and chestnut oak.

Tordon plus Endothal killed locust and maple.

Three compounds when sprayed at rates of 10, 25, 40, 55, 70, 85, and 100 pounds per acre showed the following activity:

Dowco 173 killed maple, cherry, and locust at 70 pounds per acre, but it took 100 pounds per acre to kill pine.

Cacodylic acid killed pine, maple, sweet gum, blackberry, cherry, aspen, and American chestnut at 10 pounds per acre, but 40 pounds per acre were required to kill pin oak.

Butynediol defoliated pine, pin oak, maple, sweet gum, huckleberry, persimmon, and sumac at 70 pounds per acre. Recovery may occur on all species at this rate.

One compound when sprayed at 25 and 40 pounds per acre showed the following activity:

DEF defoliated aspen, maple, and persimmon at 25 pounds per acre. Regrowth occurred on maple and persimmon in eight weeks. At 40 pounds per acre black cherry, willow oak, maple, and huckleberry were completely defoliated in four weeks. Regrowth occurred on huckleberry in eight weeks.

HRS-910 sprayed at five and ten pounds per acre had very little effect on sweet gum, pine, pin oak, or blackberry.

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## I. INTRODUCTION

Defoliation experiments at Fort Detrick are carried out in two phases: greenhouse screening (primary and secondary) and field screening. Primary screening consists of spraying beans (Phaseolus vulgaris var. Black Valentine) with candidate compounds at 0.1 and 1.0 pound per acre. Secondary screening consists of spraying seedling trees at 1.0 and 10.0 pounds per acre with those candidate compounds showing a high rate of activity in primary screening.\*

Field screening consists of taking the more active candidate compounds, as judged by secondary screening, into the field and applying them at five and ten pounds per acre to rows of established nursery stock or to 15- to 20-foot trees in naturally wooded areas.

Two field defoliation experiments were carried out during the summer of 1963; one at Fort Ritchie, Maryland on individual trees, the other at Fort Meade, Maryland on plots of 150 square feet. Spraying in both areas simulated, as nearly as possible, aerial spraying. Observations and photographs were taken of all trees and plots before spraying and at weekly intervals thereafter for 11 and 8 weeks, respectively. The terms used in rating effects of candidate compounds were (a) slight, less than 25 per cent injury; (b) moderate, 26 to 75 per cent injury; and extreme, more than 76 per cent injury.

## II. FIELD SCREENING

### A. FORT RITCHIE

#### 1. Materials and Methods

Eighteen trees each of Fraxinus americana (white ash), Ulmus americana, (American elm) Acer rubrum (red maple), Robinia pseudoacacia (black locust), Quercus montana (chestnut oak), and Quercus borealis (northern red oak) were sprayed at five and ten pounds per acre with the following chemicals:

---

\* Frank, J. Ray; Buschmann, Ralph E.; and Morneweck, Robert F. "Defoliation studies: Screening of defoliants, herbicides, and desiccants," Crops Division, U.S. Army Biological Laboratories, Frederick, Maryland. (In preparation)

|          |                                                |
|----------|------------------------------------------------|
| Tordon   | 4-Amino-3,5,6-trichloropicolinic acid          |
| 2,4-D    | 2,4-Dichlorophenoxyacetic acid                 |
| Orange   | 2,4-D and 2,4,5-T <i>n</i> -butyl esters 50:50 |
| Diquat   | 1,1'-Ethylene-2,2'dipyridylum dibromide        |
| Endothal | 3,6-Endoxohexahydrophthalic acid               |
| Tordon   | In combination with all compounds              |

Tordon, Diquat, and Endothal formulations are water-soluble; hence, a premeasured quantity of the compound was mixed with water and sprayed on the trees. The butyl esters are not water-soluble, so it was necessary to dissolve the ester in about 20 cubic centimeters (cc) of acetone, add one per cent Triton X-155 surfactant, then mix the solution with water.

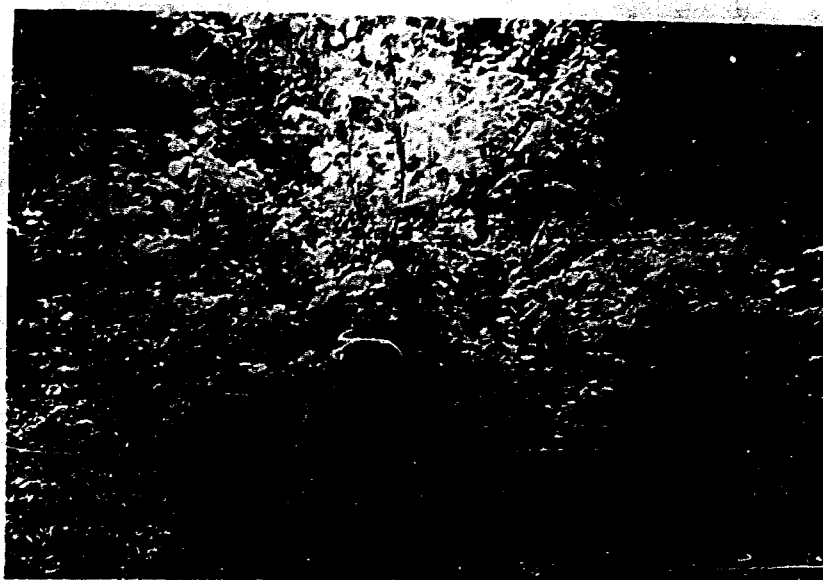
The spray apparatus was a three-gallon tank sprayer fitted with a pressure gauge pumped up to 30 pounds pressure. A 9-foot stainless steel wand having an 18-inch boom with three No. 2 Whirljet nozzles was attached to the hose of the sprayer. The sprayer was then mounted on a tank truck and personnel sprayed trees from this position. All sprays were directed down on the foliage until the tank was emptied. The sprays were applied on 11 and 12 July 1963. Observations, records, and color photographs were taken weekly until 26 September, an elapsed period of 11 weeks. Some of the sprayed trees were destroyed by construction and excavation operations before results could be obtained.

## 2. Results and Conclusions

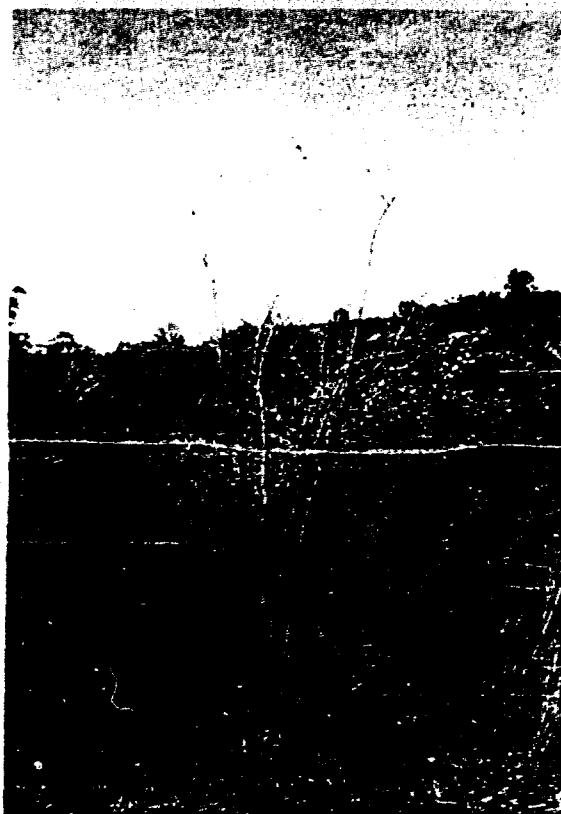
Combinations were used at the total rate of five and ten pounds per acre. For the five-pound rate, 2 1/2 pounds of each compound were used.

The combination Tordon and Diquat gave the best results at ten pounds per acre (Figure 1 and Table I). Tordon alone was not effective on Fraxinus or Quercus borealis at five pounds per acre and only slightly more effective on these trees at ten pounds per acre. Tordon was effective on Ulmus, Robinia, and Acer at both rates. Diquat alone was effective on all trees, particularly at ten pounds per acre, but regrowth occurred about three weeks later (Figure 2). Both Quercus species were more resistant to Diquat than Acer, Fraxinus, Ulmus, or Robinia. The tree species found to be most susceptible to all compounds tested were Robinia and Acer.

Additional observations and records will be taken on these 100-- trees during the 1964 growing season to determine the amount of complete kill or regrowth that occurs.

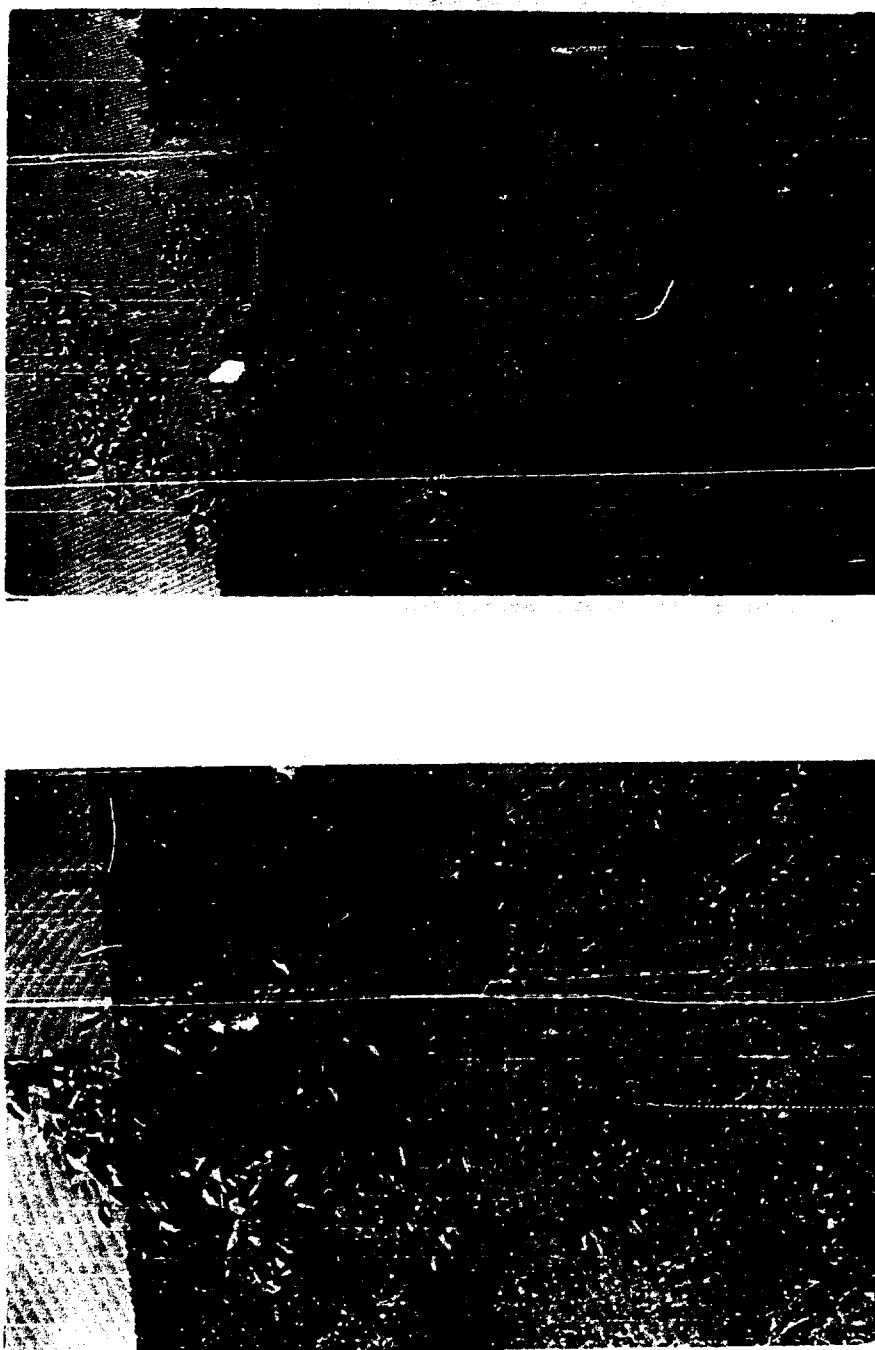


A



B

Figure 1. Elm (Ulmus) Sprayed with a Combination of Diquat and Tordon at Ten Pounds Per Acre.  
A. Before Spraying.  
B. No Regrowth After 11 Weeks.



B

A

Figure 2. Ash (Fraxinus) Sprayed with Diquat at Ten Pounds Per Acre.  
A. Before Spraying.  
B. One Week After Spraying.

TABLE I. DEGREE OF INJURY AFTER SPRAYING TREES WITH COMPOUNDS AT FIVE AND TEN POUNDS PER ACRE, FORT RITCHIE 1963-

| SPECIES            | Tordon |    | 2,4-D |     | Orange |    | Diquat |     | Endothal |    | Tordon plus |        |        |          |    |    |
|--------------------|--------|----|-------|-----|--------|----|--------|-----|----------|----|-------------|--------|--------|----------|----|----|
|                    | 5      | 10 | 5     | 10  | 5      | 10 | 5      | 10  | 5        | 10 | 2,4-D       | Orange | Diquat | Endothal | 5  | 10 |
| <u>Fraxinus</u>    | MAE    | S  | M     | MAE | S      | S  | EDR    | *   | *        | *  | MAE         | S      | *      | *        | ED | M  |
| <u>Ulmus</u>       | ED     | ED | ED    | M   | M      | *  | M      | ED  | S        | M  | ED          | ED     | M      | M        | ED | M  |
| <u>Robinia</u>     | ED     | ED | MR    | ED  | ED     | E  | M      | EDR | M        | M  | ED          | ED     | ED     | *        | ED | ED |
| <u>Acer</u>        | E      | E  | S     | S   | E      | S  | E      | E   | S        | E  | E           | E      | E      | E        | E  | E  |
| <u>Q. montana</u>  | E      | S  | S     | M   | E      | E  | M      | S   | M        | M  | E           | M      | E      | E        | E  | S  |
| <u>Q. borealis</u> | S      | S  | S     | S   | S      | M  | S      | S   | S        | S  | S           | M      | M      | S        | S  | E  |

a. MAE No apparent effect.

S Slight chemical injury.

M Moderate chemical injury.

ED Extreme chemical injury.

MR Extreme defoliation.

E Recovery.

\* Trees destroyed before results were obtained.

## B. FORT MEADE

## 1. Materials and Methods

Twenty-four plots, each approximately 150 square feet, were marked off. Vegetation in these plots consisted of the following:

|                                |                            |
|--------------------------------|----------------------------|
| <u>Pinus virginia</u>          | Scrub pine                 |
| <u>Acer rubrum</u>             | Red maple                  |
| <u>Quercus palustris</u>       | Pin oak                    |
| <u>Quercus phellos</u>         | Willow oak                 |
| <u>Diospyros virginiana</u>    | Common persimmon           |
| <u>Populus tremuloides</u>     | Quaking aspen              |
| <u>Prunus serotina</u>         | Black cherry               |
| <u>Liquidambar styraciflua</u> | Sweet gum                  |
| <u>Robinia pseudoacacia</u>    | Black locust               |
| <u>Castanea dentata</u>        | American chestnut          |
| <u>Gaylussicia</u> spp.        | Huckleberry                |
| <u>Smilax rotundifolia</u>     | Greenbrier                 |
| <u>Rubus</u> spp.              | Blackberry                 |
| <u>Rhus glabra</u>             | Sumac                      |
| <u>Viburnum</u> spp.           | Viburnum                   |
|                                | Various sedges and grasses |

Not all of these species were found in each plot; however, pine was in 19 of the 24 plots and maple was in 14 of the 24.

Twenty plots were sprayed with three different compounds at rates of 10, 25, 40, 55, 70, 85, and 100 pounds per acre. These compounds were:

Dowco 173

Cacodylic acid

Butynediol

dimethyl-arsinic acid

2-butyne-1,4-diol

Two plots were sprayed at five and ten pounds per acre with HRS-910; two were sprayed at 25 and 40 pounds per acre with DEF (S,S,S-tributyl phosphorotithioate). These five compounds were selected for various reasons. Dowco 173 was selected for its ability to defoliate certain species in the greenhouse without desiccating, cacodylic acid for its strong desiccating action, butynediol for its defoliating action, and HRS-910 and DEF because they are known to be cotton defoliants.

Sprays were applied 2 August 1963 and observations, records, and color photographs were taken at weekly intervals until 25 September, an elapsed period of eight weeks.

## 2. Results and Conclusions

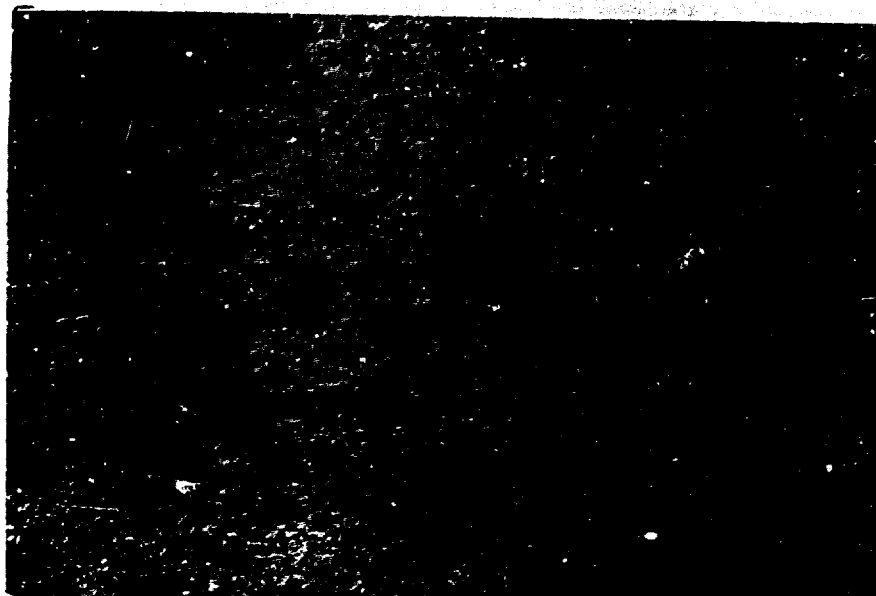
Perhaps the most outstanding observation in this experiment was that of scrub pine, which desiccated and shed some needles when cacodylic acid was sprayed at 40 pounds per acre (Figure 3). Pine has never before been found to shed as a result of cacodylic application. In general, cacodylic acid at all rates gave better top kill and defoliation than any other compound used in this test (Table II).

HRS-910 caused the least response of any compound tested. No apparent effect was noted on pine or pin oak and only slight effect on sweet gum and blackberry. The two latter species recovered before the beginning of autumnal coloration.

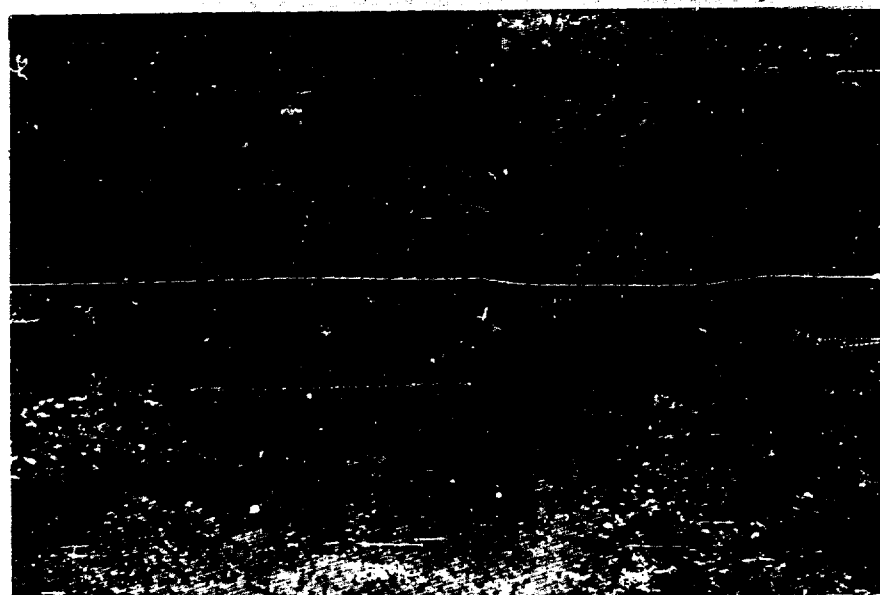
DEF, an ill-smelling compound, at 40 pounds per acre defoliated maple, cherry, huckleberry, and willow oak.

Because these plots were in a naturally wooded area, all species were not tested against each chemical.

Before this experiment is terminated, observations will be made in the spring and summer of 1964.



A



B

Figure 3. Plot Sprayed with Cacodylic Acid at Forty Pounds Per Acre.  
A. Before Spraying.  
B. Eight Weeks After Spraying.

TABLE II. DEGREE OF INJURY TO VEGETATION SPRAYED WITH FIVE COMPOUNDS AT SEVERAL RATES, FORT MEADE 1963<sup>a</sup>

| COMPOUND        | RATE,<br>lb/acre | SPECIES |       |             |              |        |               |                |       |        |               |                 |                  |      |          |           |
|-----------------|------------------|---------|-------|-------------|--------------|--------|---------------|----------------|-------|--------|---------------|-----------------|------------------|------|----------|-----------|
|                 |                  | Pine    | Maple | Pine<br>Oak | Sweet<br>Oak | Cherry | Willow<br>Oak | Per-<br>simmon | Aspen | Locust | Chest-<br>nut | Black-<br>berry | Mockle-<br>berry | Rhus | Viburnum | Saxifrage |
| Dowco 173       | 10               | MAE     |       | MAE         |              |        | MAE           | E              |       | S      |               | MAE             |                  |      | M        |           |
|                 | 40               | MAE     |       |             |              |        | MAE           |                |       | E      |               | S               |                  |      |          |           |
|                 | 55               | S       | N     |             |              |        |               |                |       |        |               |                 |                  |      |          |           |
|                 | 70               | E       | ED    |             |              | ED     |               |                |       |        |               |                 | S                |      |          | MAE       |
|                 | 100              | E       | M     |             |              |        |               |                |       |        |               |                 |                  |      |          |           |
| Caedyle<br>Acid | 10               | E       | ED    |             |              |        |               |                |       |        |               | M               |                  |      |          | S         |
|                 | 25               | E       | ED    | M           | ED           |        |               |                |       |        |               | E               |                  |      |          | S         |
|                 | 40               | E       | ED    | ED          | M            | ED     |               |                |       |        |               | E               |                  |      |          |           |
|                 | 55               | E       | E     | E           | ED           |        |               |                |       |        |               | E               |                  |      |          |           |
|                 | 70               | E       | ED    | M           | ED           |        |               |                | ED    |        |               | E               |                  |      |          |           |
|                 | 85               | E       | ED    | M           | ED           |        |               |                | ED    |        |               | E               |                  |      |          |           |
|                 | 100              | E       |       | ED          | ED           |        |               |                | ED    |        |               | ED              |                  |      |          |           |
| Butyne-<br>diol | 10               |         | ED    | S           | M            | ED     |               |                |       |        |               | S               |                  |      |          |           |
|                 | 25               | S       | M     | E           | S            | S      |               |                |       |        |               | S               |                  |      |          |           |
|                 | 40               | M       | ED    |             |              |        | ED            |                |       |        |               | E               |                  |      |          |           |
|                 | 55               | E       | M     |             |              |        |               |                |       |        |               | E               |                  |      |          |           |
|                 | 70               | S       | ED    |             | ED           |        |               |                |       |        |               | E               |                  |      |          |           |
|                 | 100              | E       | ED    | ED          | S            |        |               | ED             |       |        |               | S               |                  |      |          |           |
| MEG-910         | 5                | MAE     |       | S           | S            |        |               |                |       |        |               | S               |                  |      |          |           |
|                 | 10               | MAE     |       | MAE         |              |        |               |                |       |        |               |                 |                  |      |          |           |
| MEV             | 25               | S       | ED    |             | M            |        | E             | ED             | ED    |        |               | M               |                  |      |          | S         |
|                 | 40               | S       | ED    |             |              |        | ED            |                |       |        |               |                 |                  |      |          |           |

a. MAE No apparent effect.  
S Slight chemical injury.  
M Moderate chemical injury.  
E Extensive chemical injury.  
ED Extreme chemical injury; extreme defoliation; regrowth.  
E Extreme chemical injury; extreme defoliation; regrowth.

### III. CONCLUSIONS

A combination of Tordon and Diquat sprayed at ten pounds per acre gave the best results on individual trees at Fort Ritchie. Tordon alone was effective on elm, black locust, red maple, and chestnut oak, but not on ash and northern red oak. Diquat, a very rapid desiccating agent, was effective on all trees, but regrowth occurred between three and eleven weeks later, depending upon the species.

Cacodylic acid sprayed at ten pounds or more per acre was the most effective on plots at Fort Meade.



DEPARTMENT OF THE ARMY  
US ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND  
EDGEWOOD CHEMICAL BIOLOGICAL CENTER  
5183 BLACKHAWK ROAD  
ABERDEEN PROVING GROUND, MD 21010-5424

REPLY TO  
ATTENTION OF

RDCB-DPC-RS

03 MAR 2011

*AMB* 3 MAR 11

MEMORANDUM THRU Edgewood Chemical Biological Center, Technical Director,  
(RDCB-D/Mr. Wienand), 5183 Blackhawk Road, Aberdeen Proving Ground, MD 21010-5424

FOR RDECOM Office of Chief Counsel (AMSRD-CC/Mr. Brian May), 5183 Blackhawk Road,  
APG, MD 21010-5424

SUBJECT: RDECOM Freedom of Information (FOIA) Request

1. References:

a. Army Regulation 380-86, Classification of Former Chemical Warfare and Biological Defense, and Nuclear, Biological, and Chemical Contamination Survivability Information, dated 22 Jun 05.

b. Army Regulation 25-55, The Department of the Army Freedom of Information Act Program, dated 1 Nov 97.

2. The request from RDECOM asks for release of the following three documents pertaining to agent orange. ECBC subject matter experts have recommended allowing public release for these documents.

a. Technical Memorandum 46, Field Screening of Desiccants and Defoliants, Kenneth D. Demaree, April 1964.

b. Proceedings of the First Defoliation Conference, 29-30 July 1963, published January 1964.

c. Technical Report BWL 16, Defoliation and Desiccation, Preston, W.H., Downing C.R., and Hess, C.E., July 1959.

3. The ECBC point of contact is the undersigned at 410-436-7232 or [june.sellers@us.army.mil](mailto:june.sellers@us.army.mil).

Concur with ECBC's recommendation.

BRIAN A. MAY

FOIA Officer, HQ RDECOM

JUNE K. SELLERS

ECBC Security Manager

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