CHARACTERISTICS AND RADIOPHGRAPHIC DETECTION
OF SEED BUG DAMAGE TO SLASH PINE SEED

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ABSTRACT

A leaf-footed bug, Leptoglossus cuculcus (Say), and the shield-back bug, Tetyra bipunctata (H. + S.), feed on seeds of the major pine species grown in seed orchards in the Southeast. Characteristic of the inconspicuous damage caused by these seed bugs are described, along with the use of radiography to detect damage in mature seed. At least 82% as many damaged seeds were detected on radiographs as could be detected in ocular examination at 60X.

In my research on seed orchard insects the need arose for a simple, accurate method of detecting inconspicuous seed damage by two sucking insects: a leaf-footed bug, Leptoglossus cuculcus (Say) (Hemiptera: Coreidae), and the shield-back bug, Tetyra bipunctata (H. + S.) (Hemiptera: Pentatomidae) (Fig. 1). Gilbert et al. (1967) studied the biomics of T. bipunctata in association with jack pine, Pinus banksiana Lamb., and suggested that this species feed on developing pine seeds. DeBarr (1967) first

Fig. 1.—Left: adult of the leaf-footed bug, Leptoglossus cuculcus (Say); right: adult of the shield-back bug, Tetyra bipunctata (H. + S.).

This paper describes the characteristics of slash pine seed damage by *L. corculus* and *T. bipunctata*, along with results of an evaluation of radiography for detecting damage in mature seed.

**SEED DAMAGE**

*Leptoglossus corculus* and *T. bipunctata* are well adapted to feeding on pine seeds. Their mouth parts consist of a long, slender proboscis containing a bundle of 4 interlocking, bristle-like stylets encased in a retractable sheath. To reach a seed lying along the cone axis within a closed cone, the insect inserts its stylet bundle through alternate layers of cone scales and seed wings (Fig. 2). Punctured cone scales seldom exhibit external symp-

![Fig. 2.—Longitudinal diagram of a slash pine cone showing how the stylets of seed bugs penetrate alternate layers of cone scales and seed wings to puncture seeds lying along the cone axis.](image)

...tons that might indicate the presence of damaged seeds within a cone.

Damaged seeds also lack conspicuous symptoms; the stylet puncture hole in the seedcoat is the only visible external evidence of seed damage. On a dark-colored seedcoat the damage often appears as a minute white fleck, $0.29 \pm 0.08$ mm in diameter (Fig. 3a). This fleck is caused by partial digestion of the seedcoat by the insect’s saliva. Located in the center of the fleck is a puncture hole, $0.06 \pm 0.01$ mm in diameter (Fig. 3b). In some cases, however, the puncture hole closes after the stylets are withdrawn. If damage occurs before the seedcoat is completely developed, the hole is difficult to detect.

Damage to the endosperm varies with the length of time the insect feeds. When feeding is undisturbed, the entire endosperm can be reduced to a shrunken remnant. If the insect withdraws its stylets shortly after penetrating the seedcoat, only a small necrotic area develops in the endo-
sperm beneath the puncture hole. But, even slight damage to the endosperm may reduce the chance that a seed will germinate successfully. In addition, the puncture hole in the seedcoat also provides an entrance port for pathogens.
Fig. 3b.—Enlarged view of the flecks in fig. 3a showing holes where insect’s stylets penetrated the seedcoat.

**Damage Detection**

Unopened, second-year cones of slash pine were collected from 2 trees about 2 weeks prior to cone-maturity, and stored at 2°C. During a period of 4 months these cones were periodically removed from cold storage and used to maintain laboratory colonies of nymphs and adults of _L. corculus_ and _T. bipunctata_. The cones were placed in 1-gal. glass jars and exposed to colonies of feeding insects for periods ranging from 7 to 28 days. Then the cones were removed and allowed to open fully; cones failing to open were dissected. The seeds from each cone were collected separately and stored in glass vials.

The seeds were glued in rows on sheets of white paper, which were placed directly over ready packs of type AA industrial X-ray film. Exposures were made with a Picker Industrial X-ray unit, Model No. 805D at 15 KV, 3 ma, 6 sec. at a 30-inch focal-film distance.

Radiographs were evaluated on a small light box. Based on the radiographic image (Fig. 4), each seed was classified as:

A. *Sound*—Endosperm undamaged; no necrotic areas; appeared a solid white.

B. *Hollow*—Seeds empty; no necrotic areas or collapsed endosperm; trace of shriveled, aborted gametophyte present.

C. *Damaged by seed bugs*—Endosperm partially destroyed; often with small, dark, necrotic areas; endosperm shrunken, partially collapsed, or almost entirely missing.
D. Damaged by the slash pine seedworm—Endosperm destroyed; packed with granular larval frass; frass often appeared as grey concentric rings.

To evaluate accuracy of the radiographic interpretations, each seedcoat was examined ocularly using 60X magnification and determined to be:

1. Not damaged by insects—Seedcoat without a styllet puncture hole or seedworm larval entrance or exit hole.

2. Damaged by seed bugs—Seedcoat with a styllet puncture hole.

3. Damaged by seedworms—Seedcoat with the characteristic seedworm larval entrance or exit hole.

A total of 2,956 seeds from 62 cones exposed to the 2 laboratory insect colonies was examined ocularly and radiographically. In addition, a random sample of 10 slash pine cones was collected from an orchard where L. cornulus and T. bipunctata had been observed on numerous occasions. The seeds were extracted and classified as described above. The radiographic interpretations were then compared with the ocular examinations.

RESULTS

For cones exposed to the laboratory colonies, the radiographic technique provided 92% accuracy or better in distinguishing sound seeds, naturally hollow seeds, and seeds damaged by seed bugs or by seedworms. Radiographic and ocular examinations yielded similar counts of seeds in each category (Table 1).

1Laspeyresia anaranjada Miller (Lepidoptera: Olethreutidae).
<table>
<thead>
<tr>
<th>Seed bug species</th>
<th>Sample size</th>
<th>Classification technique</th>
<th>Classification of seed</th>
<th>Not damaged by insects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cones</td>
<td>Seeds</td>
<td>Bug damaged</td>
<td>Seedworm damaged</td>
</tr>
<tr>
<td>T. bipunctata</td>
<td>35</td>
<td>1,395</td>
<td>X-ray</td>
<td>497</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ocular</td>
<td>485</td>
</tr>
<tr>
<td>L. corculus</td>
<td>27</td>
<td>1,561</td>
<td>X-ray</td>
<td>451</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ocular</td>
<td>404</td>
</tr>
<tr>
<td>Both species</td>
<td>62</td>
<td>2,956</td>
<td>X-ray</td>
<td>948</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ocular</td>
<td>889</td>
</tr>
</tbody>
</table>
### TABLE 2. — Classification of seed damage detected by ocular (60X) and radiographic methods.

<table>
<thead>
<tr>
<th>Ocular classification</th>
<th>Total seed in each class by ocular examination</th>
<th>X-ray classification</th>
<th>Seed misclassified by X-ray**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sound</td>
<td>Naturally hollow</td>
<td>Bug-damaged</td>
</tr>
<tr>
<td>Not damaged by insects</td>
<td>1,987</td>
<td>1,189*</td>
<td>663*</td>
</tr>
<tr>
<td>Bug-damaged</td>
<td>889</td>
<td>0</td>
<td>83</td>
</tr>
<tr>
<td>Seedworm-damaged</td>
<td>80</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>2,956</td>
<td>1,189</td>
<td>749</td>
</tr>
</tbody>
</table>

*Number of seed correctly classified by X-ray.

**Seed misclassified by X-ray = total number of seed in each ocular classification minus the number correctly classified by X-ray.
None of the seeds identified as sound on the radiographs exhibited the puncture hole. On the radiographs, 948 seeds were classified as damaged by seed bugs (Table 2). Ocular examination of these seeds revealed that 1% was damaged by seedworms and 85% damaged by seed bugs. The remaining 14% of the 948 seeds had no puncture holes. These seeds were cut open; more than half had shrunken or collapsed endosperms, many of which were covered with fungal mycelium.

Of the seeds classified as hollow on the basis of radiographs, 11% had a puncture hole in their seedcoats. These seeds may have been severely damaged by insects or could have been empty before the insects penetrated them.

**DISCUSSION**

Overall there was close congruity between the radiographic detection of seed bug damage and ocular detection of damage. Ninety-one percent of the seed damaged by seed bugs in the laboratory and 82% of those damaged in the field were correctly distinguished on the radiographs. Severely fed-upon seeds, or seeds damaged in the early stages of their development are not always distinguishable from naturally hollow seeds. Thus, estimates of seed bug damage based on radiographs of mature seed are conservative. On radiographs, seedworm damage was easily distinguished from seed bug damage.

Mature slash pine seeds show no obvious external evidence of damage by *L. corculus* and *T. bipunctata*. The minute stylet puncture hole in the seedcoat is the only reliable visible indication of seed damage, and it can only be observed by time-consuming scrutiny of each individual seedcoat under considerable magnification. Although future studies are needed to evaluate the extent of seed bug damage to immature seeds, radiography, for the present, should prove to be a valuable tool for forest entomologists involved in damage surveys and in research on sucking insects destroying pine seeds. It can be used in slash pine seed orchards and production areas as a survey method to scan quickly large samples of seed and detect seed bug damage. In addition, it should provide researchers with an efficient method of evaluating the effectiveness of insecticides for seed bug control in orchards because of the rapidity with which the presence of damaged seed can be detected.

**ACKNOWLEDGEMENTS**

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**LITERATURE CITED**


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