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INDUCED DROUGHT ON LODGEPOLE PINE (PINUS CONTORTA VAR. LAT. ENGL.) AND ITS RELATIONSHIP TO SUCCESSFUL MOUNTAIN PINE BEETLE (D. MONTICOLAE HOPK.) ATTACKS

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INTERIM REPORT

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Introduction

A study of the history of past bark beetle outbreaks, indicates that a period of drought has preceded most infestations. This could be a major factor in the pre-conditioning of a stand so that it becomes susceptible to a successful attack of outbreak proportions. Although this drought condition has been observed, little has been attempted to show the amount of moisture deficiency necessary to condition a tree for a successful attack.

In 1957, a project was initiated to study the effect of induced drought on lodgepole pine (Pinus contorta var. latifolia Engl.) and the success of subsequent attacks by the mountain pine beetle (Dendroctonus monticolae Hopk.). The problem was approached by measuring the changing soil moisture created by artificial drought conditions imposed on trees which showed some indication of resistance to bark beetle attacks by excessive production of resin.

A study on the biology of the mountain pine beetle is presently in progress in the Windermere, B.C. region. This infestation is the source from which the beetles are taken for inducing the attacks on both the drought trees, and checks, to indicate susceptibility. The stand conditions there provide the basis for comparison in selecting the study trees and site. A suitable experimental area was located at the base of Mt. Eisenhower in the Bow Valley of Banff National Park, Alberta, after careful consideration of the following requirements.

Experimental requirements

1. The experimental area should be located where the present bark beetle population is at an extremely low level but where it is known that the region has supported and is capable of supporting a population of outbreak proportion.

2. The stand should exhibit similar physical characteristics of tree size, age, type, crown and bark, to those found in an area that is undergoing an attack.

3. The study trees should demonstrate a definite resistance to induced beetle attacks and successful brood establishment, as exhibited by the drowning out of the beetles by excessive resin flow.

4. The soil conditions should be as uniform as possible so that soil moisture readings will be comparable for all study trees. The soil should have a low water table and be adequately drained.

5. The area should be readily accessible for ease of plot establishment and maintenance of the desired frequency of readings.

Selection and Description of Experimental Area

The study area is located on Highway 1A, 3 miles west of the Banff-Lake Louise-Radium junction near Mt. Eisenhower. It is located on a very gentle south-east slope on the north side of the valley.

The stand is composed of pure lodgepole pine, 70 - 80 years of age and 50 - 60 feet high. It is situated in a shallow, well drained soil. The main rooting habit of lodgepole pine is lateral with the majority of roots in the top 12" of soil.

During the period 1940-1943 a mountain pine beetle infestation occurred in the Bow Valley with the western limit approximately 5 miles from the site of this study. The stand conditions of both areas do not differ markedly. The outbreak covered 15,000 acres and was controlled by removal of 30,000 infested trees. The present mountain pine beetle population is at such a low point that intensive searching failed to produce a specimen in the area.

After the site was chosen with due regard to the physical features, the trees were selected on the basis of their degree of resistance to induced beetle attacks. The selected trees were not subjected to these attacks as the danger of introducing blue stain fungi was too great and the possibility of conditioning the tree to subsequent natural attack, so only trees that were to be removed from the plot were treated.

Two cages were placed on each trunk of seven trees. Each cage had 5 pairs of freshly emerged adults from the Windermere outbreak placed inside. These were permitted to remain throughout July, August and early September before the trees were examined for beetle galleries and brood development. The seven trees yielded the information shown in Table I.

All seven trees showed evidence of beetle entrance. Out of a total of 140 beetles introduced, 68 failed to enter the trees. The 56 dead ones were either pitched out in the gallery or in the pitch tube. All the galleries had a hard encrusted layer of pitch on the walls. In some cases eggs had been deposited but these were in a deflated condition covered with hardened pitch. This condition was also found in some trees in the Windermere infestation. These results indicated that the trees in the locality were resistant to successful beetle establishment by reason of copious pitch flow and so the trees were assumed to be suitable for this study.

TABLE I

INDUCED ATTACK BY DENDROCTONUS MONTICOLAE

No. Tree	No. Galleries	No. Adults Dead	No. Adults Alive	Average Length Gallery Dead	Average Length Gallery Alive
1	6	12	--	1.2"	--
2	7	14	--	1.7"	--
3	5	10	--	2.1"	--
4	4	2	6	2.8"	5.3"
5	6	4	8	2.2"	4.0"
6	4	8	---	2.1"	--
7	4	6	--	4.5"	4.3"
7	36	56	16	2.4"	4.9"

Method

Twelve trees were selected from the chosen site. These were grouped into six pairs, the trees of a pair separated by a minimum of 30 feet. All the pairs were situated within an area having a 75 yard radius. All the trees within a 15 foot radius of each study tree, were cut and removed. The debris and slash was removed so that no source remained which might be attractive to beetles in the wild population.

A 24 foot square plywood platform was erected 2 to 3 feet above the major portion of the rooting system. The second tree of each pair was the control. The platforms were covered with a polyethelene sheet for waterproofing and each had gutters to provide for water removal from the tree site.

The soil moisture condition for each study tree was measured by means of a Parks Electronic Moisturometer model 910, which uses the conductance-impedance principle through a transistorized circuitry. The probes were imbedded in a special gypsum cylinder $2\frac{1}{2}$ inches long by 1 inch in diameter, which was placed in the soil to the desired depth by means of a hand auger. The leads for each probe were extended to the edge of each platform or to the trunk in the case of the control trees.

The probes for one study pair, were placed at two stations, 4 and 8 feet respectively from the tree, on each of 4 quadrants about each tree. They were inserted in the soil to 6, 12, and 18 inch depths at each station. One probe was placed as deep as possible at each trunk base.

The remaining five pairs of trees had only five probes for each tree; one at a 6 inch depth, one 7 feet from the tree on each of 4 quadrants, and the last as deep as possible at the tree base. This depth varied between 12 and 20 inches, depending on the soil texture. The 6 inch depth was selected as being representative of the zone where the larger part of the rooting system in lodgepole pine is distributed.

A record of the soil temperature was maintained by means of thermocouples inserted alongside various moisture probes and read by a direct reading Rubicon potentiometer.

Each tree had a dendrometer station established at breast height for radial increment observations.

The relative humidity and air temperature is recorded on the plot by means of a hygrothermograph while a rain gauge measures the precipitation.

Snow fall records are being recorded by the District Park Warden three miles from the plots in the valley level.

Discussion and Results

Due to the limited period of operation during the latter part of 1958, the results of the steadily dropping moisture readings merely indicate a drying trend. This trend is brought about not only because of the dry summer but also because the moisture probes which were saturated before insertion, also dried to a state of equilibrium with the soil moisture. The drying of the probes appears to take 4 to 6 weeks to reach the soil moisture level. There was insufficient rainfall of such an intensity or duration to penetrate the soil to the probe level and cause noticeable reading fluctuations.

The moisture content of the soil will have to be calibrated against the soil probes. The wilting point and field capacities will also be determined.

During the course of the experiment an attempt will be made to relate tree moisture content and resin flow to the soil moisture condition, tree growth characteristics and the success of induced bark beetle attacks.

The study will continue for a number of years. After the artificial drought conditions have exerted enough influence to produce measurable difference of growth between the control and study trees, then one or more pairs will be selected for analysis. Bark beetles will be introduced to the selected trees in such a manner that they may exercise some selection between the control tree and drought affected tree. The trees will also be subjected to induced beetle attacks and left for a suitable period. The trees will then be cut and the galleries and brood development of each compared

for success of attack. Growth, tree moisture content, soil moisture and other data on the trees will complete the relationships. The other trees will be treated at different degrees of drought duration in successive years, so that the degree of reduced moisture necessary to provide successful beetle attacks may be determined.

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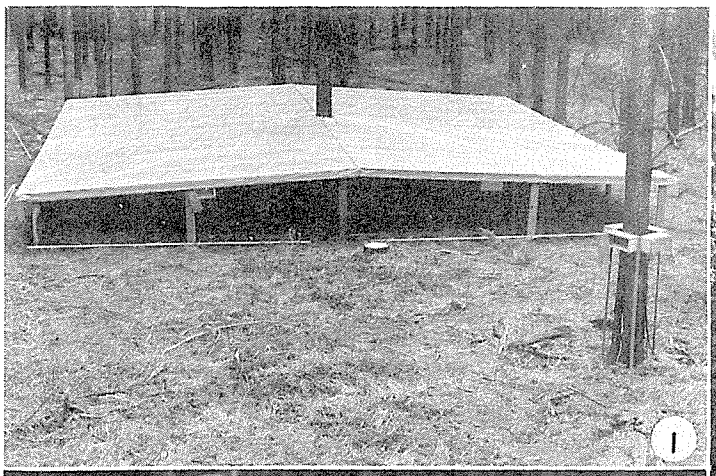
Illustration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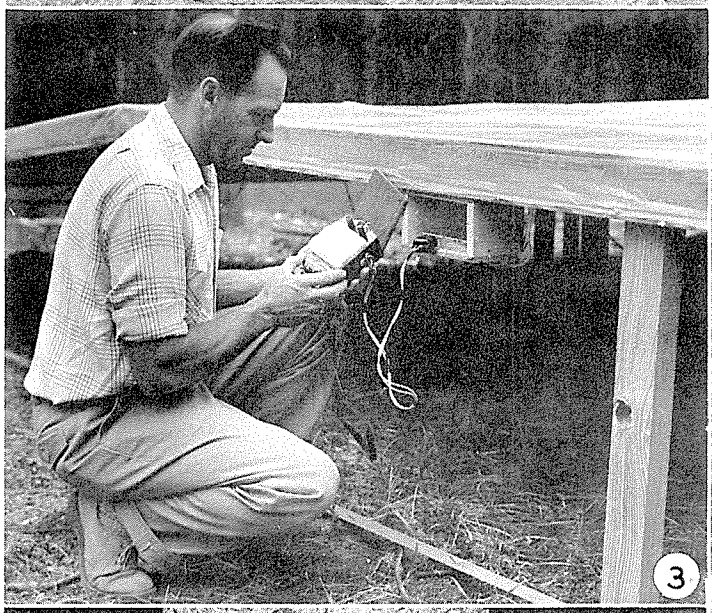
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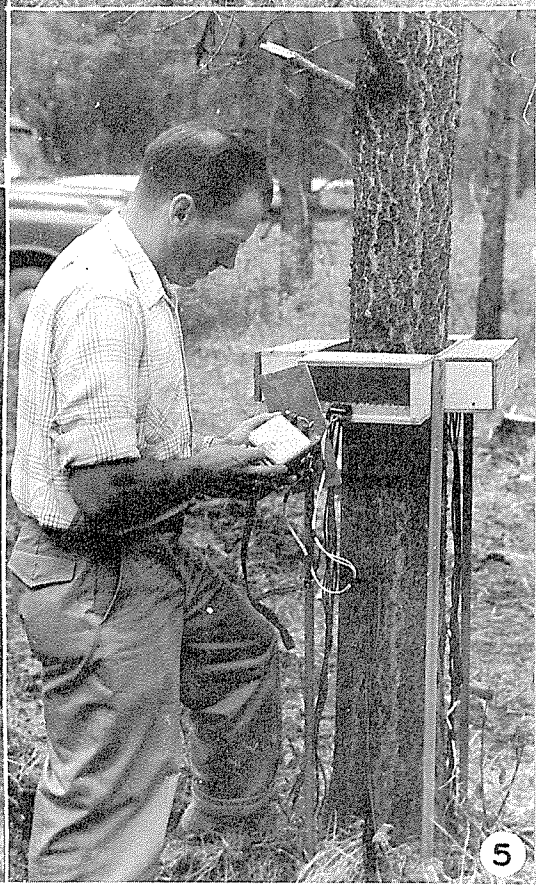
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