on the majority of the common crops in this section, and it will
certainly be difficult to raise a spring crop next season in fields
where the beetles have been abundant this summer.

PROGRESS REPORT ON DUSTS CONTAINING ROTENONE
FOR THE CONTROL OF FLEA BEETLES ATTACKING
SHADE-GROWN CIGAR-WRAPPER TOBACCO

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From information obtained thus far it appears that dust
mixtures containing rotenone have established their value in
combating flea beetles upon shade-grown cigar-wrapper tobacco,
especially the types of tobacco grown in northern Florida, southern
Georgia, and the Connecticut Valley. In the Georgia and
Florida producing region the crop is attacked by the tobacco
flea beetle (Epitrix parvula F.), while in the Connecticut Valley
the potato flea beetle (E. cucumeris Harr.) is the attacking
species. While dust mixtures made from ground derris root
will apparently exert a control quite similar to that of cube root
powder, the latter material thus far has been used almost
exclusively in investigational work and in commercial control
operations, owing to its lower cost.

The advantages of rotenone dust mixtures.—The three main
advantages of the rotenone-bearing dust mixtures made of cube
powder over the insecticides used previously to control flea
beetles on shade-grown cigar-wrapper tobacco are speed of action,
safety to the crop, and absence of objectionable residue, com-
bined with a relatively high toxicity to the insect. A quick kill
of flea beetles is essential in the case of wrapper tobacco, where
the leaves are the marketable part of the crop and where even
a few small holes detract from the value of the cured product.
The rotenone dust mixtures meet this requirement to a greater
extent than any of the materials utilized previously for flea
beetle control. Safety to foliage is a most exacting requirement
for an insecticide to be used in the culture of wrapper tobacco.
Any insecticide that has a tendency to burn, bleach, or discolor
the leaves to a noticeable degree is automatically eliminated
from further consideration. The question of residue on the crop,
resulting from insecticidal applications, is likely to assume even greater importance in the future.

The disadvantages of rotenone dust mixtures.—The outstanding disadvantage of this material is that its efficiency is of short duration under the conditions imposed in tobacco shades. During the month of May 1936 a limited series of experiments designed to show the deteriorating effect of sunlight upon cube was carried out with three samples of dust mixtures containing 1.5, 1, and 0.5 percent of rotenone, respectively. Each dust mixture was applied carefully to the foliage of a different half-grown potted tobacco plant in such a manner that a very light film of the material was visible upon the leaf surface. The plants were kept beneath a cloth tobacco shade from 8 a.m. to 5 p.m. each day of the exposure period, with the exception of a few short rainy periods, at which times they were removed to a closed shed. They were also placed within the closed shed each night to protect them from the washing effect of dew or possible rains.

Immediately after the dust applications had been made, one half of a 12-inch leaf was removed from each of the three treated plants and from an untreated check plant. These leaf parts, each containing approximately 40 square inches of leaf surface, were placed within large lantern globes protected from direct sunlight. One hundred tobacco flea beetles (Epitrix parvula F.) were then introduced into each cage. Forty-eight hours later the beetle mortality was determined in each of the cages. Similar-sized leaf parts were removed from each of the plants after exposure to the sun for 24, 42, and 50 hours, respectively, and the toxicity of the dust-mixture residue was determined in the manner just described. The results of these tests indicated that the cube dust mixture containing 1 percent of rotenone exerted a 74 percent kill of the flea beetles after an exposure of 24 hours to sunlight, which was about the equivalent of 2 days of cloudless exposure. This work also indicated that the dust mixture containing 1.5 percent of rotenone maintained its toxicity much longer than the 0.5 percent material.

From the information now available it appears probable that the effectiveness of cube dust mixtures containing 1 percent of rotenone is limited to about 3 days under field conditions. The value of cigar-wraper tobacco, however, is comparatively high, and frequent applications of the poison are justified in order that the flea beetles may be controlled.
Cube is not toxic to grasshoppers and it exerts only a very limited control of the tobacco hornworms (*Protoparce* spp.) and the tobacco budworm (*Heliothis virescens* L.). Applications of paris green, which are made occasionally to shade-grown tobacco for flea beetle control, aid materially in the control of the above-mentioned pests.1 The outstanding disadvantage of paris green, however, is the burning hazard which attends its use even under the most favorable conditions. Barium fluosilicate, which is used frequently and is effective in controlling flea beetles upon newly set tobacco, is also very effective in controlling grasshoppers on the young plants.2 The use of this insecticide upon large wrapper tobacco is hazardous, however, since it may cause burning of the leaves under certain weather conditions.

**Dilution of cube root powder and dosage rates.**—Preliminary field tests conducted during 1934 and 1935 indicated that a cube dust mixture with a rotenone content of approximately 1 percent is effective in controlling flea beetles on cigar tobacco. During 1936 additional data were obtained from an experiment performed in a 1½-acre shade of tobacco grown under contract by the North Florida Experiment Station, to determine the relative toxicity to the tobacco flea beetle of three cube dust mixtures containing 0.5, 1, and 1.5 percent of rotenone, respectively. The dust mixtures were applied by a hand duster to individual plots, 69 feet wide by 50 feet long, arranged as a Latin square. Each treatment was replicated three times and a series of four untreated check plots was included. Previous experience has shown that counts of living or dead flea beetles made within the dense growth of a tobacco shade are of questionable accuracy. For this reason the effectiveness of the three treatments was determined from the percentages of beetle-injured leaves. This work was facilitated greatly by spreading the cured sample leaves in a moist and pliable condition upon a large glass plate which was illuminated from below. Five applications of the dust mixtures were made during the season, at the rate of 7 pounds per acre per application. No attempt was made in this experiment to obtain a complete control of the beetles, since a sufficient degree of feeding was desired so that significant comparisons could be made. The applications of the insecticides


were delayed, therefore, until the progeny of the over-wintered beetles had emerged from the soil.

The results, which are given in Table 1, show that relatively light applications of a cube dust mixture exert a marked controlling effect against the tobacco flea beetle. They also indicate that dust mixtures containing 1 and 1.5 percent of rotenone, respectively, exert a greater controlling effect upon the insect than a dust mixture containing 0.5 percent of rotenone. The data should not be construed, however, as indicating the necessity of using dust mixtures containing 1.5 percent of rotenone, since it is possible that commercial control may be obtained with material of lower rotenone content applied at the proper intervals. Until additional data are obtained it seems desirable to continue the present recommendations of a 1 percent rotenone-bearing dust mixture for the control of flea beetles upon shade-grown cigar-wrapper tobacco.

**Table 1.**—The Percentage of Tobacco Leaves Injured by Flea Beetles When Treated with Dust Mixtures Containing Various Percentages of Rotenone.

<table>
<thead>
<tr>
<th>Rotenone content of dust mixture</th>
<th>Injured leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent</td>
<td>Mean percent</td>
</tr>
<tr>
<td>1.5</td>
<td>20.5</td>
</tr>
<tr>
<td>1.0</td>
<td>31.9</td>
</tr>
<tr>
<td>0.5</td>
<td>44.1</td>
</tr>
<tr>
<td>Check</td>
<td>75.2</td>
</tr>
</tbody>
</table>

Rotenone dust mixtures appear to kill flea beetles principally because the irritating properties of this insecticide impel the beetles to "clean up" after coming in contact with it. Dosages of this insecticide should, therefore, be sufficient to give good coverage of the plants. For newly set tobacco plants a dosage of 4 or 5 pounds per acre should be sufficient, while in the mature crop a dosage of 8 to 10 pounds per acre is believed necessary.

Choice of diluent.—Finely ground Georgia clay, kaolin, or diatomaceous earth may be used as the diluent for cube root powder when the dust mixture is to be applied to newly set tobacco. The application of these white-colored materials to the maturing crop may, however, cause a discoloration of the cured product. Experiments have shown that finely ground tobacco dust is a satisfactory diluent for use on cigar-wrapper
tobacco, and it leaves no discoloration. While the addition of a small proportion of clay to the tobacco dust may improve its physical qualities, the quantity of clay added should not be sufficient to change perceptibly the brown color of the tobacco dust. Tobacco dust used for this purpose should be certified by the manufacturer as being sterilized and free from pathogenic organisms which might spread tobacco diseases.

Time of day for applications.—While positive proof is not yet available, the writers are of the opinion that cube dust mixtures should be applied to cigar-wraper tobacco early in the morning, late in the afternoon, or in the evening (Fig. 1). Weather conditions are usually most favorable for efficient dust applications during these hours of the day and the dust mixture appears to be more effective under moist than under dry conditions. Growers in the Florida area have found this true in practice and frequently apply the dust mixture to their tobacco crops immediately after a light rainfall. The safety of the material under these critical conditions is in marked contrast to the insecticides formerly used to combat flea beetles. Since maturing shade-grown tobacco is frequently damp for a large proportion of the day, the safety of rotenone-bearing dust mixtures under these conditions is a great advantage.

Fig. 1.—Applying cube dust mixture to maturing shade-grown cigar-wraper tobacco for the control of the tobacco flea beetle.