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COMPATIBILITY OF FRUITS AND
VEGETABLES DURING TRANSPORT
IN MIXED LOADS

Marketing Research Report No. 1070

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COMPATIBILITY OF FRUITS AND VEGETABLES DURING TRANSPORT IN MIXED LOADS

By WERNER J. LIPTON, *plant physiologist*; and JOHN M. HARVEY, *plant pathologist*

INTRODUCTION

Shippers or receivers of fresh fruits and vegetables frequently prefer to handle shipments that consist of more than one commodity, the so-called mixers. In mixed loads, it is important to combine only those commodities that are compatible with respect to their requirements for (1) temperature, (2) modified atmosphere, (3) relative humidity, and (4) protection from odors or (5) from physiologically active gases, such as ethylene. To facilitate the choice of compatible crops and to help avoid shipments of undesirable combinations, we have prepared the ensuing compatibility tables in which about 85 crops are placed into nine compatibility groups. All factors enumerated above were considered in the groupings.

Compatible commodities are those that can be shipped together without adverse effects on any one of them *during the usual maximum transit period for the most perishable commodity in the load*. Compatibility does not imply that crops in the same group now normally are, or likely will be, shipped together, but merely that they may be shipped together if circumstances demand it.

Grouping of the various commodities is based on evidence drawn from material published for individual crops and on our experience. Adverse effects of mixing incompatible or marginally compatible commodities would be greater when the transit period is longer. Thus, greater caution would have to be exercised for surface shipments overseas than for normal transcontinental shipments. In contrast, limitations on compatibility generally can be ignored during wholesale distribution requiring 1 day or less. During this period, temperatures should be adjusted to satisfy the needs of the most perishable item in the load, with due regard to chilling sensitivity of some commodities.

The Recommended Transit Conditions given for each group *may differ from the optimum temperatures and humidities* for individual members of a group. However, within the limitations given in the previous paragraphs, the Recommended Conditions represent a satisfactory compromise. For optimum conditions for solid loads or for extended storage, consult one of the following references:

- The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks. U.S. Dept. Agr., Agr. Handbook 66.
- Protecting Perishable Foods During Transport by Motortruck. U.S. Dept. Agr., Agr. Handbook 105.
- Protection of Rail Shipments of Fruits and Vegetables. U.S. Dept. Agr., Agr. Handbook 195.

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COMMODITIES WITH SPECIAL REQUIREMENTS

Avocados

Ripening would be rapid at 55° to 65° F (13° to 18° C); chilling injury may occur below 50° F (10° C).

Citrus Fruits

Biphenyl, which is used as a fungicide on citrus fruits, may impart off-odors to other commodities.

Lemons.—For holding 1 month or less, 32° to 55° F (0° to 13° C) is acceptable; for longer periods, 50° to 55° F (10° to 13° C) is necessary.

Limes.—Do not hold below 45 °F (7.5° C) longer than about 2 weeks.

Oranges and Tangerines.—Compatibility depends on source. Florida-grown or Texas-grown oranges are shipped at 32° to 40° F (0° to 4.5° C), but California-grown and Arizona-grown ones are shipped at 40° to 44° F (4.5° to 7° C).

Grapes

Compatible with other crops only if the grapes are not fumigated with sulfur dioxide (SO₂) in vehicle and if no chemicals that release SO₂ are included in packages.

COMPATIBILITY GROUPS

*Group 1***Recommended Transit Conditions:**

Temperature: 32° to 34° F (0° to 1.5° C).

Relative humidity: 90 to 95 percent.

Atmosphere: Normally used on berries and cherries only—10 to 20 percent CO₂.

Ice: Never in contact with commodity.

Note: Most members of this group not compatible with Group 6a or 6b because ethylene production by Group 1 can be high, and thus harmful to members of Groups 6a or 6b.

Apples

Apricots

Berries (except cranberries)

Cherries

Figs (not with apples, danger of odor transfer to figs; also see Group 6a)

Grapes (see Commodities with Special Requirements; also see Group 6a)

Peaches

Pears

Persimmons

Plums and prunes

Pomegranates

Quinces

*Group 2***Recommended Transit Conditions:**

Temperature: 55° to 65° F (13° to 18° C).

Relative humidity: 85 to 95 percent.

Ice: Never in contact with commodity.

Avocados (see Commodities with Special Requirements)

Bananas

Eggplant (also see Group 5)

Grapefruit, Arizona and California; Florida before Jan. 1 (see Commodities with Special Requirements—Citrus Fruits)

Guava

Mangoes

Muskmelons, other than cantaloupes

Casaba

Crenshaw

Honeydews

Persian

Olives, fresh

Papayas

Pineapples (not with avocados, danger of avocados' odor absorption)

Tomatoes, green

Tomatoes, pink (also see Group 4)

Watermelons (also see Groups 4 and 5)

*Group 3***Recommended Transit Conditions:**

Temperature: 36° to 41° F (2.5° to 5.0° C).

Relative humidity: 90 to 95 percent; cantaloupes about 95 percent.

Ice: In contact only with cantaloupes.

Cantaloupes

Cranberries

Lemons (adjust temperature to other commodity: see Commodities with Special Requirements)

Lychees (also see Group 4)

Oranges (see Commodities with Special Requirements)

Tangerines (see Commodities with Special Requirements)

Group 4

Recommended Transit Conditions:

Temperature: 40° to 45° F (4.5° to 7.5° C);
beans 38° to 42° F (3.5° to 5.5° C).

Relative humidity: About 95 percent.

Ice: Never in contact with commodity.

Beans, snap

Lychees (also see Group 3)

Okra

Peppers, green (not with beans)

Peppers, red (if with green peppers,
temperature adjusted toward top of
range)

Squash, summer

Tomatoes, pink (also see Group 2)

Watermelons (also see Groups 2 and 5)

Group 5

Recommended Transit Conditions:

Temperature: 40° to 55° F (4.5° to 13° C);
ginger not below 55° F.

Relative humidity: 85 to 90 percent.

Ice: Never in contact with commodity.

Cucumbers

Eggplant (also see Group 2)

Ginger (not with eggplant, also see
Group 7)

Grapefruit, Florida (after Jan. 1) and
Texas

Limes (see Commodities with Special
Requirements)

Potatoes (late crop)

Pumpkin and Squashes, winter

Watermelon (temperature adjusted for
other members of group; also see
Groups 2 and 4)

Group 6a

This group, except for figs, grapes, and mushrooms, is compatible with Group 6b.

Recommended Transit Conditions:

Temperature: 32° to 34° F (0° to 1.5° C).

Relative humidity: 95 to 100 percent.

Ice: Never in contact with asparagus, figs,
grapes, and mushrooms.

Artichokes

Asparagus

Beets, red

Carrots

Endive and escarole

Figs (also see Group 1)

Grapes (see Commodities with Special
Requirements, also see Group 1)

Greens

Leek (not with figs or grapes)

Lettuce

Mushrooms

Parsley

Parsnips

Peas

Rhubarb

Salsify

Spinach

Sweet corn

Watercress

Group 6b

This group is compatible with Group 6a, except for figs, grapes, and mushrooms.

Recommended Transit Conditions:

Temperature: 32° to 34° F (0° to 1.5° C).

Relative humidity: 95 to 100 percent.

Ice: Contact acceptable for all.

Broccoli

Brussels sprouts

Cabbage

Cauliflower

Celeriac

Celery

Horseradish

Kohlrabi

Onions, green (not with rhubarb, figs, or
grapes; probably not with mush-
rooms or sweet corn)

Radishes

Group 6b—Continued

Rutabagas
Turnips

Group 7

Recommended Transit Conditions:

Temperature: 55° to 65° F (13° to 18° C).

Relative humidity: 85 to 90 percent.

Ice: Never in contact with commodity.

Ginger (also see Group 5)

Group 7—Continued

Potatoes, early crop (temperatures adjusted for others)
Sweetpotatoes

Group 8

Recommended Transit Conditions:

Temperature: 32° to 34° F (0° to 1.5° C).

Relative humidity: 65 to 75 percent.

Ice: Never in contact with commodity.

Garlic

Onions, dry

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Peaches	1	Cantaloupes	3
Pears	1	Casaba	2
Persimmons	1	Crenshaw	2
Pineapples	2	Honeydew	2
Plums and prunes	1	Persian	2
Pomegranates	1	Okra	4
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