LAUDANI, ET AL: INSECT PROBLEM 191

posure is also shown for temporary storage between production and long distance trans-

portation.

The total equivalent of each step calculates to 142.5 hours or about a 6-day exposure at

35°F. An examination of Fig. 10 shows that such an exposure will produce severe cloud

loss and most likely a No. 3 gel in some commercial concentrates. The same slides show

that properly protected concentrate will with-

stand the total exposures described above.

Fig. 14 shows the relative contribution to

high temperature exposure of each step in

warehousing and distribution. It is obvious

that the operations centered around the break-

up operation should get, and are getting, first

attention. Improvements in refrigerator freezer

compartments are also in progress.

We may conclude, therefore, that occasion-

ally orange concentrate processed in Florida
does not have sufficient protection built into
the product to withstand the rigors of present
warehousing and distribution practices. Al-

though concerted efforts are being made and

will continue to be made to improve distribu-
tion practices, we feel it is up to the processor
to pack his product so that it will withstand
present-day handling.

DRIED CITRUS PULP INSECT PROBLEM AND ITS POSSIBLE SOLUTION WITH INSECTICIDE-

COATED PAPER BAGS

Hamilton Laudani, Dean F. Davis
George R. Swank, and A. H. Yeomans¹

Stored-Product Insects Laboratory
Savannah, Georgia

During the early days of processing citrus
pulp into animal feed, the bulk of the feed
was disposed of immediately. Very little, if
any, went into storage. With the recent ex-
pansion of the citrus juice concentrate indus-
try, and the demand for a continuous supply
of citrus pulp and meal animal feed, year-
round storage became necessary. Long-term
storage has created a serious warehouse insect
problem because citrus pulp and meal are
very susceptible to insect infestation.

Why is the insect problem serious?

Insects pose a serious problem to the animal-
feed producer for several reasons. The feed
actually can be destroyed by insects or its
composition changed so that the feed is un-
derirable from a handling standpoint or un-
acceptable to the animals. The presence of in-
sects in any food makes the commodity un-
desirable to shippers, warehousemen, and the
consumer because of the danger of spreading
the infestation to other commodities in the
vicinity.

Insect species involved

During the past 3 years the authors have
conducted surveys in several dried-citrus-pulp
storage warehouses throughout Florida and
determined what insect species are infesting
the various types of pulp that are stored.
These studies have shown that the saw-
toothed grain beetle, Oryzaephilus surinam-
sis (L.), is the primary species almost always
associated with the coarse grind pulp. The
cigarette beetle, Lasioderma serricorne (F.),
is the species which most commonly attacks
pellets and fine-grind meals. The Indian-meal
moth, Plodia interpunctella (Hbn.), the Ang-
goumois grain moth, Sitotroga cerealella
(Oliv.), the Mediterranean flour moth, Ana-
gasta kuhniella (Zell.), and the almond moth,
Ephestia cautella (Wlk.), are commonly
found in the coarse material but have been
found in the fine-grind meals at some loca-
tions. Other insect species which have been
found in dried citrus pulp are the confused
and red flour beetles, Tribolium confusum
Duv. and T. castaneum (Hbst.), and the flat
grain beetle, Laemophloeus pusillus (Schonh).

¹The authors are with the U. S. Department of
Agriculture, Agricultural Marketing Service, Market-
Ing Research Division, Stored-Product Insects Sec-
tion, Savannah, Ga.
Control measures being used

Based on the results of the surveys described above and on previous experience with similar food products, several recommendations were made to the citrus industry for use in combating its warehouse insect problem. Many of the industry members are practicing the following recommendations:

1. Sanitation. Before moving new material into storage, thoroughly clean the warehouse. Sweep down walls, rafters, beams, and other parts of the building where old feed or dust can lodge. Remove all accumulated refuse from the warehouse. Clean up spillage and trash near the warehouse. Burn, bury, or remove from the premises all refuse collected in these operations.

2. Residual sprays. Apply a residual DDT, methoxychlor, or TDE spray to the interior of the empty warehouse, covering floors, walls, beams, and ceiling; to the outside of the building on the walls up to a height of 6 to 8 feet; and to the ground to a distance of 6 feet from the building. Use these insecticides at a concentration of 2.5 percent applied at a rate of 2 gallons per 1,000 square feet. This concentration can be obtained by adding 1 quart of a 25-percent emulsifiable concentrate or 1 pound of 50-percent wettable powder to 2/2 gallons of water.


4. Periodic application of aerosol. Aerosol applications should be started as soon as the first load of dried pulp is placed in the warehouse and applied each week for the duration of the storage period. Applying insecticides in the form of an aerosol is relatively inexpensive, rapid, and very effective in getting good distribution in a filled warehouse. Aerosols must be considered only as a preventive measure, not a cure. Their purpose is to kill the insects before they can infest the stored feed. Once the insects get a foothold, particularly those that work deep into the bags, the aerosol applications are not very effective since they contact only those adults that crawl on the surfaces or fly above the stacks.

The mechanical aerosol generators generally produce larger insecticide particles than the thermal type and are, therefore, more suitable for use in warehouses that are not very air tight. The larger particles settle out fairly quickly and do not travel far from their source. These two factors make it necessary to "walk" mechanical aerosol dispensers through the larger warehouses in order to get good distribution. On the other hand, the thermal aerosol generators are capable of dispensing the insecticide in the form of very small particles which stay suspended in the air a relatively long time and travel a long distance before settling out. These two factors insure a good distribution of the insecticide throughout a large warehouse, provided it is fairly air tight. Size of the warehouse, number to be treated, type of construction, personnel available, and other factors should be considered when selecting the type and size of the aerosol generator.

The most suitable insecticide formulation to be used depends on the type of generator available. For the mechanical type the following formula is recommended: Pyrethrins (0.5 percent by weight), synergist (piperonyl butoxide, sulfoxide, n-propyl isome, or MGK 264-5.0 percent), tetrachloroethylene (50.0 percent), and deodorized kerosene (44.5 percent). This should be applied at the rate of 1 pint per 10,000 cu. ft. of free air space in the warehouse. For the thermal type of generator the following formula is recommended: Pyrethrins (0.2 percent by weight), synergist (2.0 percent), tetrachloroethylene (50.0 percent), and deodorized kerosene (47.8 percent). This should be applied at the rate of 2½ pints per 10,000 cu. ft. of free air space in the warehouse. The generators should be set for small particles, about 5 to 10 microns mass median diameter. The aerosol should be released into the building from the windward side so that good distribution will be obtained.

For the past two years, many of the producers have followed to some degree the recommendations given above. The preventive measures taken have greatly helped in keeping down the infestations but have not been entirely effective. The reasons for most of the failures have been interruptions in the aerosol schedule and the introduction of badly-infested pulp or other animal feed into the warehouse. As mentioned before, the insecticide which is presently being recommended and used is not effective for controlling insect infestations under such adverse conditions,
but should be used to prevent the establishment of an infestation in clean feed.

Limitations in insecticides which can be used

Why cannot a more effective insecticide be used? Animal feed is considered a processed commodity and therefore falls under the jurisdiction of Section 406 of the Food, Drug, and Cosmetic Act. It should not contain any insecticide residue, because no tolerances have yet been established for such products. The necessity for protecting the feed against insect damage has been recognized and therefore the use of synergized pyrethrum, which is relatively non-toxic to humans and animals and has tolerances established for similar uses, is temporarily permitted. Steps should be taken to establish a tolerance in citrus pulp as soon as possible.

There are a number of other insecticides available which might be more effective in preventing an insect infestation. Before they can be recommended to and used by industry, however, much basic work has to be conducted to determine (1) their effectiveness to prevent or control the insects involved; (2) the residues produced in feed when the insecticides are applied in the quantity and frequency required to give satisfactory insect control; and (3) whether these residues are harmful to the animals or to the consumer of the milk and meat. These detailed data must be obtained and presented to the Food and Drug Administration for consideration before these materials can be recommended for use. Research on these phases of the problem is being conducted at the present time on a limited scale. It is hoped that the work can be expanded.

Insecticide-coated multiwalled paper bags

Because of the above-mentioned limitations and restrictions, the immediate answer to the citrus-pulp insect problem is the use of insect-resistant paper bags. Large-scale testing of insecticide-coated bags for the protection of flour and other foods was started in 1948-49 at the request of the Office of the Quartermaster General, U. S. Army. These tests showed that bags coated with synergized pyrethrum, methoxychlor, or lindane were effective in preventing flour from becoming infested for 9 to 12 months, even when exposed to very heavy insect infestations (Laudani and Davis, 1955). Subsequent tests confirmed these results and also showed that insect-tight closures and treated thread and tape were necessary to obtain maximum protection (Davis and Laudani, 1956). Based on the results of these tests, the use of pyrethrum-coated multiwalled paper bags for packaging flour was accepted by the Food and Drug Administration and the U. S. Army Quartermaster. The ultimate use of lindane and methoxychlor will depend upon whether these two materials migrate through the bags and, if so, to what extent. Tests are now underway to obtain this information. The substitution of either of these two materials for synergized pyrethrum will reduce the cost of treated bags significantly.

Tests have been conducted also to evaluate the protection rendered by the insect-resistant treatment on burlap bags. The results have shown that little or no protection results from using the insecticides which are presently permissible for this use.

Tests with treated bags containing citrus pulp

Storage tests were conducted to determine specifically whether multiwalled paper bags coated with the recommended insecticide coating (5 mg./sq. ft. of pyrethrins plus 50 mg./sq. ft. of piperonyl butoxide) would protect bagged citrus meal against insect infestation. The test bags and citrus meal were supplied by the Minute Maid Corporation, Plymouth, Florida, and the storage tests were conducted at and by the Savannah Stored-Product Insects Laboratory.

The insecticide-treated kraft paper bags were obtained from regular commercial stock and were of 100-pound capacity, 4-ply, and the open-mouth type. The bags used as controls were exactly the same except that no insecticide treatment was present.

The citrus meal was fumigated with methyl bromide to make certain that the feed was insect-free. As each test bag was filled, it was closed by sewing through untreated paper tape which was folded over the open end of the bag.

The bags were stored in a room which had a very heavy infestation of 15 species of stored-product insects, including those previously listed as commonly infesting citrus pulp.

Inspections were made after 3, 6, 9, and 12 months of storage. Each inspection consisted
of sampling four treated and four untreated bags to determine the level of insect infestation and the number of insect penetrations in each bag. As shown in Table 1, no insect penetrations were present on any of the treated bags, whereas a total of 24 and 60 penetrations were present on the untreated bags at 9 and 12 months respectively. The calculated infestation in the treated bags was 7 and 24 insects at 9 and 12 months, respectively, as compared with 48 and 1,246 insects in the untreated bags.

Based on the results of the tests described, the recommended insect-resistant bag should have 5 mg./sq. ft. of pyrethrins and 50 mg./sq. ft. of piperonyl butoxide on the surface of the outer ply of multiwalled paper bags and synergized pyrethrum-treated thread and tape with a tape-over-stitching closure.

Table 1. Insect penetrations counted and insects estimated in insecticide-treated and untreated paper bags containing citrus pulp and exposed for 1 year in a room heavily infested with stored-product insects

<table>
<thead>
<tr>
<th>Bags</th>
<th>Insect penetrations</th>
<th>Calculated infestation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Treated</td>
<td>Untreated</td>
</tr>
<tr>
<td></td>
<td>Number</td>
<td>Number</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>After 9 months' exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>After 12 months' exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

The continuous protection rendered over a period of one year by insect-resistant bags offers many advantages. First, the protection given by insect-resistant bags extends from producer to the consumer; while in the producer's warehouse, during transit, while in the wholesaler's or retailer's warehouse, and while in the consumer's storage bin. Second, the use of insect-resistant bags eliminates the expensive space treatments and preshipment fumigations; thus, the protection obtained is not only greater but considerably less costly. Third, the use of insect-resistant bags will practically eliminate the discarding of the badly-infested end-of-the-year stock and the costly moving of infested stock out of warehouses where new feed is to be stored. Fourth, by keeping the feed insect-free, the insect-resistant bags will maintain the high feed value and physical quality of the citrus pulp. Fifth, by maintaining the feed insect-free, the use of insect-resistant bags will tend to increase the dealers' and consumers' acceptance of the product as an animal feed, and will make it a more acceptable product to warehousemen.

**LITERATURE CITED**


---

**Vegetable Section**

**PROGRESS REPORT ON CANTALOUPE VARIETIES**

B. F. Whitner, Jr.

*Central Florida Experiment Station*

Sanford

The cantaloupe industry is growing, with an annual value in excess of fifty million dollars. With the development of a melon that will consistently produce a high quality fruit, we can expect an even greater demand.

There is a gradual increase in the acreage planted in Florida despite the risk entailed in their production. Some of the problems faced by the grower have been alleviated or solved by the introduction of varieties resistant to one or more diseases. New fungicides and insecticides have helped much. However, before our state can hope to develop a really large scale cantaloupe production, we must have varieties more suitable to our conditions.

The high humidity of Florida and the coastal regions of the southeastern part of our country offer particularly hard problems to solve. Diseases attacking vines and fruit are often severe. A healthy vine is necessary for the production of quality fruit. In the past a solution or partial solution to one problem has left another to assert itself. The introduction of the Smith Perfect with its considerable resistance to downy mildew, increased the length of vine life, permitting powdery mildew to become destructive. Mr. Frank Van Haltern of the Georgia Experiment Station made an outstanding contribution by combining, in Georgia 47, a resistance to both downy mildew, powdery mildew, and some lesser diseases. Then gummy stem blight (*Mycosphaerella melonis*) showed its remarkable power of destruction. No variety seems to offer any resistance to it. Then, often when melons have been brought successfully to maturity, fruit rots, soil or airborne, take a heavy toll.

Vagaries of the weather, temperature and rainfall, soil type, horticultural practices and the ability of the grower to bring about favorable conditions are very pointedly involved in successfully producing this crop.

Florida needs varieties that are vigorous and hardy, high yielding, and adaptable to as wide a range of moisture conditions as possible.