Picking and hauling oranges

Many of the estimated coefficients of zero-one variables were significantly different from zero at an acceptable level. This result substantiates the hypothesis that much of the variation in cost can be associated with firm and specific crop year differences.

In both the picking and hauling operation, volume showed a significant inverse relationship with costs in the range where firms were operating. This result substantiates the hypothesis that larger volumes can be picked and hauled at lower costs.

Packing and selling oranges

Again, many of the estimated coefficients of the zero-one variables were significantly different from zero and substantiated the hypothesis that much variation in costs can be associated with differences among firms and crop years.

Costs were affected by volume as evidenced by the significance of the estimated coefficients of volume. Over the period of the study, the firms operating at larger volumes experienced lower costs. Lower per unit costs gave the larger firms a stronger competitive position than the small firms when adequate supplies of fruit were available.

The method of analysis used in this study could be extended to analysis of costs for other products for which cost data have been collected—possibly (as in the case of this study) for another purpose. Since it uses existing data, the method provides an estimate of what happens to cost as volume increases for very little cost in terms of research time and money.

LITERATURE CITED


POSTHARVEST DECAY OF SPECIALTY HYBRID CITRUS FRUITS
IN RELATION TO DEGREEING TIME

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ABSTRACT

Fruits of specialty citrus hybrid varieties, including Robinson, Lee, Nova, and Page, reach minimum eating quality early in the fall before good color break has occurred. Fruit at this stage requires long ethylene degreening periods prior to packing. In tests conducted with fruit from both East Coast and interior groves of Florida, postharvest decay was directly related to length of degreening time. Excessive amounts of Diplodia and Phomopsis stem-end rot and anthracnose decay developed in fruit ethylened for 45 hours or more. Anthracnose was more prevalent in early-harvested than in more mature fruit and was not effectively reduced for standard decay-control treatments. Decay was minimized when harvesting was delayed until little or no degreening was needed.

INTRODUCTION

The specialty citrus varieties, Robinson, Lee, Nova, and Page, are hybrids released since 1960 by the U. S. Department of Agriculture (4, 5, 6, 7). Robinson, Lee, and Nova are hybrids of Clementine mandarin × Orlando tangelo, and Page is a hybrid of Minneola tangelo × Clementine mandarin. These varieties have been planted commercially in Florida since their release and are now bearing fruit in marketable quantities.

In Florida, fruits of these varieties reach...
minimum palatability in September and October before attaining a desirable orange rind color. At this stage of maturity, these fruits require extended periods of ethylene degreening prior to packing, a procedure that may increase the incidence of stem-end rot (2).

Several growers have experienced difficulty in shipping these specialty fruits to northern markets in acceptable condition due to decay. The purpose of this investigation was to determine the effect of external maturity, as evidenced by degreening time, and the date of picking on the subsequent development of postharvest decays.

**Materials and Methods**

The source of fruits of the four varieties used is shown in Table 1. All fruits were from commercial groves except fruit of the Page variety which was from the U. S. Department of Agriculture experiment farm near Leesburg, Fla. Robinson fruit was tested in the fall of 1964 and 1965, the other varieties during 1966.

Successive harvests of each variety were made during the fall season by clipping, beginning after the fruits reached a minimum palatability and a definite break in rind color had occurred. The earlier harvests were spot picked for best size and color as is commonly practiced for early-season fruits. Subsequent harvests were made from the same trees. Fruit was washed and dried in commercial equipment on the day picked. Fruit to be degreened was then placed in the coloring room and subjected to approximately 10 ppm ethylene gas at 85°F and 90% relative humidity. When sufficiently degreened for marketing, the fruit was removed from the coloring room, graded, and randomized into 2 lots of 100-125 fruits each. One lot was waxed only with a solvent-type wax; the other lot was treated with 1% 2-aminobutane (1), dried, and waxed. Samples were held at 70°F and inspected semi-weekly for rind breakdown and decay. Isolations of causal organisms were made in agar culture to confirm symptoms.

**Results**

**Robinson**

In 1964 Robinson fruit was harvested from two sources in mid-October and required 46 and 63 hours degreening time, respectively. A second harvest was made the first week in November when no degreening was necessary. Following the early harvest, 82 and 53 percent decay,

<table>
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<th>Table 1. Sources of experimental fruit</th>
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<td><strong>Variety</strong></td>
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<td>Robinson</td>
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<td>Lee</td>
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Fig. 1.—The effect of harvest date and degreening time on postharvest decay in waxed only and 2-aminobutane-treated fruits of Robinson (A), Lee (B), Nova (C), and Page (D) held at 70° F.

respectively, developed after 2 weeks at 70° F. in both untreated lots. Less than 5 percent decay developed in the untreated fruit from the second harvest which required no ethylene. In 1965 (Figure 1A), fruit was harvested from the same two sources three times during the season. Progressively less decay developed as the fruit matured and less degreening time was required.

During both years stem-end rots caused by Diplodia natalensis and Phomopsis citri were the
most prevalent decays. Anthracnose (*Colletotrichum gloeosporioides*) at the stem end and on the sides of the fruit was fairly common on the earlier harvested fruits, particularly from St. Lucie County. Rind breakdown was of minor importance during both years.

Little or no decay control was effected by the use of 2-aminobutane on fruit gassed for 45 hours or more. Control was good on fruit from the last picking in 1965 when only 16 hours or less of ethylene was used.

**Lee**

Lee fruit was harvested on three dates in 1966 (Figure 1B). Some color break occurred prior to the first harvest on October 7. Continued natural degreening of fruit on the tree was slow so that 46 hours of ethylene was required for the third harvest on November 21. Decay was excessive following each harvest but was less severe as the season progressed. Anthracnose was the predominant disorder following all three harvests, occurring mostly at the stem end of the fruit. The remainder of the decay was Diplodia stem-end rot.

**Nova**

Fruits of the Nova variety were harvested October 7, October 28, and November 21, and required degreening times of 88, 70, and 22 hours, respectively. Decay was heavy in the first two picks and relatively light in the last harvest which received only 22 hours of degreening (Figure 1C). The higher incidence of decay in the second harvest over the first was attributed to a high incidence of green mold (*Penicillium digitatum*). Anthracnose amounted to approximately one-half of the decay in the first harvest, less in the second, and none in the last harvest. Diplodia, and to a lesser extent *Phomopsis*, stem-end rot accounted for the remaining decay except for the green mold encountered in the second harvest. Decay was reduced somewhat by application of 2-aminobutane after degreening.

**Page**

Page fruits were harvested in late October, twice in November, and in December 1966 as shown in Figure 1D. Fruit in the first harvest, which required 66 hours degreening, developed 29 percent decay after 2 weeks and 42 percent after 3 weeks. Decay was progressively less with increased maturity. Less than 1 percent resulted when the fruit was gassed for 20 hours or less.

Anthracnose was the predominant disorder in the first two harvests, in addition to *Phomopsis* and Diplodia stem-end rots. *Phomopsis* stem-end rot was the only type of decay to develop in the fruit of the November and December harvests. The incidence of decay for this variety was substantially lower than for the other hybrid varieties tested.

**Discussion**

Decay of citrus fruits after harvest for any given season depends on a number of factors over which the grower or shipper has little or no control. These include variety, age of tree, climate, grove location, time of bloom, local weather conditions prior to harvest, abundance of inoculum of fungi causing decay, and many others. However, he does have some control over other factors which also greatly affect the shelf life of the fruit; these include maturity of the fruit, proper care and timing in harvesting, handling, processing, shipping, and storage.

Anthracnose, which was a major cause of decay in these tests, is a disease normally reported in fruit from weak, unhealthy trees and in overripe or slightly damaged fruit (3, 8). The fruits used in these tests were harvested from relatively young vigorous trees and were not overripe or damaged. Stem-end rot, particularly *Diplodia* stem-end rot, has long been known to be increased by exposing the fruit to ethylene gas (2). The increased incidence of anthracnose decay for early-harvested fruits requiring long degreening periods has not been reported previously. These mandarin hybrids “mature” from 6 weeks to 2 months prior to Dancy tangerine and Orlando tangelo and before the end of the summer rainy season. The decrease in decay with maturity may well be associated with the advent of the dry season in October as well as with shorter degreening time.

These results, based on 1 or 2 years' experiments, are preliminary, but they show the relationship of external maturity of these varieties, as expressed by picking date and degreening time, to the incidence of stem-end rot and anthracnose decay. On the basis of these results, these hybrid fruits should not be harvested before the latter part of October or at such time that over 36 hours degreening time would be required. Earlier harvesting could be expected to result in heavy decay which is difficult to control with fungicidal treatment.
FACTORs AFFECTING THE FLAVOR OF FROZEN CONCENTRATED ORANGE JUICE

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ABSTRACT

Data obtained from the examination of over 700 samples of commercial frozen concentrated orange juice packed during 4 citrus seasons were statistically analyzed. Severe freezes occurred during 2 of these seasons. Using flavor scores of the reconstituted juices, as the dependent variable, and values for 15 other characteristics, as independent variables, multiple regression equations for flavor were calculated using an IBM 709 computer. The fit of the equations to the data, as measured by the per cent of the observed flavor variation explained (\%R), was very poor. These values ranged from 9.1 to 33.3\% for the midseason and late season samples and from 10.7 to 52.8\% for the total samples from each of the 4 seasons. This implied that at least 47.2\% of the variation in flavor of the frozen concentrated orange juices was either inherent in the process or was due to factors not yet considered in this study.

INTRODUCTION

Evaluation of the flavor of reconstituted frozen concentrated orange juice is possible today only by the use of subjective procedures. Thus, judges on a taste panel may be asked to express their opinions on the flavor of several samples of orange juice by indicating a numerical score for each sample.

Many characteristics of reconstituted juices, such as acidity, color, viscosity, or recoverable oil content can be measured rapidly by chemical or physical methods. Although statistical significance exists between some of these characteristics, such as the color (7) and flavor of orange juices, this significance was of no practical importance.

The purpose of this study was to determine if measured values for 4 or 5 characteristics of orange concentrates would collectively be statistically significant and also practically important. This would provide a means of obtaining objective rather than subjective flavor scores for reconstituted orange juices.

PROCEDURES

Data for statistical analysis.—Data were available to determine the relationship between the flavor of reconstituted frozen concentrated orange juices and other characteristics of either the concentrates or the reconstituted juices. Such data had been obtained (1, 3, 5, 7) by the examination of over 700 samples of commercial frozen concentrated orange juice. These products were processed and packed in Florida during the 1956-57, 1957-58, 1958-59 and 1962-63 citrus sea-