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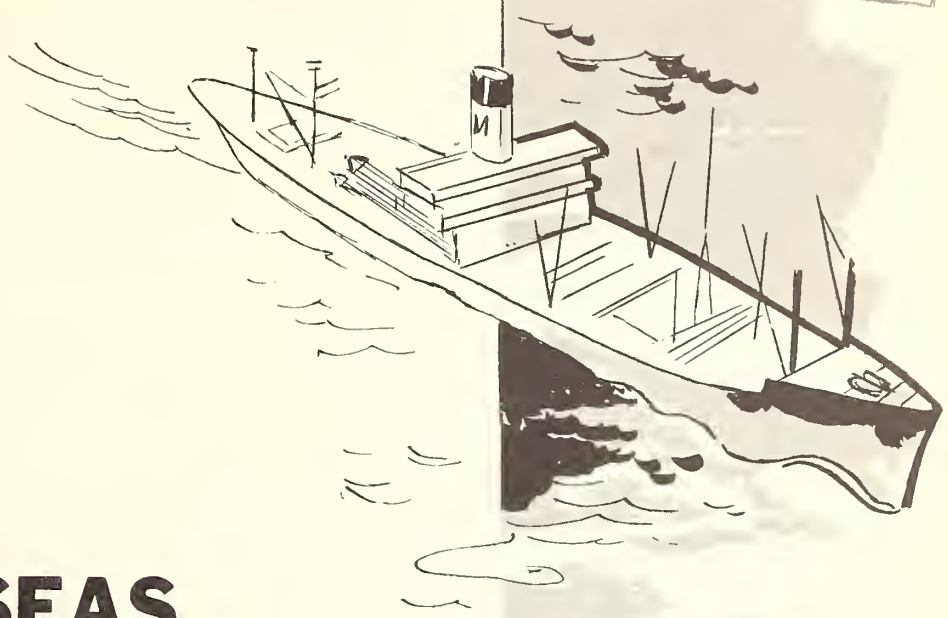

OVERSEAS VENTILATED SHIPPING TESTS WITH FLORIDA ORANGES AND GRAPEFRUIT

UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Marketing Service • Marketing Research Division

CONTENTS

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SUMMARY

Ventilated shipments of treated Florida Valencia oranges and Marsh Seedless grapefruit were made to the Netherlands late in the citrus season (in March, April, and May 1957). The purposes were to determine the feasibility of commercially shipping citrus fruits to European markets without refrigeration at this time of year, and to compare the effectiveness of different chemical treatments to inhibit decay.

Regardless of treatments used to inhibit decay, all 4 of the test shipments of oranges in ventilated holds arrived in unacceptable condition. Those in the semirefrigerated last shipment arrived in acceptable condition. Of grapefruit, only 1 of the 5 shipments arrived in totally unacceptable condition.

Shipment under ventilation is therefore not suitable for oranges at this season of the year. Fair success seems possible with grapefruit shipped in March. In every shipment except the last, grapefruit arrived with a lower percentage of decay than oranges. Rind breakdown, in most cases, also was greater in oranges than in grapefruit. The unacceptable arrival condition of many of the treated oranges was due to rind breakdown.

Chemical treatments inhibited decay in oranges and grapefruit. In oranges, biphenyl + DH was the most effective, followed by DH alone as the second best, and biphenyl alone as third. Regardless of treatment, and excepting the semirefrigerated fifth shipment, orange temperatures were too high and resulted in excessive decay and rind breakdown. Temperature proved to be the most important factor in preventing spoilage.

Treated grapefruit from some sources arrived in either acceptable or borderline condition in most shipments. However, except in the first shipment, the fruit became unacceptable because of decay or rind breakdown during the holding period after arrival at Rotterdam.

The source of grapefruit and oranges was also important in relation to the extent of decay and rind breakdown which developed during the marketing period.

The possibility of precooling oranges and grapefruit so as to obtain lower fruit temperatures during the early part of the trip, when fruit temperatures in ventilated shipments are ordinarily high, should be considered.

Reducing elapsed time between harvesting and loading on board ship also would add to the potential shelf life of oranges and grapefruit on foreign markets.

OVERSEAS VENTILATED-SHIPPING TESTS WITH FLORIDA ORANGES AND GRAPEFRUIT

By T. T. Hatton, Jr., and J. R. Winston, Biological Sciences Branch,
Agricultural Marketing Service

INTRODUCTION

The Florida citrus industry is much interested in the possibility of shipping oranges and grapefruit to Europe in ventilated holds, rather than the more expensive refrigerated holds. Although ventilated shipments of Florida citrus fruits from South Atlantic and Gulf ports are frequently unsuccessful during the winter, an even greater risk exists during the warmer months late in the season. This study was conducted to determine: (1) How late in the season ventilated shipments of citrus fruit, which had been chemically treated to inhibit decay, could successfully be made, taking into consideration the sources of the oranges and grapefruit, and (2) the relative effectiveness of various chemical treatments.

MATERIALS AND METHODS

From mid-March to mid-May 1957, five shipments of treated Valencia oranges and Marsh Seedless grapefruit were made from Tampa and Jacksonville, Fla., to Rotterdam, The Netherlands. The first 4 shipments were in ventilated holds, and the fifth was stowed in the hatch square between refrigerated compartments. The port of Rotterdam was selected because it receives a large percentage of the citrus fruit imported into Europe.

All oranges and grapefruit were waxed with a citrus water wax emulsion. The test packages of oranges and grapefruit were packed in half-boxes (4/5-bushel wirebound crates) at Orlando and then transported by truck to shipside. Every shipment contained oranges and grapefruit from 2 different sources (groves), obtained from packing houses.

Oranges were treated with (1) 2 sheets of biphenyl-treated paper (11 x 17 inches) per box; or (2) 2 percent sodium orthophenylphenate + 1 percent hexamine in a 3-minute dip, followed by a rapid water rinse (hereafter referred to as DH); or (3) a combination of the 2 treatments. A fourth lot was untreated and served as a control. All oranges were "color-added" and size 216 except some of the oranges in the first shipment, which were size 176.

Grapefruit were treated with DH. A second lot was untreated and served as a control. Some of the grapefruit in the first shipment were size 64, but most were size 70; the second shipment consisted entirely of size 112, and all remaining shipments were size 70.

Recording thermometers were placed in boxes of oranges and grapefruit to record fruit temperature in transit. A thermograph was placed above the load to record the ambient air temperatures in the hold throughout the voyage. Another thermograph was placed on an outside deck to record outside air temperature during the crossing. In most cases, the ship's captain furnished sea temperatures so that relationships between water temperature and hold temperature could be studied.

Upon arrival in Rotterdam, each fruit was examined for rind breakdown (aging and pitting) and decay, and the amount of each was calculated per box. After disposal of decayed fruit, the entire shipment was placed in cold storage for 2 weeks with commercially imported citrus fruit, at a temperature of 38° to 40° F. It was then reinspected as described, the decayed fruit being again discarded. Finally, the shipment was held at room temperature for 1 week and again examined. Room temperature averaged 50° in the first shipment, 70° in the last shipment, and 60° for the other shipments. The oranges and grapefruit were placed in cold storage and then at room temperature to simulate the handling of commercially imported citrus fruit into The Netherlands.

Trace and slight[1] rind breakdown data were not shown in the figures herein because trace rind breakdown is not commercially detectable, and slight rind breakdown is not important unless found extensively. Trace and slight rind breakdown data, however, are included in the tables and statistical analyses in the appendix.

Picking, shipping, and arrival dates are shown for oranges and grapefruit in table 1. Grapefruit and oranges were shipped in the same hold.

Table 1.--Picking, loading, and arrival dates for overseas shipments of Florida oranges and grapefruit to Rotterdam, The Netherlands, 1957

Shipment No.	Sources[1]	Picking dates		Loading port[2]	Loading date	Arrival date	Remarks
		Oranges	Grapefruit				
		March					
1	A	13	14	Jackson-	March	April	Test fruit accompa-
	B	12	12	ville	20	6	nied commercially ventilated fruit
2	C	21	26	Tampa	April	April	Test fruit accompa-
	D	20	26		2	17	nied commercially ventilated fruit
		April					
3	E	15	15	Jackson-	April	May	Test fruit did not
	F	17	17	ville	23	8	accompany commercially ventilated fruit
4	G	25	24	Tampa	May	May	Test fruit did not
	H	27	24		6	21	accompany commercially ventilated fruit
		May					
5	I	12	9	Jackson-	May	June	Test fruit stowed
	J	14	13	ville	20	4	alone in hatch square adjacent to refrigerated chambers

[1] Sources (groves) for oranges and grapefruit are different although the lettering is the same.

[2] Ships loaded in Jacksonville stopped in Savannah en route to Europe. Ships loaded in Tampa sailed directly to Europe.

[1] "Trace" rind breakdown is pinpoint in size up to 1/4 inch in diameter; "slight" rind breakdown is recorded when the disorder, or the aggregate of the disorders, is smaller than a dime (5/8-inch diameter) but larger than 1/4 inch in diameter.

RESULTS

Fruit and Air Temperatures

Outside air temperatures showed more fluctuations and extremes than hold air temperatures. As was expected, outside air temperatures directly influenced temperatures inside the ventilated holds. Although hold temperatures lagged behind outside air temperatures, whenever outside air temperatures became higher, hold temperatures also became higher. The same relation prevailed when temperatures became lower. Sea temperatures had no direct relation to hold temperatures.

In all shipments, outside air temperatures and temperatures in the ventilated holds were relatively high at time of loading and remained high for the first 5 days at sea. Ships loaded in Tampa and sailing directly to Europe were exposed to the same comparative durations and extremes of temperature as those loaded in Jacksonville and stopping in Savannah.

The average temperature inside boxes of oranges and grapefruit at loading ranged from 68° F. for the second shipment to 78° for the fourth shipment. As is normally the case, temperatures recorded en route within the boxes of oranges and grapefruit were usually a few degrees higher than the free air temperatures in the hold. Temperatures in boxes of oranges and grapefruit on top of the load were usually higher than those on the bottom of the load. The lowest outside air temperature encountered was 35°, recorded on the seventh or eighth day after loading in the first, second, and third shipments.

Figures 1 through 5 show the recorded temperatures until time of unloading for each shipment. Only outside air temperatures and temperatures inside the boxes are included, since they are the most pertinent.

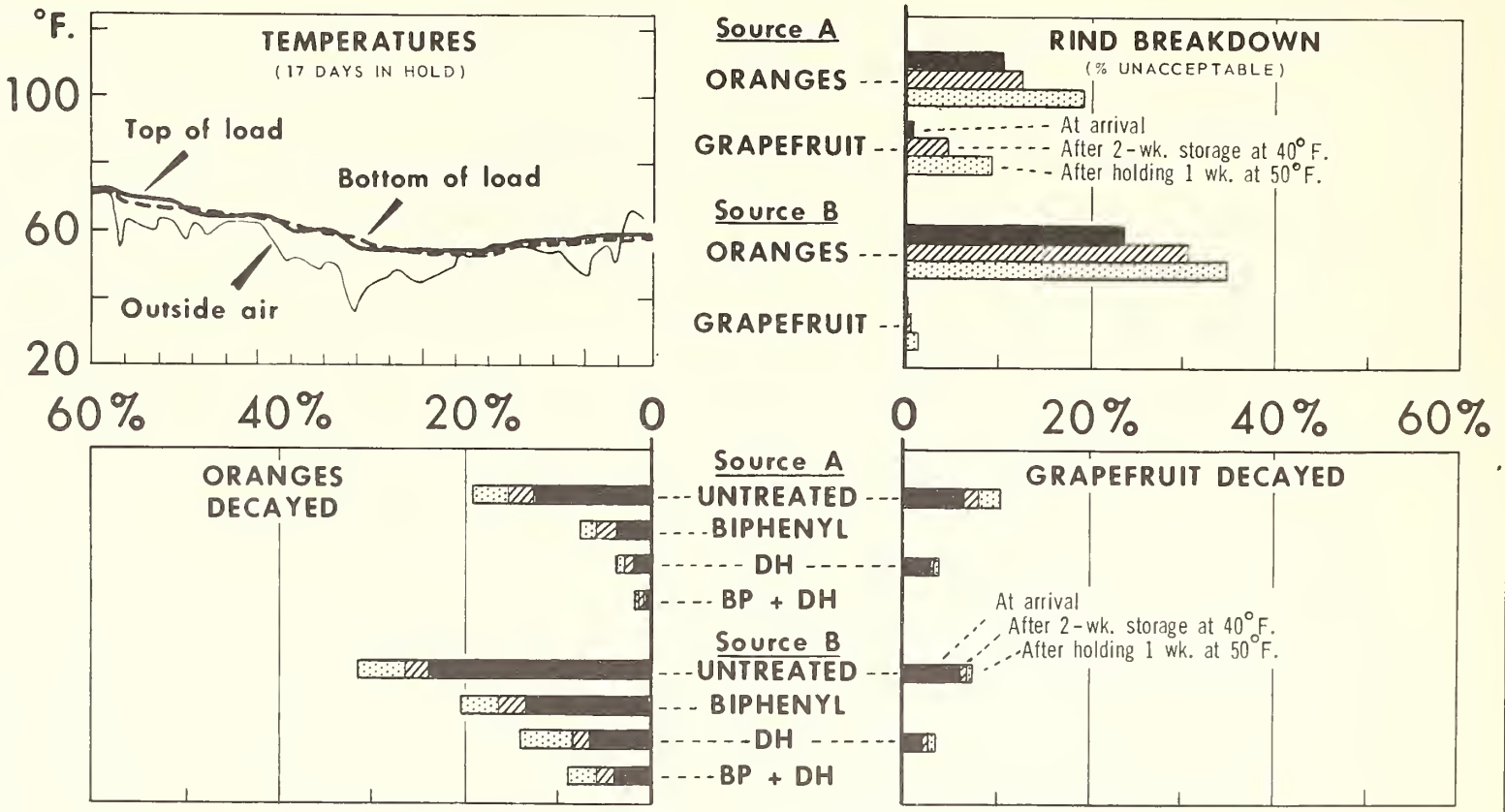
The first shipment was exposed to relatively cool outside air temperatures throughout the voyage (fig. 1). The highest average outside air temperatures were in the 60° to 70° F. range at Jacksonville and Savannah as well as for the first few days at sea. On the eighth day after the ship's departure from Jacksonville, the outside air temperature dropped and remained low for the remainder of the voyage. However, temperatures inside boxes of oranges and grapefruit did not closely follow this sudden drop of outside air temperature. When the outside air temperature was 35°, the temperature in the test fruit boxes was 57°. Commercial lots of ventilated oranges and grapefruit, in the same compartment with the experimental fruit, were inspected on the sixth day after leaving Jacksonville, and a strong odor of mold was detected. Some oranges and grapefruit completely consumed with green mold were observed through the box slats. The outside air temperature at the time of this inspection was 52° and the temperature of this fruit ranged from 52° to 57°.

The second shipment was exposed to outside air temperatures ranging from 70° to 83° F. at the time of loading and for the first few days at sea (fig. 2). On the sixth and seventh days at sea, the outside air temperature became lower and remained below 55° for the rest of the voyage. The seventh day after the ship left Tampa, the outside air temperature was 35°, and at the same time the free air temperature in the ventilated hold was 47°.

The third shipment was exposed to outside daytime temperatures of 70° to 90° F. at the time of loading and for the first few days at sea (fig. 3). Outside air temperatures at night during this period were 65° to 75°. On the sixth and seventh days after the ship left Jacksonville, the temperature reached 35°. At the same time, the free air temperature in the hold was 38° for a short period, which in turn affected the temperature of the fruit only briefly. Thereafter, temperatures ranged between 51° and 55° for the remainder of the voyage.

TRANSIT TEMPERATURE AND CONDITION OF FLORIDA CITRUS FRUITS IN OVERSEAS SHIPMENTS

Test 1 - Ventilated Shipment Leaving Jacksonville March 20, 1957



VALENCIA ORANGES AND MARSH SEEDLESS GRAPEFRUIT SHIPPED TO ROTTERDAM, THE NETHERLANDS

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Figure 1

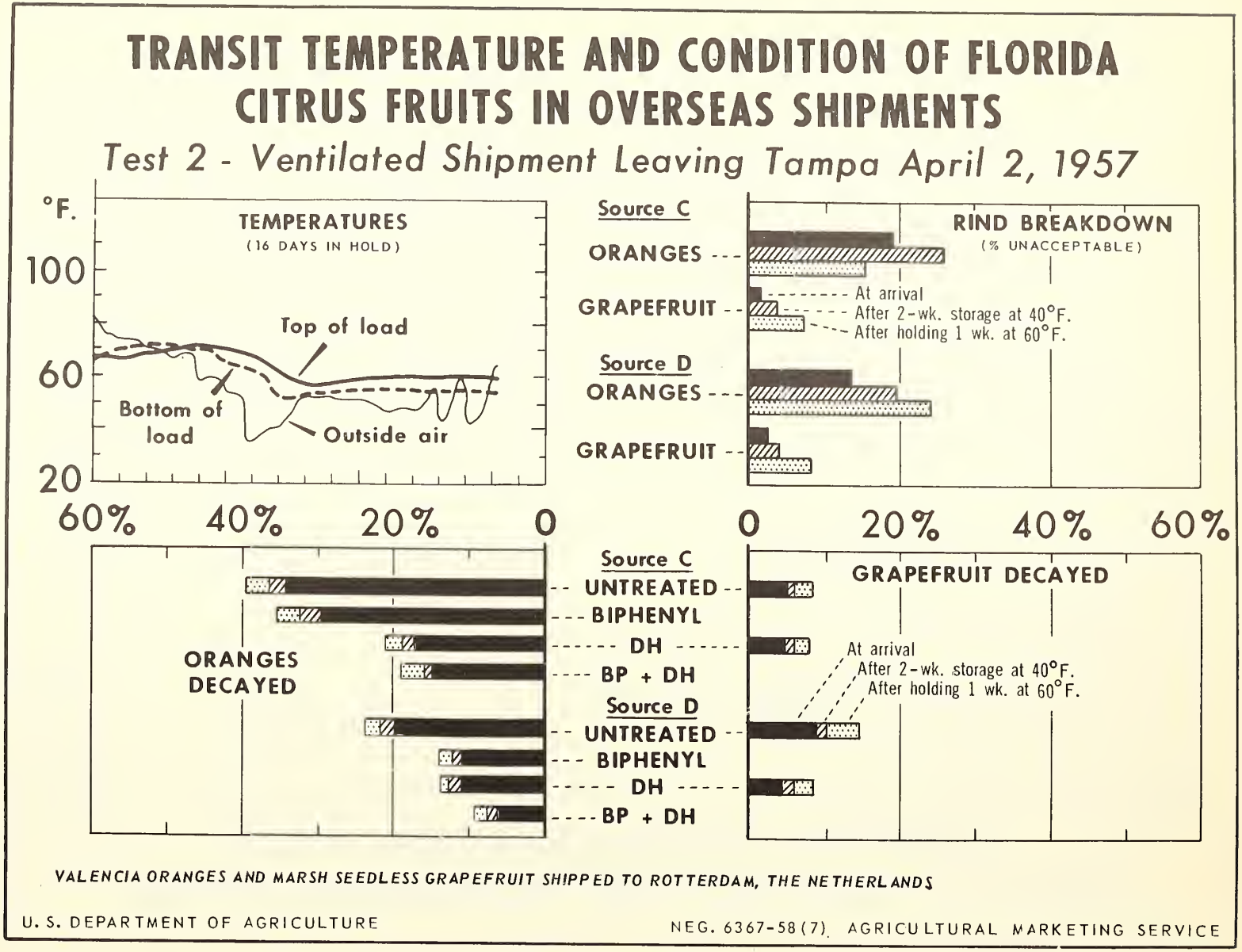
TRANSIT TEMPERATURE AND CONDITION OF FLORIDA CITRUS FRUITS IN OVERSEAS SHIPMENTS
Test 2 - Ventilated Shipment Leaving Tampa April 2, 1957
°F.
TEMPERATURES
(16 DAYS IN HOLD)
100
60
20
Top of load
Bottom of load
Outside air
Source C
ORANGES
GRAPEFRUIT
Source D
ORANGES
GRAPEFRUIT
RIND BREAKDOWN
(% UNACCEPTABLE)
At arrival
After 2-wk. storage at 40°F.
After holding 1 wk. at 60°F.
60%
40%
20%
0
ORANGES DECAYED
Source C
UNTREATED
BIPHENYL
DH
BP + DH
Source D
UNTREATED
BIPHENYL
DH
BP + DH
0
20%
40%
60%
GRAPEFRUIT DECAYED
At arrival
After 2-wk. storage at 40°F.
After holding 1 wk. at 60°F.
VALENCIA ORANGES AND MARSH SEEDLESS GRAPEFRUIT SHIPPED TO ROTTERDAM, THE NETHERLANDS
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Figure 2

Of all 5 shipments, the highest temperatures were recorded during the fourth shipment (fig. 4). At the time of loading and for the first 3 days the ship was at sea, the temperatures in this shipment ranged from 70° to 85° F. Outside air temperatures became lower on the sixth and seventh days at sea. When the outside air temperature was 42°, fruit temperatures were 63° to 67°.

The fifth shipment was loaded when temperatures were approximately 95° F. (fig. 5). The outside air temperatures during midday reached 95° for the first few days after loading. By the seventh day, the temperatures were mostly in the 55° to 70° range. Two days before arrival of the ship in Europe, the temperature gradually increased, reaching highs of 77° and 80°, respectively. Fruit temperatures in the hold steadily declined after loading and leveled off after 5 days at 48° at the bottom of the load and 52° at the top. Stowage of the test boxes of oranges and grapefruit near refrigerated compartments accounted for the relatively low fruit temperatures.

Condition of Test Fruit

Statements made concerning effects of chemical treatments have been statistically confirmed by an analysis of variance. They are shown in tabular form in the appendix.

Chemical treatments significantly inhibited decay in oranges and grapefruit. However, except for the semirefrigerated fifth shipment, all shipments of oranges, regardless of treatment, arrived in unacceptable[2] condition, due mostly to the combination of decay and unacceptable rind breakdown[3]. Treated grapefruit from some sources arrived in either acceptable or borderline condition in most shipments.

Decay

Phomopsis stem-end rot and green mold were the major decays observed throughout the shipments. Stem-end rot was found more frequently than green mold, especially in oranges. For both oranges and grapefruit, the percentage of stem-end rot increased with each inspection, while the percentage of green mold decreased. Figures 1 through 5 graphically show the cumulative percentages of decay observed in oranges and grapefruit at the 3 inspections--upon arrival, after 2 weeks in storage, and after holding for 1 week.

Oranges in the first, second, and fifth shipments arrived with stem-end rot accounting for 64 to 68 percent of the decay present, green mold constituting the remainder. Of decay present on arrival in the third and fourth shipments, stem-end rot accounted for 97 percent and 88 percent, respectively, and green mold accounted for the small remainder as secondary infection.

In grapefruit, on the other hand, the observed decay on arrival was 65 percent green mold in the first shipment and 71 percent green mold in the fifth shipment; stem-end rot constituted the remaining decay. Although the percentage of stem-end rot increased in succeeding inspections, green mold still accounted for the greater percentage of decay in these 2 shipments. On arrival of the second and fourth shipments, decay was 76 and 65 percent stem-end rot, respectively. The third shipment of grapefruit differed from other shipments in that green mold on arrival accounted for 53 percent of the decay present, but at subsequent inspections most of the decay was stem-end rot.

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[2] In this study, condition of oranges and grapefruit was determined by combining the percentage of decay and unacceptable rind breakdown and classifying them as follows: Acceptable = less than 5 percent; borderline = 5 percent - 8 percent; unacceptable = above 8 percent.

[3] Unacceptable rind breakdown included all moderate and severe aging and pitting. Moderate rind breakdown was determined when the aggregate of the disorder exceeded the size of a dime (5/8-inch diameter) but less than the size of a half-dollar (1-1/8-inch diameter); severe rind breakdown was recorded when it exceeded the size of a half-dollar.

Untreated oranges in every shipment arrived with significantly more decay than treated oranges. Biphenyl + DH afforded the best protection from decay. DH alone inhibited decay second best, followed last by biphenyl. Treatments on oranges inhibited decay the same relative amount in all shipments. DH effectively inhibited decay in grapefruit shipments.

Both oranges and grapefruit had little additional decay during the 2 weeks' storage at 40° F.

Usually, a large amount of decay developed in both treated and untreated oranges and grapefruit during the final week of holding at room temperature, indicating that the fungistatic treatments had lost their effectiveness.

Most of the treated oranges in the first shipment arrived with less than 5 percent decay (fig. 1). Of the 3 inspections in this shipment, the greatest amount of decay was observed at the arrival inspection. At this time, there was no significant difference in amount of decay between oranges treated with DH and those treated with the biphenyl + DH treatment. However, both treatments held decay significantly below that in oranges given the biphenyl treatment.

All treated oranges in the second shipment, except some of those treated with the biphenyl + DH treatment, arrived with more than 8 percent decay (fig. 2). The biphenyl + DH treatment again significantly inhibited decay the most, followed by DH and then biphenyl. In this shipment, most of the decay occurred in transit, only a relatively small amount occurring during the holding periods.

Upon arrival of the third shipment, only oranges treated with the biphenyl + DH treatment arrived with less than 5 percent decay (fig. 3). Some of the oranges treated with biphenyl and with DH arrived with 5 to 8 percent decay. This shipment of oranges differed from previous shipments in that more decay developed during the holding periods than during transit.

All oranges in the fourth shipment arrived in unacceptable condition due to decay (fig. 4). Decay in oranges of this shipment was the highest of all orange shipments. Upon arrival of the shipment, the odor of decayed fruit could be detected some distance from the ship. Even though the chemical treatments significantly reduced decay, the oranges were not acceptable. Decay during transit was far more than that which developed during holding, yet decay during holding also was comparatively high.

Generally, oranges in the fifth shipment arrived with less decay than those in previous shipments (fig. 5). Most of the treated oranges in the shipment arrived in excellent condition. All chemical treatments again effectively inhibited decay. Although treated oranges in this shipment arrived in excellent condition, they were similar to the 2 previous shipments in having a brief storage and holding life. Decay observed at the final inspection was high.

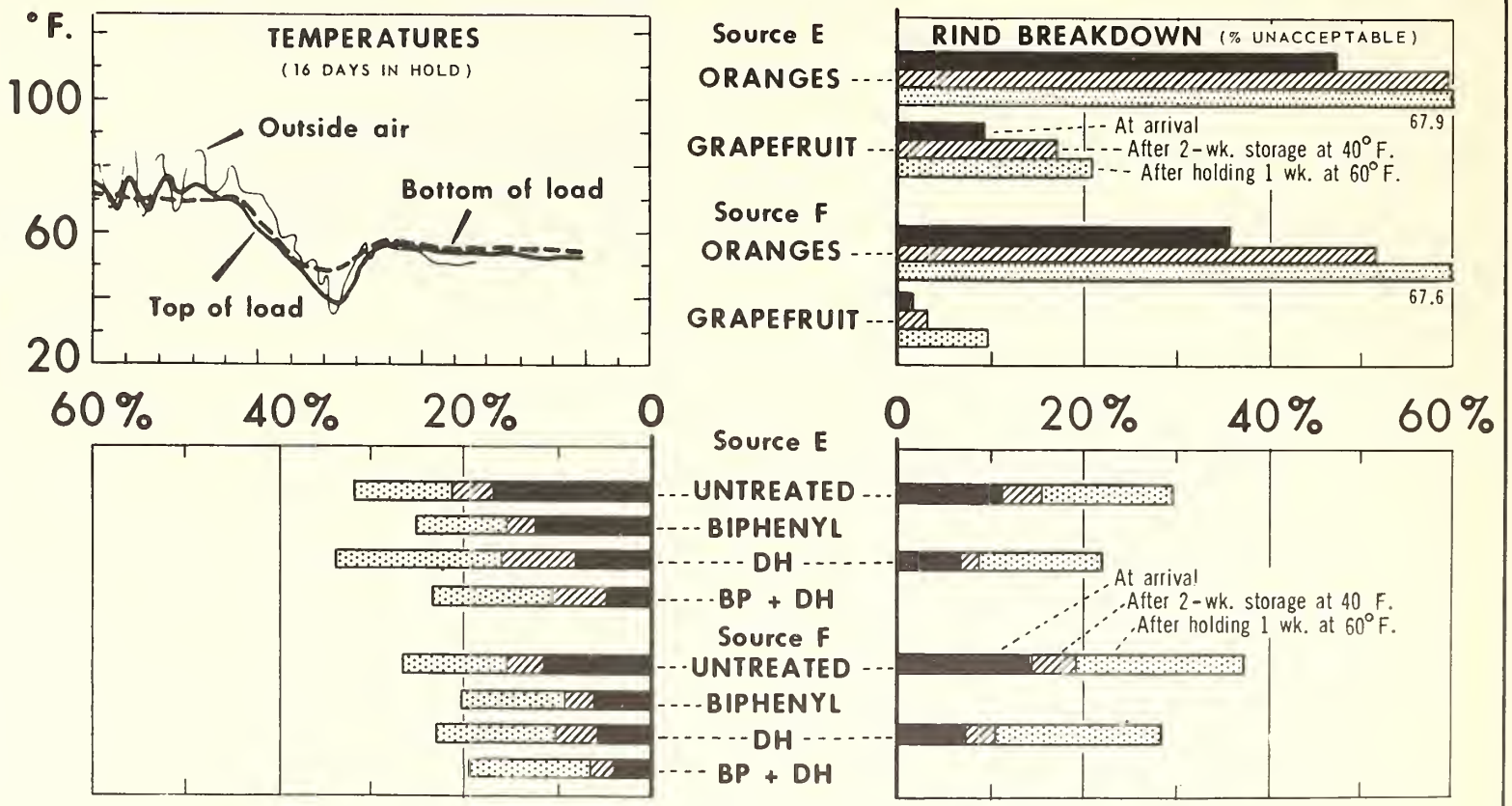
Treated grapefruit in the first and second shipments arrived with less than 5 percent decay, while decay in untreated grapefruit of these 2 shipments ranged from 5.2 to 9.2 percent (figs. 1 and 2). A statistical analysis showed that DH significantly inhibited decay. More decay developed during the transit period than during holding.

Grapefruit in the third shipment arrived with more decay than other grapefruit shipments (fig. 3). Decay in untreated grapefruit at arrival ranged from 11.3 to 14.6 percent, while decay on treated fruit ranged from 6.7 to 7.1 percent; DH significantly reduced the amount of decay. More decay developed during the final week of holding at room temperature than occurred during transit.

Treated grapefruit in the fourth shipment arrived with decay ranging from 5.4 to 9.0 percent; untreated grapefruit arrived with decay ranging from 6.3 to 13.8 percent (fig. 4). Decay during the final 1-week holding at room temperature was excessive in

TRANSIT TEMPERATURE AND CONDITION OF FLORIDA CITRUS FRUITS IN OVERSEAS SHIPMENTS

Test 3 - Ventilated Shipment Leaving Jacksonville April 23, 1957



VALENCIA ORANGES AND MARSH SEEDLESS GRAPEFRUIT SHIPPED TO ROTTERDAM, THE NETHERLANDS

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Figure 3

TRANSIT TEMPERATURE AND CONDITION OF FLORIDA CITRUS FRUITS IN OVERSEAS SHIPMENTS

Test 4 - Ventilated Shipment Leaving Tampa May 6, 1957

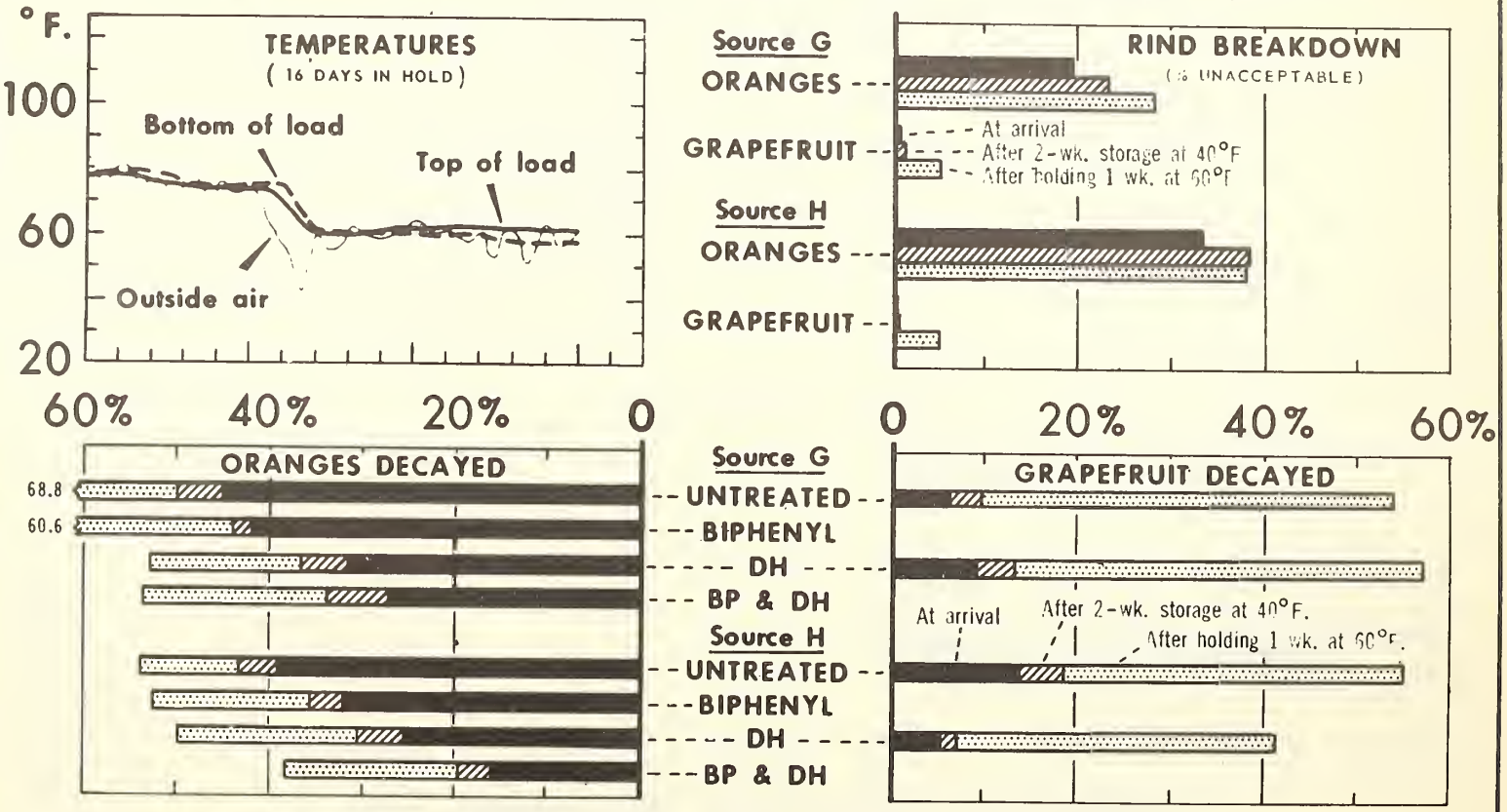

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Figure 4

grapefruit of this shipment, and was several times greater than that which developed in transit.

Treated grapefruit in the semirefrigerated fifth shipment arrived with decay ranging from 4.6 to 7.1 percent; decay in untreated grapefruit ranged from 7.5 to 11.7 percent (fig. 5). A high amount of decay developed during the final week of holding at 70° F.

Rind Breakdown

Throughout the shipments, pitting was never a factor on oranges. On grapefruit, pitting was observed in every shipment, but was usually only a trace or slight. Aging was the most common type of rind breakdown found on both fruits.

Figures 1 through 5 graphically show the percentages of unacceptable rind breakdown observed in oranges and grapefruit at the 3 inspections. Since chemical treatment had no great effect on the extent of rind breakdown, the figures do not show the amount of rind breakdown according to chemical treatment. A statistical analysis showed that DH had no significant effect on the extent of rind breakdown in grapefruit when compared with untreated fruit (table 5). There was likewise, no statistically significant difference in the extent of rind breakdown between untreated oranges and those treated with DH (table 4). However, oranges treated with biphenyl and biphenyl + DH showed significantly less rind breakdown than those treated with DH alone, but the differences were slight and of little or no commercial importance. In the figures, the amount of rind breakdown at each inspection is shown separately instead of cumulatively because the same fruits were observed each time for extent of rind breakdown, instead of being discarded as was decayed fruit.

Oranges in the first shipment arrived with average unacceptable rind breakdown of 10.4 percent in oranges from 1 source and 23.7 percent in those from the other source (fig. 1).

Unacceptable rind breakdown in the second shipment of oranges on arrival was heavy, accounting for an average of 13.8 percent in oranges from 1 source and 19.1 percent in those from the other source (fig. 2).

In the third shipment of oranges, rind breakdown in the form of severe aging was responsible for the cull condition of over one-third of the entire shipment on arrival (fig. 3). Many of the oranges in this shipment also had a desiccated appearance on arrival.

Oranges in the fourth shipment arrived with an average of 19.5 percent unacceptable rind breakdown in oranges from 1 source and 33.5 percent in those from the other source (fig. 4).

In the fifth, or semirefrigerated, shipment, rind breakdown was negligible and oranges arrived in good condition (fig. 5).

All grapefruit arrived with a negligible amount of rind breakdown except that from 1 source in the third shipment (figs. 1 to 5).

Relation of source to condition

Source of oranges and grapefruit in most shipments influenced the amount of decay and rind breakdown.

Although the source of grapefruit had only slight effect on the amount of decay on arrival, large differences were apparent after a week of holding at room temperature. This was strikingly different from the record for oranges, which often had great differences in the amount of decay on arrival that were related to the source of fruit.

DISCUSSION

The importance of temperatures in ventilated overseas shipments of oranges and grapefruit cannot be overemphasized. The excellent condition in which the last, unventilated, semirefrigerated shipment arrived demonstrated the importance of cool temperatures en route. This is especially apparent since these oranges and grapefruit, picked late in the season, were more mature than fruit picked earlier and would normally be of poor keeping quality. Regardless of chemical treatment to inhibit decay, cool temperatures were paramount for extending the storage and holding life of oranges and grapefruit.

Temperatures in the hold did not respond as quickly or become as low as outside air temperatures, and these relationships indicate that ventilated holds had a relatively slow replacement of air. Therefore, any means of taking advantage of cool outside air would be desirable in ventilated shipments at this time of the year.

Because outside and hold air temperatures were highest during the first 5 days after loading, attention should be given to the problem of reducing the temperatures of fruit and hold, and maintaining low levels during this period. Precooling of oranges and grapefruit might be considered.

Since the ventilated holds were on the top deck and above the water line, sea temperatures had little, if any, direct effect on temperatures in the ventilated holds.

The elapsed time from picking until the oranges and grapefruit were loaded aboard ship was usually from 6 to 8 days, but ran as long as 13 days. No doubt careful selection and proper timing to lessen the elapsed time from tree to ship would add to storage and holding life.

Although chemical treatments reduced decay, oranges and grapefruit in shipments like the third and fourth, which were exposed to the highest temperatures encountered, arrived in the worst condition. Where decay on treated oranges was negligible, severe or moderate rind breakdown usually caused them to be unacceptable. For example, in the third shipment all oranges treated with biphenyl + DH arrived with a small amount of decay and would have been acceptable had not excessive rind breakdown been present. Rind breakdown is a serious disorder, not only because it causes poor appearance but because it provides a possible means for the entrance of decay organisms.

There were instances where treatment definitely prevented oranges and grapefruit from arriving in borderline or unacceptable condition. For example, grapefruit in the first shipment and oranges in the fifth shipment would have arrived in unsatisfactory or questionable condition had not chemical treatment been used.

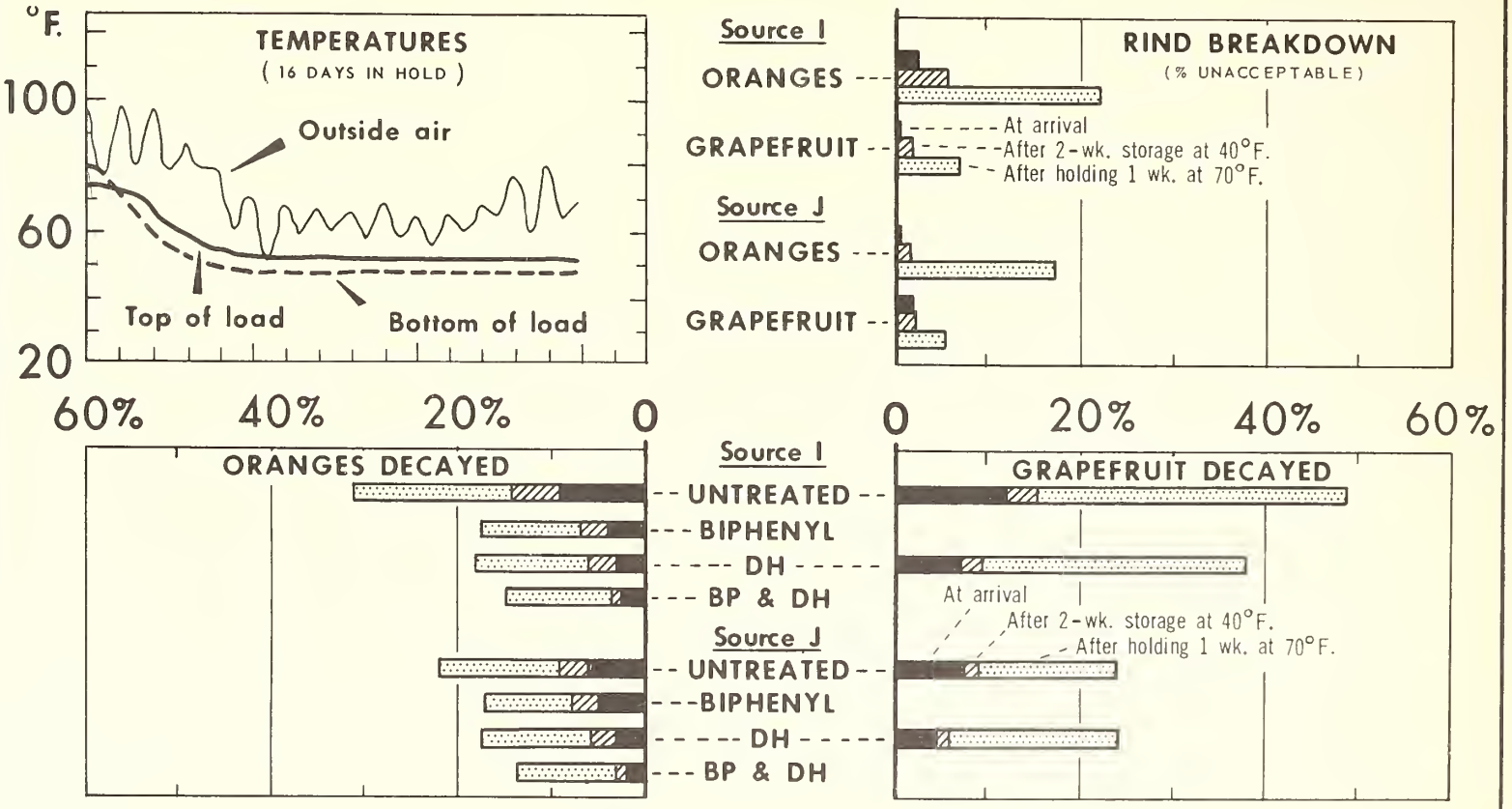
Although green mold caused less decay than stem-end rot, most green mold was detected at the arrival inspection and was found to accompany mechanical injury to the oranges and grapefruit. Since green mold flourishes in cool temperatures and Phomopsis stem-end rot prefers warmer temperatures, shipments exposed to cool temperatures contained more green mold than those exposed to higher temperatures.

High percentages of decay during the final week of holding occurred in the last 3 shipments of oranges and grapefruit. This is probably due to the more advanced maturity of the fruit, which was susceptible to the entry of decay, especially when a high incidence of rind breakdown was present as well as the higher holding temperatures.

During the final week of holding at room temperature there was little difference in the amount of decay development between treated and untreated oranges, and in some cases the untreated oranges had less decay, indicating that the fungistatic treatments had lost their effectiveness at the time of the final inspection. The exception to this was in treated oranges of the semirefrigerated last shipment, which developed significantly

TRANSIT TEMPERATURE AND CONDITION OF FLORIDA CITRUS FRUITS IN OVERSEAS SHIPMENTS

Test 5 - Semi-Refrigerated Shipment Leaving Jacksonville May 20, 1957



VALENCIA ORANGES AND MARSH SEEDLESS GRAPEFRUIT SHIPPED TO ROTTERDAM, THE NETHERLANDS

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Figure 5

less decay during the final week, indicating that the effectiveness of fungistatic treatments was prolonged by lower temperatures.

Under the conditions of these tests, grapefruit appear to be more adaptable for ventilated shipments than oranges. In every shipment except the last, grapefruit arrived with a lower percentage of decay than oranges. Rind breakdown, in most cases, also was greater in oranges than grapefruit. Regardless of treatment, all shipments of oranges arrived in unacceptable condition except those in the semirefrigerated last shipment. The unacceptable arrival condition of many of the treated oranges was due to rind breakdown. Of grapefruit, only the third shipment arrived in totally unacceptable condition.

None of the oranges shipped in ventilated holds between mid-March and mid-May arrived in satisfactory condition, because rind breakdown and decay were excessive. Treated grapefruit in the first 2 shipments, made in March and early April, arrived with less than 5 percent decay. After holding at Rotterdam, there was an average of 8.6 percent decay in the treated fruit of the second shipment, but only 3.3 percent in the treated fruit of the first shipment made on March 20. However, rind breakdown developed on grapefruit from 1 of the 2 sources in this shipment to such an extent as to make the fruit unmarketable after this long a holding period.

On the basis of these tests, it does not appear feasible to make ventilated shipments or oranges from Florida as late as mid-March. Fair success was obtained with grapefruit shipped in mid-March, but not with later shipments.

APPENDIX

Table 2.--Mean[1] number of decayed fruit per box in test shipments of Florida Valencia oranges, Rotterdam, The Netherlands, 1957

Treatments	Shipment No.	Inspection			Average of treatment means
		Upon arrival	After 2 weeks at 40° F. storage	After 1 week at room temperature	
Untreated	1	16.5	3.3	5.0	12.8
	2	30.1	3.3	3.8	
	3	15.1	4.8	12.0	
	4	45.4	4.8	16.0	
	5	9.1	5.4	17.1	
	Average	23.2	4.3	10.8	
Biphenyl	1	9.7	2.7	2.8	10.2
	2	22.7	3.3	3.6	
	3	9.8	4.3	11.3	
	4	39.9	3.1	17.9	
	5	5.7	4.1	11.9	
	Average	17.6	3.5	9.5	
DH	1	3.5	2.2	4.3	9.4
	2	16.1	2.8	2.8	
	3	7.2	6.9	16.8	
	4	30.8	5.2	19.3	
	5	4.3	4.3	14.9	
	Average	12.4	4.3	11.6	
Biphenyl + DH	1	2.7	2.0	2.8	7.9
	2	12.2	2.3	3.7	
	3	4.4	4.5	14.2	
	4	23.4	5.4	22.3	
	5	3.3	2.1	13.8	
	Average	9.2	3.3	11.4	
Average of inspection means		15.6	3.8	10.8	

LSD[2] for treatment means .01 = 1.9
" " " " .05 = 1.4
" " inspection " .01 = 5.8
" " " " .05 = 4.3

[1] Each mean represents the average number of decayed oranges per box from 6 boxes in the first shipment and 12 boxes in the other shipments.

[2] LSD - Difference required for significance between treatment or inspection means at 1-percent level (.01) or 5-percent level (.05).

Table 3.--Mean[1] number of decayed fruit per box in test shipments of Florida Marsh Seedless grapefruit, Rotterdam, The Netherlands, 1957

Treatments	Shipment No.	Inspection			Average of treatment means
		Upon arrival	After 2 weeks at 40° F. storage	After 1 week at room temperature	
Untreated	1	2.8	1.4	1.4	5.1
	2	5.0	1.7	3.0	
	3	6.2	2.8	7.5	
	4	5.0	2.6	17.2	
	5	4.8	2.0	12.7	
	Average	4.8	2.1	8.4	
DH	1	2.0	1.1	1.2	4.2
	2	3.7	1.8	2.4	
	3	3.8	2.1	7.3	
	4	3.9	2.1	16.6	
	5	3.3	1.7	10.4	
	Average	3.3	1.8	7.6	
Average of inspection means		4.1	1.9	8.0	

LSD[2] for treatment means .01 = 0.8
" " " " .05 = 0.5
" " inspection " .01 = 4.6
" " " " .05 = 3.3

[1] Each mean represents the number of decayed grapefruit per box from 18 boxes in the first shipment and 24 boxes in the other shipments.

[2] LSD - Difference required for significance between treatment or inspection means at 1-percent level (.01) or 5-percent level (.05).

Table 4.--Mean rind breakdown index[1] per box in test shipments of Florida Valencia oranges, Rotterdam, The Netherlands, 1957

Treatments	Shipment No.	Inspection			Average of treatment means
		Upon arrival	After 2 weeks at 40° F. storage	After 1 week at room temperature	
Untreated	1	0.90	1.15	1.39	1.76
	2	1.01	1.31	1.54	
	3	2.34	2.93	3.59	
	4	2.11	2.40	3.26	
	5	0.27	0.54	1.61	
	Average	1.33	1.67	2.28	
Biphenyl	1	0.81	0.98	1.37	1.63
	2	1.13	1.37	1.56	
	3	2.40	2.77	3.45	
	4	1.97	2.19	2.91	
	5	0.18	0.40	1.05	
	Average	1.30	1.54	2.07	
DH	1	1.14	1.34	1.63	1.83
	2	1.18	1.55	1.72	
	3	2.47	2.95	3.56	
	4	2.16	2.42	3.12	
	5	0.22	0.42	1.52	
	Average	1.43	1.74	2.31	
Biphenyl + DH	1	0.92	1.16	1.42	1.67
	2	1.17	1.41	1.49	
	3	2.29	2.73	3.50	
	4	1.94	2.20	2.95	
	5	0.19	0.43	1.18	
	Average	1.30	1.59	2.11	
Average of inspection means		1.34	1.63	2.19	

LSD[2] for treatment means .01 = 0.14
" " " " .05 = 0.10
" " inspection " .01 = 0.18
" " " " .05 = 0.13

[1] Each mean represents the average rind breakdown index per box in oranges from 12 boxes except those means in the first shipment representing fruit treated with biphenyl and untreated fruit, in which case the average was taken from 10 boxes of oranges. For statistical analyses, ratings were given for the amount of rind breakdown observed on each orange: None - 0, trace = 1, slight = 2, moderate = 3, and severe = 4. The numerical ratings of individual, undecayed oranges in each box were added and then averaged. This procedure gave one value, a rind breakdown index on a per-fruit basis, for each box of oranges.

[2] LSD = Difference required for significance between treatment or inspection means at 1-percent level (.01) or 5-percent level (.05).

Table 5.--Mean rind breakdown index[1] per box in test shipments of Florida Marsh Seedless grapefruit, Rotterdam, The Netherlands, 1957

Treatments	Shipment No.	Inspection			Average of treatment means
		Upon arrival	After 2 weeks at 40° F. storage	After 1 week at room temperature	
Untreated	1	0.05	0.20	0.40	0.55
	2	0.32	0.48	0.74	
	3	0.55	0.85	1.39	
	4	0.13	0.30	1.02	
	5	0.27	0.44	1.06	
	Average	0.26	0.45	0.92	
DH	1	0.05	0.24	0.45	0.49
	2	0.32	0.45	0.69	
	3	0.51	0.75	1.24	
	4	0.12	0.23	0.77	
	5	0.23	0.36	0.89	
	Average	0.25	0.41	0.81	
Average of inspection means		0.25	0.43	0.87	

LSD[2] for treatment means = n.s.
" " inspection " .01 = 0.44
" " " " .05 = 0.32

[1] Each mean represents the average rind breakdown index per box in grapefruit from 24 boxes. For statistical analyses, ratings were given for the amount of rind breakdown observed in each grapefruit: None = 0, trace = 1, slight = 2, moderate = 3, and severe = 4. The numerical ratings of individual, undecayed, grapefruit in each box were added and then averaged. This procedure gave one value, a rind breakdown index on a per-fruit basis, for each box of grapefruit.

[2] LSD = Difference required for significance between inspection means at 1-percent level (.01) or 5-percent level (.05).

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