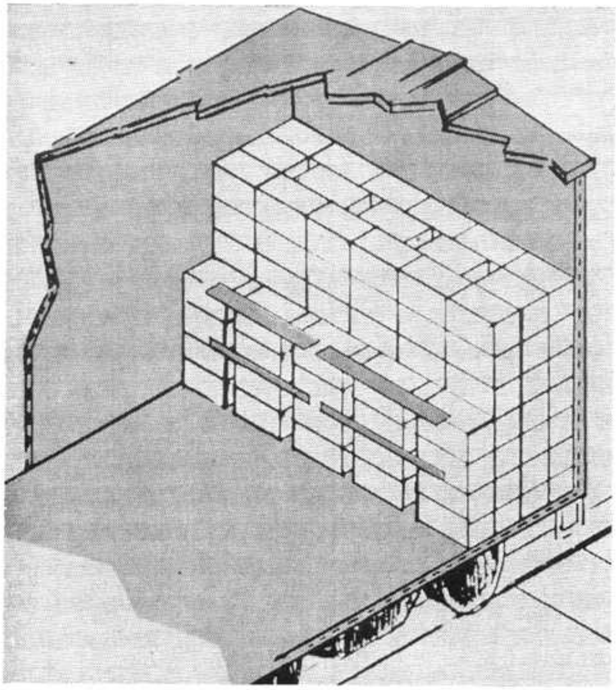


Sketch of solid/spaced loading pattern, showing tiers of solid loaded containers alternated with tiers of spaced containers. Spaced tiers are immobilized through the use of angled strips of corrugated board which are securely stapled to the containers.

SOLID/SPACED

During the past season a new carloading pattern for the shipment of fresh fruit was developed and tested. This "solid/spaced" loading pattern used tiers of solid containers alternating with tiers of spaced (but secured) boxes. It was effective for the loading of plums and nectarines in corrugated paper containers. The new loading method is easy and economical. It helps maintain load and temperature stability during transit with no ill effects on the container or its contents. It appears to offer a solution to many problems which have limited the acceptance of new packages for fruits such as cherries, peaches, and nectarines. It could also provide a margin of safety for pears or plums which may require a few degrees of additional cooling during transit. The results of these tests indicate that this loading pattern is worth evaluating for commercial use.

An essential characteristic of a new fresh fruit package is that it keep the product at an even temperature during transit to market. With older containers this requirement was met through the use of special loading patterns. In these patterns, strips or blocks were used to direct air circulation while also immobilizing the load. They generally required substantial amounts of labor and special materials. The advent of new packing methods and new corrugated paper containers led to the development of new loading patterns.

Corrugated paper containers are adaptable to completely solid-pattern loading into a railcar with resulting elimination of shifting or container damage from transit impacts or vibration. While this solid loading pattern requires no dunnage, minimizes labor needs, and provides load stability, it also greatly restricts air circulation past individual containers. This limitation is especially acute in mixed loads of tightly stacked corrugated paper containers and spaced wooden containers. In such a load, the circulating cold air may completely bypass the corrugated paper containers.

It is usually essential that cool air be circulated through a load to remove heat caused by respiration and to prevent excessive warming during transit. Heat is produced by all fresh fruits during transit, and the rate of production varies widely with species, variety, maturity, product temperature and other factors. The heat produced by a physiologically active fruit like the sweet cherry may cause excessive warming during transit. This warming was a limiting factor in recent attempts to adapt new packing methods for use with sweet cherries. Even the physiologically less active fruits (such as pears and plums) may produce excessive heat during transit unless they have been thoroughly cooled before loading (table 1).

The increasing use of the new tight-fill packing method for fruits has made loading patterns an essential consideration. Early commercial development of the packing method involved pears and plums, which have a low rate of heat evolution. Even these fruits would warm up when they were not initially completely cooled. However, if the product was *thoroughly* cooled before loading (with the core temperature about 32°F), heat removal during normal transcontinental transit was not essential.

Methods which have been used in the past to facilitate air circulation through such loads have not been successful. Longitudinal channels between containers were difficult to maintain during transit.

A New Carloading Pattern FOR TIGHT-FILL PACKED FRUIT

F. G. MITCHELL · G. MAYER · C. H. CAMPBELL, JR.

If any one container shifted, so would adjacent containers, thus quickly loosening the entire load. Longitudinal channels may also cause serious container bulging and reduce the effectiveness of the tight-fill pack. A chimney loading pattern was found to have some promise for temperature maintenance. However, longitudinal impacts during transit may cause container creasing and subsequent compression bruising of soft fruits.

Containers with top and bottom vents for vertical air circulation have been used with limited success. To avoid covering the air vents, the pads which are essential in tight-fill packed containers must be split. Such pads are difficult to manufacture and install, and they leave a relatively unprotected area in the center of the container. The vents also reduce the container's resistance to top bulge. In commercial practice it is extremely difficult to maintain vertical alignment of containers in a load so the vents can be kept open.

New pattern

A new loading pattern tested during the past season was designed to combine load stability and air circulation. The new pattern, tentatively designated the "solid/spaced load," is adaptable to all types and sizes of cars, and loads mixed with other packages. It consists of alternate solid and spaced tiers of containers (figure 1). The solid tiers provide stability; they may be loaded either lengthwise or crosswise in the car. The spaced tiers provide the vertical ducts for air circulation. They should be loaded crosswise in the car, to expose only the relatively short container ends to conditions that may cause bulging. The resulting vertical air ducts are several inches wide, depending upon the car width.

In these trials corrugated angle strips were stapled to the containers to stabilize the spaced tiers. These strips were made of 200-lb-test, double-faced corrugated board, 6 inches wide by 42 inches long, curtain-coated on both sides and scored down the center. During installation, they were bent at the score line to form an angle. One strip could immobilize two layers by first stapling one side to the box tops, then loading the next layer, bending the strip up, and side stapling. The strips were secured with a retractable anvil stapler, adjusted to penetrate all but the inside layer of paper of the container. A hydraulic squeeze was used to eliminate any slack space which was left during loading.

Various combinations of loading patterns were evaluated in these tests. Some cars had mixed loads of corrugated paper containers and wooden containers, some had combinations of two different loading patterns and others had a single container and loading pattern. The solid/spaced pattern was compared with both the solid load and the channel load. Plums and nectarines were used in these tests.

Fruit temperatures were determined manually at the time of loading, and Ryan recording thermometers were placed within packed containers in most loads. These recorders were located so that the fruit temperature pattern within the load could be approximated. One car was equipped with a recording thermograph attached to thermocouple wires placed into fruits to provide detailed transit temperature records.

Loads were evaluated on arrival at the market whenever possible. Fruit temperatures were measured at various positions in the load. The condition of the fruit, the containers and the load were carefully evaluated. Variations associated with loading method, container type, or car position were noted.

Uniformity

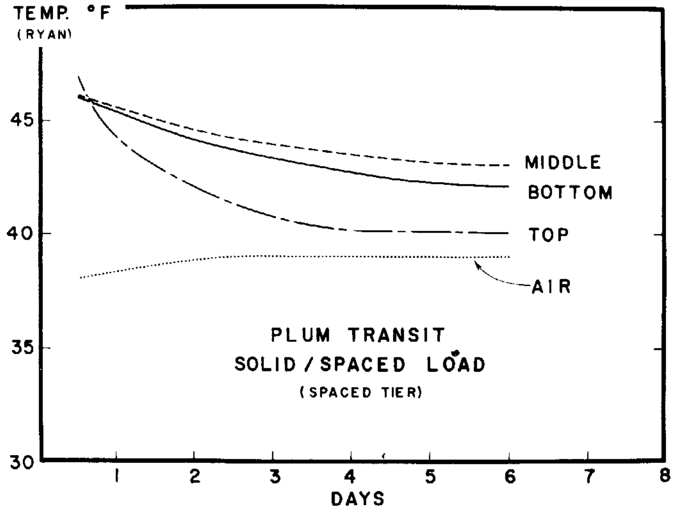
Arrival temperatures were fairly uniform throughout all test cars with little variation between the top, middle and bottom positions (table 2). The temperature was uniform for both plums and nectarines. Temperature changes were related to the initial fruit temperature and the transit air temperature in the car, rather than irregularities in air circulation through the load. Both the solid and spaced tiers of the new solid/spaced load showed the same temperature pattern.

One test in which the initial fruit temperature exceeded air temperature of the car by approximately 10°F, showed cooling of 4° to 7°F (graph 1). Warming occurred in other tests in which the fruit temperature was initially lower than the air temperature of the car. The lowest fruit temperature on arrival was 38°F, and many temperatures recorded were above 40°F.

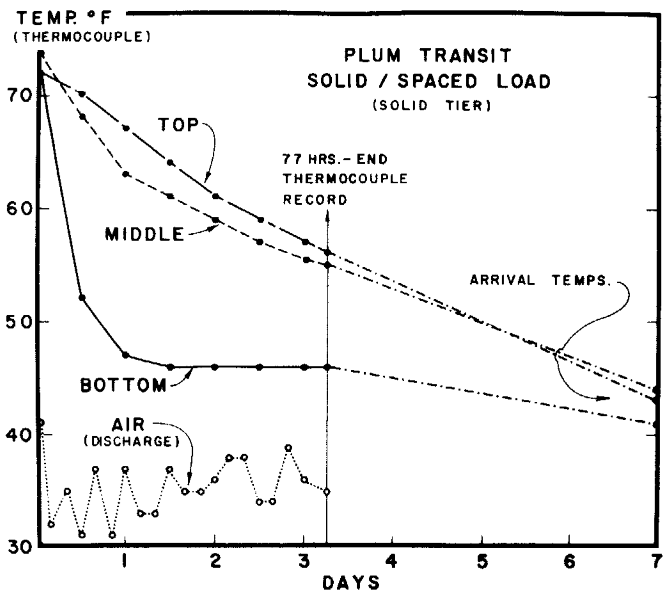
Occasionally small amounts of warm

fruit are packed in with cold fruit to complete a load. Because of the slow cooling which results, this practice is not recommended with any container or loading pattern. To determine the cooling and transit conditions of such fruit in a solid/spaced pattern, a block of 120 containers of warm plums was loaded in with cold plums to make up a carload. This test showed this practice to be unsatisfactory; there was very slow cooling in the middle and bottom of the load (figure 3). While fruit temperatures had approached a reasonable level for transit on arrival, the fruit had already reached an advanced stage of ripeness. At such a slow rate of cooling, it would take 10 days to cool these plums to a temperature below 40°F. Thus, fruit cooling would still be in progress when the fruit reached its destination. Obviously air circulation through the load was insufficient to cool the fruit rapidly. Since the balance of the load was cold, the refrigeration capacity of the car was not taxed.

GRAPH 1. COOLING DURING TRANSIT OF A SOLID/SPACED LOAD OF PLUMS IN WHICH INITIAL FRUIT TEMPERATURE WAS SLIGHTLY WARMER THAN RAILCAR AIR TEMPERATURE



GRAPH 2. SLOW COOLING SHOWN IN BLOCK OF WARM FRUIT IN SOLID/SPACED LOAD, WITH FRUIT TEMPERATURES EXCESSIVE THROUGHOUT TRANSIT—DESPITE ARRIVAL TEMPERATURES APPROACHING DESIRABLE TRANSIT LEVELS



Good stability

The solid/spaced pattern provided good stability in all loads. Observations made on arrival, however, indicated that certain improvements in loading procedures could be made. In one load, some corrugated paper angle strips broke loose because of improper stapler adjustment and inadequate staple penetration. Some shifting also occurred when containers in the second layer below the top were not immobilized with strips. Non-coated strips which were used in one trial had softened, but had not failed, whereas the curtain-coated strips remained rigid. Despite these minor difficulties, none of the movement which occurred in these tests resulted in measurable bulge or breakdown of containers.

One load arrived with some creasing of container lids, apparently caused by a severe impact during transit, but there had been no shifting of the load. Creasing was equally distributed between lengthwise and crosswise loaded containers, and between spaced and solid tiers. It did not extend to the container bodies, and did not result in fruit injury. In spite of the obviously severe impact which this load had received, container corners had not cut into the sides of other containers as sometimes happens with chimney loads.

No fruit damage was found in the solid/spaced loads which could be attributed to loading pattern or container shifting during transit. No difference in fruit injury was noted between solid and spaced tiers. Fruit injury was slight in all containers which were properly tight-fill packed, with the level of injury well within the limits of commercial acceptance.

Summary

The solid/spaced load performed satisfactorily in all tests. It offered the temperature management advantages of both the channel and chimney loads, without the structural weaknesses associated with those patterns. The test results clearly showed that the fruit needs to be cooled to the anticipated transit temperature before loading. (This is consistent with current recommendations for modern produce shipping operations.) Warm fruit should not be used to complete a load. If additional cold fruit is needed, shippers may resort to a rapid method of air cooling before loading.

The solid/spaced load places all fruit in the standard tight-fill containers within less than one foot of an air channel, thus minimizing the distance for conductive cooling. The removal of the heat of respiration of the fruit during transit was so effective that the temperature in the center of the load was never more than 4°F above the coldest fruit in the car, and often within ± 1°F of the high and low temperatures. This loading pattern afforded effective transit temperature management whenever the fruit had been properly cooled. It appears that satisfactory results may be obtained even when fruit temperatures are initially as much as 10°F above transit air temperatures. Plums and nectarines responded equally well in these tests.

The solid/spaced pattern was easy to load, requiring a minimum of instruction and no practice. It is adaptable to any width of railcar. The exact loading pattern for a particular vehicle can be easily determined on the spot; or patterns for various car widths can be diagramed in advance.

Angled strips

The angled strips of corrugated paper board immobilized the load adequately, as long as a sufficient number were properly fastened. For good load stability, at least the top three layers of containers and alternate layers below this should be stripped. However, since one strip could be used to immobilize two layers of containers, all spaced containers can be stripped with a minimum dunnage expense.

The staples holding the strips must be securely fastened to the containers. The stapler was properly adjusted if the staple completely penetrated all but the inner layer of paper of the container. When properly adjusted, the staples will hold securely with no danger of damaging fruit within the container. If penetration is insufficient, staples may loosen and permit the container to shift.

The alternating solid tiers of this loading pattern provided adequate load stability. These solid tiers performed equally well whether loaded crosswise or lengthwise in the car. The choice appears to depend only on the car width. Any space remaining after loading the solid tier can be centered and immobilized with the same strips used in the spaced tiers. This solid/spaced loading pattern essentially isolates individual containers in the spaced tiers, preventing any loosening from being transmitted to other parts of the load.

Load dividers are becoming standard equipment in many modern refrigerator cars. They may be used effectively to limit the longitudinal movement of containers during impacts by isolating sections of the car. These dividers are sometimes used to reduce the total loading area of a car. In such cases any floor area which is not covered by containers should be lined with paper to prevent the circulating air from bypassing the load and thus nullifying the benefits of the loading pattern.

The containers used in these tests were strong enough to resist bulging into the open air ducts. They did not crease as a result of the loading pattern. The excellent arrival condition of the fruit substantiates the effectiveness of the packing method, the containers and the loading pattern in protecting the product.

The solid/spaced loading pattern is worth trying with sweet cherries. The partial cooling which occurred with plums suggests that cherry temperatures could be maintained during transit despite the higher respiration rate of the fruit. However, it is essential that sweet cherries be thoroughly cooled before loading to minimize fruit deterioration and reduce the rate of heat evolution.

The solid/spaced loading pattern might also be used for early pears. Since this fruit is maintained at an elevated temperature so that there can be some ripening during transit, the total cooling requirement is limited. Solid/spaced loads should be explored cautiously with early pears, however, since no tests have been conducted.

TABLE 1. ESTIMATED ARRIVAL TEMPERATURE OF CENTER OF SOLID MASS OF FRUIT AFTER EIGHT DAYS IN TRANSIT, ASSUMING THERE IS NO HEAT REMOVAL*

Initial loading temperature	Arrival temperature		
	Pear & plum	Peach & nectarine	Sweet cherry
°F	°F	°F	°F
32	36	38	41
36	42	44	48
40	49	52	56

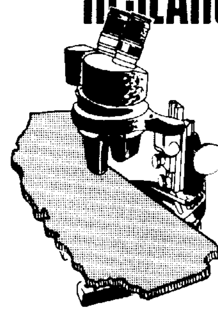
* Values shown are estimates based upon reported respiration rates of these fruits. Actual warming could vary substantially above or below these values depending upon a number of factors including variety, stage of maturity, fruit injury, presence of rot organisms, conduction cooling, and air circulation.

TABLE 2. ARRIVAL TEMPERATURES OF FRUIT IN DIFFERENT POSITIONS IN SOLID/SPACED LOADS

Fruit	Solid tier			Spaced tier		
	Top	Center	Bottom	Top	Center	Bottom
	°F	°F	°F	°F	°F	°F
Plums	40	44	43	40	44	42
Plums	38	38	38	38	39	38
Plums	43	44	41	41	42	39
Plums	39	39	40	..	..	..
Plums	41	42	41	41	41	42
Nectarines	38	38	38	38	38	38
Nectarines	39	39	40	39	39	41
Average	40	41	40	40	41	40

F. Gordon Mitchell is Extension Pomologist, Marketing, and Gene Mayer is Laboratory Technician IV, Department of Pomology, University of California, Davis. C. Harvey Campbell, Jr. is Product Development Manager, Menasha Corporation, Container Division, Anaheim. *Many shippers, transporters and receivers also cooperated in these trials, including: L. R. Hamilton Co., Reedley; Kern Fruit Co., Bakersfield; Mayflower Fruit Assoc., Exeter; Pacific Fruit Express Co., San Francisco; and Santa Fe Refrigerator Department, Los Angeles.*

RESEARCH PREVIEWS



A continuing program of research in many aspects of agriculture is carried on at University campuses, field stations, leased areas, and many temporary plots loaned by cooperating landowners throughout the state. Listed below are some of the projects currently under way, but on which no formal progress reports can yet be made.

CANNING PEACH IMPROVEMENT

Experiments by both pomologists and food scientists at Davis are aimed at developing new varieties of cling and freestone peaches with high flavor quality for canning that would fill seasonal gaps in harvesting not filled by present varieties. The project tests the fruit all the way from the tree through harvesting and canning in University facilities.

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PHOSPHORIC ACID DIVIDEND

Vegetable crops specialists at the West Side Field Station have found that phosphoric acid sprays used as anti-crustants, appear to have a beneficial growth response on vegetables. This unexpected "dividend" will be explored further.

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ALFALFA VARIETY TRIALS

Agronomists at Davis, Riverside, and the Imperial Valley Field Station hope to develop alfalfa varieties more adaptable than those used now in the southwestern U. S. where relatively warm winters and the high incidence of phytophthora root rot are prevalent. Three closely related germ plasm pools, tolerant to phytophthora have been released to plant breeders for further work.

•

COTTON IRRIGATION TESTS

Studies at the West Side Field Station indicate the possibility of decreasing foliage and increasing fruiting of cotton by careful manipulation of irrigation—withholding moisture during times of rapid growth, and irrigating during times of slow growth. The techniques are being studied further.

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SESAME TRIALS

Small acreages of sesame have been planted and are being carefully studied at the West Side Field Station, in an effort to develop new oil seed crops for San Joaquin Valley growers. Under test are different row spacings and four nitrogen levels with two irrigation treatments.