The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.

Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

84 Mr
.2

Marketing Research Report No. 308

U. S. DEPARTMENT OF AGRICULTURE

LIBRARY
CURRENT SERIAL RECORD
★ APR ... ★

Agricultural Marketing Service
Marketing Research Division
Washington, D. C.

Commercial Packaging and Storing of

BARE-ROOT ROSE BUSHES

Uota, Masami, 1918–

Commercial packaging and storing of bare-root rose bushes [by M. Uota, John M. Harvey and Robert W. Lateer] Washington [U. S. Govt. Print. Off., 1959]

31 p. illus. 27 cm. (U. S. Dept. of Agriculture. Marketing research report no. 308)

Bibliographical footnotes.

1. Roses[—Storage] 2. Roses—Packaging. (Series)

HD1751.A9183 no. 308 635.9333 Agr 59–74

U. S. Dept. of Agr. Libr. for Library of Congress 1Ag84Mr no. 308 †

PREFACE

This report is part of a broad program of continuing research designed to reduce the cost of marketing farm products.

In this report it is sometimes necessary to mention specific trade names, for purposes of identification. Mention of these trade names does not constitute endorsement by the U. S. Government.

ACKNOWLEDGMENTS

The Refrigeration Research Foundation, Colorado Springs, Colo., assisted in acquiring experimental materials.

The following chemical companies supplied the fungicides tested for decay control:

California Spray Chemical Co., Richmond, Calif.
Dow Chemical Co., San Francisco, Calif.
Grasselli Chemical Department, E. I. DuPont de Nemours and Co., San Francisco, Calif.
Naugatuck Chemical Division of United States Rubber Co., Los Angeles, Calif.
R. T. Vanderbilt Co., Inc., New York, N. Y.

The following paper and container companies supplied test packages and liners:

American Box Corp., Corrugated Container Division, Newark, Calif.
Arkell Safety Bag Co., New York, N. Y.
Container Corp., of America, California Container Corp. Division, Portland, Oreg.
Crown Zellerbach Corp., Western Waxide Division, San Leandro, Calif.

The following growers and shippers supplied greenhouse space and bushes used in experimental and commercial lots:

Amling-deVor Nurseries, Inc., Livermore, Calif.
Avasino-Mortenson Co., Inc., San Leandro, Calif.
Sakai Brothers Nurseries, Hayward, Calif.
Twin Nurseries, San Leandro, Calif.

L. J. Klotz, Citrus Experiment Station, Riverside, Calif., supplied the ammonia preparations tested in the 1956-57 season.

Harry Kohl, University of California at Los Angeles, assisted in planting and growing rose bushes in the 1955-56 season.

The Modern Ice and Cold Storage Co., San Jose, Calif., supplied refrigerated storage space for test packages.

K. R. Farrella, University of California Extension Service, Berkeley, Calif., made a statistical analysis of planting data.

CONTENTS

March 1959

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 15 cents

COMMERCIAL PACKAGING AND STORING OF BARE-ROOT ROSE BUSHES

By M. Uota, horticulturist, and John M. Harvey, senior plant pathologist
Biological Sciences Branch, Agricultural Marketing Service,
U. S. Department of Agriculture, Fresno, Calif.

and

Robert W. Lateer, farm adviser
County of Alameda, Hayward, Calif.

SUMMARY

Storage of year-old bare-root rose plants has been limited by the development of decay and loss of moisture in the plants. A new method of packaging that almost eliminates drying out has been developed and tested during 4 storage seasons. This method utilizes a polyethylene-coated kraft paper liner fitted into a carton, crate, or box. The use of cartons with the special liners would cut package costs about one-third as compared with costs of the conventional wirebound crate with waxed-paper lining and sphagnum moss and excelsior packing. The new method requires less labor to prepare the carton and liner for use than the old method; it reduces the weight of the packages by 20 percent, lowering the costs of shipping to eastern markets.

Several fungicides were also tested. Decay in storage was controlled most consistently in these tests by dipping the bushes before packing into a suspension of 2 pounds of captan 50 WP in 100 gallons of water. This treatment not only reduced losses due to decay in storage but lessened the amount of labor required to recondition the bushes before planting. Other fungicides tested were somewhat less effective, while still others were either ineffective or harmful to the bushes.

INTRODUCTION

Year-old rose bushes are usually harvested in California during December and are held in refrigerated storage for 3 to 5 months before marketing. A large portion of the crop is planted under glass in midwestern and eastern areas of the country by growers catering to the florist trade. The chief problems that arise during storage are decay and desiccation.

Rose plants are harvested when the canes are relatively mature and hardened and most of the leaves have fallen. The plants are taken from the field to a central packing house where they may be held under moist conditions for one to several days before further handling. The bushes are rather severely trimmed, leaving only 2 or 3 mature canes 6 to 10 inches long. Immediately after trimming, the bushes are counted into lots of 25 or 50, depending upon the sizes of individual plants, and are packed.

The common method of packaging bare-root rose bushes has been to place the plants with moist sphagnum moss and excelsior into a large wirebound crate lined with waxed paper. Each crate holds from 400 to 500 plants. This method requires considerable labor to prepare the crate, paper liner, excelsior, and moist moss for use; also, proper and uniform moisture in the moss is difficult to obtain under operational conditions. Not wetting the moss enough may cause desiccation, while wetting it too much may increase the development of decay. Certain workers have found that the moisture content of granulated peat moss and shingletow when used in rose packages should be 42 percent,[1] but the sphagnum moss used by California growers usually contains about 72 percent moisture. As moisture in the moss is gradually depleted in storage, frequently water must be added to the moss. This adds to the total cost (about $2.37) of the complete moss-excelsior-wirebound package. The added weight of the packing materials also increases shipping costs. Since much of the crop is marketed in midwestern and eastern sections of the country, shipping weight is an important item of expense.

After packing, the plants are hauled to a cold-storage warehouse where they may be held as long as 5 months before marketing. Temperatures are maintained at 31° to 32° F. and humidities range from 85 to 95 percent in storage rooms. Losses resulting from decay and desiccation are frequently high, and improved methods are needed to maintain the quality of the plants.

PACKAGING

The ideal container for stored bare-root rose plants should be moisture-retentive, should be permeable enough to carbon dioxide and oxygen to prevent harmful modification of the atmosphere, should cool rapidly, should withstand physical breakdown during long storage periods, and should be relatively inexpensive. From the large amount of information available on packaging fresh fruits and vegetables, it appeared that polyethylene film would fulfill many of these requirements. However, it was apparent that the sharp rose thorns would damage a liner made of polyethylene film alone. In view of this problem several types of kraft paper and corrugated paper backings were tested for their effectiveness in keeping the film intact. The polyethylene was either coated on the backing or laminated between layers of paper.

Permeabilities of the various liners, as evidenced by loss of moisture and modification of the atmosphere, were also investigated. The effect of the different packages on the plants during storage was determined in greenhouse planting tests.

Materials and Methods

Preparation of test plants.--Bushes were examined and trimmed to remove immature and injured canes. Two to three canes 6 to 10 inches long were left on each plant. After trimming, the bushes were divided into lots of 50. Plants prepared in the 1954-55 season were sprayed lightly with water, while those in subsequent tests were dipped in a fungicidal solution before packing. One-percent "Vancide 51" was used in the 1955-56 season and a solution containing 2 pounds of captan per 100 gallons of water was used in subsequent years. Varieties tested were Golden Rapture, Pink Delight, Red Delight, and Better Times.

Experimental containers.--Preliminary tests were made using small wirebound or kraft-veneer crates with dimensions of 10 x 12-1/2 x 22 inches. These were fitted with the various types of liners indicated in tables 1 and 2. Materials that performed satisfactorily in preliminary tests were tested later in containers of commercial size (39-3/4 x 20 x 22 inches, tables 3 and 4). The small containers held 50 plants and the commercial packages held 400 to 500 plants. Conventional packaging methods were compared with each of the experimental packages tested.

Liners coated with an exposed layer of polyethylene were heat-sealed at the seams. Those with polyethylene or asphalt laminated between sheets of paper (Plasticrepe Duplex and Crinkle Duplex, respectively) were sewn together at the seams. After packing, the liners were closed by heat-sealing, folding and stapling, or folding and taping, as indicated in the section on results.

[1] Yerkes, G. E., and Gardner, F. E. Dormant rose plants as affected by temperature and moisture while in storage. Amer. Soc. Hort. Sci. 32: 347-350. 1934.

Stacking strength of the corrugated fiberboard boxes (described in table 4, footnote 1) filled with plants were tested by placing 3 pallet loads of rose bushes (4 crates per pallet) on top of the test packages and holding them in storage for 4 months.

Cooling rates.--Cooling rates of plants in the different types of containers were measured with thermocouples placed in the tissue of plants located in the center of each package. The containers were placed in a 32° F. room and temperature readings were taken at intervals of approximately 1 hour.

Storage.--All lots were stored at 31° to 32° F. in a commercial refrigerated-storage plant. Relative humidity in the storage rooms ranged from 85 to 95 percent. Storage periods are indicated in tables 1 to 9.

Modification of Atmosphere.--Changes in the concentrations of carbon dioxide and oxygen in the liners were measured with an Orsat-type gas analyzer. Liners were fitted with special rubber tubes and valves, through which gas samples could be withdrawn at intervals during storage. When only a single analysis was made at the end of the storage period, the sample was taken by piercing the liner with a hypodermic needle. In some of the large commercial packages analyses also were made several days after removal of the plants from storage to determine the effect of high temperature on the buildup of CO_2 and depletion of O_2 in the package. Some packages were ventilated when removed from storage to prevent harmful modification of the atmosphere. Normal atmosphere contains 0.03 percent carbon dioxide and about 20 percent oxygen; any variation in the concentrations of these gases may affect the growth of the plants.

Evaluation of quality after storage.--Aside from general appearance, the indexes used to rate bushes after storage were weight loss and growth responses in greenhouse plantings. Bushes were carefully weighed before and after storage.

Planting tests to determine the effects of various treatments on growth were made in polyethylene- or glass-covered greenhouses. The buds at different stages of development 10 days after planting were counted, and the dry weight of the shoots 42 days after planting was also determined. Stages of flowering at 42 days were observed and recorded.

Results

Weight loss.--Percentages of weight lost from lots stored in the 1954-55 season are shown in table 1. All packages with liners made of polyethylene films, laminations, or coatings were more effective in restricting the movement of water vapor than other types of packaging. Moisture loss from plants packed in a liner with an asphalt barrier (Crinkle Duplex) was intermediate between that in the polyethylene liners and that in check lots in conventional packages. Plants held in the polyethylene-film and polyethylene-coated paper liners retained their original fresh appearance while those in the check lots became dried and dull in appearance. The checks were discarded after 89 days' storage since they became too dry to market under commercial conditions.

Losses of weight in the plants were considerably higher after 159 days than after 89 days, but the polyethylene liners were effective in maintaining the quality of the bushes even after this long storage period. The Plasticrepe Duplex liners were not quite as effective in reducing weight loss as the other polyethylene liners, probably because the film lacked uniform thickness and the inner paper layer of the liner took up some moisture from the plants. Moisture loss from bushes packed in the Crinkle Duplex liner became more pronounced after the long storage period than it was at the first date of examination.

The types of polyethylene film tested in 1955-56 were about equally effective in reducing weight loss (table 2). Plants packed in liners made of 2-mil polyethylene lost no more weight than those packed in 4-mil materials. Heat-sealing the top of the liner was no more effective in reducing moisture loss than folding the top over and taping it down.

Since the plants were dipped in water before weighing and packing, some of the free water drained off during storage. This resulted in slightly higher apparent loss of weight than in the previous season.

Commercial-sized containers also were tested in 1955-56 (table 3). Red Delight plants stored for 3 months in wirebound crates with waxed-paper liners, sphagnum moss, and excelsior lost approximately 3 times as much water as plants stored in crates with polyethylene liners. However, plants packed in a corrugated carton with polyethylene laminated between the outer and inner surfaces lost more weight than those in the moss pack. Apparently considerable moisture was lost through the seams of the carton where gaps in the film occurred. Plants remained a bright green color in the polyethylene liners and the buds were plump and beginning to break by the end of storage.

A comparison of weight losses from plants stored in polyethylene-coated liners and in polyethylene-coated, corrugated boxes was made in 1957-58 (table 4). After 57 days' storage, plants in the coated, corrugated boxes had lost considerably more moisture and had a poorer appearance than plants in the coated liners. Closing the top of the liner by heat-sealing or merely by folding and taping made little difference in weight loss. The relatively high weight loss in the coated carton was probably due to a lack of uniformity in the polyethylene coating on the inner surface of the container and also to gaps in the film at the top and bottom flaps.

Modification of atmosphere.--Concentrations of carbon dioxide and oxygen obtained in 1954-55 in packages with 2 types of sealed liners are shown in table 5. Respiration, by the relatively small number of plants in the experimental containers, did not cause a marked change in the levels of carbon dioxide or oxygen, although slight modification occurred within the liners made of 1.5-mil polyethylene film. To assure that this film was not punctured, the canes were wrapped with heavy paper before the bundle of bushes was placed in the liner. The coating of polyethylene on the Plasticrepe liner was not uniform and apparently was too permeable to bring about a significant modification of atmosphere. Lack of uniformity in the film coating was probably due to the crinkling process used to increase the stretching properties of the material.

In packaging tests made in the 1955-56 season (table 6), the levels of carbon dioxide and oxygen were modified much more than in tests made in the previous year. The greater modification was due largely to the use of heavier gage polyethylene (2.0 and 4.0 mil) than the 1.5-mil film used previously. A smooth kraft paper used in the coated liners permitted a much more uniform coating of polyethylene than was possible on the creped paper.

Four-mil polyethylene film alone and kraft paper coated with 4-mil polyethylene caused slightly higher carbon dioxide and lower oxygen levels to develop than kraft paper coated with 2-mil polyethylene. However, considerable variation in atmosphere modification occurred in individual liners of the same type. In general, the greatest modification occurred near the beginning (27 days) of the storage period and the degree of modification gradually diminished as the storage period lengthened (table 6). Even after 141 days, the concentrations of carbon dioxide and oxygen did not reach an equilibrium in the liners, as evidenced by the continued changes in the levels of the two gases. The addition of dry ice to the packages (units 22 and 23) caused a rapid buildup of CO_2 that apparently caused some injury to the plants. Although certain polyethylene liners (units 24 and 25) were not sealed, considerable change in the concentrations of carbon dioxide and oxygen occurred. Apparently folding the top of the liner was effective in reducing gas exchange, but not quite as effective as heat-sealing.

Surface mold on the canes was visibly reduced in plants stored in liners in which the concentration of carbon dioxide was higher than 5 percent and the concentration of oxygen was lower than 10 percent. The conditions also reduced sporulation by the grey mold fungus on affected areas. However, atmosphere modifications in the packages appeared to have only a slight effect on the percentage of decayed wood.

Modified atmospheres found in commercial packages in 1956-57 are indicated in table 7. Concentrations of carbon dioxide ranged from 8.0 to 3.0 percent after the packages had been stored for 13 days and concentrations of oxygen ranged from 10.8 to 18.0 percent. At the end of storage (132 days) the carbon dioxide concentrations ranged between 4.4 and 1.2 percent, while the oxygen concentrations ranged between 13.8 and 19.8 percent. In this test, closing the liners by folding the tops appeared to produce as much modification of the atmosphere as heat-sealing.

When lined packages were held at room temperature for 5 days without ventilation, the level of carbon dioxide increased and that of oxygen decreased rapidly (table 7). When the liners were ventilated with an 8-inch slit across the top after 5 days at room temperature, there was a drop in the concentration of carbon dioxide and an increase in the concentration of oxygen. The plants in all lots were green and turgid with plump, healthy buds at the end of storage. However, the buds had begun to break in the lots that were held at room temperature for 7 days after removal from storage.

Atmospheres found in polyethylene liners in corrugated containers in the 1957-58 season are shown in table 8. Percentages of carbon dioxide were between 1.8 and 6.2 and those of oxygen were between 14.2 and 19.3 at the end of 111 days' storage at 32° F. Differences in puncturing by the thorns probably accounted for variability in the levels of the 2 gases in replicated packages. After 4 days at room temperature there was an increase in atmosphere modification. Although slightly less modification occurred in ventilated liners than in liners that remained sealed during holding at room temperature, modifications in both lots were near dangerous levels. All plants grew satisfactorily in greenhouse plantings, however.

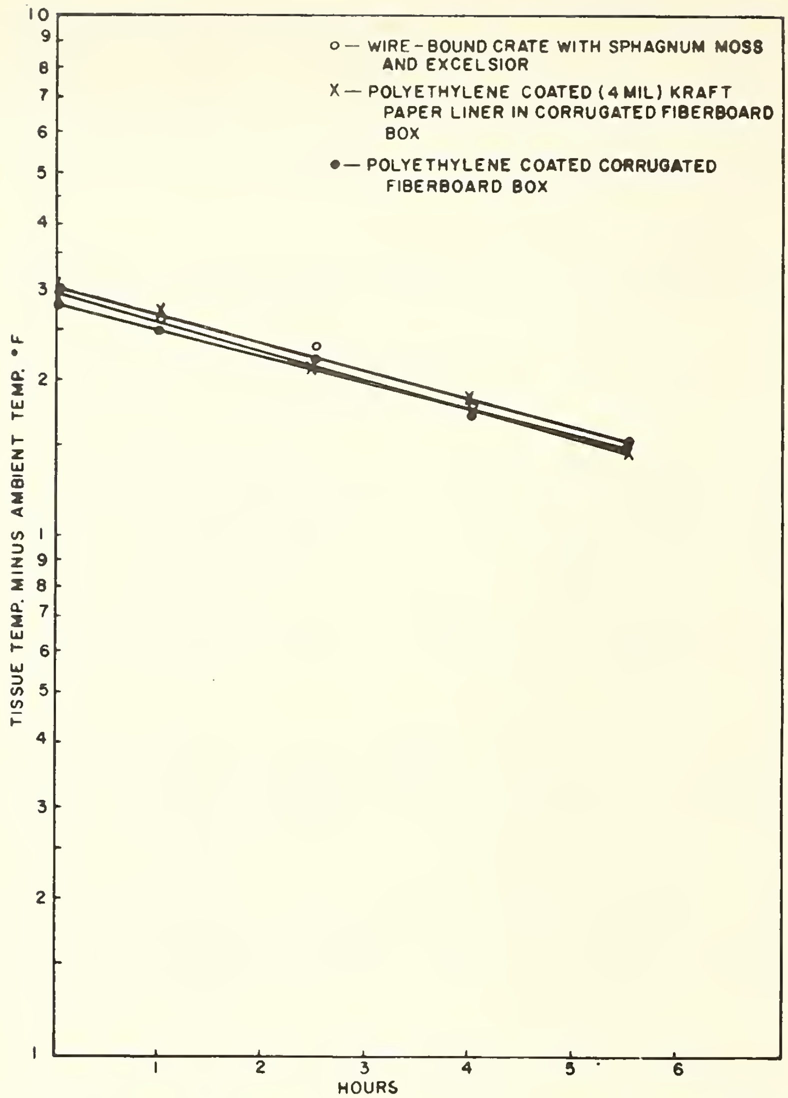
Results of a test to determine the relative permeabilities of polyethylene-lined packages and polyethylene-coated corrugated boxes indicated that greater atmosphere modification occurred in the liners than in the coated boxes (table 4). These differences in permeability were also reflected in measurements of moisture loss.

Cooling rates.--Rates of cooling of rose bushes in commercial-sized packages in 1955-56 are plotted on semilogarithmic paper (fig. 1). There were practically no differences in cooling rates of the 3 types of packages tested. This finding provided evidence that the corrugated boxes with or without a liner would not afford greater insulation in cold weather than the wirebound crate with moist moss and excelsior around the plants.

Tests in 1957-58 (fig. 2) indicated that the cooling rates of plants packed in a corrugated fiberboard box with a polyethylene-coated kraft-paper liner (fig. 3) were approximately the same as those in a corrugated box coated with polyethylene. However, plants packed in a wirebound crate with a polyethylene-coated kraft-paper liner cooled slightly faster than those in the other 2 types of containers. Without moss and excelsior, therefore, the wirebound unit lost some of its insulation value.

Stacking strength.--After 4 months' storage, fiberboard boxes with polyethylene liners were in good condition. No wetting or buckling occurred from the weight of the 12 boxes of plants stacked on the experimental containers.

Growth after storage.--Greenhouse plantings made in 1954-55 indicated that plants stored in polyethylene-film or polyethylene-coated liners grew better than those stored in packages that allowed excessive desiccation. The buds of plants stored in liners made of the polyethylene materials were beginning to break when the bushes were removed from storage. Initiation of growth was quicker in these lots than in plants stored with sphagnum moss and excelsior. However, these differences in growth were not apparent 1 month after planting, except in cases of extreme desiccation wherein buds were actually killed.



U. S. Department of Agriculture
Agricultural Marketing Service

Neg. 6682-58(11)

Figure 1. --Relative cooling rates of bare-root rose plants in indicated packages, California, 1955-56.

Growth responses of plants stored under various modified atmosphere conditions in 1955-56 are shown in table 9. Ratings taken 10 days after planting indicated that units 28, 29, and 31 had a significantly greater number of shoots that were at least 1-1/2 inches long (stage 2) than the check lot did. Units 29 and 31 also had a significantly greater number of shoots that were less than 1-1/2 inches long with the first leaf tip showing (stage 1). However, in several instances initial growth was retarded significantly if oxygen levels were below 1.0 percent (units 30, 32, and 33). After 42 days from planting, little difference in growth was apparent in lots in which the carbon dioxide concentration was below 9 percent and the oxygen concentration was above 2 percent, but in packages in which modification was greater than this, the dry weight of the plants was significantly lower than that of plants in the check lot. When carbon dioxide was added to the package initially (unit 22) or when the oxygen level became extremely low (unit 32), flowering of the plants was retarded 42 days after planting. Plants that were injured by low concentrations of oxygen eventually recovered if viable buds were present and the tissue was not completely dead when the plants were removed from storage.

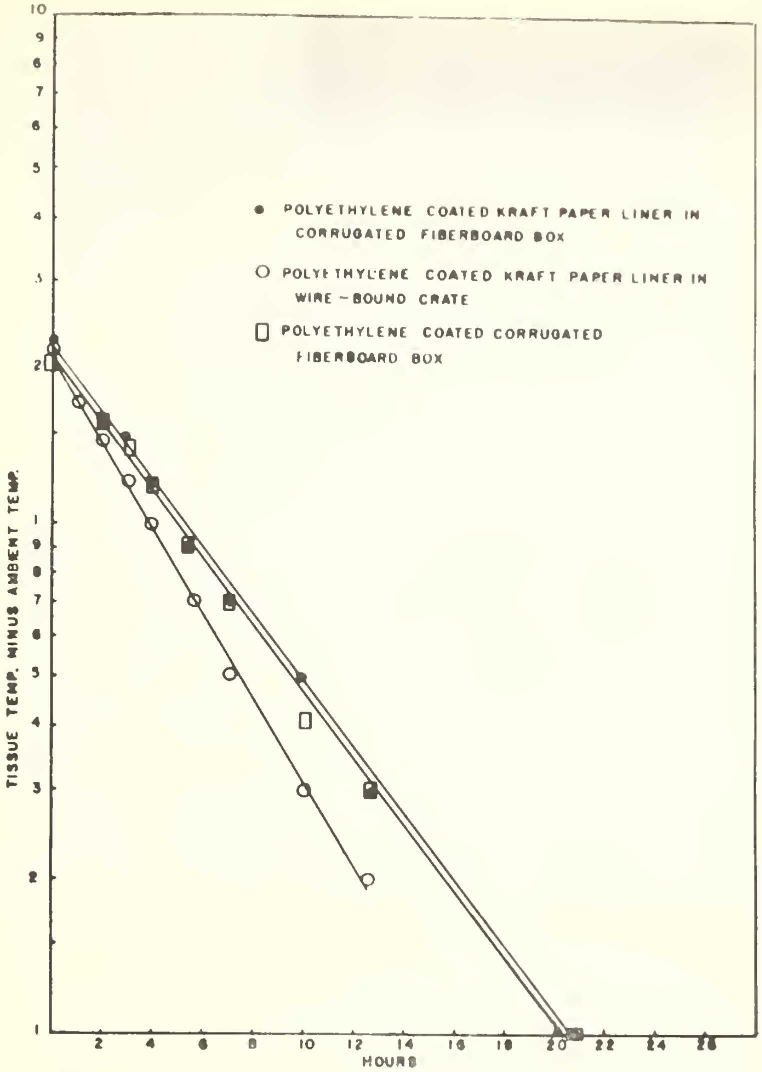


Figure 2. --Relative cooling rates of bare-root rose plants in indicated packages, California, 1957-58.

CONTROLLED-ATMOSPHERE STORAGE

Modification of the atmosphere within sealed plastic liners can be controlled only to the extent provided by varying the film thickness and by ventilating the liner with small perforations. Precise control of atmospheres can only be obtained in chambers that allow periodic adjustments of the levels of carbon dioxide and oxygen as needed for a particular experiment. Such controlled-atmosphere chambers were used in this study to determine the effects of relatively high carbon dioxide concentrations and low oxygen levels on stored, bare-root rose plants.

Materials and Methods

Two controlled-atmosphere chambers were used for this study. Atmospheres of 10 percent carbon dioxide and 5 percent oxygen were maintained in one chamber and concentrations of 20 percent carbon dioxide and 5 percent oxygen were maintained in the other.

BN-7092

Figure 3.--Bare-root rose plants packed in a corrugated fiberboard box with polyethylene-coated kraft-paper liner (top) and in a conventional wire-bound crate with sphagnum moss and excelsior (bottom).

The levels of the gases were kept constant by introducing the required amount of carbon dioxide, oxygen, and nitrogen into the chambers periodically after the composition of the atmosphere was determined with an Orsat-type gas analyzer. Lots of Pink Delight bushes were held in the chambers at 32° F. for 150 days, after which they were planted in a polyethylene greenhouse to measure the rate of growth and time of flowering. Check lots stored in normal atmospheres were also maintained.

Results

After 150 days no apparent injury could be detected in plants stored in concentrations of 20 percent carbon dioxide and 5 percent oxygen (table 11). However, both 10 days and 42 days after planting, bushes stored in an atmosphere of 10 percent carbon dioxide and 5 percent oxygen had greater growth than those stored at the higher carbon dioxide concentration or in normal atmosphere. Both lots stored under controlled atmosphere had more shoots in stage 1 than the check lots 10 days after planting. Plants stored in the 10 percent carbon dioxide and 5 percent oxygen atmosphere also bloomed slightly earlier than the other lots. Plants stored in the higher carbon dioxide atmosphere had less growth than the check lots 42 days after planting, but bloomed at about the same time.

EXPOSURE TO FRUIT VOLATILES AND ETHYLENE IN STORAGE

In commercial cold storage warehouses, rose plants may be stored in the same room with certain fresh fruits such as apples which produce volatile substances that contaminate the storage room atmosphere. Another material, ethylene, frequently is present in emanations from fruit and certain microorganisms. These gaseous materials are known to affect growth in many plants. It was important, therefore, to determine their effect on the growth of rose plants exposed to them in storage.

Materials and Methods

The effect of apple volatiles and ethylene on Better Times rose plants was determined in 1954-55 (table 10). Twelve randomly selected plants were sealed in each of 3 chambers. Plants in one chamber were ventilated with fresh air; those in another were exposed to volatiles from 8 kilograms of Yellow Newtown apples; and in the third chamber, an air mixture containing 10 p. p. m. ethylene was passed over the plants. The rate of flow through all the chambers was 50 liters per hour. The plants were stored for approximately 5 months after which they were potted and grown in a glasshouse.

In a second test made in 1955-56, 25 Pink Delight plants were sealed in each of the 3 chambers. Fresh air was passed over the fruit in the check lot at a rate of 50 liters per hour. Four kilograms of Yellow Newtown apples were used as a source of fruit volatiles and were placed together with the test plants in the second chamber. Enough fresh air was provided to prevent accumulation of carbon dioxide. In the third chamber, an air mixture containing 2 p. p. m. ethylene was continuously passed over the plants at the rate of 25 liters per hour. Storage was at 32° F. for 150 days, after which the bushes were planted in a polyethylene greenhouse. The plants were examined 10 and 42 days after planting.

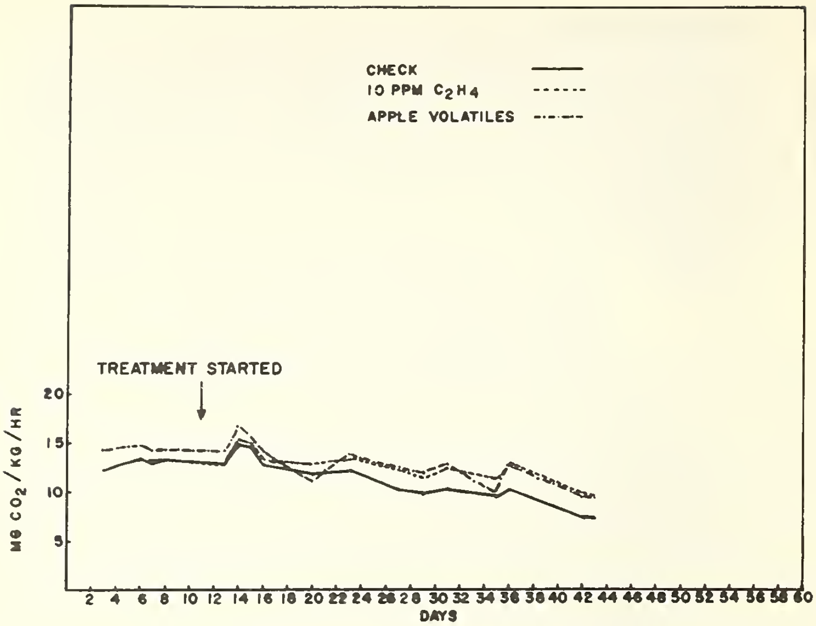
The effect of apple volatiles and ethylene on the respiration rates of plants during storage was determined by measuring the evolution of carbon dioxide. Individual lots of 12 plants were placed in closed chambers through which carbon dioxide-free air was passed at the rate of 50 liters per hour. The carbon dioxide evolved from the plants was separated from the air stream by passing it through a sodium hydroxide solution. Resultant changes in the alkalinity of the solution were determined by titration with hydrochloric acid and the total amount of carbon dioxide evolved was calculated. Exposures to apple volatiles and ethylene were the same as those described above for growth responses in 1954-55.

Results

Growth of plants in 1954-55 was slower when they were exposed to apple volatiles or ethylene during storage than when they were not exposed (table 10). Some of the canes of exposed bushes died back and flowering was delayed. Ten p. p. m. ethylene was more injurious to the plants than volatiles from 8 kilograms of apples.

Initiation of growth was slow in plants exposed to apple volatiles and ethylene in 1955-56. After 42 days the total growth of plants exposed to ethylene was significantly less than that of plants in a check lot (table 10). Flowering of the plants also was delayed.

Shoots of the plants treated with ethylene frequently were initiated from basal buds on the canes. Early growth tended to be short and brushy, resembling a witches' broom, but this aspect gradually disappeared as the shoots elongated. Apple volatiles had a similar, but less pronounced, effect on growth.



U. S. Department of Agriculture
Agricultural Marketing Service

Neg. 6684-58(11)

Figure 4. --Effect of apple volatiles and ethylene on respiration rates (carbon dioxide evolution) of Better Times bare-root rose plants stored for 45 days at 32° F., California, 1954-55.

Exposure to apple volatiles and ethylene caused the plants to respire at a slightly higher rate than when unexposed (fig. 4). Although the differences in respiration rates among the three treatments were not great, post-storage growth of the plants indicated a significant effect from exposure to the materials.

CONTROL OF DECAY IN STORAGE

Storage at 32° F. prevents the growth of many decay-causing organisms, but certain fungi are capable of growth and development even at this low temperature. In California, the primary cause of spoilage in stored bare-root rose bushes is the grey mold fungus (Botrytis cinerea Pers.). The canes are the only part of the bushes affected by grey mold, which frequently infects the plant through the cut ends of the canes or through lateral breaks in the bark. Decay is evidenced by a browning and softening of the tissue and is usually accompanied by a growth of grey mold over the surface of affected plant parts.

Since refrigeration alone does not arrest development of decay, application of a fungicide to prevent infection by the grey mold fungus appeared to be a promising means of reducing decay. The most favorable point during handling at which to apply a fungicide appeared to be immediately after trimming and bundling at the packing house. Trimming removes all the leaves and most of the tender parts of the cane which are most susceptible to decay, leaving, in most cases, only bushes with relatively well-hardened wood for storage.

Materials and Methods

Fungicides were applied either as dipping solutions or as fumigants within the package. The bushes were treated with the fungicidal dips at the concentrations shown in the list of fungicide treatments at the end of this report, and were allowed to drain briefly before packing. When volatile materials, such as the ammonia preparations and biphenyl, were tested, these were placed in paper-covered pads that were added to the packages just before closing.[2]

Test packages were 10 x 12-1/2 x 22 inches in dimension and, with the exception of certain lots packed in sphagnum moss and excelsior in the 1954 season, the packages were all lined with various types of polyethylene liners. A 1.5-mil polyethylene-film liner was used in 1954 and in all the lots packed in 1955. A liner made of kraft paper coated with polyethylene was used for plants packed in 1956 and 1957. All packages were ventilated with a 1/4-inch hole to prevent atmosphere modification.

Varieties used for the fungicide tests were those in which decay had been a serious storage problem in previous years. In the Livermore, Calif., area such varieties were Red Delight, Pink Delight, and Golden Rapture. The particular varieties used in individual tests, and dates of harvest and examination, are as follows (see also figs. 5 to 14):

Season	Harvest date	Examination date	Variety
1954-55	Dec. 17, 1954	Mar. 15, 1955	Golden Rapture
1955-56	Dec. 20, 1955	May 11, 1956	Pink Delight
1956-57[1]	Dec. 19, 1956	May 20, 1957	Red Delight
1956-57[2]	Jan. 19, 1957	May 21, 1957	Red Delight and Better Times
1957-58	Dec. 17, 1957	May 5, 1958	Golden Rapture

[1] Experimental packages.
[2] Commercial packages.

Bushes were rated for decay by carefully trimming and weighing all the decayed wood on the canes. The total weight of each lot of bushes was also taken before and after the storage period. With the exception of the 1954-55 test, the lots were also rated for the number of bushes that required trimming after storage. This rating reflected the amount of labor required to recondition the bushes before planting as well as the amount of decay in storage.

Storage was in a commercial cold-storage plant at 32° F. and 85-95 percent relative humidity.

In 1956-57, an additional test with the most promising of the fungicidal materials was made under commercial conditions. The test included check lots and lots treated with the following fungicides: Captan, Vancide 51, and biphenyl. Concentrations were the same as those indicated for the small test packages in the same year. However, 120 grams of biphenyl were used to obtain a concentration in the large commercial packages that was comparable to that in the small test packages. Four test bundles of 50 plants each were placed in each of the commercial packages which were lined with kraft paper coated with polyethylene. In each check lot and each fungicide-treated lot one liner was heat-sealed and the other was left unsealed, but folded over. Two varieties, Better Times and Red Delight, were tested.

---

[2] Gunther, F. A., Kolbeżen, M. J., Blinn, R. C., and others. Ammonium succinate and inorganic ammonia-producing materials as fungicides for the control of blue-green mold decay of citrus fruits. Phytopath. 46(11): 632-633. 1956.

Roistacher, C. N., Eaks, I. L., and Klotz, L. J. Ammonia gas to control blue-green mold decay of citrus fruits. Pl. Dis. Rptr. 39(3): 202-205. 1955.

Roistacher, C. N., Klotz, L. J. and Eaks, I. L. Fumigation with ammonia gas for control of Penicillium decay of citrus fruits. Phytopath. 47(9): 532-533 (abstract). 1957.

Roistacher, C. N., Klotz, L. J., Kolbezen, M. J., and Staggs, E. A. Patterns of ammonia release in cartons as related to control of decay of citrus fruits. Phytopath. 47(9): 533 (abstract). 1957.

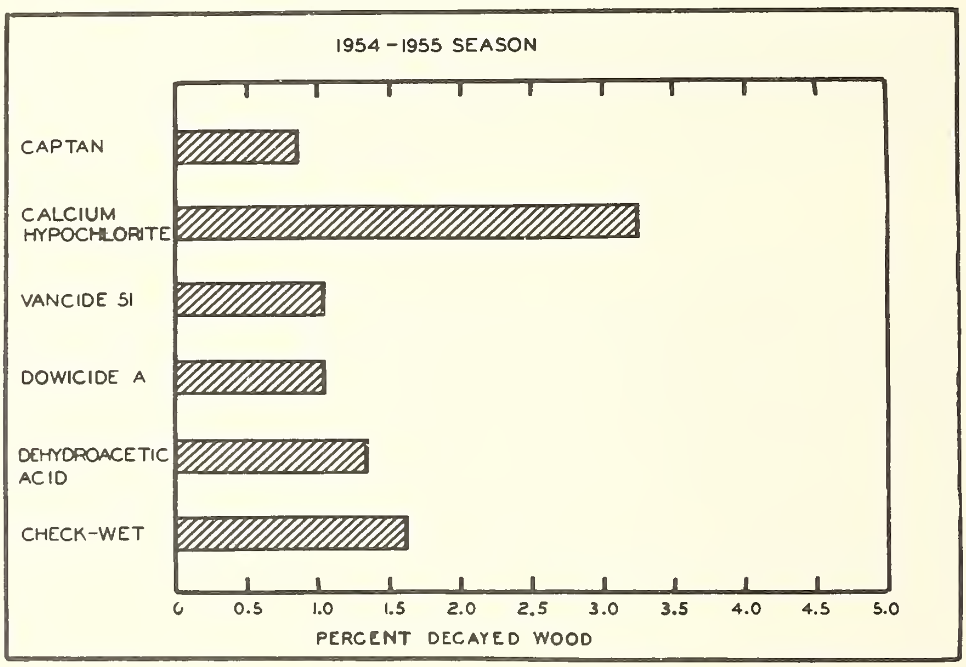
Planting tests were made in 1954-55 and 1955-56 to determine possible effects of the various materials on plant growth after storage. In 1955, a dozen bushes from each lot were planted in a commercial greenhouse and were rated at the time of bud break and at two monthly intervals thereafter for growth rates. In 1956, plantings were made in a polyethylene-covered greenhouse, using 40 plants from each lot.

Respiration rates of Better Times plants were measured during storage in 1954-55 after lots of 12 bushes each had been treated with a 1 percent solution of Vancide 51, a 5 percent solution of calcium hypochlorite (200 p.p.m. chlorine), and a water dip (check lot). These bushes were harvested December 22 and treated December 23. Each lot of plants was dipped in its respective treating solution for one-half minute. Carbon dioxide evolution was determined by the same method described in the section on apple volatiles and ethylene.

Results

1954-55 season.--Control of decay in the liners was best in roses treated with captan. These had about one-half as much decay as bushes in the check lot (fig. 5). Bushes treated with Vancide 51 and Dowicide A were next, with about two-thirds as much decay as the check lot. Dehydroacetic acid reduced decay only slightly and the use of calcium hypochlorite resulted in an increase in decay.

Decay in all the lots stored in liners averaged 1.6 percent, while decay in lots stored in the waxed-paper packages with sphagnum moss and excelsior averaged 0.8 percent. Differences in moisture content in the latter, however, made it difficult to make valid comparisons between fungicide treatments. The fact that almost twice as much decay developed in bushes held in liners as in those held in the moss pack, indicated the need of an effective fungicide for use in conjunction with the polyethylene liners.



U. S. Department of Agriculture
Agricultural Marketing Service

Neg. 6685-58(11)

Figure 5.--Effect of fungicides on percentage of decayed wood in Golden Rapture bare-root rose plants after 3 months' storage at 32° F., California, 1954-55.

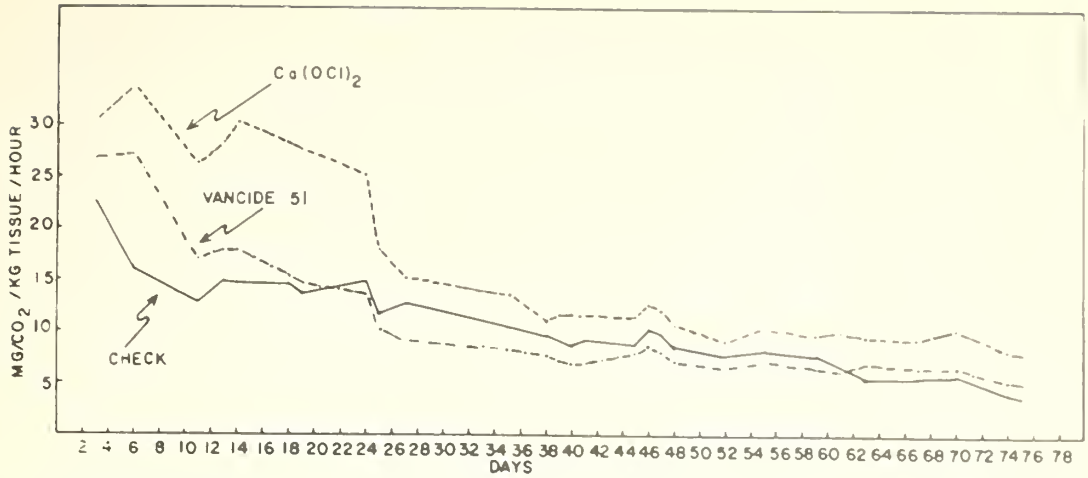


Figure 6. --Effect of calcium hypochlorite and Vancide 51 on respiration rates (carbon dioxide evolution) of Better Times bare-root rose plants stored for 76 days at 32° F., California, 1954-55.

Injury to the bushes occurred only in the lot treated with Dowicide A. The buds of bushes treated with this material were darkened and dried. No distinct injury was apparent in bushes treated with calcium hypochlorite, but the high percentage of decay that developed in this lot was an indication that some undetectable injury to the plants favored infection by decay organisms.

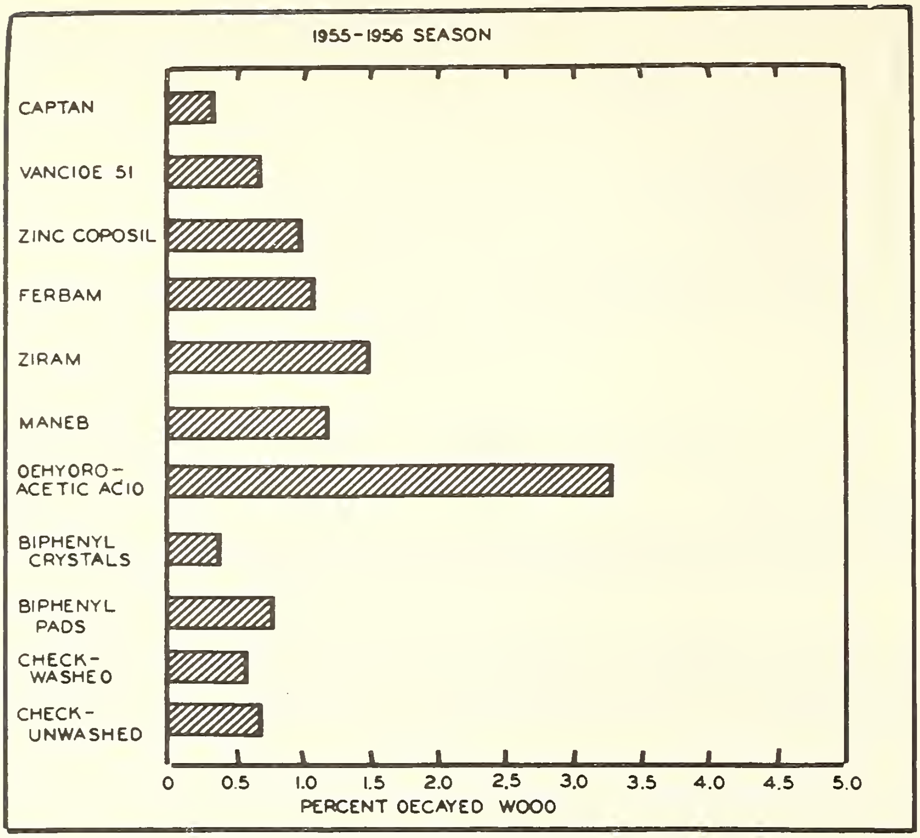
Planting tests showed that a few of the plants treated with Dowicide A and dehydroacetic acid were slightly slow in starting, but differences in growth due to fungicide treatments were not apparent 2 months after the planting date.

The respiration rate of rose plants treated with calcium hypochlorite was higher than that of untreated bushes (fig. 6), an indication that bushes treated with this material were injured. Treatment with Vancide 51 also increased the respiration rate, but only during the early portion of the storage period. After 2 weeks' storage, the respiration rates of bushes treated with Vancide and of those in the check lot did not differ greatly. Although injury from Vancide 51 was not apparent in this test, a distinct injury to the tips of the canes was observed when this material was applied in subsequent seasons.

1955-56 season. --Decay was best controlled with captan, when rated by weight of decayed wood (fig. 7). Bushes treated with captan had about one-half as much decay as the check lot. This reduction in decay, however, was also equaled in the treatment with biphenyl crystals. Decay in plants treated with Vancide 51 almost equaled that in the unwashed check lot. The use of dehydroacetic acid caused an increase in decay which was associated with phytotoxicity. Injury occurred at the tips of the canes and at bruised areas. The other materials did not reduce decay below that which developed in check lots.

A rating by percentage of bushes that required trimming after storage (fig. 8) showed the same trends in control of decay as were apparent in the rating by weight of decayed wood. When captan was used only 15 percent of the bushes required trimming, while 26 to 27 percent of the bushes in the check lots had to be trimmed. When zinc coposil, zerlate, or biphenyl crystals were applied, only slightly fewer bushes required trimming than in the check lots. That dehydroacetic acid increased decay was again apparent--about 84 percent of the bushes in this lot had to be trimmed.

Planting tests in a greenhouse indicated that bushes from all lots grew normally with the exception of those treated with dehydroacetic acid. Initial growth was delayed in about 45 percent of the bushes treated with this material and growth remained behind that in bushes from other lots for the duration of the test.



U. S. Department of Agriculture
Agricultural Marketing Service

Neg. 6687-58(11)

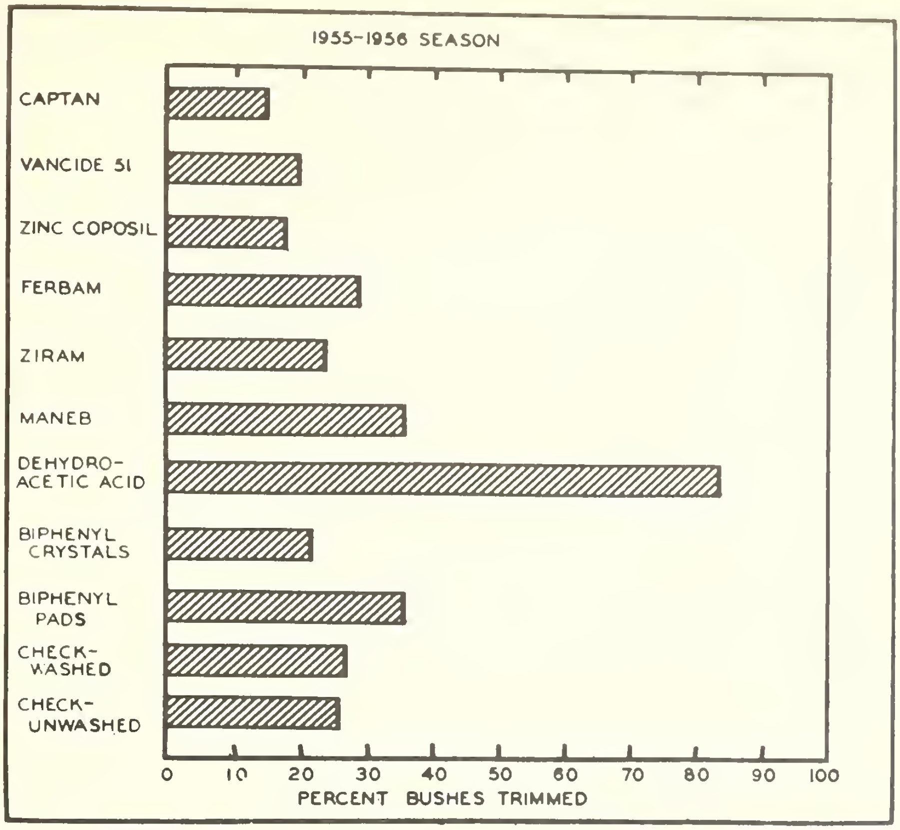
Figure 7.--Effect of fungicides on percentage of decayed wood in Pink Delight bare-root rose bushes after 5 months' storage at 32° F., California, 1955-56.

1956-57 season.--The percentage of decayed wood was reduced in the experimental captan lots to about one-half that in the check lot (fig. 9). An increase in decay occurred in the Vancide-treated lot. This increase was associated with injury at the tips of the cut canes. Good control of decay was obtained with both of the concentrations of biphenyl tested, but treatments with the various ammonia preparations resulted in such severe decay that these lots were a total loss. The high moisture in the test packages apparently caused the ammonia to be released very rapidly from the pellets, resulting in injury to the canes. The injured tissues made the plants highly susceptible to attack by secondary decay organisms in storage.

Trimming required after storage in the small experimental lots was least in the biphenyl-treated bushes (fig. 10). Bushes treated with captan had only slightly more decay than those treated with biphenyl. However, almost all the bushes treated with Vancide 51 had to be trimmed because of injury and decay at the tips of the canes.

Commercial lots tested in 1956-57 indicated that captan almost completely controlled decay (fig. 11). Almost 5 times as much decayed wood developed in bushes treated with Vancide as in those in the check lot. Biphenyl did not reduce decay in this particular test.

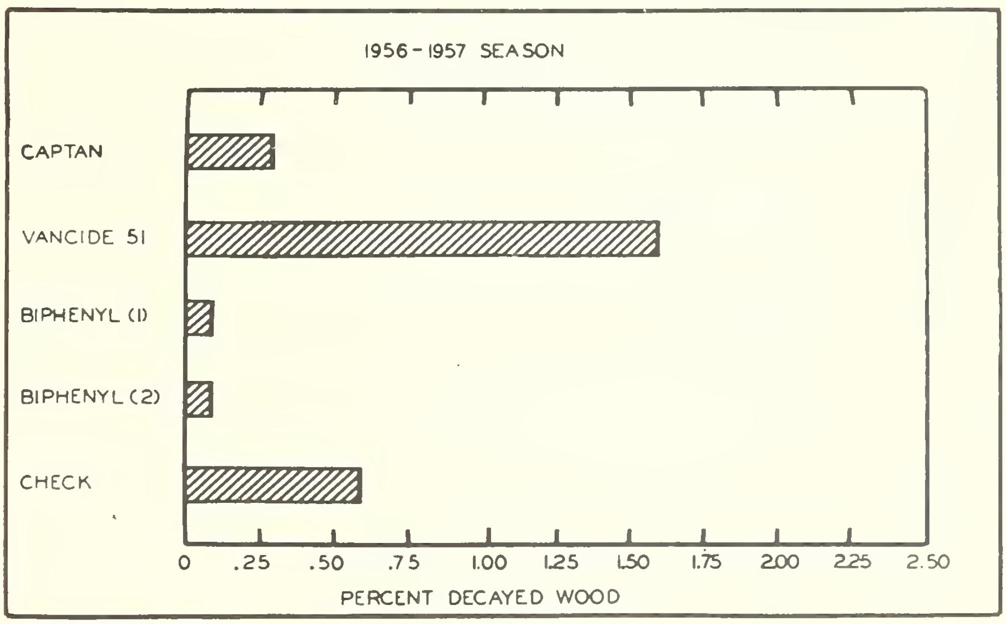
The percentage of bushes requiring trimming in the commercial lots was negligible when they were treated with captan (fig. 12), but a high percentage of the Vancide-treated bushes had to be trimmed. The percentage of bushes requiring trimming in the biphenyl-treated lots was about the same as that in the check lots in this particular test.



U. S. Department of Agriculture
Agricultural Marketing Service

Neg. 6688-58(11)

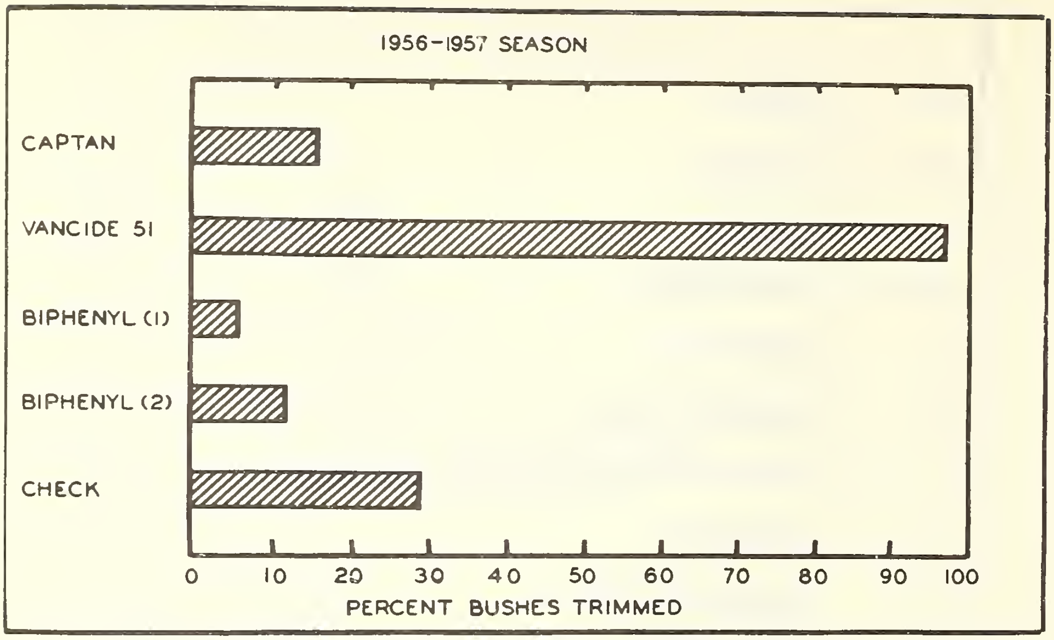
Figure 8.--Effect of fungicides on percentage of Pink Delight bare-root rose bushes requiring trimming after 5 months' storage at 32^{o} F., California, 1955-56.



U. S. Department of Agriculture
Agricultural Marketing Service

Neg. 6689-58(11)

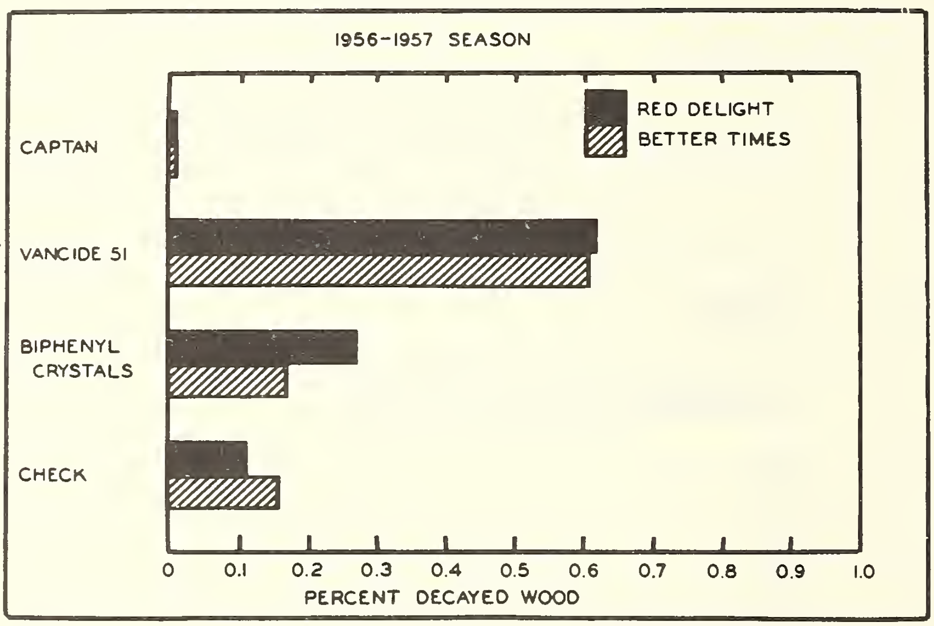
Figure 9.--Effect of fungicides on percentage of decayed wood in Red Delight bare-root rose bushes after 5 months' storage at 32^{o} F. in small test packages, California, 1956-57.



U. S. Department of Agriculture
Agricultural Marketing Service

Neg. 6690-58(11)

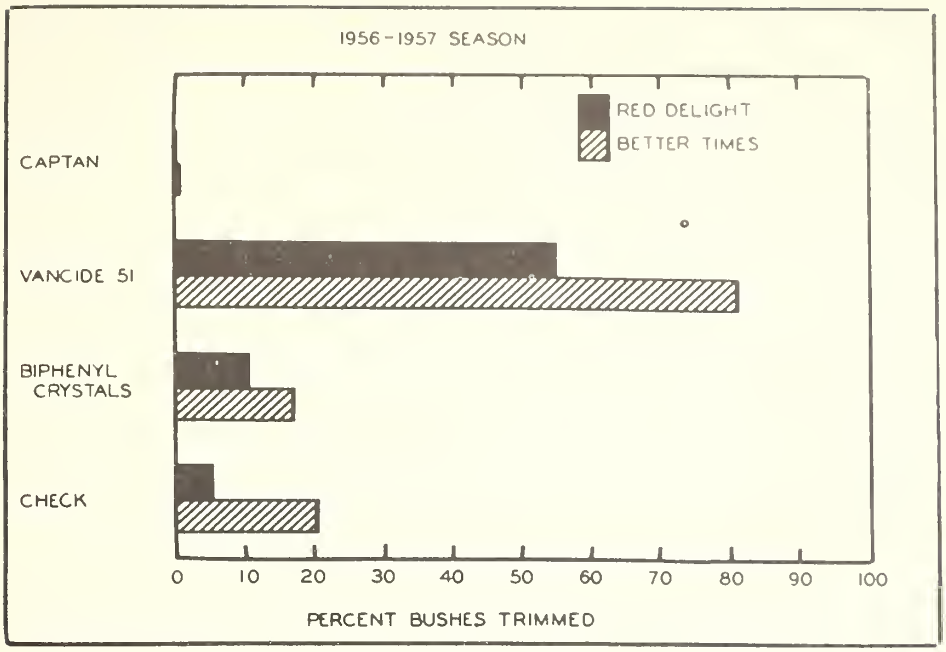
Figure 10. --Effect of fungicides on percentage of Red Delight bare-root rose bushes requiring trimming after 5 months' storage at 32° F. in small test packages, California, 1956-57.



U. S. Department of Agriculture
Agricultural Marketing Service

Neg. 6691-58(11)

Figure 11. --Effect of fungicide treatments on percentage of decayed wood in Red Delight and Better Times bare-root rose bushes after 5 months' storage at 32° F. in commercial pack, California, 1956-57.



U. S. Department of Agriculture
Agricultural Marketing Service

Neg. 6692-58(11)

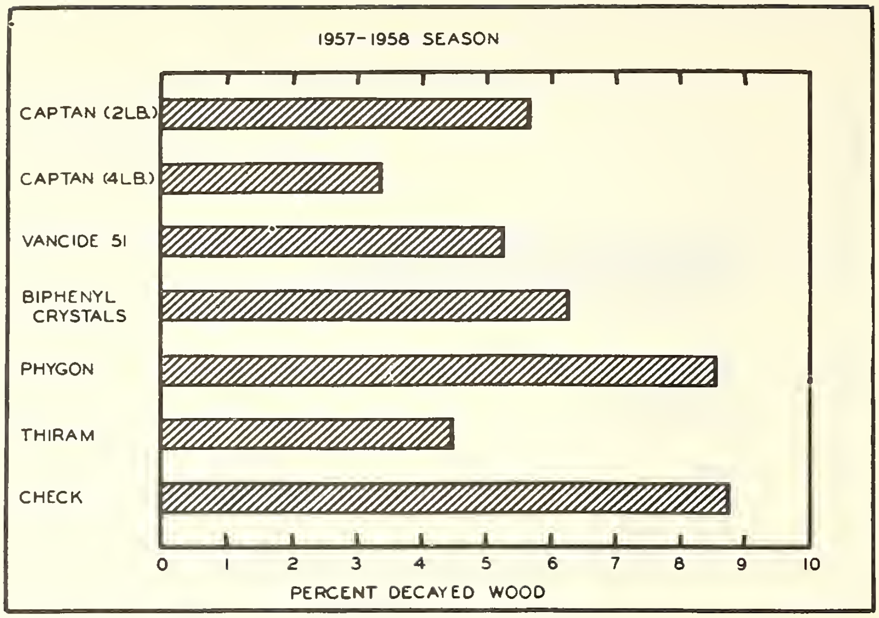
Figure 12.--Effect of fungicide treatments on percentage of Red Delight and Better Times bare-root rose bushes requiring trimming after 5 months' storage in commercial pack, California, 1956-57.

Heat-sealing of the liners appeared to have no consistent effect on decay. Apparently folding over the tops of the liners provided about as effective a seal as heat-sealing did. The tightness of the liners was evidenced by the modifications of atmospheres (see previous section). Consequently the data shown in figures 11 and 12 represent averages of lots in sealed and unsealed liners.

1957-58 season.--Bushes harvested in 1957 were grown under mild weather conditions that did not allow the plants to "harden" properly before the first frost of the season. Consequently the bushes were much more susceptible to decay than test bushes used in previous years. This susceptibility is evidenced in the comparatively high percentages of decayed wood found after 4-1/2 months' storage (fig. 13).

Bushes treated with 2 pounds of captan per 100 gallons of water had about two-thirds as much decay as those in the check lots. Those treated with 4 pounds of captan had only about one-third as much decay as the check lots. Vancide 51 reduced decay about as much as the lower concentration of captan in this test, but, as in previous years, caused injury to the tips of the canes. Injury was frequently followed by secondary fungus infections. Under the conditions of this test, biphenyl was not as effective in reducing decay as it was in earlier experiments. It also caused a slight injury to the tips of the canes. Such injury was not serious enough to lower the grade of the bushes, however. Phygon did not reduce decay below that in the check lots, but bushes treated with thiram had about half as much decay as the check lots.

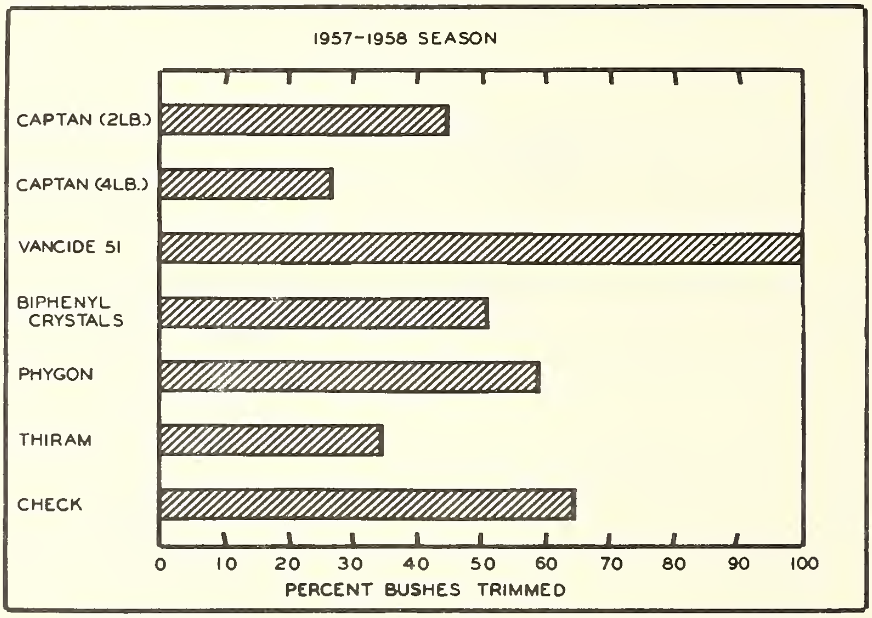
The percentage of bushes that required trimming after storage indicated the same relative effectiveness of the various fungicides as the rating by weight of decayed wood, with the exception of Vancide 51 (fig. 14). All plants treated with the latter material had to be trimmed because of the injured tips of the canes.



U. S. Department of Agriculture
Agricultural Marketing Service

Neg. 6693-58(11)

Figure 13.--Effect of fungicides on percentage of decayed wood in Golden Rapture bare-root rose bushes after 5 months' storage at 32° F., California 1957-58.



U. S. Department of Agriculture
Agricultural Marketing Service

Neg. 6694-58(11)

Figure 14.--Effect of fungicides on percentage of Golden Rapture bare-root rose bushes requiring trimming after 5 months' storage at 32° F., California, 1957-58.

CONCLUSIONS

1. Packaging.--Containers with various types of polyethylene liners were much more effective in reducing loss of moisture from stored bare-root rose plants than the conventional wirebound container with sphagnum moss and excelsior. A liner made of

kraft paper coated with polyethylene was easier to handle and was less prone to physical damage than a polyethylene film liner. Polyethylene-coated cartons were not as effective in reducing loss of moisture as the various types of polyethylene liners used either in wirebound crates or in corrugated fiberboard boxes. The thickness of the film appeared to have little effect on loss of moisture as long as the film was continuous and free of large punctures or open seams.

Modification of the atmosphere in rose packages lined with polyethylene depended upon the thickness of the film and the amount of physical damage to the film caused by the rose thorns. Liners closed at the tops by heat-sealing retained atmospheres in the packages only slightly better than liners closed by careful folding and taping. Atmospheres in packages were modified rapidly when plants were removed from cold storage and held at room temperature before planting. Liners should be well ventilated when taken from storage to prevent harmful accumulations of carbon dioxide and depletion of oxygen within the package.

Cooling rates were found to be about the same in the conventional moss pack and in a corrugated fiberboard box with a polyethylene liner. This was an indication that the two types of packages would provide about equal protection against freezing in shipments made during cold weather. Some additional protection should be provided for both types of packages when exposed to extreme cold.

Stacking strength of corrugated fiberboard containers was found to be satisfactory when each container was fitted with a continuous polyethylene liner that prevented moisture from weakening the carton.

Growth of rose plants after storage in polyethylene-lined packages was more rapid initially than in plants stored under drier conditions in the moss pack. With the exception of plants stored in heavy gage (4-mil) polyethylene liners, modification of the atmosphere in the lined packages was never great enough in storage to cause injury, and plants stored in packages with slight modification grew better in greenhouse plantings than those stored in normal atmospheres.

2. Controlled atmosphere in storage. --Plants stored in an atmosphere containing 10 percent carbon dioxide and 5 percent oxygen grew slightly better and bloomed earlier than plants stored in an atmosphere containing 20 percent carbon dioxide and 5 percent oxygen. Atmospheres obtained in commercial packages during storage were usually less modified than the lower of the controlled atmospheres tested.

3. Exposure to fruit volatiles and ethylene in storage. --Rose plants should not be stored together with apples or other fruits that produce volatile materials that affect growth. Exposure to both apple volatiles and relatively low concentrations of ethylene in storage was found to retard subsequent growth of rose plants.

4. Control of decay in storage. --Certain fungicidal materials such as calcium hypochlorite, dehydroacetic acid, Vancide 51, and Dowicide A were found to injure rose plants when applied as dips before storage. Injury appeared as darkened buds, darkened tips of canes, and delayed starting when bushes were planted in the greenhouse. Ammonia preparations used as fumigants within the packages injured the plants severely. Captan 50 W applied at the rate of 2 pounds in 100 gallons of water as a prestorage dipping solution provided the most consistent control of decay during 4 seasons' tests.

5. Economic factors. --The cost of a corrugated fiberboard container with a polyethylene-coated, kraft-paper liner is about one-third less than the conventional wirebound crate with a waxed-paper liner and with sphagnum moss and excelsior packed around the plants. Use of the new container also results in a saving in the labor required to prepare the package and a 20 percent reduction in the gross weight of the package. The reduced weight is important in reducing shipping charges to distant markets.

The use of an effective fungicide not only reduces losses from decay in storage, but also brings about a saving in the labor required to recondition the bushes before planting.

Packing bushes in polyethylene liners reduces the need for critical control of humidity in storage and eliminates the necessity of adding water to the packages during storage.

TABLE 1.--Effects of various packaging materials on weight loss and general condition of bare-root rose plants stored for indicated periods at 32° F., California, 1954-55

Length of storage, packaging material, and variety of rose	Weight loss in storage	Condition at end of storage
89 days' storage	*Percent*	
Polyethylene liner:[1]		
Golden Rapture	0.5	Excellent, plants wet, buds plump.
Pink Delight	0.0	
Plasticrepe Duplex liner:[2]		
Golden Rapture	2.0	Excellent, plants wet, buds plump.
Pink Delight	1.3	
Plasticrepe liner:[3]		
Golden Rapture	1.0	Excellent, plants wet, buds plump.
Pink Delight	1.0	
Crinkle Duplex liner:[4]		
Golden Rapture	6.2	Good, plants dry, but not wilted or shriveled.
Pink Delight	6.5	
Sphagnum moss and excelsior (check lot):[5]		
Golden Rapture	14.0	Poor, plants dry and shriveled, buds small and darkened.
159 days' storage		
Polyethylene liner:[1]		
Pink Delight	2.1	Excellent, plants wet, few buds breaking.
Plasticrepe Duplex liner:[2]		
Pink Delight	5.6	Excellent, plants dry but not shriveled, buds not breaking.
Golden Rapture	5.6	
Plasticrepe liner:[3]		
Pink Delight	1.9	Excellent, plants wet, few buds breaking.
Golden Rapture	2.5	
Crinkle Duplex liner:[4]		
Pink Delight	12.2	Good, plants dry, few shriveled, buds not breaking.

[1] Polyethylene film (1.5 mil), seams and top heat-sealed.
[2] Polyethylene (10 lb. ream) laminated between 2 sheets kraft paper (30 lb. ream), creped, top folded.
[3] Polyethylene (1.5 mil) coated on kraft paper (40 lb.), creped, top heat-sealed.
[4] Asphalt (30 lb.) laminated between 2 sheets kraft paper (30 lb.), creped, top folded.
[5] Sphagnum moss with 70 percent moisture at packing, container lined with waxed paper.

TABLE 2.--Effects of various package liners on weight loss and general condition of Pink Delight bare-root rose plants stored for 142 days at 32° F., California, 1955-56

Package liner and unit No.	Closure	Weight loss in storage	Condition at end of storage
		Percent	
Polyethylene film (4.0 mil):			
20	Heat-sealed	5.9	Good
21	Heat-sealed	6.2	Good
22[1]	Heat-sealed	5.5	Very poor
23[1]	Heat-sealed	6.5	Poor
24	Folded	5.5	Good
25	Folded	5.4	Good
Polyethylene (2.0 mil) coated on 40 lb. bleached kraft paper:			
26	Heat-sealed	5.9	Good
27	Heat-sealed	5.6	Good
28	Heat-sealed	3.3	Good
29	Heat-sealed	5.0	Good
Polyethylene (2.0 mil) coated on 40 lb. unbleached kraft paper:			
30	Heat-sealed	4.2	Good
31	Heat-sealed	4.0	Good
Polyethylene (4.0 mil) coated on 40 lb. bleached kraft paper:			
32	Heat-sealed	4.4	Good
33	Heat-sealed	4.3	Good
36	Folded	2.2	Good
37	Folded	1.4	Good
38	Folded	6.1	Good

[1] CO_2 (20 grams dry ice) added to package before sealing.

TABLE 3.--Effects of various packaging materials on weight loss of Red Delight bare-root rose plants stored in commercial-sized containers for 3 months at 32° F., California, 1955-56

Packaging material	Closure	Weight loss in storage
		Percent
Wirebound crate, waxed-paper liner[1]		3.1
Wirebound crate, 4-mil polyethylene-coated kraft-paper liner	Folded	1.1
Wirebound crate, 2-mil polyethylene-coated kraft-paper liner	Heat-sealed	1.1
Corrugated carton, polyethylene laminated between inner and outer surfaces[2]	Taped	4.2

[1] Sphagnum moss packed around roots and excelsior around canes.
[2] Full-telescope container, 200 heavy duty material flap cut lid and body, dimensions 19-1/8 x 18-7/8 x 20-7/8 inches, 2 half-crates placed in master corrugated carton.

TABLE 4.--Effects of polyethylene-coated kraft-paper liners and polyethylene-coated corrugated cartons on weight loss of plants and atmosphere in packages of Golden Rapture bare-root rose plants stored for 57 days at 32° F., California, 1957-58

Packaging material	Closure	Replicate No.	Weight loss in storage	Atmosphere at end of storage	
				CO_2	O_2
			Percent	*Percent*	*Percent*
Polyethylene-coated kraft paper liner (1.0-1.5 mil on 60 lb. kraft) in corrugated carton.[1]	Folded	1	2.8	2.4	18.5
		2	2.1	1.0	20.3
		3	2.9	3.7	16.8
Polyethylene-coated kraft paper liner (1.0-1.5 mil on 60 lb. kraft) in corrugated carton.[1]	Heat-sealed	1	1.8	2.4	18.6
		2	1.4	2.9	17.3
		3	2.3	3.8	15.7
Polyethylene-coated corrugated fiber-board carton.[2]	Taped	1	3.3	0.3	21.0
		2	3.3	0.4	20.9
		3	4.1	0.3	21.1

[1] Regular slotted container, 275 lb. test/square inch material, double wall construction, water resistant adhesive.
[2] Regular slotted container, 200 lb. test/square inch material, double wall construction, inner surface coated with 7 lb. polyethylene/ream, dimensions 19-7/8 x 19-5/8 x 21-1/4 inches, 2 half-crates placed in master corrugated carton.

TABLE 5.--Effects of polyethylene liners on atmosphere in experimental packages of bare-root rose plants stored for indicated periods at 32° F., California, 1954-55

Type of liner and variety of rose	Atmosphere in packages after storage for indicated period					
	25 days		61 days		89 days	
	CO_2	O_2	CO_2	O_2	CO_2	O_2
Polyethylene film:[1]	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Golden Rapture..............	1.9	18.7	1.1	19.3	1.2	18.4
Pink Delight................	2.4	15.6	1.8	16.8	1.6	17.2
Pink Delight................	2.6	13.8	2.0	14.8	1.8	15.6
Pink Delight................	2.8	13.0	2.0	14.0	1.6	17.4
Plasticrepe:[2]						
Golden Rapture..............	.8	20.4	.7	20.0	.6	20.6
Pink Delight................	.8	20.3	.8	20.0	.8	20.2
Pink Delight................	.8	20.4	.5	20.4	.4	20.6
Pink Delight................	1.2	19.8	.9	19.5	.8	20.2

[1] Polyethylene film (1.5 mil), seams and top heat-sealed.
[2] Polyethylene (1.5 mil) coated on kraft paper (40 lb.), creped, seams and top heat-sealed.

TABLE 6.--Effects of various polyethylene liners on atmosphere in test packages of Pink Delight rose plants stored for indicated periods at 32° F., California, 1955-56

Type of liner and unit No.	Closure	Atmosphere in packages after storage for indicated period							
		27 days		48 days		83 days		141 days	
		CO_2	O_2	CO_2	O_2	CO_2	O_2	CO_2	O_2
		Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Polyethylene film (4.0 mil):									
20	Heat-sealed	10.0	6.8	10.6	4.8	9.0	5.0	7.4	7.2
21	Heat-sealed	11.6	2.1	10.2	.7	8.4	.4	7.2	.2
22[1]	Heat-sealed	16.8	2.6	13.3	1.7	10.4	1.6	10.2	3.2
23[1]	Heat-sealed	11.4	8.4	9.7	8.1	8.4	9.4	6.8	12.0
24	Folded	7.0	14.0	6.0	15.0	4.4	16.6	2.8	18.2
25	Folded	--	--	3.6	17.4	2.6	18.4	2.0	19.0
Polyethylene (2.0 mil) coated on 40 lb. bleached kraft paper:									
26	Heat-sealed	8.2	5.6	6.2	10.0	4.6	13.2	3.0	17.0
27	Heat-sealed	8.8	3.4	6.5	1.9	4.8	1.4	4.0	2.2
28	Heat-sealed	7.8	5.8	6.4	6.4	5.2	8.0	4.2	10.6
29	Heat-sealed	8.6	4.0	6.8	2.2	5.0	3.0	4.6	4.4
Polyethylene (2.0 mil) coated on 40 lb. unbleached kraft paper:									
30	Heat-sealed	8.2	1.6	6.0	.3	6.0	.2	5.7	.5
31	Heat-sealed	7.6	7.0	6.7	7.1	5.2	8.8	4.2	10.8
Polyethylene (4.0 mil) coated on 40 lb. bleached kraft paper:									
32	Heat-sealed	12.0	.4	12.0	.4	11.8	.3	11.5	.2
33	Heat-sealed	11.5	2.0	10.0	.8	9.4	.2	10.6	.1

[1] CO_2 (20 grams dry ice) added to package before sealing.

TABLE 7.--Effects of polyethylene liners on atmosphere in commercial packages of bare-root rose plants stored for indicated periods at 32° F., California, 1956-57[1]

Variety of rose, closure of package and unit No.	Atmosphere in packages after storage at 32° F. for indicated period								Atmosphere in packages after indicated number of days at room temperature					
	13 days		42 days		83 days		132 days		2 days		5 days		7 days[2]	
	CO_2	O_2	CO_2	O_2	CO_2	O_2	CO_2	O_2	CO_2	O_2	CO_2	O_2	CO_2	O_2
Red Delight														
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Heat-sealed:														
1	4.0	17.0	3.0	18.0	2.8	18.0	2.0	18.5	--	--	--	--	--	--
2	3.0	18.0	2.0	19.0	1.0	19.0	1.2	19.8	--	--	--	--	--	--
3	6.8	12.9	5.3	13.9	3.0	16.4	2.8	16.2	--	--	--	--	--	--
4	5.8	14.7	4.4	15.6	3.4	17.0	3.4	17.1	--	--	--	--	--	--
Folded:														
5	6.8	12.6	5.6	13.0	4.3	15.6	3.0	16.6	--	--	--	--	--	--
Better Times														
Heat-sealed:														
6	5.5	14.4	4.8	15.0	3.5	16.0	3.4	16.1	7.2	11.0	10.2	6.1	8.2	9.2
7	5.8	13.8	5.2	13.8	4.0	15.2	3.4	15.4	--	--	--	--	--	--
8	4.2	16.8	3.0	18.0	2.0	19.0	1.2	19.6	--	--	--	--	--	--
9	8.0	10.8	7.3	9.7	4.8	13.0	4.4	13.8	8.0	8.8	9.8	5.8	5.2	15.2
10	7.0	12.2	6.0	13.0	4.2	16.0	3.8	16.2	--	--	--	--	--	--
Folded:														
11	5.2	15.8	4.0	17.0	2.8	17.6	2.4	18.1	--	--	--	--	--	--

[1] Liners were polyethylene (1.5 to 2.0 mil) coated on kraft paper (40 lb.).
[2] Packages were ventilated after 5 days at room temperature by an 8-inch slit across top of liners.

TABLE 8.--Effects of polyethylene liners on atmosphere in commercial packages of bare-root rose plants stored for 111 days at 32° F., 1957-58[1]

Unit No.	Atmosphere in packages at removal from storage		Atmosphere in packages after holding at room temperature for 4 days	
	CO_2	O_2	CO_2	O_2
	Percent	*Percent*	*Percent*	*Percent*
1	5.2	16.2	[2] 10.6	8.7
2	1.8	19.3	--	--
3	4.2	15.5	[2] 10.5	9.1
4	3.6	17.2	--	--
5	3.6	17.7	[2] 7.5	14.0
6	6.2	14.2	13.2	4.8
7	4.0	16.5	11.6	6.2
8	2.8	18.6	--	--
9	3.1	18.0	--	--
10	3.6	18.1	10.5	8.8

[1] Packages were corrugated fiberboard cartons, lined with polyethylene (1.0 to 1.5 mil) coated on kraft paper (60 lb.).
[2] Packages ventilated when removed from storage by making 14-inch slit across top of liner.

TABLE 9.--Effects of package atmospheres on growth of Pink Delight bare-root rose plants stored for 142 days at 32° F., California, 1955-56

Unit No.[1]	Average atmosphere in packages during storage		Growth of plants 10 days after planting				Growth of plants [illegible]2 days after planting		
			Number of buds at stage 1[2]		Number of buds at stage 2[3]		Dry weight of shoots		Stage of flowering
	CO_2	O_2	Mean	Difference from check lot	Mean	Difference from check lot	Mean	Difference from check lot	
	Percent	*Percent*					*Grams*	*Grams*	
20......	9.3	6.0	6.67	*2.37	1.11	0.09	47.50	-3.03	Buds showing color, few blossoms open.
21......	9.4	.8	6.60	*2.30	.75	-.27	37.87	-12.86	Buds showing color, no blossoms open.
22......	12.7	2.3	3.75	-.55	.17	-.85	33.00	*-17.53	Buds tight, no color showing.
23......	9.1	9.5	6.50	*-2.20	1.45	.43	49.50	-1.03	Buds showing color, no blossoms open.
24......	5.1	16.0	6.25	*1.95	1.83	.81	54.12	3.59	Buds showing color, few blossoms open.
25......	2.7	18.3	5.17	.87	1.83	.81	56.00	5.47	Buds showing color, numerous blossoms open.
26......	5.6	11.5	7.60	*3.30	1.40	.38	58.33	7.80	Most blossoms open.
27......	6.0	2.2	6.30	*2.00	1.65	.63	58.75	8.22	Buds showing color, numerous blossoms open.
28......	5.9	7.7	5.90	1.60	2.30	*1.28	51.33	.80	Buds showing color, numerous blossoms open.
29......	6.3	3.4	7.00	*2.70	2.60	*1.58	56.92	6.39	Most blossoms open.
30......	6.5	.7	1.00	*-3.30	0.00	*-1.02	43.58	-6.95	Few buds showing color.
31......	5.9	8.4	6.25	*1.95	2.15	*.95	44.67	-5.86	Buds showing color, few blossoms open.
32......	11.8	.3	.05	*-4.25	0.00	*-1.02	21.17	*-29.36	Buds tight, no color showing (growth retarded).
33......	10.4	.8	.45	*-3.85	0.00	*-1.02	39.00	-11.53	Few buds showing color.
Check lot...	--	--	4.30	--	1.02	--	50.53	--	Buds showing color, few blossoms open.
Least significant difference 5%	--	--	--	1.72	--	0.89	--	15.11	

[1] See table 6 for descriptions of packages.
[2] Stage 1: Shoots with first leaf tip visible or up to 1-1/2 inches long.
[3] Stage 2: Shoots 1-1/2 inches or longer.
* Statistically significant differences between the treated lot and the check lot are indicated by an asterisk.

TABLE 10.--Effects of apple volatiles and ethylene on growth of Better Times bare-root rose plants stored for 5 months at 32° F., California, 1954-55

Treatment in storage	Number of buds started 10 days after planting	Number of buds started 20 days after planting	Growth 25 days after planting	Plant condition and stage of flowering 60 days after planting
Check lot..............	1	7	7 shoots 2 buds breaking 3 buds dormant	12 plants healthy 6 plants blooming
Apple volatiles.........	0	6	6 shoots 3 buds breaking 3 buds dormant 4 canes dying back	7 plants healthy[1] 4 plants stunted 1 plant almost dead 1 plant blooming
Ethylene (10 p.p.m.)....	0	3	2 shoots (short) 3 buds breaking 6 buds dead 3 canes dying back	7 plants healthy[2] 4 plants stunted 1 plant dead 1 plant blooming

[1] Most buds on canes injured; in 7 plants only the basal buds developed.
[2] Most buds on canes injured or dead; only the basal buds developed.

TABLE 11.--Effects of controlled-atmosphere storage, apple volatiles, and ethylene on growth of Pink Delight bare-root rose plants stored 140 days at 32° F., California, 1955-56

Treatment in storage	Growth of plants 10 days after planting				Growth of plants 42 days after planting		
	Number of buds at stage 1[1]		Number of buds at stage 2[2]		Dry weight of shoots		Stage of flowering
	Mean	Difference from check lot	Mean	Difference from check lot	Mean	Difference from check lot	
					Grams	*Grams*	
Controlled atmosphere:							
10% CO_2 and 5% O_2.......	5.54	*2.68	1.89	*1.58	61.25	5.69	Many buds showing color, few blossoms open.
20% CO_2 and 5% O_2.......	6.59	*3.73	.38	.07	46.44	-9.12	Few buds showing color, no blossoms open.
Apple volatiles...........	2.54	-.32	0.00	-.31	49.56	-6.00	Buds just forming on most plants.
Ethylene (2 p.p.m.).......	2.79	-.07	.21	-.10	37.56	* -18.00	Buds just forming on most plants.
Check lot.................	2.86	--	.31	--	55.56	--	Few buds showing color, no blossoms open.
Least Significant Difference 5%...........	--	1.53	--	0.44	--	15.11	

[1] Stage 1: Shoots with first leaf tip visible or up to 1-1/2 inches long.
[2] Stage 2: Shoots 1-1/2 inches or longer.
* Statistically significant differences between the treated lot and the check lot are indicated by an asterisk.

FUNGICIDE TREATMENTS

The following fungicide treatments for the control of decay in bare-root rose plants stored at 32° F. were tested during indicated seasons in California:

Season and treatments	Concentration
1954-55:	
Captan (50 percent N-trichloromethyl thiotetrahydrophthalimide)	2 lb./100 gal. H_2O.
Calcium hypochlorite	5.0 percent (200 p.p.m. chlorine).
Vancide 51 (30 percent sodium dimethyldithiocarbamate and sodium derivative of 2-mercaptobenzothiazole)	1.0 percent.
Dowicide A (sodium o-phenylphenate)	0.5 percent.
Dehydroacetic acid (3-(1-Hydroxy-ethylidene)-6-methyl-2H-pyran-2,4(3H)-dione)[1]	0.5 percent.
Check lot, wet	No treatment.
Check lot, dry	No treatment.
1955-56:	
Captan[2]	2 lb./100 gal. H_2O.
Vancide 51	2.0 percent.
Zinc coposil (Cu 19 and Zn 19 percent)[2]	4 lb./100 gal. H_2O.
Ferbam (76 percent ferric dimethyldithiocarbamate)[2]	2 lb./100 gal. H_2O.
Ziram (76 percent zinc dimethyldithiocarbamate)	2 lb./100 gal. H_2O.
Maneb (70 percent manganese ethylene bisdithiocarbamate)	2 lb./100 gal. H_2O.
Dehydroacetic acid[3]	0.5 percent.
Biphenyl crystals	17 grams/test package.
Biphenyl pads	4 lb./1,000 sq. ft. treated surface.
Check lot, washed	No treatment.
Check lot, unwashed	No treatment.
1956-57:	
Captan[2]	2 lb./100 gal. H_2O.
Vancide 51	2.0 percent.
Ammonia Winn-mat-3[4]	2 mats/test package.
Ammonia mat WB-13[4]	2 mats/test package.
Ammonia mat WB-14[4]	2 mats/test package.
Ammonia C-Z sheets ("C" sheet impregnated with 4.2 grams ammonium sulfate, "Z" sheet with 3.6 grams sodium carbonate)	2 pair sheets/test package.
Biphenyl crystals (1)	17 grams/test package.
Biphenyl crystals (2)	34 grams/test package.
Check lot	No treatment.
1957-58:	
Captan[2]	2 lb./100 gal. H_2O.
Captan[2]	4 lb./100 gal. H_2O.
Vancide 51	2.0 percent.
Biphenyl crystals	17 grams/test package.
Phygon (50 percent 2,3-Dichloro-1,4-naphthoquinone)	1/2 lb./100 gal. H_2O.
Thiram (75 percent tetramethyl thiuram disulfide)	2 lb./100 gal. H_2O.
Check lot	No treatment.

[1] Plus Tween-20 wetting agent at 0.01 percent. [2] Plus Ortho dry spreader at 1 lb./100 gal. H_2O. [3] Plus Carbowax wetting agent at 1 lb./100 gal. H_2O. [4] A mat consists of 9 pellets, each composed of 0.50 gram ammonium sulfate, 0.38 gram sodium carbonate, and pelletizing agents; mat WB-13 contains 0.10 gram calcium chloride and WB-14 contains 0.10 gram diammonium succinate in addition to the foregoing ingredients (supplied courtesy of L. J. Klotz, Citrus Experiment Station, Riverside, Calif.).

☆ U. S. GOVERNMENT PRINTING OFFICE : 1959 O - 497926