SIMULATED MARKETING TESTS WITH PREPACKAGED CITRUS

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Abstract

A preliminary holding test using lemons indicated that differences in decay due to the degree of ventilation of consumer packages persist, although these packages are enclosed in bag-master cartons for as long as 4 weeks. Simulated marketing tests were used to study keeping quality of 5 types of citrus fruits in 5 types of consumer package, with and without fungicides. Decay was least in the Vexar net bag, followed by an experimental 144-hole, 2-mil polyethylene bag. 2-Aminobutane used in vapor form, either as a prefumigation treatment for fruit to be bagged or as an aerosol spray applied to shrink-film trays prior to packing, provided more consistent decay control than did diphenyl. The most successful combination was prefumigation with 2-aminobutane followed by packaging in Vexar net bags. Average losses for fruit so treated were 0.2% at simulated "retail sale" and 5.1% after 1 week under simulated "fruit bowl" conditions. Nevertheless, even at these low levels of decay, the "retailer" had 2% spoiled packages and one-third of the "fruit bowls" had one or more rotten fruit in the week after simulated "purchase."

Introduction

A report to this Society last year (4) described the Citrus Experiment Station's continuing program of research on response of various citrus varieties to consumer packaging. A second season's work is reported here. Review of literature and methods used are not restated, except for additional material or when methods were changed.

Materials and Methods

Fruit: Varieties and Sources

'Dancy' tangerines and 'Orlando' tangelos from commercial groves and 'Marsh' grapefruit and 'Murcotts' from the Citrus Experiment Station groves were prepared for packaging in the Experiment Station packinghouse. 'Bearss' lemons and 'Temples' were commercially grown and packed, in cartons and wire-bound boxes, respectively, prior to being procured for these studies. In every case, care was taken to see that the fruit received approximately the same treatments that they would have received in commerce.

Fruit Preparation

Standard packinghouse equipment was used. All fruit was washed, dried, and treated with Flavorseal 98, a commercial fruit wax. In addition, the 'Temples' received a Dowicide-A hexamine fungicidal treatment in the packinghouse and 'Bearss' lemons had been treated with diphenyl during preparation for market.

Two fungicidal treatments were used in connection with the packaging and simulated marketing experiments. Diphenyl was used as diphenyl pads, containing a total of approximately 4.5 grams of diphenyl, in each master container. Unlike the previous season, 2-aminobutane (2-AB) was not applied by commercial packinghouse methods. Much consumer packaging is done in warehouses or supermarkets, remote from the citrus packinghouse. Efforts were therefore made to develop methods which might also be suitable for packaging at stores and terminal markets where packinghouse equipment is not available for fruit treatment. When 2-AB was used with shrink-film trays, 2-AB (free base) was applied to the trays prior to packing using an aerosol can loaded with 2-AB and Freon as a propellant. The cans were weighed before and after each experiment. Treated trays were analyzed (6) for 2-AB to determine the amount of fungicide absorbed per package. The underside of each tray received a 2-second spray
averaging 2.23 grams of mixture containing 1.15 grams of 2-AB, of which only 0.03 grams was found per tray at time of packing. When 2-AB was used for bagged fruit, it was applied as a 24-hour fumigation treatment prior to packaging. The fruit was placed in a 60-cubic foot chamber in which 20 ml of 2-AB was evaporated at 60° F in the 24-hour period.

Packaging

Types of packages were as reported before (4) plus an additional experimental container. This was a 5-pound bag made of 2-mil polyethylene film and having 144 half-inch holes. This bag had 8 times the ventilation area of the standard polyethylene bag, which has 72 quarter-inch holes (3).

Packaging Procedure

All packaging was manual, the only packaging equipment used being the shrink tunnel for applying shrinkfilm to the paper trays. All shrinkfilm packages were open at both ends. The filled consumer packages were placed in master containers. Initially, 4/5-bushel telescope cartons were used as master containers, thereafter bagmaster cartons were used.

Holding Tests

There has been considerable discussion in trade circles as to whether the use of a master container eliminates inherent differences due to packaging in polyethylene film bags, as opposed to Vexar net bags. This was investigated in a preliminary experiment using 'Bearss' lemons. Size 95 lemons were packed in either 72-hole poly bags or Vexar net bags. Bag-master cartons were filled with either net bags or poly bags and stored, without opening, for 4 weeks at 60° F or at 70° F. This was repeated 4 times at 60° F and twice at 70° F, each time using 12 fruit per bag and 6 bags per carton.

Simulated Shipping and Marketing Tests

Twelve simulated shipping and marketing tests (runs) were conducted: 4 with 'Temples,' 5 with 'Murcotts,' and 1 each with 'Dancy' tangarsines, 'Orlando' tangelos, and 'Marsh' grapefruit. Ten fruit were used per package and 10 of each type of package were used in each run. Two exceptions occurred when fruit were too large to use 10 per package. These were the single runs with 'Orlando' tangelos and 'Marsh' grapefruit.

Simulated shipping conditions were at 40° F. "Retail sale" conditions and the "fruit bowl" conditions for the simulated week after "purchase" were at 70° F. Any packages having one or more decayed fruit at the "retail sale" examination were recorded and discarded, on the principle that an observant customer would not have purchased them. Thus, all packages continuing into the second week (in the "customer's home") were sound and free of decay at time of "purchase."

RESULTS

Results are presented in 2 ways: percentage of decayed fruit is presented in Tables 1 and 2. For the 2 principal varieties used in this study ('Temples' and 'Murcotts'), bar charts present comparisons in terms of percentage of "spoiled packages" (Figure 1). "Spoiled packages" describes those that had one or more rots at time of simulated retail sale, or samples in which one or more rots developed under "fruit bowl" conditions during the week after "purchase."

The contrast between percentage decayed fruit and percentage spoiled packages was very marked and affords a measure of the importance of consumer packages in multiplying the hazards of decay since the entire package has to be discarded or reworked at a financial loss.

"Bagmaster Effect"

The preliminary experiment with lemons indicated that the enclosure of the bagged fruit in bagmaster cartons did not efface the difference between containers as far as stem-end rot (1) was concerned (Table 1). Even after 4 weeks in an enclosed carton at 70° F, stem-end rot was 4 times greater in the poly bags than in the Vexar bags. Differences in losses due to Penicillium mold were inconsistent, but over-all differences in decay due to the type of consumer package were not obviated by the use of the master container.

Table 1. Percentage decay in 'Bearss' lemons stored for 4 weeks in polyethylene film and Vexar net bags, both in bagmaster cartons.

<table>
<thead>
<tr>
<th>Type of bag</th>
<th>Stem-end Penicillium mold Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stored at 60° F</td>
</tr>
<tr>
<td>72-hole poly</td>
<td>1.4 14.6 16.0</td>
</tr>
<tr>
<td>Vexar net</td>
<td>0.0 10.4 10.4</td>
</tr>
<tr>
<td></td>
<td>Stored at 70° F</td>
</tr>
<tr>
<td>72-hole poly</td>
<td>12.5 8.4 20.9</td>
</tr>
<tr>
<td>Vexar net</td>
<td>2.8 9.7 12.5</td>
</tr>
</tbody>
</table>
Table 2. Percentage decayed fruit in various consumer packages during simulated shipping and marketing tests.

<table>
<thead>
<tr>
<th>Variety of fruit</th>
<th>No. of runs</th>
<th>At &quot;retail sale&quot;</th>
<th>During &quot;week after purchase&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Poly bags 72-144- hole</td>
<td>Vexar net hole</td>
</tr>
<tr>
<td>Dancy</td>
<td>1</td>
<td>1.0 -- 2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Orlando</td>
<td>1</td>
<td>6.0 -- 2.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Marsh</td>
<td>1</td>
<td>0.0 0.0 0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Temple</td>
<td>4</td>
<td>0.6 0.3 0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Murbott</td>
<td>5</td>
<td>0.2 0.4 0.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Weighted average</td>
<td></td>
<td>0.9 0.3 0.6</td>
<td>1.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variety of fruit</th>
<th>No. of runs</th>
<th>At &quot;retail sale&quot;</th>
<th>During &quot;week after purchase&quot;</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Poly bags 72-144- hole</td>
<td>Vexar net hole</td>
</tr>
<tr>
<td>Dancy</td>
<td>1</td>
<td>2.0 -- 2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Orlando</td>
<td>1</td>
<td>3.0 -- 2.0</td>
<td>4.0</td>
</tr>
<tr>
<td>Marsh</td>
<td>1</td>
<td>0.0 0.0 0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Temple</td>
<td>4</td>
<td>0.6 1.0 0.3</td>
<td>0.8</td>
</tr>
<tr>
<td>Murbott</td>
<td>5</td>
<td>0.2 0.2 0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Weighted average</td>
<td></td>
<td>0.8 0.4 0.4</td>
<td>0.8</td>
</tr>
</tbody>
</table>

"Consumer Package Effect"

On the average (Table 2), losses up to the time of "retail sale" were seldom over 1%. In the days prior to consumer packaging, this would have been considered extremely successful. However, the few rotten fruit were inevitably scattered through several containers and, expressed in terms of percentage of spoiled packages (Figure 1), losses were high enough to represent a considerable factor in reducing the retailer's profit.

Differences between containers, or due to the use of fungicides, were inconsistent at the "retail sale" level. This is not surprising when the losses, in terms of percentage of decayed fruit, were so low.

Losses increased sharply in the week after "purchase" during which the fruit were held under "fruit bowl" conditions at 70°F, although this temperature is probably cooler than most homes. Expressed in terms of those customers who had one or more decayed fruit, these losses become disconcerting. However, it should be remembered that, since the fruit would normally be consumed throughout this period, actual chances of a customer having a rotten fruit would probably be approximately half that shown in Figure 1.

Since all fruit were removed from the package at the first examination and then placed in open paper bags to simulate "fruit bowls," any subsequent differences between types of package are due to a residual effect of the container in which they were "shipped" and "sold." Differences between types of package were not as marked as they were last season (4), although the same relationship with degree of ventilation was maintained. Decay was, on the average, least in Vexar net bags in all 3 comparisons, i.e.: no fungicide; with diphenyl; and with 2-AB (Table 2).

Comparison Among Varieties

No true comparison among varieties is possible due to the difference in the number of runs for the various varieties and because the 'Temple's' had received a prior fungicidal treatment on a commercial packing line prior to being purchased for this experiment.

Effect of Fungicides

The most disconcerting result was the very low decay control when using diphenyl as a fungicide (Table 2). Very little decay control was
Fig. 1.—Average losses in simulated marketing experiments with 'Temples' (4 runs) and 'Murcotts' (5 runs). Losses at “retail sale” are expressed as percentage of packages unsalable because of one or more decayed fruit. Losses under “fruit bowl” conditions are expressed as percentage of samples that developed one or more rots during the week after “purchase.” (2-AB = 2-aminobutane; Poly = polyethylene bags with 72 quarter-inch holes; W.B. = polyethylene bags with 144 half-inch holes; Vexar = polyethylene net bags; I.S.F. = intact shrinkfilm; and P.S.F. = perforated shrinkfilm.)

obtained except with ‘Temples,’ in which decay was reduced by about 40%. In the single run with ‘Dancy’ tangerines, decay increased in shrinkfilm packaged tangerines to which diphenyl had been added.

2-Aminobutane proved far more effective, even though a certain amount of fruit was damaged due to inexpert application of this new fungicide.

**DISCUSSION**

The previous observation that decay tends to be higher in perforated film bags than in Vexar net bags was confirmed, with evidence that the effect was more marked on stem-end rot than on Penicillium mold. Handling such bagged citrus in master cartons did not obscure the difference in decay levels due to these 2 types of package. The difference between decay in perforated polyethylene bags and Vexar net bags was very much reduced when the new 2-mil bags with 144 half-inch holes were used instead of the usual 1¼-mil bags with 72 quarter-inch holes (5).

The increase in decay when diphenyl was used with shrinkfilm packaged ‘Dancy’ tangerines was not entirely unexpected. It has been found in previous experiments (5) that diphenyl used in more than minimal amounts, or with restricted ventilation, can be phytotoxic to tangerines. That diphenyl can cause a consistent increase in
respiration rate of sound oranges and lemons has been demonstrated by Eaks (2), but that the effect can nullify decay control has been demonstrated only for 'Dancy' tangerines (5).

Diphenyl provided considerably less decay control with all varieties than has been obtained in previous years and concern is felt lest this be associated with resistant strains of *Penicillium digitatum* recently reported by Smoot and Winston as being present in Florida (7). It may, however, be used another aspect of the marked variability between crops and seasons that is characteristic of this type of study with Florida citrus.

The new fungicide, 2-AB, continues to show promise, but it has not yet been approved by the Food and Drug Administration.

ACKNOWLEDGEMENTS

Appreciation is expressed to the Florida Fresh Citrus Shippers Association and Minute Maid Company for donations of fruit, to Mr. Haydn Leigh for donation of the 2-mil large hole bags, to the Crown Cork and Seal Corporation for preparing the aerosol cans of 2-AB, and to the Diamond National Corporation for donation of the trays to Reynolds Metals Co. for films used in shrink-film packaging.

LITERATURE CITED

3. Florida Citrus Commission. Regulation 105-1.03: Adoption and use of containers, including packs, stamping and marking of containers and fruits. Regulations pursuant to Chap. 601, Florida Statutes, as amended Aug. 9, 1967.

COST AND VOLUME RELATIONSHIPS FOR PICKING, HAULING, AND PACKING AND SELLING FLORIDA ORANGES

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ABSTRACT

The objectives of this paper were to estimate the long-run average cost curves for picking, hauling, and packing and selling Florida oranges and to examine the implications of these cost-volume relationships for the citrus industry. Estimates for the packing and selling operation were for oranges moving into the fresh market.

Specifically, cross-sectional and time series data were combined within the framework of covariance analysis to empirically verify the theoretical concept of an economic planning curve.

Statistical tests indicated that every volume coefficient in the estimated equations were significantly different from zero and consistent in sign with economic theory.

An analysis of the effects of technological improvements on long-run average costs indicated that over time the cost structure had shifted downward and to the right.

The results indicate that firms in the industry could decrease costs considerably by increasing their size of operation. The estimated functions indicated that the average firm was operating at 21, 17, and 38 per cent of an estimated "least cost" volume for picking, hauling, and packing and selling Florida oranges, respectively.