Temperature and Lettuce Losses

variables of time and temperature as they affect deterioration of harvested lettuce investigated

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Lettuce—like most leafy vegetables—deteriorates rapidly and steadily after harvest. Loss of quality is inevitable and can only be minimized by rapid handling and with the best possible storage conditions.

The more rapid rates of deterioration characteristic at the higher temperatures show that more quality may be lost by warm lettuce in a few hours of handling—between field and refrigerator car—than would be lost during several days of transportation at a desirably low temperature.

The current change in the industry from an iced pack to a dry pack, with resulting changes in the temperature history of the lettuce during handling and transit, makes it desirable to know more about the influence of specific temperatures upon lettuce deterioration.

Therefore, a study project was started to determine the storage life and rate of deterioration of lettuce held at different temperatures but with other conditions at optimum. The study was concerned with the variables of time and of temperature only. Field diseases, water loss, mechanical injuries of handling, and similar variables were minimized.

Samples from Salinas

Samples of the Great Lakes variety were harvested in the Salinas area early in the morning. They were handled as gently as possible, and the heads were not packed tightly in the crates. Enough ice to last all day was placed within paper wraps between the layers of lettuce. The lettuce was transported to Davis at once, sorted, trimmed if necessary, and matched into samples which were placed at the test temperatures on the day of harvest. In trimming the heads, any broken leaves were removed, and the resulting head approximated the average trimming of shed-packed lettuce. The samples studied consisted of eight matched heads, and in each experiment two samples were placed at each temperature.

The lettuce was placed in closed containers, and a stream of humidified air was passed continuously through each. The rate of respiration was determined frequently by measuring the carbon dioxide produced, and the containers were opened periodically for examination and quality rating of each individual head.

Six Experiments

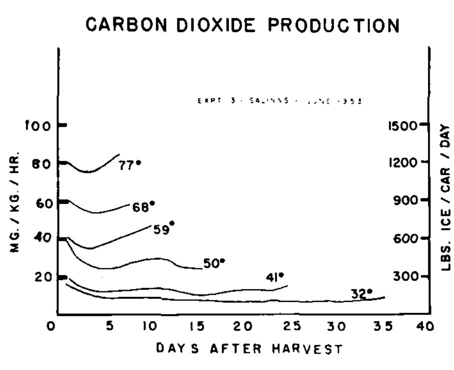
To evaluate any possible seasonal effect, six experiments were conducted during the 1953 season. The first harvest was on April 30 and the last on August 26. These six experiments were divided into two series. The lettuce of the first, third, and fifth harvest was not trimmed during the course of the experiments, while during the course of the alternate tests—second, fourth, and sixth—the outer leaves of each head were trimmed away as they developed injuries or spoilage. These two types of tests were conducted to simulate possible commercial practices at both wholesale and retail levels.

Results

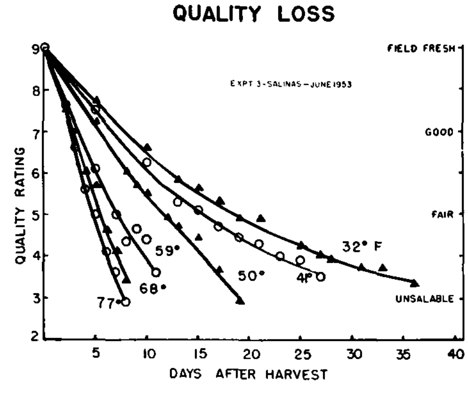
No seasonal trend appeared in the experiments, and in general both trimmed and untrimmed lettuce showed the same response to temperature. Hence, data from two of the experiments are typical of the entire series. The graphs present the behavior of lettuce at temperatures ranging by steps of 9° F from the temperature of melting ice—32° F—to the temperature of a very warm room—77° F or 86° F. The necessity of low temperature for maintenance of quality during the transit period is evident. Lettuce for out-of-state shipment cannot avoid a storage period of several days en route, and if satisfactory quality is to appear on the market, the temperatures during these first days are important. Even for short periods, there is an advantage in lowering lettuce temperature at least to 50° F.

The graph reproduced in column 1 represents the respiration rate of lettuce in terms of carbon dioxide production at various temperatures throughout its storage life. The vital heat of respiration is expressed in terms of approximate ice meltage per car per day. The higher the temperature, the higher is the rate of respiration and the shorter is the storage life. The difference between 41° F and 32° F is appreciable. The longer storage

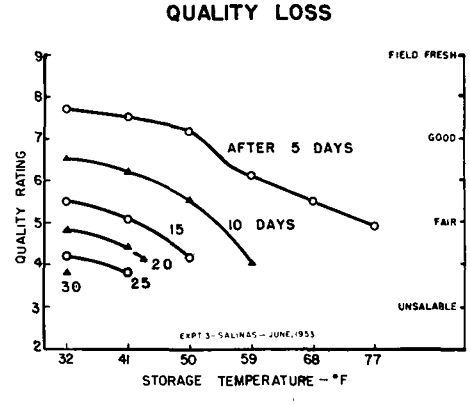
The effect of storage temperature—°F—on respiration rate of lettuce during its usable storage life.



The effect of storage temperature and time on quality—appearance—of untrimmed lettuce.



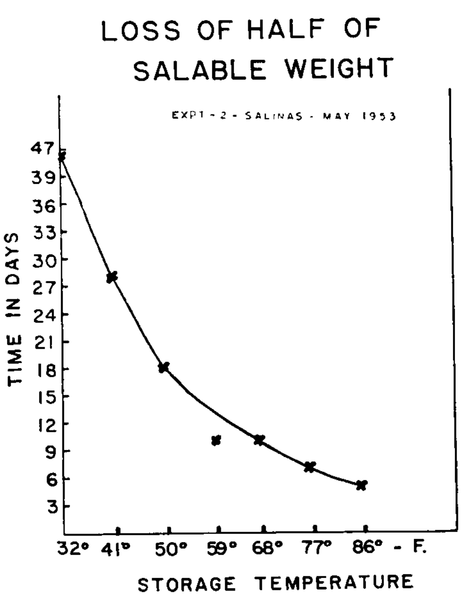
The quality of untrimmed lettuce after being held for the indicated periods and temperatures.



life at 32° F is also reflected in better quality at any time after harvest. A higher rate of respiration also means a higher rate of heat production by the lettuce—more ice will be melted per day by the lettuce at a higher temperature because of the heat of respiration.

Similar data were obtained for the experiments in which the lettuce was trimmed by continually removing spoiled outer leaves. There is very little difference between the rates of respiration under these two types of treatment; both the shapes and magnitudes of the curves are similar. A higher temperature—86° F—was included in some experiments, and the results are those that could be expected—the rate of respiration is higher than at 77° F, and the storage life is shorter.

A numerical rating scale arbitrarily numbered from one to nine was used to evaluate quality loss in terms of appearance. The ratings are shown in the graphs in columns 2 and 3 on page 14. Each head was individually rated, and the curves were drawn as the best fit to the averages of all head ratings. As expected, the life of untrimmed lettuce at the higher temperatures was short. Any lowering of storage temperature for a given holding period resulted in a measurable improvement in quality. There was a striking reduction in quality, even at 32° F, during the unavoidable holding period between field and consumer.



The effect of temperature on time elapsing before half the salable weight was trimmed away because of deterioration.

A rating based on appearance cannot be applied to the heads which were trimmed during the experiments, because the appearance was continually being improved by the trimming. The number of days required at various temperatures before half the salable weight of lettuce was lost by trimming are shown on this page. The graph illustrates the type of data that can be expected for the deterioration of any fresh produce that is not subject to chilling injury.

Storage Life

The storage life of lettuce at the higher temperatures is short, and as the temperature is lowered, storage life progressively lengthens, following a mathematically predictable curve which holds all the way to the lowest possible storage temperature.

The conclusions to be drawn from the experiments on lettuce apply in both kind and degree to the handling of broccoli, asparagus, celery, spinach, green peas, cabbage, carrots, and other cool-season crops—and also to sweet corn. They do not apply to most warm-season crops such as tomatoes, melons, summer squash, cucumbers, or sweet potatoes—which are subject to chilling injury.

With the established behavior of the best lettuce as a yardstick, an evaluation is planned of the comparative gain or loss of storage life resulting from different fertilizer and other cultural practices, field defects or diseases, variety differences, and the role of mechanical injury and delays in handling.

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VALENCIAS

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circles and heavily coated with asphalt and then on the upper surface with aluminum paint. The lids usually were only partially closed. The transpirational water loss was replenished with distilled water which was employed at all times in preparing the nutrient solutions to be used in the tests.

The same nutrient solution was used for each culture except for the various concentrations of calcium acid phosphate. Before the phosphate was added, the nutrient solution was prepared by using Hoagland's stock solution A and double Hoagland's stock solution B, and substituting 185 ppm—parts per million—of potassium as the sulfate for the usual 42 ppm of potassium as the phosphate found in Hoagland's stock solution C. Expressed as concentrations of the various elements, the test solution contained—in ppm—calcium, 318; magnesium, 54; potassium, 327; sodium, 7; chlorine, 10; sulfate, 444; and nitrate, 1211. The trace or minor elements used were—in ppm—boron, .2; manganese, .2; zinc, .2; iron—as sulfate—.2; aluminum—as citrate—3; copper, .25; and molybdenum, .1.

Concentrations Varied

To the nutrient solution—common for each culture—were added the various concentrations of phosphate shown in the table on page 11. During the first two years of growth, culture No. 11 received only 15.5 ppm of phosphate in its culture solution. When it was evident that the tree would be severely injured or die, the concentration was increased to 201.5 ppm. The data given in the table shows the average diameter of the largest fruit as being approximately three inches. The data also shows that the fruits produced at the three lowest phosphate concentrations were the smallest in size, regardless of the number of the fruits.

The leaves of the trees grown at the three or four highest calcium acid phosphate concentrations showed definite symptoms of magnesium deficiency and indicated that the concentration of magnesium should have been increased. That this would be the case might have been predicted because the high calcium and potash content of the nutrient was unbalanced by increasing the calcium content through the addition of the calcium acid phosphate. Phosphate, moreover, was also found to be more effective when an adequate magnesium supply was available.

The results obtained with these silica sand cultures lend support to the view that one of the means of affecting Valencia orange fruit size may lie in the interrelation or improved balancing of the various elements that go to make up the trees' nutrient solution.

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