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Biphenyl Control of LEMON Spoilage

Influence of Time, Temperature, and Carton Venting

U.S. DEPARTMENT OF AGRICULTURE
Agricultural Marketing Service
Market Quality Research Division

PREFACE

The study on which this report is based is part of a continuing research program by the Agricultural Marketing Service to improve quality and to reduce spoilage losses of agricultural products during marketing.

The California Citrus Research Committee supplied the fruit used in this work and gave substantial financial assistance. Crown Zellerbach Corporation supplied the biphenyl-impregnated sheets.

Additional information on the use of biphenyl on citrus fruit to reduce losses during marketing may be found in the following publications: Effect of Biphenyl Treatment and Carton Ventilation on Decay and Soilage of California Lemons in Overseas Shipment, by G. L. Rygg, C. W. Wilson, and M. J. Garber, in U. S. Dept. Agr. Marketing Research Report No. 500, 1961; Absorption of Biphenyl from Biphenyl-treated Cartons by Citrus Fruits and Its Effect on Decay, 1953-54, by E. M. Harvey, AMS-3; Report on Sterilization and Storage Trials and Other Work to Milduras Citrus Field Day, by J. R. Botham, in Citrus News 35: 133-138, 1959; Effects of Biphenyl on Respiration of Oranges and Lemons, by I. L. Eaks, in proceedings of the American Society for Horticultural Science, 66: 135-140, 1955; Biphenyl-Induced Variation in Citrus Blue Mold, by P. R. Harding, Jr., in Plant Disease Reporter 43: 649-652, 1959; Biphenyl-Resistant Strains of Citrus Green Mold, by P. R. Harding, Jr., and D. C. Savage, in California Citrograph 46: 280, 306-308, 1961; Differential Sensitivity to Sodium Orthophenylphenate by Biphenyl-Sensitive and Biphenyl-Resistant Strains of P. digitatum, by P. R. Harding, Jr., in Plant Disease Reporter 46: 100-104, 1962; and Simulated Packing, Shipping, and Marketing Experiments with Valencia Oranges, by W. Grierson, in Proceedings of the Florida State Horticultural Society, 72: 248-253, 1959.

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CONTENTS

Cover photograph: Vented carton showing top biphenyl-impregnated pad in place, before covering with telescope top.

BIPHENYL CONTROL OF LEMON SPOILAGE

Influence of Time, Temperature and Carton Venting

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SUMMARY AND DISCUSSION

European markets, particularly West Germany, are concerned with additives to foods. They have raised the question as to biphenyl residues on American-grown citrus fruit. This report gives information on: How control of decay can be effectively obtained without excessive biphenyl residue; the effects of temperature, storage time, and carton venting on the rate of loss of biphenyl; and the relationship of these factors to decay, sporulation, and soilage of lemons. (Soilage is dusting of sound fruit with spores of fungi from decaying fruit.)

Twenty-five lemons per standard-size carton were inoculated with a pure strain (single spore culture) of biphenyl-sensitive Penicillium digitatum. They were stored with and without biphenyl in vented and nonvented cartons for 1 and 4 weeks at 40°, 48°, and 56° F. The contents of one-half of the cartons in each treatment were examined for decay, sporulation and soilage, and biphenyl content of the fruit and of the biphenyl-impregnated sheets of kraft paper at the end of the storage period. The remaining cartons were held for 1 more week at 68°, and then examined.

The biphenyl sheets in vented cartons lost biphenyl twice as rapidly as those in nonvented cartons, and the sheets on top of the fruit lost biphenyl 1.4 times as rapidly as those on the bottom of the cartons.

Venting the cartons permitted good aeration but also permitted rapid escape of biphenyl vapor, thus reducing the effectiveness of the biphenyl treatment.

Biphenyl reduced decay in lemons moderately and reduced sporulation and soilage markedly. The beneficial effect on sporulation and soilage was more pronounced in nonvented than in vented fiberboard cartons.

Low temperature reduced the loss of biphenyl and also reduced the rate of decay development. Continuous use of low temperatures while moving the fruit to overseas markets would greatly promote the retention of good quality and reduce loss from decay and soilage. However, present facilities at origin and destination do not permit the most desirable temperature to be maintained continuously. Further, the well-known susceptibility of lemons to chilling injury precludes the use of very low temperatures over an extended period. Some of the results suggest that 40° F. is a better transit temperature than 48°; other results favored 48°. In view of these conflicting results and the susceptibility of lemons to chilling injury, the use of 40° cannot, at present, be recommended.

Lemons in nonvented cartons with biphenyl absorbed about twice as much biphenyl as those in vented cartons, but, after 4 weeks' storage plus 1 week at 68° F., the amount still remained less than one-half the current West German legal tolerance of 70 parts per million. From 33 to 80 percent of the absorbed biphenyl escaped from the lemons during 1 week's aeration at 68° in open trays.

INTRODUCTION

Biphenyl-impregnated paper pads have been used for more than a decade to reduce spoilage in citrus fruits en route to market. Impregnated fruit wrappers are used when the fruit is packed in wooden crates, but kraft paper is used as a biphenyl carrier when fruit is packed in fiberboard cartons.

Commercial experience and experimental work have shown that 4 pounds of biphenyl per 1,000 square feet of paper is a fairly satisfactory dosage when two sheets per carton are used. Decreasing the dosage to 2 pounds or less reduced the effectiveness (5). [1] If changes in formulation and dosage could reduce the rate of sublimation and extend the period of effectiveness, less decay might be encountered in export shipments of citrus fruits.

The practical upper limit of biphenyl dosage, with the present formulation, is determined by the legal tolerance of biphenyl in the fruit as well as by the cost of the material. Factors thought to influence the amount accumulated in the fruit include biphenyl vapor pressure, storage temperature, storage time, degree of carton venting, and kind of fruit. The same factors can be assumed to affect the rate of depletion of biphenyl from the application sheets. A relatively high concentration of biphenyl vapor in the carton atmosphere aids in controlling fruit decay and soilage (dusting of sound fruit with spores from fungi on decaying fruit). However, it also induces a high rate of absorption by the fruit (5) and shortens the time for the concentration in the fruit to reach or exceed the legal tolerance.

Information is needed on the most effective temperature and the most desirable amount of carton venting for best control of spoilage with a minimum biphenyl accumulation in the fruit. This information is lacking, in spite of the fact that over 20 years have elapsed since Tomkins (8) first proposed that biphenyl might be useful in reducing spoilage in citrus fruits during transit and marketing, and Farkas (3) demonstrated its effectiveness in shipping tests conducted under commercial conditions.

Biphenyl is a fungistat, rather than a fungicide, and at least a minimum concentration of the vapor must be present in the package atmosphere to keep spoilage at a minimum. A continuous source of biphenyl vapor should, therefore, be maintained within the package during the entire marketing period, whether domestic or overseas. To insure an adequate supply of biphenyl for a time long enough to cover the marketing period, the rate at which biphenyl sublimates from the application sheets must be known. Information on the effects of temperature, storage time, and carton venting on the rate of loss of biphenyl from the sheets is given in this report. The report also contains information on the influence of temperature and carton venting on the effectiveness of biphenyl in reducing decay, sporulation, and soilage, and on the accumulation of biphenyl in lemons during storage and the loss of biphenyl during subsequent aeration.

MATERIALS AND METHODS

Lemons were obtained from commercial packinghouses in Upland and San Dimas, Calif. They were randomized into uniform lots of 165 fruits each, packed in cartons, and stored at constant temperatures from 40° to 56° F.

Biphenyl-impregnated sheets of kraft paper were obtained from lemon packinghouses or directly from the manufacturer's warehouses. Sheets to be stored more than a few days before use were wrapped in aluminum foil and held at 0° F. Under these conditions, periodic analyses detected no loss of biphenyl during storage.

After the fruit had attained the temperature of the subsequent storage, it was packed in cartons with one biphenyl-impregnated sheet on the bottom of the carton and one over the fruit.

The experimental cartons were stacked in three layers; the contents of the three cartons in each stack had the same carton ventilation and biphenyl treatment. A nonvented, nonexperimental carton was placed on top of each stack to make the exposure of the top layer of experimental cartons similar to that of the other cartons.

[1] Underscored figures in parentheses refer to Literature Cited, page 14.

Some of the packed cartons were stored 1 week at constant temperatures of 40°, 48°, and 56° F. to simulate the period of transcontinental rail shipments, and others were stored 4 weeks at these temperatures to simulate overseas shipments from the Los Angeles area to western European harbors. Some of the packed cartons were examined at the end of the simulated transit period. Others were held for an additional week at 68°, to simulate movement in the market, without refrigeration, and then examined. A total of 144 cartons of fruit was used in this test. All treatments were made in triplicate and each figure in the tables is the average of data from three cartons.

Twenty-five lemons in each carton were inoculated with a single-spored culture of a biphenyl-sensitive strain (M6A) of Penicillium digitatum (1). Lemons were inoculated with an inoculator similar to one described by Roistacher and Klotz (7). The wounds made by this instrument were 1 mm. deep and about 1 cm. long. Some Penicillium strains that are not sensitive to biphenyl are common in lemon packinghouses. Although in these tests, inoculations were carried out with a sensitive strain, varying amounts of decay and soilage were caused by natural infections of nonsensitive strains. Natural infections of sensitive strains could be expected to be controlled about as effectively as the strain used for inoculation. A rapid method for determining whether a strain is sensitive to biphenyl was devised by Duran (2).

Sporulation was rated by giving an index value of 0.1 for a sporulating surface up to 0.75 inch in diameter, 0.5 to fruit with a sporulating surface from 0.75 inch in diameter to half of the fruit surface, and 1.0 to fruit with more than half of the surface covered with spores. The sporulation index is the sum of the values of each fruit divided by the total number of fruit and multiplied by 100.

The method used for measuring biphenyl has been described by Gunther, Blinn, and Barkley (4). Biphenyl was distilled from the fruit or paper sample into a solvent and the interfering materials were removed by oxidation and differential solubility. The biphenyl concentration of the final solution was determined spectrophotometrically by measuring the absorbance at wave-length 248 millimicrons.

RESULTS

Biphenyl Sheets

Biphenyl Content of Fresh Kraft Sheets

The biphenyl content of the fresh kraft sheets ranged from 0.39 to 3.71 grams per sheet, but most of the sheets analyzed (54 of 72 sheets analyzed, or 75 percent) contained from 1.50 to 2.50 grams. Fifteen sheets (21 percent) contained 2.1 grams; 29 sheets (40 percent) contained 2.1±.2 grams. The average of 2.15 grams per sheet was almost identical with the 2.14 grams necessary to coincide with the content of 4 pounds per 1,000 square feet shown on the package labels. Table 1 shows the range and average biphenyl content of sheets obtained from citrus packing houses and from factory warehouses.

Even though the biphenyl content of the sheets varies, the sheets may be satisfactory for commercial use, for an occasional paper with low biphenyl content will probably be paired with one of at least average content. However, in the experiments reported here, some difficulties arose that make the interpretation of the results somewhat unsatisfactory when the average of a lot is used as the initial value for each sheet.

TABLE 1.--Biphenyl content of fresh kraft sheets

Lot No.	Source	Number of analyses	Biphenyl per sheet		
			Minimum	Maximum	Average
			Grams	Grams	Grams
1.....	Packinghouse	16	1.99	3.71	2.58
2.....	Packinghouse	14	.39	2.66	2.10
3.....	Packinghouse	2	1.08	1.40	1.24
4.....	Warehouse	4	1.85	2.33	2.18
5.....	Packinghouse	10	1.31	2.20	1.83
6.....	Warehouse	26	1.82	2.51	2.11
	All sources				
	Total	72	--	--	--
	Lowest	--	0.39	--	--
	Highest	--	--	3.71	--
	Average	--	--	--	2.15

Factors Affecting Rate of Biphenyl Loss

The effects of carton venting, location of the sheets in the carton, time, and temperature on the rate of biphenyl loss from the kraft application sheets were investigated.

Carton venting.--Biphenyl escaped from the sheets much more rapidly in vented than in nonvented cartons (table 2; fig. 1). Sheets in vented cartons lost an average of 46.3 percent and those in nonvented ones lost only 22.8 percent. The greater relative loss in vented cartons was more noticeable at the lower temperatures than at the higher temperatures. For example, the loss in 4 weeks at 40° F. was about four times as high in vented as in nonvented cartons; at 48° F. the ratio was about 3 to 1, and at 56° F., less than 2 to 1. However, actual loss was greater at the higher temperatures. This will be discussed later.

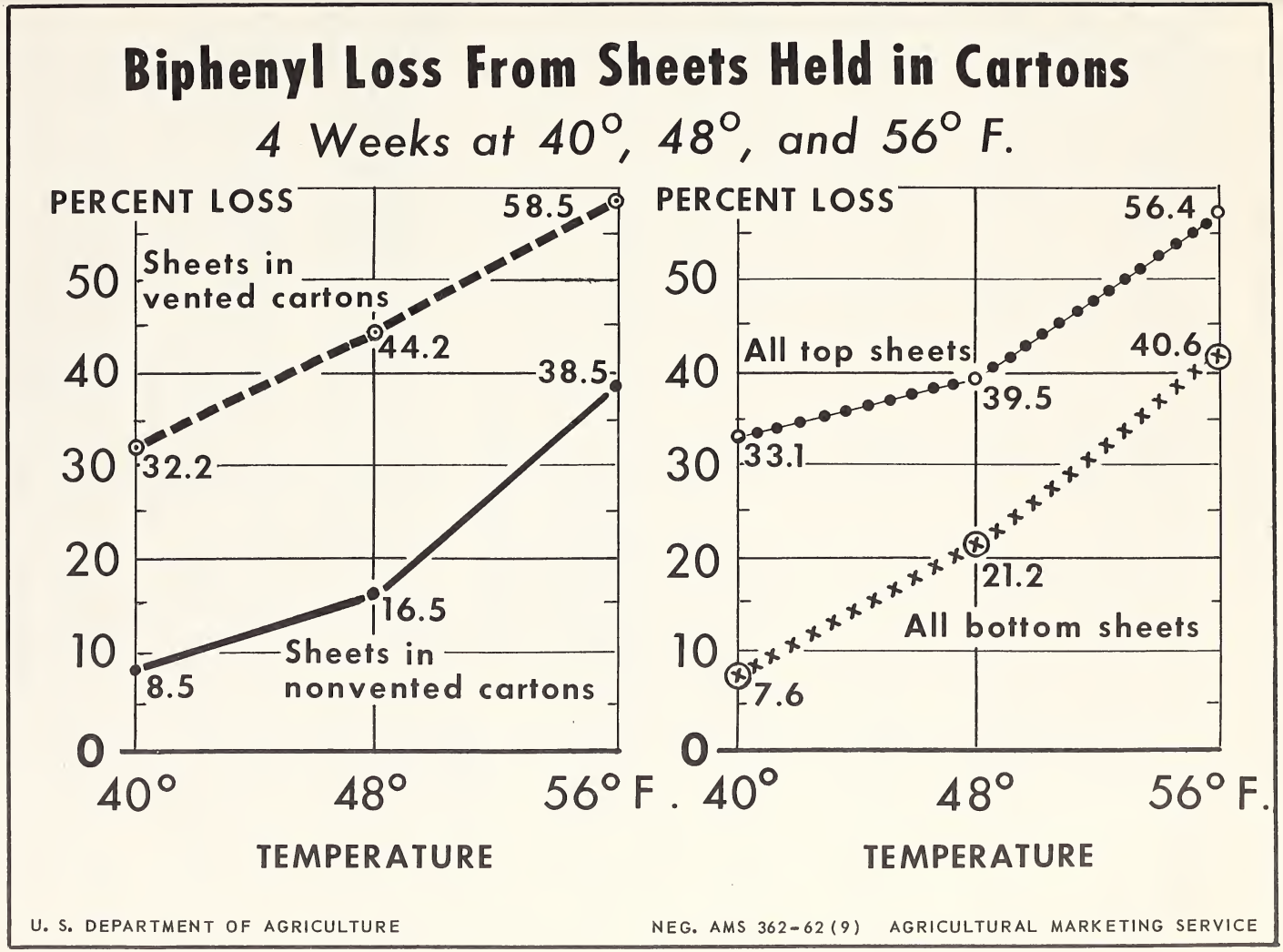
Location of sheets.--The biphenyl-impregnated sheets placed on top of the lemons in cartons lost biphenyl faster than those placed below the fruit (table 2; fig. 1). The difference in loss between top and bottom sheets was greatest at the low temperatures. In 4 weeks at 40° F. the top sheets lost about four times as much biphenyl as the bottom sheets. At 48° F., the ratio was nearly 2 to 1, and at 56° F., about 3 to 2.

The average rate of biphenyl loss from top sheets in vented cartons was twice that from top sheets in nonvented cartons. Likewise, the average rate of loss from bottom sheets in vented cartons was twice that from the bottom sheets in nonvented cartons. In both kinds of cartons, the top sheets lost biphenyl 1.4 times as fast as the bottom sheets (table 2).

Time.--On the average, the kraft sheets in all the cartons lost 10.2 percent of the original biphenyl in 1 week and 33.1 percent in 4 weeks. The average rate was, therefore, only slightly higher during the first week than during the following 3 weeks (table 2).

Temperature.--The rate of biphenyl loss increased rapidly with a rise in temperature (fig. 1 and table 2). The average rate was about 50 percent faster at 48° F. than at 40°, and about twice as fast at 56° as at 40°.

Biphenyl usually escaped from the sheets at a greatly accelerated rate after the cartons were transferred to 68° F., provided most of the biphenyl was still in the papers at the time of the transfer.


Biphenyl Loss From Sheets Held in Cartons
4 Weeks at 40°, 48°, and 56° F.
PERCENT LOSS
50
40
30
20
10
0
Sheets in vented cartons
58.5
44.2
32.2
38.5
16.5
8.5
Sheets in nonvented cartons
40°
48°
56° F.
TEMPERATURE
PERCENT LOSS
All top sheets
56.4
40.6
39.5
33.1
21.2
All bottom sheets
7.6
40°
48°
56° F.
TEMPERATURE
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NEG. AMS 362-62 (9) AGRICULTURAL MARKETING SERVICE

Figure 1

TABLE 2.--Loss of biphenyl from impregnated sheets during storage in cartons of lemons[1] [2]

Temperature (°F.) and length of storage	Vented cartons		Nonvented cartons	
	Top sheets	Bottom sheets	Top sheets	Bottom sheets
	Percent	Percent	Percent	Percent
40°:				
1 week	17.5	13.1	0	1.1
1 week plus 1 week at 68°	53.6	43.1	36.9	26.3
4 weeks	48.7	15.8	17.5	0
4 weeks plus 1 week at 68°	70.0	64.6	34.3	21.8
48°:				
1 week	18.3	13.1	7.6	1.9
1 week plus 1 week at 68°	59.7	39.0	30.6	23.0
4 weeks	60.8	27.6	18.2	14.8
4 weeks plus 1 week at 68°	79.5	70.8	41.1	27.0
56°:				
1 week	19.9	11.8	4.7	13.1
1 week plus 1 week at 68°	59.7	46.3	33.3	28.4
4 weeks	71.3	45.7	41.4	35.5
4 weeks plus 1 week at 68°	89.7	73.8	57.2	31.3
Average of all	54.1	38.6	26.9	18.7

[1] Each value is average of 3 cartons of lemons.
[2] Loss in percent of average initial value of 2.11 grams per sheet.

Condition of Lemons

Effect of Carton Venting

Decay.--Carton venting reduced decay in inoculated fruit when no biphenyl was used (table 3). The percentage of decayed fruit was about the same in vented and nonvented cartons when biphenyl was used. Biphenyl reduced decay about 30 percent in vented cartons and 60 percent in nonvented ones. No account was taken of differences in severity in tabulating the decay data in table 3. Differences in severity are brought out later, where the amounts of sporulation and soilage are discussed.

Sporulation.--Venting the cartons reduced sporulation only slightly when no biphenyl was used; the difference between vented and nonvented cartons was not significant. When biphenyl was used, the average sporulation index was less than one-half as large in nonvented cartons as in vented ones (table 4). Biphenyl reduced the sporulation index 64 percent in vented cartons and 86 percent in nonvented ones. This reduction in sporulation should result in fewer soiled fruit. This actually occurred.

Soilage.--As with sporulation, average soilage (dusting from spores produced by fungi on decaying fruit) was about equal in fruit in nonvented and vented cartons when biphenyl was not used (table 5). Biphenyl reduced percentage of soiled fruit by one-half in vented cartons and by two-thirds in nonvented ones. Soilage was about 1.7 times as high in vented cartons as in nonvented ones when biphenyl was used.

TABLE 3.--Decay in inoculated lemons stored with and without biphenyl in vented and nonvented cartons[1]

Temperature (°F.) and length of storage	Without biphenyl		With biphenyl	
	Vented cartons	Nonvented cartons	Vented cartons	Nonvented cartons
	Percent	Percent	Percent	Percent
40°:				
1 week	0	1	0	0
1 week plus 1 week at 68°	99	100	75	87
4 weeks	75	97	61	49
4 weeks plus 1 week at 68°	89	100	76	84
48°:				
1 week	7	24	0	9
1 week plus 1 week at 68°	88	91	41	51
4 weeks	71	85	36	36
4 weeks plus 1 week at 68°	71	96	71	45
56°:				
1 week	61	85	25	31
1 week plus 1 week at 68°	80	87	43	60
4 weeks	68	93	45	57
4 weeks plus 1 week at 68°	75	97	76	59

[1] Each value is average of 3 cartons; 25 inoculated lemons per carton.

TABLE 4.--Sporulation index[1] of inoculated lemons stored with and without biphenyl in vented and nonvented cartons[2]

Temperature (°F.) and length of storage	Without biphenyl		With biphenyl	
	Vented cartons	Nonvented cartons	Vented cartons	Nonvented cartons
	Percent	Percent	Percent	Percent
40°:				
1 week	0	0	0	0
1 week plus 1 week at 68°	12	38	2	5
4 weeks	0	0	0	0
4 weeks plus 1 week at 68°	79	100	36	8
48°:				
1 week	0	0	0	0
1 week plus 1 week at 68°	32	63	4	1
4 weeks	60	23	7	7
4 weeks plus 1 week at 68°	68	100	20	13
56°:				
1 week	0	0	0	0
1 week plus 1 week at 68°	77	59	25	13
4 weeks	56	32	35	17
4 weeks plus 1 week at 68°	75	96	43	7

[1] Sporulation index: See text, page 5.
[2] Each value is average of 3 cartons of lemons (25 inoculated lemons per carton).

TABLE 5.--Soilage of noninoculated lemons stored with inoculated lemons with and without biphenyl in vented and nonvented cartons[1]

Temperature (°F.) and length of storage	Without biphenyl		With biphenyl	
	Vented cartons	Nonvented cartons	Vented cartons	Nonvented cartons
	Percent	Percent	Percent	Percent
40°:				
1 week	0	0	0	0
1 week plus 1 week at 68°	7	10	1	0
4 weeks	0	0	0	0
4 weeks plus 1 week at 68°	59	73	29	6
48°:				
1 week	0	0	0	0
1 week plus 1 week at 68°	37	37	3	1
4 weeks	29	18	4	5
4 weeks plus 1 week at 68°	63	45	25	16
56°:				
1 week	1	3	1	0
1 week plus 1 week at 68°	55	33	16	13
4 weeks	30	26	24	14
4 weeks plus 1 week at 68°	66	82	47	[2] 34

[1] Each value is average of 3 cartons of lemons (140 noninoculated lemons per carton.)
[2] Much of the soilage was caused by juice of rotting fruit dripping on fruit below.

Biphenyl content of lemons.--Lemons in nonvented cartons absorbed nearly twice as much biphenyl as those in vented cartons (table 6). The highest concentration found, however, was only a little more than 30 p.p.m. (parts per million), a value far below any present legal tolerances which range in different countries from 70 to 110 p.p.m.

Effect of Temperature

Decay.--In the absence of biphenyl the decay organisms grew more slowly at the lower than at the higher temperatures, but after 4 weeks fully as many inoculated lemons stored at 40° F. showed decay lesions as in those stored at 48° or 56° (table 3). However, the lesions on the lemons stored at 40° were smaller than those on lemons stored at 48° or 56°.

When biphenyl was used, the lowest percentage of inoculated fruit showing decay after 4 weeks was found in the lots held at 48° F. Because the vapor pressure of biphenyl is very sensitive to temperature, one could conceivably produce a concentration in the atmosphere surrounding the lemons at 48° which, taken together with the direct effect of the temperature, would reduce mold growth more than the equivalent combination of biphenyl concentration and temperature at 40° or 56°. Another consideration that must be taken into account is the effect chilling might have on lemons stored at 40° for 4 weeks. One of the effects of chilling injury is an increased susceptibility to attack by decay organisms (6).

Sporulation.--The effect of temperature on sporulation (fig. 2) is similar to the effect on decay (table 4). In 1 week no sporulation developed at any temperature. In 4 weeks none developed at 40° F., either with or without biphenyl, but at 48° and 56° considerable sporulation developed, especially when no biphenyl was used. Sporulation increased rapidly after the fruit was transferred to 68° F., especially when no biphenyl was used.

TABLE 6.--Biphenyl content of lemons after simulated transit periods in vented and nonvented cartons[1] [2]

Temperature (°F.) and length of storage	Vented cartons	Nonvented cartons
	P.p.m.	P.p.m.
40°:		
1 week	5.2	9.1
1 week plus 1 week at 68°	14.6	26.1
4 weeks	10.4	18.8
4 weeks plus 1 week at 68°	18.1	32.3
48°:		
1 week	6.0	7.1
1 week plus 1 week at 68°	13.7	23.0
4 weeks	9.7	19.6
4 weeks plus 1 week at 68°	14.0	24.6
56°:		
1 week	5.1	12.7
1 week plus 1 week at 68°	10.2	24.9
4 weeks	11.4	23.8
4 weeks plus 1 week at 68°	14.7	31.0

[1] Each value is average of 3 cartons of lemons.
[2] Each analytical sample consisted of 40 lemons.

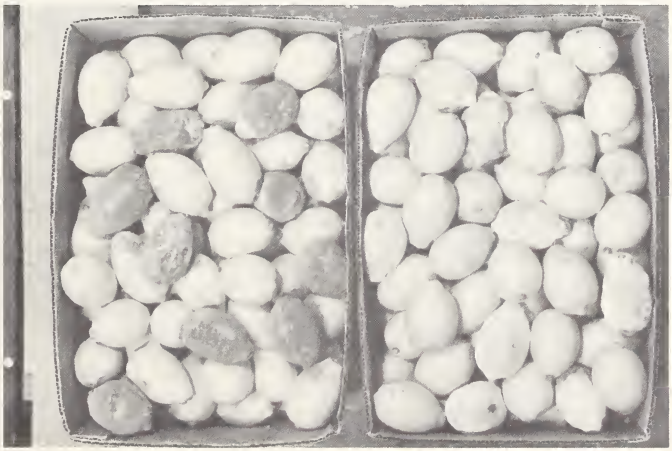

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Figure 2. --These lemons were held 10 days at 68° F. The top layer of each carton had 10 lemons inoculated with Penicillium digitatum. The carton on the left had no biphenyl; the carton on the right had biphenyl-impregnated papers on the top and bottom.

Soilage.--A temperature of 40° F. prevented soilage (fig. 1) for as long as 4 weeks whether biphenyl was used or not (table 5). A temperature of 48° prevented soilage for 1 week, but after 4 weeks considerable soilage occurred if no biphenyl was used and only a small amount when biphenyl was used. At 56° a small amount of soilage occurred in 1 week but an appreciable amount was present after 4 weeks' storage even when biphenyl was used.

Much soilage usually occurred during the week the fruit was held at 68° F. after the cold storage period. This increase was especially great after the 4-week storage period where no biphenyl was used. Fruit previously stored at 56° was in poorest condition at this time whether biphenyl was used or not.

A small amount of soilage occurred in some lots that showed no sporulation (see 56° F., 1 week, in tables 4 and 5). In these instances the fruit was soiled by spores from noninoculated fruit decaying from natural infections.

Biphenyl content of lemons.--Lemons held at 56° F. usually contained more biphenyl than those stored at lower temperatures for the same length of time in the same kind of cartons. The difference between lemons stored at 40° and 48° was not consistent. Biphenyl was absorbed rapidly after the lemons were transferred to 68° (table 6). These results agree with previously reported findings (5).

Loss of Biphenyl During Aeration of Fruit

Lemons that had been stored in the usual way in biphenyl-treated cartons were aerated by placing them in open trays without biphenyl pads, and held for 1 or 2 weeks at 68° F. Representative samples were analyzed for biphenyl content after the holding periods in the cartons and after aeration for 1 or 2 weeks. The results are given in table 7.

The loss after 1 week was from 33 to 80 percent of the amount absorbed in storage, and after 2 weeks' aeration 60 to 95 percent.

TABLE 7.--Biphenyl content of lemons after storage with biphenyl sheets in nonvented cartons and after subsequent aeration

Sample number	Temperature (°F.) and length of storage	Biphenyl content at end of storage[1]	Loss of biphenyl during subsequent aeration at 68° F.	
			1 week	2 weeks
		P.p.m.	Percent	Percent
	40°:			
1	4 weeks plus 1 week at 68° [2]	34.2	46.4	69.6
	56°:			
2	4 weeks plus 1 week at 68°	32.1	55.7	60.6
3	1 week	11.4	35.9	73.5
4	1 week	9.8	33.6	94.8
5	1 week	13.8	76.7	87.6
6	1 week	11.3	80.4	83.1

[1] Including holding 1 week at 68° F. when applicable.
[2] Fresh biphenyl pads were placed in cartons at transfer to 68° F. prior to final week of holding in cartons. These pads were removed before aeration.

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