UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 686

Contribution from the Bureau of Plant Industry
WM. A. TAYLOR, Chief

Washington, D. C. PROFESSIONAL PAPER June 24, 1918

FURTHER STUDIES OF THE ROTS OF STRAWBERRY FRUITS.

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CONTENTS.

INTRODUCTION.

The results of the investigations of the rots of strawberry fruits (*Fragaria* sp.) made by the writers during the two years ended in the spring of 1917 have already been published (10 to 12).[1] Since the preparation of these papers the problem has been studied somewhat more extensively. The work for the season of 1917 included field investigations in Florida, Alabama, and Louisiana, with experimental shipments between Hammond, La., and Chicago during April, and field work in Missouri and in the region about Norfolk, Va., in May. Observations were also made of the fruit in the various markets, most of the important markets east of Minneapolis being visited at least once during the season.

Through the courtesy of H. J. Ramsey and V. W. Ridley, of the Office of Handling and Storage Investigations of Fruits and Vegetables, one of the writers was able to accompany car-lot shipments of strawberries from Monett, Mo., to St. Paul, Minn., in order to study the condition of these shipments and to include inoculated fruit in the cars.

[1] The serial numbers in parentheses refer to "Literature cited," at the end of this bulletin.

RHIZOPUS.

TYPE OF ROT INDUCED.

Among the numerous fungi which have been found growing on ripe strawberries, Rhizopus, as pointed out in an earlier paper (12, p. 4), is by far the most important. This fungus destroys strawberry tissue more rapidly than any other yet found and causes the affected fruits to collapse with the loss of much juice, producing the characteristic "leak" which so frequently discolors strawberry boxes and crates in the market. The spores of this fungus are apparently very generally present on ripe strawberry fruits.

A list of fruits and vegetables on which *Rhizopus nigricans* Ehrb. has been reported was published by the writers (12, p. 9). On June 1, 1917, this fungus was observed fruiting abundantly on red raspberries (*Rubus* sp.) and dewberries (*Rubus* sp.) in the Chicago market, and later (July 23) on blackberries in the Washington market. In all these cases the fungus seemed to be producing the leak characteristic of its action on strawberries and other fruits (12, p. 11). The berries had settled to about one-half their original height in the box, and the juice was leaking from the bottoms of the boxes or crates.

It is of interest to note that in his studies of Rhizopus, Wormald (14, p. 483) proved that both the so-called plus (+) and minus (−) strains of this fungus are able to produce the characteristic soft rot of tomatoes (*Lycopersicon esculentum*).

It is probable that Rhizopus occurs as a fruit rot of tomatoes in this country, although no reference to it can be found in available literature. In a car of tomatoes from Cuba which was examined in Boston in January, 1918, by Mr. C. E. Merrill, food products inspector of the Bureau of Markets, and one of the writers, several instances were found in which a species of Rhizopus was producing a soft rot of tomatoes.

IMPORTANCE OF CAREFUL HANDLING.

Early in their investigations (10, p. 364) the writers became convinced that Rhizopus rarely, if ever, enters strawberries through the uninjured epidermis. Continued observations and experiments have confirmed this conclusion. As strawberries are very easily injured, they should be handled as little and as carefully as possible. Sorting, or at least some examination at the packing shed, is usually necessary, but berries should be handled carefully in order to reduce to a minimum injury and the consequent decay. When practicable, as when most of the picking is done by the grower's family or by experienced help, the berries may be sorted as picked. This is probably the most desirable procedure. The importance of careful handling as a means of reducing loss from decay in various fruits has been clearly shown in several investigations by Ramsey (5 and 6), Powell

(4), and others, and it is apparently of first importance in the strawberry.[1]

IMPORTANCE OF LOW TEMPERATURE.

The careful studies of Miss Ames (1) indicate the close relation between temperature and the rate of growth of Rhizopus. Rhizopus grows very slowly at a temperature of 10° C. (50° F.). The rate of growth increases very rapidly with the rise of temperature above that point, however, so that the fungus will develop more in a short time at a relatively high temperature than in a much longer time at a lower temperature. Miss Ames found, for instance, that *Rhizopus nigricans* would produce mature sporangia in 36 hours at a temperature of 33° C., while at temperatures of 10° to 12° C. three weeks were required.

The importance of low temperature in reducing rots of strawberries was strikingly shown by tests conducted in connection with experimental shipments between Monett, Mo., and St. Paul, Minn. Similar boxes of strawberries of the Warfield variety were inoculated with spores and mycelium of *Rhizopus nigricans* through needle wounds. The berries, at a uniform temperature of about 24° C. (75° F.), were all placed in the cars about 6 p. m.

Accurate temperature records kept by Mr. V. W. Ridley showed that the most marked difference in the conditions to which the four boxes referred to in Table I were subjected was in the time consumed in reaching a temperature below 10° C. (50° F.). Examination of the fruit four days later, on arrival at destination, showed that the longer the time consumed in reaching 10° C., the greater the amount of rot developed. The results are summarized in Table I.[2]

TABLE I.—*Relation of temperature to the growth of Rhizopus in inoculated strawberries of the Warfield variety, in connection with experimental shipments between Monett, Mo., and St. Paul, Minn.*

Crate.	Hours consumed in reaching 10° C. (50° F.).	Condition on examination after arrival at destination.
No. A.....	40	Berries practically all rotten, most of them bearing aerial hyphæ with immature sporangia.
No. B.....	30	All berries showing a rotten area about one-fourth of an inch in diameter around the inoculation.
No. C.....	7	70 per cent of berries showing no indication of fungous growth, the remaining 30 per cent showing small rotten spots.
No. D.....	5	91 per cent of berries showing no indication of fungous growth, the remaining 9 per cent showing very slight softening around the point of inoculation.

Other boxes of inoculated fruit of the Warfield variety, as well as some Aromas, were also included in this experiment. The results

[1] Mr. E. L. Markell, of the Bureau of Markets, informs the writers that his own investigations, conducted during 1915 and 1916 at Hammond, La., the results of which are as yet unpublished, clearly showed the importance of care in handling strawberries.

[2] See also Ridley, V. W. Factors in transportation of strawberries from the Ozark region. U. S. Dept. Agr., Markets Doc. 8, 10 pp., 6 fig. 1918.

in all cases were similar to those given in Table I. The significant fact is that the only perceptible difference between the boxes was in their temperature after loading on the cars. Boxes of berries as nearly alike as possible were chosen for the experiment. The berries were of the same variety, grown in the same locality, picked at the same time, and inoculated in the same way with the spores and mycelium of *Rhizopus nigricans* which came from a single original culture.

WASHING STRAWBERRIES.

Washing strawberries before packing for shipment is regularly practiced by a few growers in Florida and is resorted to by a large number when the berries are very sandy. Experiments conducted in Florida by the writers during 1916 (12, pp. 15–19) showed that the practice is not necessarily harmful provided the fruit is packed wet,[1] handled with care, and placed under refrigeration within a reasonable time. They indicated, indeed, that the keeping quality of the fruit might even be improved by this treatment. To allow the washed fruit to dry before packing, on the other hand, had a decidedly injurious effect.

In order to verify these results, the writers experimented by washing strawberries in Louisiana and Missouri during 1917. Various methods of washing were first tested. Experiments were conducted in which a part of the berries were packed in boxes and then washed either by dipping the entire box in clean cold water or by running the water over and through the box, while an equal quantity of the berries was poured into the water, dipped out immediately, and then packed in boxes. Klondike berries picked at Hammond, La., were used and after treatment were placed in crates while wet and examined after 48 hours. Table II summarizes the results of these tests.

TABLE II.—*A comparison of the keeping quality of strawberries washed before packing with strawberries washed after packing at Hammond, La., in 1917.*

Treatment.	Washed after packing.		Washed before packing	
	Number of berries.	Sound on examination.	Number of berries.	Sound on examination.
		Per cent.		*Per cent.*
Held without refrigeration	183	28	143	13
Shipped to Chicago under refrigeration	820	56	786	45
Total	1,003	51	929	40

Without exception, the results were in favor of packing the fruit before rather than after washing. In subsequent washing experiments, therefore, this method was followed.

[1] Still better results are obtained by packing dry and then washing.

In six tests, which included three varieties from two localities, washed berries which had been placed in the crates while wet were compared with unwashed berries. The results are given in Table III.

TABLE III.—*Effect of washing strawberries, as shown by six tests of fruit grown in Louisiana and Missouri in 1917.*

Test.	Variety.	Locality where grown.	Unwashed fruit.		Washed fruit.	
			Number of berries.	Sound.	Number of berries.	Sound.
				Per cent.		*Per cent.*
No. 1	Klondike	Hammond, La.	268	41	243	26
No. 2	Russell[1]	do	222	40	228	26
No. 3	Klondike	do	234	42	194	43
No. 4	do	do	638	49	658	52
No. 5	do	do	192	58	162	72
No. 6	Warfield	Monett, Mo	230	57	198	81

[1] A local name.

As was stated in a previous paper (12, p. 18), the improvement in the keeping quality due to washing berries is greatest when the temperature of the air is highest, as the improvement is apparently due to the fact that the wetted berries are at a lower temperature during the interval between packing and placing under refrigeration. The results given in Table III emphasize these facts. In tests Nos. 1 and 2 the berries were picked between 8 and 9:30 a. m. on a bright but rather cool morning following a heavy rain. Many of the berries were still wet, and their temperature was not materially lowered either by dipping or subsequent increased evaporation. The chief effect of the treatment was, then, the slight bruising incident to dipping, and the results are unfavorable to the washed fruit.

In tests Nos. 3 to 6, however, the berries were picked between 11 a. m. and 3 p. m. on warm bright days when the immersion and evaporation actually lowered the temperature of the washed fruit considerably below that of the dry.

In tests Nos. 1 to 4 the berries were kept without refrigeration for 24 hours before being loaded into cars for shipment to Chicago. The cooling due to washing persisted for only a few hours, after which the berries reached a temperature favorable for fungous growth and remained at that temperature for a considerable time prior to being placed in refrigerator cars, so the beneficial effect due to washing was largely lost. In the last two tests, on the other hand, the berries were loaded into iced cars within a few hours after picking and washing, so that the cooling effect persisted for the entire interval and the berries did not reach air temperature at any time. Under these conditions washing markedly improved their keeping quality.

The experiments in 1916 showed that if washed berries are allowed to dry before being packed their shipping quality is injured. To obtain further data on this point three shipments of Klondikes from Hammond, La., to Chicago, Ill., were made in April, 1917. The results, which are summarized in Table IV, agree closely with those of the previous year.

TABLE IV.—*Effect of drying washed strawberries before packing, as shown by shipments of fruit from Hammond, La., to Chicago, Ill.*

Treatment.	Number of berries.	Sound on examination.
		Per cent.
Not washed	1,064	49
Washed and packed wet	1,014	53
Washed, dried in shade, and packed	1,037	37

As already stated, by this treatment the beneficial cooling effect of continued evaporation from the berries is lost, and the harmful effects of softening and extra handling are emphasized.

Smith and Goodman (13, p. 84; see also 12, p. 17) found that strawberries dried for an hour in a strong current of air from an electric fan carried to market in better condition than those even slightly wet. In order to review the conclusions of these investigators, two tests were made at Hammond, La., in which wet berries were fanned before being packed. In one test the berries were prepared and held for 24 hours at room temperature, after which they were shipped to Chicago under refrigeration. In the second case they were placed in an iced car for shipment as soon as [illegible] were prepared. The results are shown in Table V.

TABLE V.—*Effect of fanning strawberries before shipment, as shown by two tests of fruit grown at Hammond, La., and shipped to Chicago, Ill.*

Treatment.	Held 24 hours without refrigeration before shipment.		Packed and shipped immediately.	
	Number of berries.	Sound on arrival.	Number of berries.	Sound on arrival.
		Per cent.		*Per cent.*
Not washed or treated	234	42	192	58
Not washed, but fanned 1 hour			184	54
Washed and dried in shade 1 hour	234	23	165	54
Washed and packed wet	194	43	162	72
Washed and fanned 1 hour	164	23	186	70

These results and those of other tests (see Table IV; also 12, pp. 16–19) indicate that no injury is likely to follow shipping berries wet. As the writers' work was done in Louisiana and Smith and Goodman's in Canada, no very satisfactory basis for a comparison of results is presented.

TEMPERATURE AT TIME OF PICKING IN RELATION TO DECAY.

Another striking illustration of the importance of temperature in controlling Rhizopus rot is found in the relation of the rate of decay to the temperature at the time of picking. In studies which are to be reported in detail elsewhere, the writiers have determined that on clear days the temperature of many small fruits, including strawberries, is much higher near midday than in the early morning or late afternoon. Experiments have shown further that the decay of strawberries picked near noon is more rapid than that of similar berries picked early in the morning. For example, strawberries of the Klondike variety were picked at Hammond, La., at various times and held in the packing shed until about 4.30 p. m., when they were shipped to Chicago under refrigeration in the regular express service, which gives second-morning delivery. They were examined and sorted on the day following their arrival. (Series A, Table VI.) Wider differences in keeping quality were obtained with another series picked and shipped under similar conditions. (Series B, Table VI.)

TABLE VI.—*Keeping quality of strawberries in relation to temperature at time of picking, as shown by three series of tests of fruit grown at Hammond, La.*

Time of picking.	Temperature when picked.		Number of berries.	Sound on examination.
	° C.	° F.		*Per cent.*
Series A:				
8 a. m.	24.5	76	140	52
9.15 a. m.	28.5	83	142	56
10 a. m.	31.0	88	204	52
12 m.	32.0	90	90	40
2 p. m.	30.5	87	133	55
4 p. m. (cloudy)	26.0	79	180	57
Series B:				
6 a. m.	15.0	59	165	65
8 a. m.	23.5	74	103	58
10 a. m.	29.5	85	273	50
12 m. (drifting clouds)	31.0	88	109	29
2 p. m.	35.0	95	153	30
4 p. m.	32.5	91	115	30
Series C:				
12 m.	31.0	88	162	12
2 p. m.	35.0	95	248	11
4 p. m.	32.5	91	222	20
5 p. m.	30.0	86	270	22
6.45 p. m.	21.0	70	387	34

In order to ship the berries to Chicago under refrigeration, it was necessary to discontinue each test at 4 p. m. (series A and B, Table VI). A third series of tests was accordingly made on the same day as that of series B, in which the berries were held at air temperature at Hammond, La., for two days, with the results shown. (Series C, Table VI.)

The results of the tests designated as series C, which parallels that recorded under Series B, Table VI (from 12 m. until 4 p. m.), indicate that berries picked late in the afternoon, after their temperature had

fallen, kept better than those picked during the hottest part of the day.

BOTRYTIS.

RELATION OF BOTRYTIS INFECTION TO MOISTURE CONDITIONS.

Botrytis [1] is characteristically a cause of field rot of strawberries. It is, however, by no means of uniform importance. Its abundance seems to be closely correlated with moisture conditions. During the past three years the writers have observed three epidemics of Botrytis, all associated with abundant moisture. The first occurred in the early part of June, 1915, at the Arlington Experiment Farm, in Virginia. Not only were green and ripe fruits affected, but fruit pedicels and leaf petioles as well.

The epidemic began during a week of almost continuous cloudy weather in which over 3 inches of rain fell, as indicated by the accompanying report (Table VII) taken from the Monthly Meteorological Summary for Washington, D. C., published by the Weather Bureau of the United States Department of Agriculture.

TABLE VII.—*Meteorological data, Washington, D. C., May 28 to June 3, 1915.*

Date.	Temperature (° F.).		Precipitation (inches).	Character of day.	Percentage of possible sunshine.
	Maximum.	Minimum.			
May 28	76	48	.....	Partly cloudy	37
May 29	61	57	0.12	Cloudy	0
May 30	57	52	.10	.....do	0
May 31	73	52	.....	Clear[a]	90
June 1	68	49	.11	Cloudy	26
June 2	64	54	3.00	.....do	0
June 3	59	49	.03	.....do	1

[a] Corrected from the published Monthly Meteorological Summary on the advice of Mr. M. C. Bennett, acting chief, Climatological Division, Weather Bureau.

This infection occurred on the experimental plats of the Office of Horticultural and Pomological Investigations, in which a test was being made of more than 300 varieties of strawberries. No difference in the susceptibility of the different varieties could be noted.

A strongly localized epidemic which was of special interest because of its evident direct relation to moisture conditions occurred at Hammond, La., following a rain on April 16, 1917. On one field known for its high yields and careful culture there was great loss from Botrytis. The loss was markedly greater on one side of the field where a grove of tall trees shaded the plants during the early part of the day and evaporation took place more slowly than elsewhere. More than half of the berries picked in this field on one day were discarded as culls because of Botrytis infection. The inspection of

[1] While careful comparative studies of material from various localities have not been made, the collections of Botrytis on strawberry fruits appear to belong to a single species, probably *B. cinerea* Pers.

fruit by many growers was unfortunately less rigid, however, and during a few days some shipments contained large numbers of such culls.

In a field of the Russell variety in the same locality the moisture relation was still more evident. The soil was heavy and rather impervious, and in about 20 rows which had been coarsely cultivated just before the rain the ground was left rough and uneven. Following the rain, the water stood in pools under and around the plants in these rows after the smoothly packed uncultivated part of the field was drained and fairly dry. On the morning of April 18 a large proportion of the mature and green berries in the rough ground were infected with Botrytis, while only a small percentage of those in the rows on either side were diseased.

The third and very interesting, though less marked, epidemic occurred at Monett, Mo., during May, 1917. The first examination of the fields in this vicinity was made Sunday, May 20, following a period of drought which threatened the strawberry crop. At that time no evidence of Botrytis could be found. During the following week there was some rainfall nearly every day and comparatively little clear weather, as is shown by the accompanying report of weather observations at the near-by station of Springfield, Mo., kindly furnished by Mr. W. B. Hare, observer at that station (Table VIII). Throughout the week, May 20 to 26, strawberries in that vicinity were constantly under observation, and there was a more or less regular increase in the amount of Botrytis on the fruits, until in fruit picked Saturday, May 26, as many as 10 per cent of the berries in some fields were found to be affected by Botrytis.

TABLE VIII.—*Meteorological data, Springfield, Mo., May 20 to 27, 1917.*

Date.	Temperature (° F.).		Precipitation (inches).	Character of day.	Percentage of possible sunshine.
	Maximum.	Minimum.			
May 20	72	61	0.45	Partly cloudy	28
May 21	68	58	.69	Cloudy	20
May 22	62	41	.02	....do	0
May 23	62	40	.02	Clear	87
May 24	68	51	.07	Partly cloudy	44
May 25	66	57	.54	Cloudy	6
May 26	80	66	0	Clear	67
May 27	67	53	.74	Cloudy	7

GROWTH OF BOTRYTIS ON STRAWBERRIES UNDER REFRIGERATION.

As a cause of rot in transit Botrytis is of minor importance. Its development on ripe strawberries is so slow that it seldom does much damage in transit. Its presence in boxes is usually due to improper sorting. Most berries attacked by Botrytis can be detected and should be removed when the berries are packed. The importance

which has been attributed to Botrytis (7, p. 950) is apparently largely due to its frequent occurrence in strawberry fields under certain circumstances and to its ability to produce aerial hyphæ at relatively low temperatures. Under the conditions found in many refrigerator cars, strawberries affected with Botrytis often develop abundant fine, gray, sterile aerial hyphæ, often 2 cm. or more in length. A few such berries on the top of a crate attract immediate attention and give the impression of general decay. On removal from the cool, moist air of the refrigerator car these aerial hyphæ collapse and are replaced by much shorter (2 to 3 mm.) fertile hyphæ, which produce mature spores in a short time, often within 36 hours.

The ability of Botrytis to grow at low temperatures has been frequently noted. Brooks and Cooley (2, pp. 156 and 159, fig. 15) found that it would grow somewhat at 0° C. on corn-meal agar in Petri dishes and would even germinate at this temperature, while Fulton in the course of storage experiments on small fruits found that this fungus (3, p. 19) "grows luxuriantly in warm temperatures and slowly in the coldest temperatures in which the fruit can be stored safely without freezing." (See also 3, pl. 1, D, and pl. 3.)

The fact that berries destroyed by Botrytis are frequently brownish when they arrive at their destination has caused some inspectors to apply the term "brown-rot" to this disease. This name is, however, unfortunate, since it is now customarily limited in application to a different class of diseases.

In striking contrast to strawberries rotted by Rhizopus, those affected by Botrytis are even firmer than normal berries, retaining their shape even after abundant spores are produced and finally becoming hard and dry. For this reason, therefore, and because Botrytis is a field trouble rather than a rot of berries in shipment, it seems that the descriptive term "dry-rot," already in use among growers in some sections, might well be applied to this disease.

RELATION OF BOTRYTIS TO INFECTION BY RHIZOPUS.

In his first paper dealing with decay of strawberries in transit, F. L. Stevens regarded Botrytis as a primary cause of decay in transit and stated that "Botrytis initiates the decay, opening the way to such other saprophytes as may be present. Of such saprophytes Rhizopus is by far the most prominent and most abundant." On the basis of a histological study of strawberries infected with these two fungi, one of the writers stated in 1916 that Rhizopus ordinarily entered strawberries through wounds and was "not dependent on the presence of any other fungus in its attack on strawberries during shipment and on the market" (10, p. 366). It was, of course, recognized at this time that these observations did "not preclude the possibility of *Rhizopus* sp. following in an area originally infected by

Botrytis sp. or some other fungus." Continued study (12, p. 9) convinced the writers that the most common method of entrance of Rhizopus was through wounds.

Later investigations (8 and 9) led Stevens to modify his earlier views, and in a paper published jointly with Peterson he states (9, p. 264) that "*Rhizopus nigricans* is the fungus which, at the destination of the berry, is most in evidence and the fungus which, in reality, does most of the damage to shipped berries. * * * It is evident that this fungus does not attack sound berries, but is secondary in its nature, following one or another of the fungi mentioned above or gaining entrance through some mechanical wound." So far as concerns the importance of Rhizopus and the possibility of its entering through wounds, this is in substantial agreement with the observations of the writers.

Until the spring of 1917 no good opportunity was afforded for studying the effect on Rhizopus infection of previous infection by Botrytis. It seemed entirely probable, however, that Botrytis was of no particular advantage in the entrance of Rhizopus, since Rhizopus is very abundant in strawberries in which there is no Botrytis infection.

During the epidemic of Botrytis on strawberries of the Russell variety in the field at Hammond, La., already described, and in connection with the experiments on shipping washed and unwashed strawberries, advantage was taken of the opportunity to test the shipping quality of berries from a field badly infected with Botrytis as compared with that of berries from a field in which little Botrytis appeared. A single crate was filled, half with berries from the field of Klondikes in which there was little Botrytis and half with berries from the field of Russells in which Botrytis was so common. These boxes were chosen at random from lots which had been sorted and packed in the ordinary commercial manner. Half of each variety were dipped and half left as checks. All were then shipped to Chicago under refrigeration. The results are presented in Table III, tests 1 and 2.

While this observation is, of course, complicated by the fact that different varieties were used in the two cases, it at least shows that there was no marked increase in the amount of Rhizopus present in the berries which came from a field badly infected by Botrytis.

Further evidence as to the relation between these fungi was obtained by actual inoculation of infected fruit from the same field. Berries naturally infected with Botrytis were inoculated with spores and mycelium of Rhizopus from pure culture. Berries which had only small areas infected with Botrytis were readily inoculated with Rhizopus in the remaining sound tissue. In no case was infection

secured when Rhizopus was inoculated into an area already infected by Botrytis.

During the experimental shipment between Monett, Mo., and St. Paul, Minn., some berries attacked by Botrytis were kept in a warm car, some were exposed to the air, and others were surrounded by leaky berries on which *Rhizopus nigricans* was fruiting. While a few of the diseased berries became infected with Rhizopus, the percentage of such infections was smaller than in the case of uninfected berries kept under similar conditions as checks. Most of the berries infected with Botrytis, on the contrary, became brown in color, firm in texture, and retained their shape for a week or more except for some slight shriveling.

At Hammond, La., on April 25, 1917, boxes of apparently sound berries and also of berries infected with Botrytis were selected. These were held at room temperature, without refrigeration, for 48 hours and then examined. Of the berries which had been apparently sound, 79 per cent were now typical leaks and 9 per cent showed soft spots due to Rhizopus infection. The berries which had shown lesions of Botrytis, on the other hand, now contained only 19 per cent of leaky berries and 9 per cent which showed small Rhizopus infections. In no cases were the latter apparently associated with the Botrytis infections. This seemed to indicate that the presence of Botrytis inside the berry actually inhibited to some extent the growth of Rhizopus.

It is, of course, not impossible that Rhizopus may follow in a region infected by Botrytis. Since, however, the writers have not been able to find a case of this sort or to produce it artificially, it may perhaps be fairly assumed that this type of infection is relatively rare.

SUMMARY.

Leak, caused by *Rhizopus nigricans*, is by far the most important rot of strawberries after picking.

Losses from leak can be most effectively reduced by keeping berries at low temperatures and by handling them carefully.

Berries picked in the early morning are cool and less likely to decay than those picked during the heat of the day.

Adequate refrigeration greatly reduces the rate of growth of *Rhizopus nigricans* in transit.

Washing strawberries to remove dirt may have a beneficial effect if the berries are washed in clean water, handled with care, packed in the crates while still wet, and refrigeration is not too long delayed. Less bruising results if the berries are packed in boxes and then washed by dipping the entire box or by running water through it than if the berries are washed before packing and plating.

Botrytis sp. is characteristically a field rot of strawberries. It is most abundant and serious in the field under conditions of excessive moisture.

Berries affected with Botrytis can be recognized at the time of picking and packing and should not be included in fruit intended for market.

Although Botrytis is able to grow at low temperatures and frequently produces abundant aerial hyphæ on strawberries in refrigerator cars, its growth on ripe berries is so slow that it is of minor importance as a cause of rot in transit.

It is evident that the entrance of Rhizopus into strawberries and the production of leak are not dependent upon previous infection by Botrytis.

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