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**EFFECTS OF HYDROCOOLING
ON THE QUALITY OF
SWEET CORN**

**A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville**

Linda Lee Johnson

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ABSTRACT

Sweet corn is in a continual state of deterioration after harvest. For sweet corn to maintain high quality and a long shelf-life, it should be precooled as soon as possible after harvest. In this study, three methods of precooling were compared with no cooling of sweet corn. The precooling treatment methods were hydrocooling, well water cooling, and refrigeration cooling.

The process involved in the method of hydrocooling was to bring the harvested sweet corn into contact with flowing ice water to quickly cool the corn. The well water cooling treatment involved bringing the harvested sweet corn into contact with flowing cool water. During the refrigeration cooling treatment, the harvested sweet corn was placed in a refrigerated cooler directly after harvest to cool. The last treatment method was one in which no cooling was performed on the harvested sweet corn.

The two cultivars of sweet corn, 'How Sweet It Is' and 'Silver Queen', used in this study were harvested in the early morning hours to avoid the heat of the sun. The sweet corn was divided into four groups per cultivar for the three cooling treatments and the control. The cooling treatments were performed, and then the corn was stored in a refrigerated cooler for six days. Selected sample ears were tested for temperature changes, weight gain/loss, moisture content, texture (firmness), color, and soluble solids (degrees Brix). These tests were repeated at two, four, and six days after harvest.

The results of these tests showed that sample ear weight was affected by cooling method. Moisture content and color were affected by

date of harvest. Color was also affected by cultivar. No differences were found among tested cooling methods with respect to firmness, but the kernels from the three cooling treatments were softer than those of the control. There was a significant harvest date (REP) by treatment method within cultivar interaction for color and soluble solids of the kernels.

Cooling the fresh sweet corn ears by any of the tested methods decreased weight loss, moisture loss, soluble solids loss, and the rate of increase in firmness. Overall, no one cooling method tested excelled over the others in maintaining sweet corn quality.

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CHAPTER I

INTRODUCTION AND OBJECTIVES

Introduction

Advances have been made during the past two decades in increasing and maintaining the shelf-life of sweet corn. Shelf-life is the time period that the corn can be expected to maintain a high quality under given storage conditions. Postharvest (handling after harvest) procedures are very important in maintaining high quality sweet corn.

Sweet corn is in a continual state of deterioration after harvest. One measure of this deterioration is the change in sugar content of the corn. Sugars are lost by respiration. Harvesting during a cool part of the day will help maintain sugar content (Eisenberg, 1984). Another way to help maintain sugar is to rapidly reduce the temperature of the harvested corn. Generally, for every 10°C increase in temperature, sugar is lost twice as fast. Maintaining a temperature close to 0°C (32°F) and a relative humidity of 90-95% is recommended for sweet corn storage (Mitchell et al., 1972).

Precooling is the process of cooling or refrigerating fresh produce before packing or shipping. Precooling is probably the most important step in slowing respiration and thus maintaining product quality. Sweet corn should be cooled quickly and thoroughly to prevent the loss of sugars. The corn may be cooled rapidly by several methods, one of which is by bringing it into contact with flowing cold water. This process is called hydrocooling. Efficient hydrocooling requires that: 1) water should move over the surface of the corn; 2) water should

contact as much of the corn ear surface as possible; and 3) water must be kept as cold as possible at approximately 0°C (32°F) without endangering the corn quality (Mitchell et al., 1972).

Maintaining quality of the sweet corn can be expensive, but consumers prefer high quality tender and (sweet) sweet corn. Also, many wholesale and retail firms will not purchase sweet corn unless it has been cooled to near 4.4°C (40°F). Therefore, to preserve the postharvest quality of sweet corn, precooling procedures should be implemented as quickly as possible after harvest to insure maintenance of a high quality sweet corn.

Objectives

This study was designed to investigate the effects of cooling treatment on the storage quality of two sweet corn cultivars. Three cooling treatments were compared to a non-cooled control. The cooling treatment methods employed were hydrocooling, cooling with well water and forced air (refrigeration) cooling. The objective of this study was to monitor selected samples of treated sweet corn for specified changes in quality. The following factors were evaluated for each treatment. Temperature of selected corn cob centers was monitored for changes during the test periods. Selected corn ears were measured for changes in ear weight, kernel moisture content, kernel color, kernel texture or firmness, and kernel extract soluble solids for the duration of each test period.

CHAPTER II

LITERATURE REVIEW

Introduction to Sweet Corn

North America has been identified as the location of the first known corn production. Fossilized corn fragments dating back approximately 60,000 years have been found in Mexico. The first recorded production of "sweet" corn in North America was in 1779 near Plymouth, Massachusetts (Huelsen, 1954).

Corn, a member of the grass family *Gramineae* and the genus *Zea*, has been found to have only one species, *mays*. Sweet corn (*Zea mays* var. *rugosa* L.) has been listed as only one of several varieties of corn (Huelsen, 1954).

Most of the large commercial sweet corn production in the United States is in either the northern states or in Florida, and Georgia. Every county in Tennessee has produced sweet corn at some time for local sales. Tennessee farmer's interest in sweet corn production has increased in recent years. It has been estimated that, in 1987, 1500 acres were devoted to the production of sweet corn in Tennessee. The 'Silver Queen' cultivar has been ranked among the major cultivars grown. Also, there has been an increase in interest in the "super sweet" cultivars such as 'How Sweet It Is' which are much sweeter in taste than the normal cultivars such as 'Silver Queen' (Collins et al., 1987).

Postharvest Quality and Handling of Sweet Corn

Over the years, numerous advances have been made in sweet corn production, development of new cultivars, and postharvest handling. Most of these advances have been brought about by the need for maintaining or improving sweet corn quality. By maintaining quality, the shelf-life of the sweet corn is increased (Eisenberg, 1984).

Quality of sweet corn has been found to deteriorate rapidly after harvest. An increase in respiration rate after harvest has been found to result in rapid sugar loss and heat evolution (Maurer et al., 1969). Sugars change into starch in the sweet corn kernels, resulting in loss of desirable flavor. The loss of sugar is responsible for at least half of the flavor changes in sweet corn (Smittle et al., 1972). Ashby (1970) reported that if the heat in freshly harvested sweet corn was quickly removed by cooling, there would be decreased sugar losses.

Maurer et al. (1969) reported that the rate of sugar depletion in fresh sweet corn decreased with time until equilibrium was achieved. They also found that sweet corn stored for 24 hours at 30°C (86°F) lost over 50% of the total sugar content. However, sweet corn stored for the same length of time at 20°C (68°F) lost 25% of the sugar content, and at 10°C (50°F), lost only 15%. This finding emphasized the importance of cooling the sweet corn to prevent sugar loss and a resulting decrease in quality.

Fresh market sweet corn with fresh, dark green husks and flag leaves has been considered good quality for purchase by consumers. Generally poor quality fresh sweet corn has been identified by wilted husks and dented corn kernels. Showalter (1967) reported that trimming

shanks of freshly harvested sweet corn greatly retarded denting of corn kernels, but the husks remained fresh longer on ears with shanks intact. He also reported that total ear weight loss and kernel moisture loss were less when the flag leaves and/or shanks were removed.

Proper postharvest handling is crucial to sweet corn quality. Adequate quality loss prevention measures must be followed for sweet corn quality to be maintained. Harvesting in a cool part of the day promotes maintenance of the sugar content. Sweet corn should be kept from direct sunlight if it has been harvested in the heat of the day (Eisenberg, 1984).

Eisenberg (1984) reported that precooling is one of the most important steps in maintaining sweet corn quality. Ashby (1970) reported that lowering the temperature immediately after harvest by precooling aids in the maintenance of a fresh appearance, prevention of decay, and extension of the market life or shelf-life of most fruits and vegetables. Ashby reported on several methods of precooling sweet corn. Some of the methods were: outside-open-air cooling; portable refrigeration units; vacuum cooling; hydrocooling; temporary storage in a refrigerated room; and cooling in a transport vehicle refrigeration system.

Mitchell et al. (1972) described hydrocooling as the process of bringing the produce into contact with moving cold water which rapidly cools the produce. They noted that hydrocooling does not remove any water from the produce. They also reported that efficient hydrocooling required that water move over the surfaces of the produce; the water should contact as much of the surface of the product as possible; and

the water must be kept as cold as possible without endangering the produce, near 0°C (32°F) for sweet corn.

Mitchell et al. (1972) listed two major types of commercial hydrocoolers, the conveyor type and the "batch" or room-type. The conveyor hydrocooler was reported as the most common type used commercially. This type uses a conveyor to move produce in bulk or in containers through a shower of ice cold water inside the hydrocooler (Figures II-1 and II-2). The room-type is the least expensive of the two types. It is also a shower type without the conveyor. The produce containers are stacked in the center of the room and cooled. This type of hydrocooler has been used for temporary storage of the produce after it has been precooled.

Maurer et al. (1969) reported that hydrocooled sweet corn ears had a slower rate of increase in total soluble solids than did air-stored ears of sweet corn. Also, the total soluble solids (TSS) in the hydrocooled ears did not increase as much as the TSS in air-stored sweet corn ears. The treated sweet corn had been harvested in the early morning. The air-stored ears had been piled in a heap in a constant temperature room at 22°C (72°F). The hydrocooled ears were cooled in the hydrocooler until they reached 4°C (39°F) cob temperature. The 4°C temperature was maintained in the ears while in a cold storage room.

Collins et al. (1987) reported that hydrocooled standard sweet corn cultivars had higher soluble solids readings than did the hydrocooled super sweet cultivars. However, soluble solids decreased during refrigeration. The super sweet cultivars lost a lower percentage

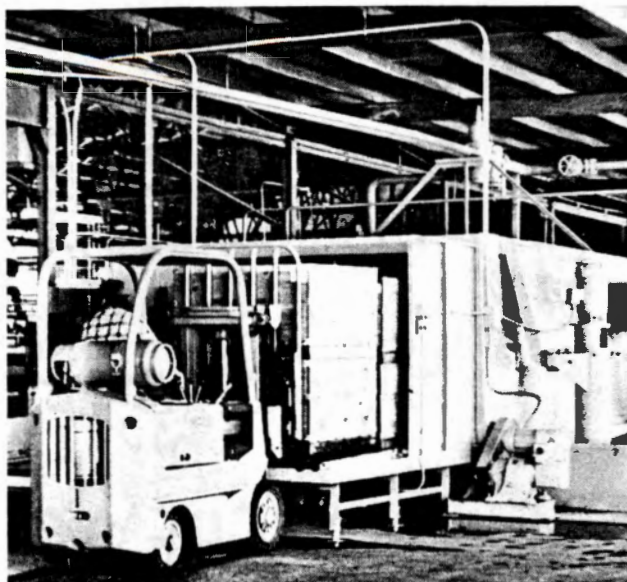


Figure II-1. Conveyor hydrocooling produce in bins (Mitchell et al., 1972).

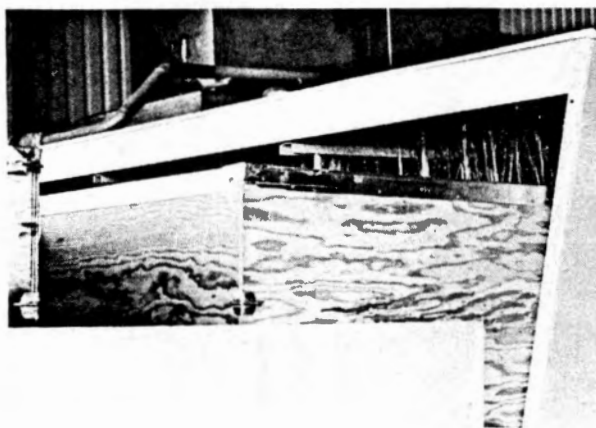


Figure II-2. A shower-type hydrocooler (Mitchell et al., 1972).

of total solids (PTS) than did the normal sweet corn cultivars after hydrocooling and refrigerated storage. The sweet corn was hydrocooled until it reached a cob temperature of 7.2°C (45°F) and then refrigerated before measurements of percentage of total solids and soluble solids were taken.

Eisenberg (1984) stated that some precautions should be noted when using a hydrocooler to precool sweet corn. The precautions were as follows: the hydrocooler water should be kept as close to 0°C (32°F) as possible; and the crates should not impede the flow of cold water around the sweet corn while it is in the hydrocooler. Eisenberg also stated that during storage after precooling, a high relative humidity should be maintained to insure kernel moisture retention. Smittle et al. (1972) stated that for quality to be maintained in harvested sweet corn, precooling of some type should be performed on the corn as quickly as possible after harvest.

CHAPTER III

PROCEDURE

Equipment and Materials

Sweet Corn

The sweet corn utilized in this study was grown at the Plateau Experiment Station, Crossville, Tennessee. Two cultivars of sweet corn were used, 'How Sweet It Is' and 'Silver Queen'; both cultivars were white in color. 'How Sweet It Is' is a super sweet cultivar, and 'Silver Queen' is a standard cultivar. The corn was harvested after reaching maturity at each harvest date. The harvest dates were: 7/31/87 and 8/3/87 for test one and 8/26/87, 9/2/87, 9/3/87 for tests two, three and four, respectively. The first date for test one was for 'How Sweet It Is', and the second date was for 'Silver Queen'. Both cultivars were harvested on the same date for tests two, three, and four.

Corn Crates

The crates utilized in the treatments were used crates obtained from a local supermarket. The crates were typical wire-bound wooden corn crates with dimensions of approximately 60.9x30.5x22.9 centimeters (24x12x9 inches) in length, width, and depth (outside dimensions), respectively. Each crate held fifty-four ears of average sized sweet corn (Figure III-1). Two crates per cultivar were used for each treatment per test period. Crates produced by different manufacturers differed slightly in size and design. Thus, all crates used for a particular test were from the same manufacturer.

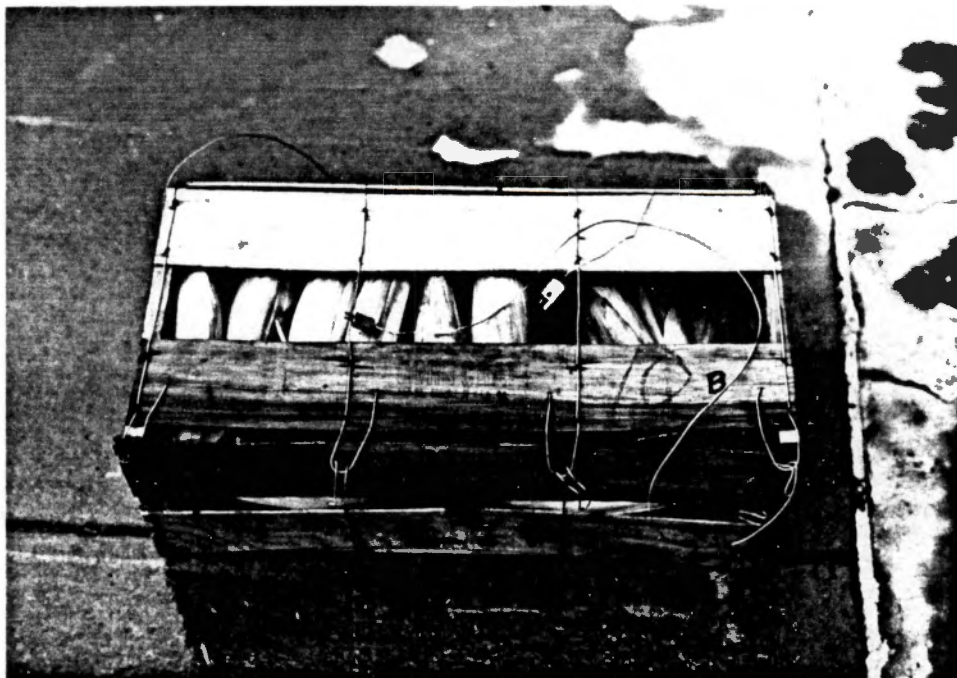


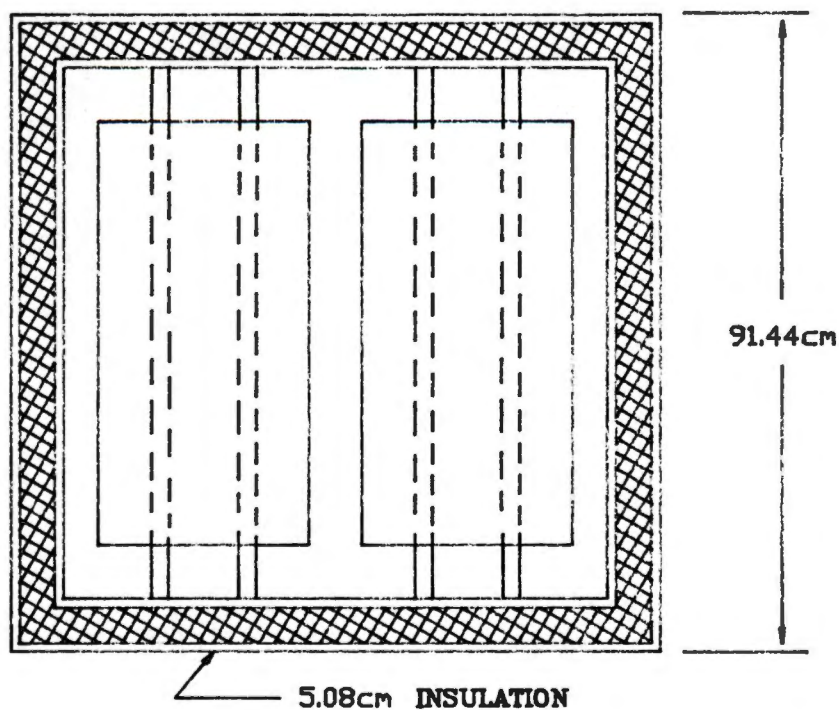
Figure III-1. Typical wire-bound corn crate filled with corn, and equipped with thermocouples for temperature measurement.

Treatment Coolers

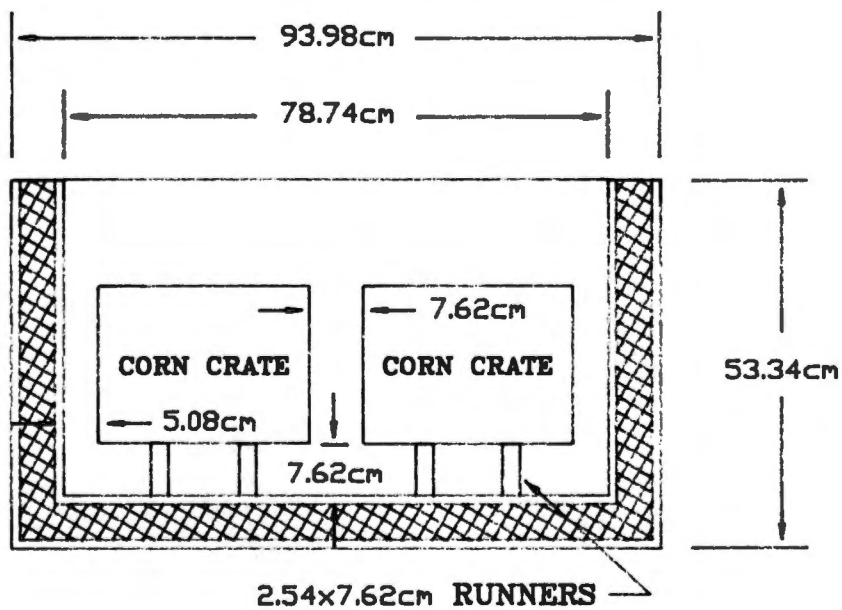
Three types of treatment coolers were utilized in this study. They were an ice water hydrocooler, a well water cooler, and a walk-in refrigeration cooler.

The ice water hydrocooler (Figure III-2) consisted of a plywood box container 94.0x91.4x53.3 centimeters (37x36x21 inches) in length, width, and depth (outside dimensions), respectively. The walls were 7.6 centimeters (3 inches) thick. These walls consisted of 1.3 centimeters (0.5 inch) thick plywood which enclosed 5.1 centimeters (2 inches) thick insulation on the sides and bottom. The top edge was capped with a sheet of aluminum. The inside surface was completely waterproofed. Four 2.5x7.6 centimeter (1x3 inch) runners were put in the bottom of the container to support the crates of corn.

A polyvinyl chloride (PVC) plumbing system (Figure III-3) was constructed to drop in over one end of the container for the circulation of ice water. Small, 0.635 centimeter (0.25 inch) diameter, holes were drilled into the pipes to allow uniform circulation of the cooling water throughout the container. The circulating pump was driven by a Dayton 1/4 HP split-phase motor, model 5K279C, that was placed outside at one end of the container. The pump continuously circulated the cooling water by drawing the water into the two PVC pipes located in the bottom of the cooling container and discharging through the single PVC pipe located at the top of the cooling container. The ice water hydrocooler system was built in the Agricultural Engineering Department.



TOP VIEW



END VIEW

Figure III-2. Details of the container used to hold ears of sweet corn for hydrocooling and well water cooling.

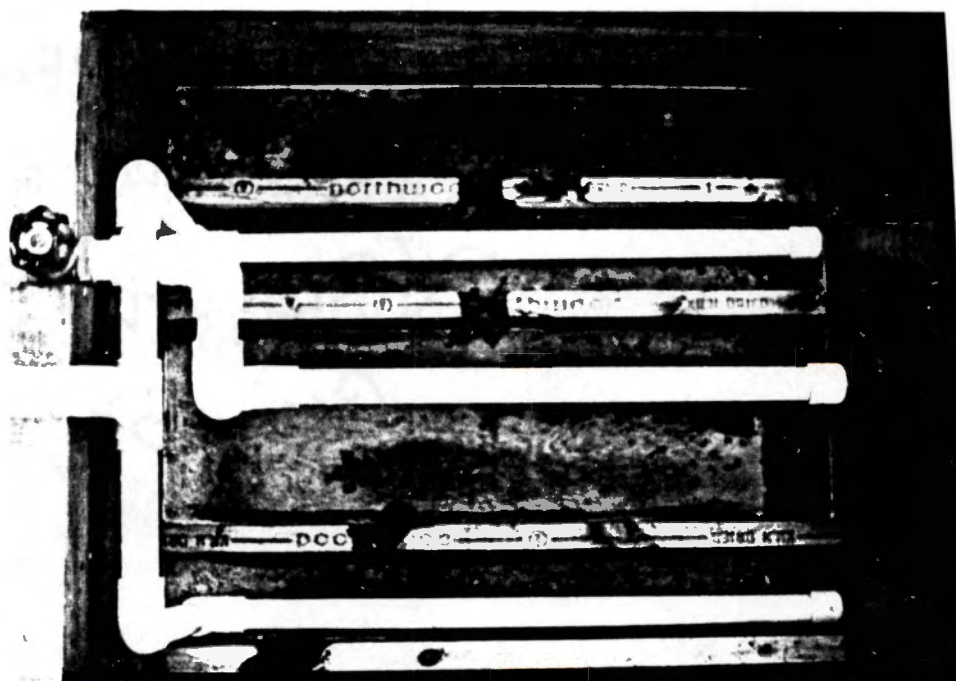
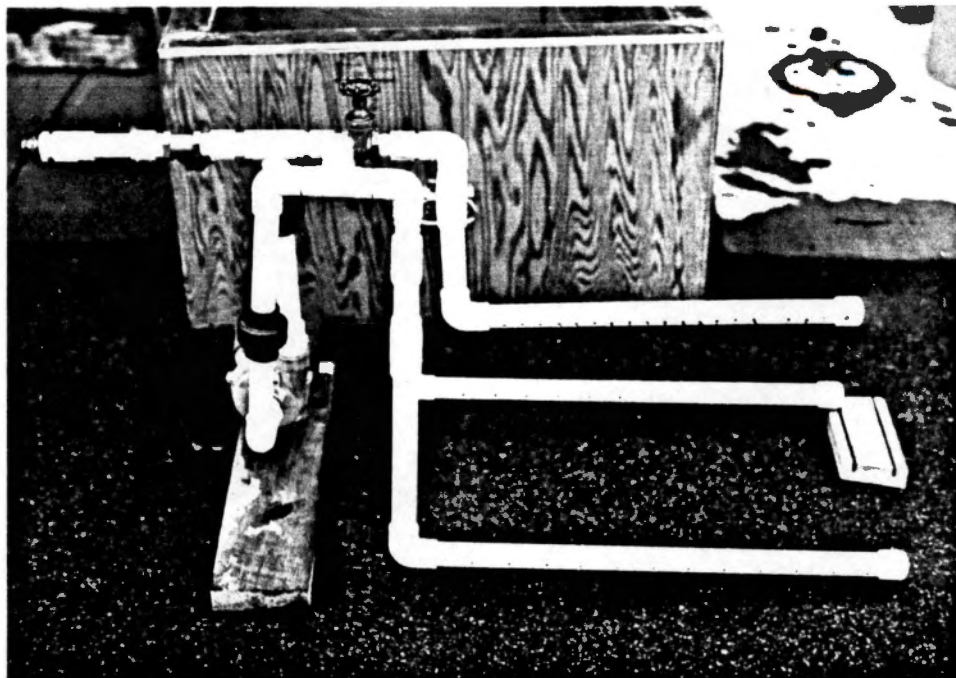


Figure III-3. The PVC plumbing for the hydrocooler, shown outside the container (top) and positioned for operation inside the container (bottom) used to hold ears of sweet corn.

The well water cooler (Figure III-2) was constructed in the same manner as the ice water hydrocooler, except that a small overflow drain was installed near the top of the box (Figure III-4). The well water cooler PVC plumbing, also containing 0.635 centimeter (0.25 inch) diameter holes for uniform water flow, was connected directly to a well water supply instead of a circulating pump. Water entered the box through the PVC plumbing located in the bottom of the cooling container. It, then, flowed upward around and through the crates of corn. The PVC water flow outlet near the top of the opposite side of the cooling container allowed for the escape of overflow of water. The well water cooler was also built in the Agricultural Engineering Department.

The refrigeration cooler was a standard walk-in type cooler measuring 2.4x2.4x2.4 meters (8x8x8 feet) in size. It was a Copeland Cooler, Model CBAM 0150-CAB-0001.

Temperature Measurement

A digital thermocouple thermometer with temperature ranges of -80 to +199.9 °C and -112 to +199.9 °F was used for all temperature measurements. The thermometer was an Atkins Technical Incorporated series 396, model 39641-T. The temperature measurements included the cob center, cooling water, ambient air, and storage cooler. Measurements were taken periodically for the duration of each test.

Type T thermocouples with plug-in connections were used with the Atkins thermometer to measure the temperature. At the time of harvest, thermocouples were inserted into the cob center of selected corn samples. This was accomplished by cutting the stalk end of the ears flat, and drilling a 0.318 centimeter (0.125 inch) diameter hole halfway

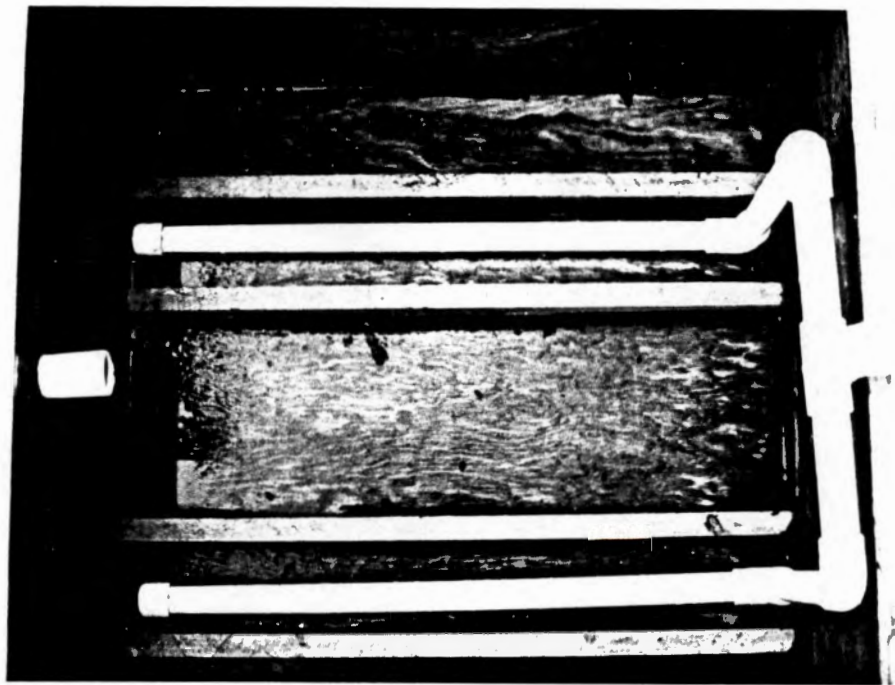
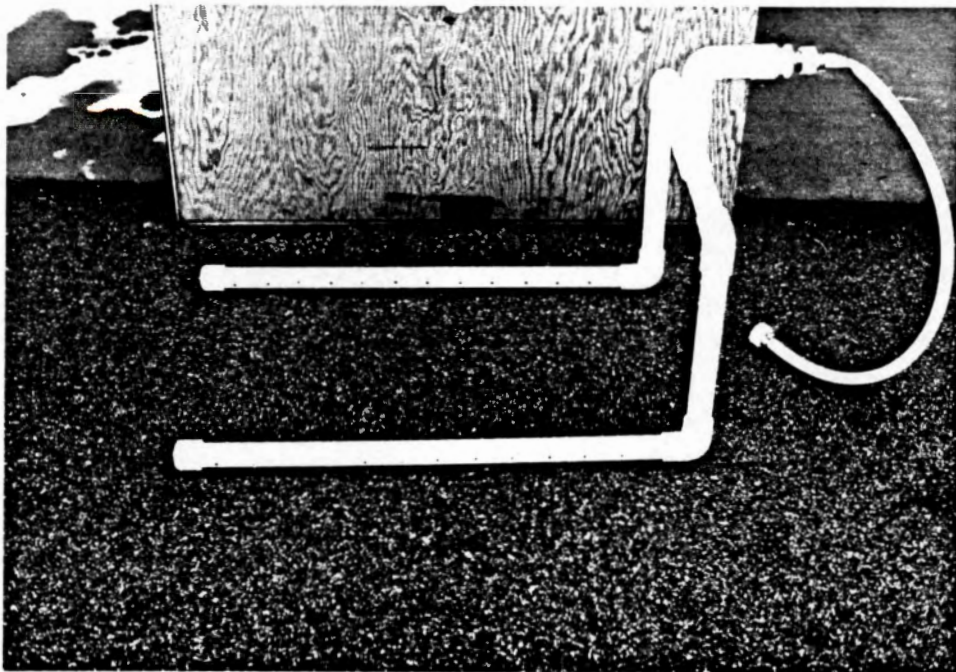


Figure III-4. The PVC plumbing for the well water cooler, shown outside the container (top) and positioned for operation inside the container (bottom) used to hold ears of sweet corn.

into the center of the corn cob with a standard power drill (Figure III-5). The thermocouple was then inserted into the cob and the hole was sealed with clear silicone sealant (Figure III-6). Sealing the thermocouple into the cob was necessary to insure that water did not leak into the cavity, causing erroneous temperature readings.

Drying Oven

The drying oven used to dry the corn kernel samples was a standard convection drying oven manufactured by the Precision Scientific Company. It was a Model 1250 with a temperature range of 35°-180°C (95°-356°F). The drying oven was operated at a temperature of 100°C (212°F).

Color Meter

The color meter used in this study was a HunterLab Color Difference Meter, Model D25-PC2. It measured both the "X", "Y", "Z", and the "L", "a", "b" values. It produced a computerized printout of the color value readings.

Texture Press

A Food Technology Corporation Texture-Test System containing a Model TB4C Digital Texturegage, a Model FTA-3000 Force Transducer, and a Model CS-1 Standard Shear Compression Cell was used in this study. This hydraulically driven shear press measured the peak force required to shear the sample.

Refractometer

An American Optical hand-held refractometer, model 10430, was used in this study. It measured soluble solids directly and had a range of 0-30 degrees Brix (°Brix).

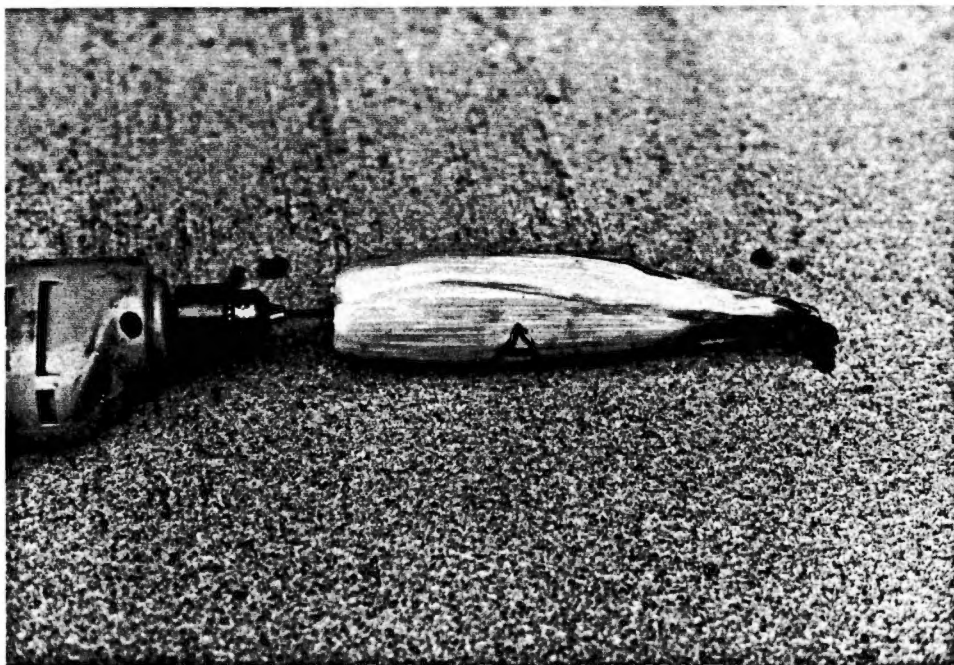


Figure III-5. Illustration of drilling hole into a marked sample ear of sweet corn.

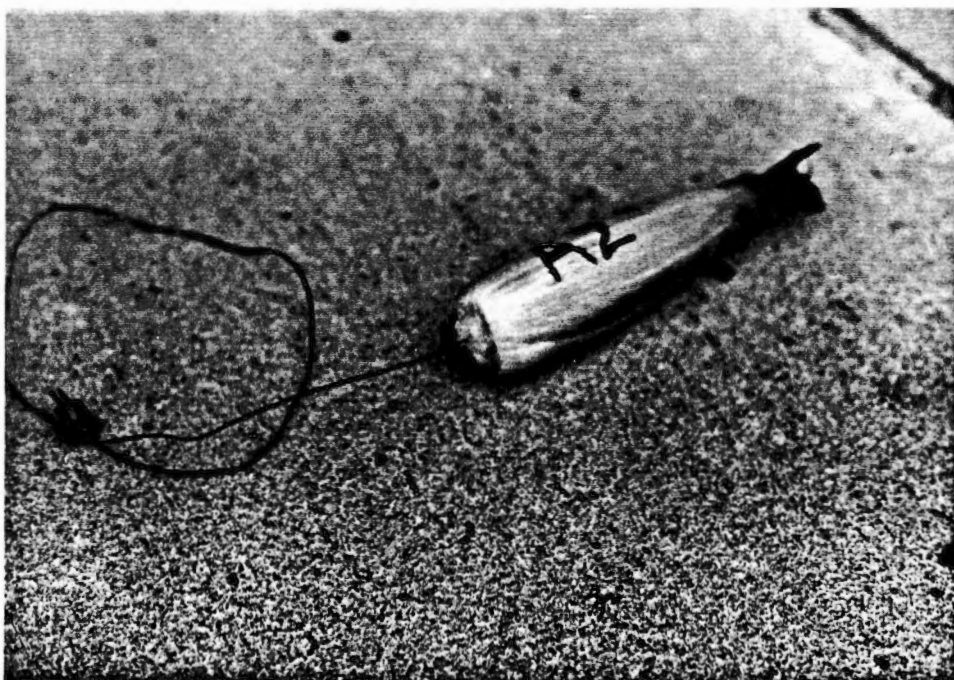


Figure III-6. Illustration of thermocouple wire sealed with clear silicone sealant into a sample ear of sweet corn.

Miscellaneous Items

Several miscellaneous items were used in this study. They included Mettler E200 and Mettler PE3600 electronic weighing scales, standard aluminum drying cans, waterproof felt tip markers, standard kitchen knives, and bagged cubed ice.

Experimental Methods

This experiment began with the harvesting of ears of sweet corn from two cultivars in the early morning hours (7:00 a.m.) to avoid the sun's heat which could cause a temperature rise within the ears of corn. After harvest, the ears were prepared for the treatments. Test sample ears were selected from average size ears of both cultivars (twelve ears per crate). The sample ears for each crate were marked for identification. Two of the twelve ears were selected for periodical weighing to measure changes in mass of the ears. The selected samples for weight measurement were weighed, and thermocouples were inserted into two ears selected for temperature monitoring before the ears were placed into the crates. Two additional ears were set aside for the initial moisture, color, texture (firmness), and soluble solids measurements. The remaining six ears were used in later measurements of these same properties. After the crates were filled with corn (including eight of the marked ears), they were placed in the designated treatments, as discussed below, and monitored. After treatment completion, the laboratory tests, described below, were completed on the two sample ears for each crate. Laboratory tests were repeated on postharvest days two, four, and six after removing two additional marked ears per crate. Figure III-7 depicts the above design.

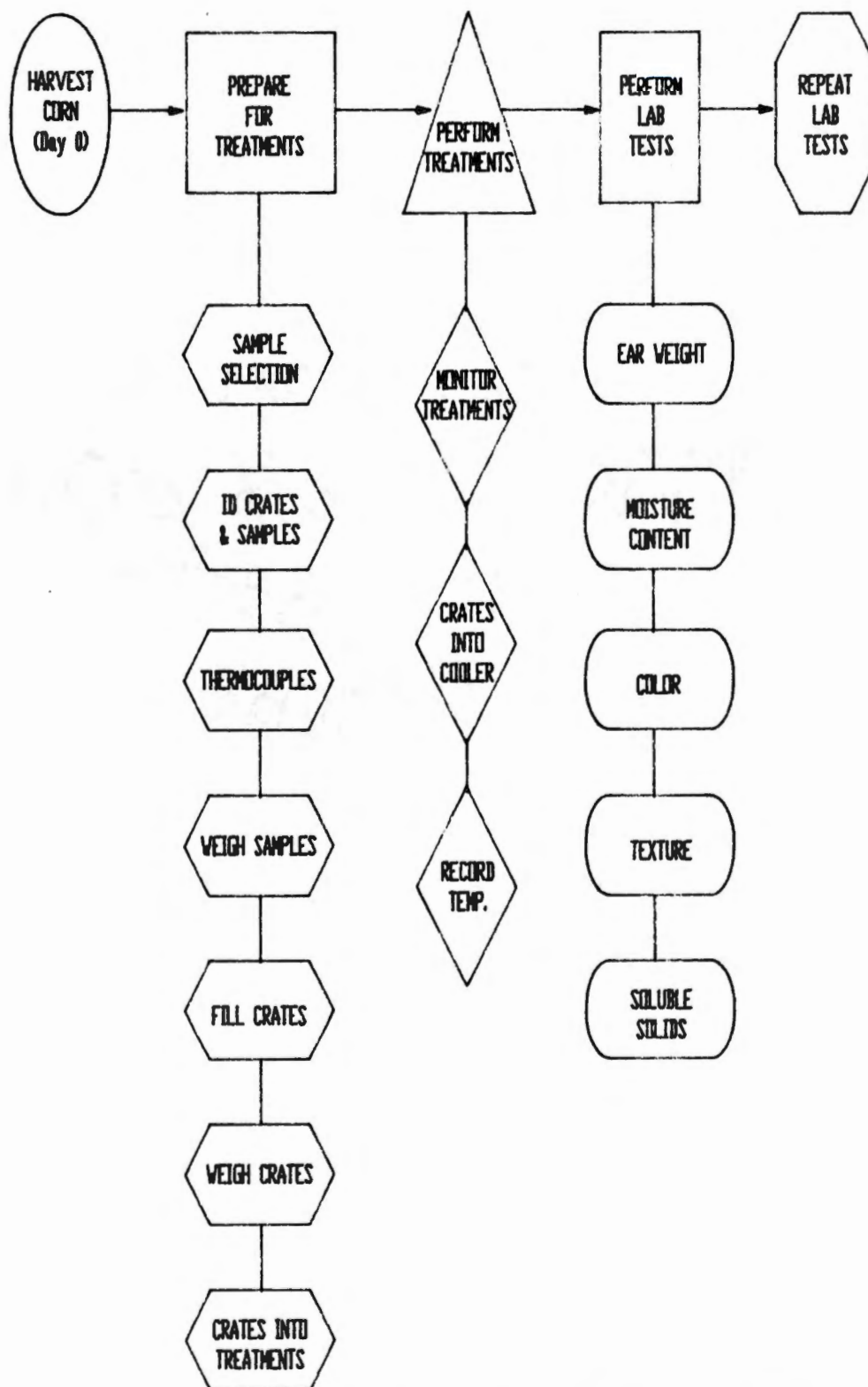


Figure III-7. Flow chart of the sweet corn study experimental design.

Four major treatments were involved in the design of the experiment. The first treatment was the hydrocooling treatment (immersion in moving ice water). The second treatment was the one in which well water was used. The third treatment was the refrigeration cooling treatment. The fourth was a control in which no precooling treatment was applied to the fresh sweet corn.

Hydrocooling Treatment

The hydrocooler (HC) was positioned in the shaded area of an open shop and filled with tap water and ice. Two sweet corn filled crates per treatment per cultivar were placed into the hydrocooler and weighted down with two standard cement blocks to keep them submerged in the flowing ice water (Figure III-8). The two sweet corn filled crates for the first treatment contained 'How Sweet It Is'. After the 'How Sweet It Is' corn was cooled to the desired temperature, the two sweet corn filled crates were removed and two sweet corn filled crates of 'Silver Queen' were placed into the hydrocooler and cooled. Each crate contained fifty-four ears of the cultivar treated. Initial corn and water temperatures were recorded.

Ice water was circulated through the crates for the treatment duration. Water and cob temperatures were monitored and recorded until the cob center temperature reached approximately 4.4°C (40°F). The corn crates were removed from the hydrocooler when this temperature was reached. The crates were immediately placed into the refrigeration cooler for the duration of the six day test period.

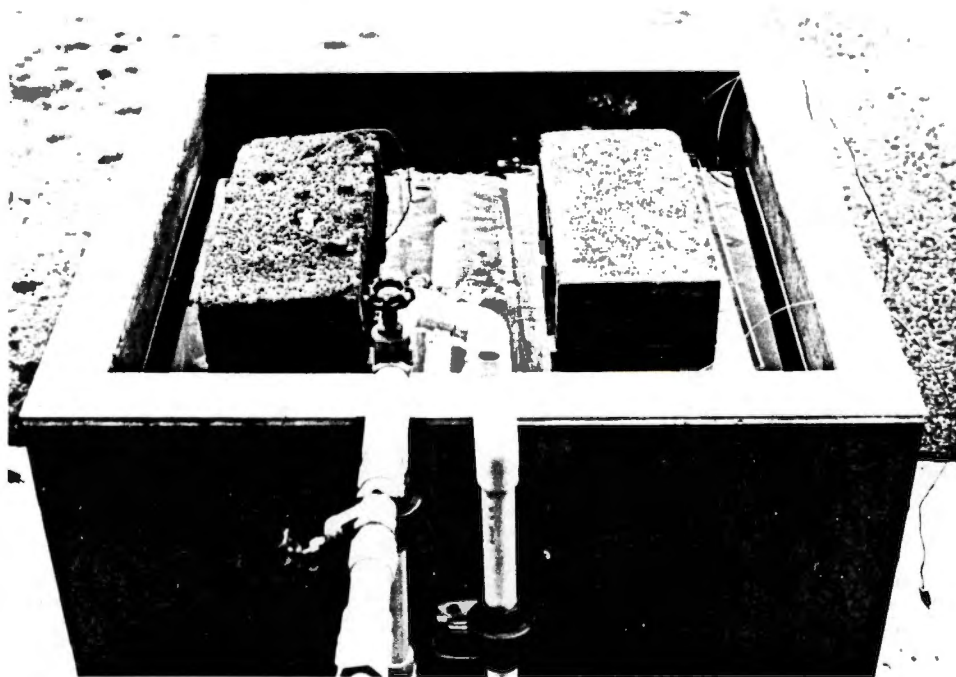


Figure III-8. Two views of the hydrocooler for sweet corn during operation. The concrete blocks were necessary to keep the crates submerged.

Well Water Treatment

The well water cooler (WW) was set up inside a pump-house and filled with 18°C (64°F), mean temperature, well water. Two crates per treatment per cultivar were placed into the cooler and weighted down with two standard cement blocks (Figure III-9). The same cooling procedure was followed as with the hydrocooling treatment (two crates of 'How Sweet It Is' followed by two crates of 'Silver Queen'). Each crate contained fifty-four ears of corn. Initial temperatures of the corn and water were recorded.

The well water was circulated through the crates for the treatment duration. Water and corn temperatures were monitored and recorded until the corn temperature reached equilibrium with the water temperature. The crates were removed from the cooler and placed into the refrigeration cooler for the duration of the six day test period.

Refrigeration Treatment

The temperature in the refrigeration cooler (REF) was lowered to 0°C (32°F). Two crates per treatment per cultivar were placed into the cooler as soon as they were filled with fifty-four ears of sweet corn per cultivar. Initial corn temperature was recorded. Also, temperature was monitored and recorded for the duration of the six day test period.

Control Treatment

The two crates per treatment per cultivar were placed outside in the shade of trees as soon as they were filled with fifty-four ears of sweet corn per cultivar for the control (CONT) treatment. Initial corn and ambient air temperatures were recorded. Also, temperature was

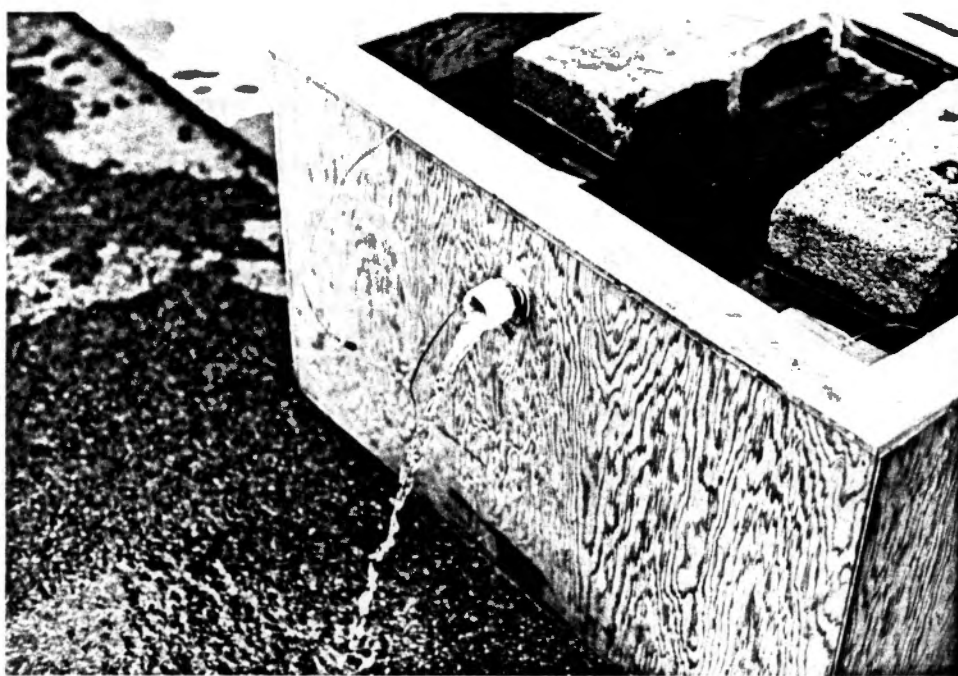


Figure III-9. Two views of the well water cooler for sweet corn during operation. The concrete blocks were necessary to submerge the crates.

monitored and recorded for the duration of the test period of six days. The crates were left outside for the duration of the test period.

Analysis of Treated Samples

After the completion of the initial treatments, several tests were conducted on the sweet corn ears. Temperatures within the cob were monitored at harvest, at treatment time, and at two day intervals for the test period of six days. Tests for weight, moisture content, color, texture, and soluble solids were conducted at harvest and at two day intervals for the six day storage period. To perform tests for moisture content, color, texture, and soluble solids, the corn kernels were cut off the cob from two sample ears per crate and placed into a labeled bowl.

The following analyses were made on all of the samples of sweet corn. These analyses permitted the evaluation of effects of treatment on quality of the sweet corn.

Temperature

The temperature inside the cobs of two selected ears of corn per crate were recorded during the initial treatments on harvest day. Cob temperatures were also recorded at two day intervals for the six day test duration.

Weight

Each crate of corn was weighed before treatment and on the second, fourth, and sixth day after treatment. These weights measured the total crate weight gain/loss over each two day period.

Two sample ears per crate of both corn cultivars were weighed before treatment and on the second, fourth, and sixth days after treatment. These weights were used to estimate corn weight gain/loss for the duration of the test periods. The marked ears were removed from near the center of the crate, weighed, and returned to the crate.

Moisture

Approximately twenty grams of corn kernels from the sample ears of each corn crate were weighed and placed in standard laboratory drying containers. These containers were then placed in an oven and dried for approximately twenty-four hours at 100°C (212°F) for moisture content determination.

Color

Corn kernels of the two sample ears from each crate were mixed and placed into a glass dish that was placed on the HunterLab Color Difference Meter to record the color readings. The values of "L", "a", "b" were recorded. The "L" scale refers to luminosity and ranges from 0-100. The "a" scale refers to redness (+a) and greenness (-a) and ranges from -100 to +100. The "b" scale refers to yellowness (+b) and blueness (-b) and ranges from -100 to +100 (Francis et al., 1975). These color readings were used to determine if the treatments had any effect on the color of the corn kernels.

Firmness

Corn kernels from the sample ears of each corn crate were placed in the shear compression cell of the texture press. The cell was filled, without packing, and placed into the press. The readings

obtained from the texture press were used to determine the effect of treatment on the firmness of the corn kernels. The readings were converted from pounds per square inch (psi) to megapascals (MPa) by the equation:

$$\text{MPa} = [(\text{psi}) \times (6.09)] / 1000$$

Soluble Solids

A drop of the corn kernel juice extracted by the texture press was placed onto the prism of a refractometer with a small plastic applicator. The reading from the refractometer, expressed as °Brix, is a measure of all soluble substances present in the juice sample. This measurement indicates the percentage of total soluble solids.

Statistical Methods

The statistical design used was a randomized complete block with a split plot factorial arrangement of treatments with subsampling. Blocking was made across harvest dates with cultivar being the main plot and treatment method being the split plot. Crates were treated as subsamples within each split plot. The experiment consisted of four blocks (harvest dates), two cultivars, four treatments, and two crates within each treatment method.

The raw data collected is given in the Appendix (Tables A-1 through A-9). The data were analyzed by analysis of variance (ANOVA) using the General Linear Model (GLM) procedure of the Statistical Analysis System (SAS) package. The ANOVA table for this experiment is given in the Appendix (Table A-10). The significance among means was determined by Student-Newman-Keuls (SNK) mean separation at the 0.05 level of probability.

CHAPTER IV

RESULTS AND DISCUSSION

Temperature

Corn cob center and mean ambient air temperatures for all four treatments on harvest day and two, four, and six days after harvest for each test are listed in Tables A-1 and A-2 in the Appendix. The temperatures of sweet corn ears for the last two harvest dates were lower than for the first two harvest dates.

The mean temperatures for one typical test period (six days) for both 'How Sweet It Is' and 'Silver Queen' are illustrated in Figures IV-1 and IV-2. The 'How Sweet It Is' and 'Silver Queen' hydrocooled corn cooled more quickly than the other treated corn to the desired temperature of approximately 5°C (41°F). The 'How Sweet It Is' and 'Silver Queen' well water cooled corn cooled partially to 15°C (59°F), and 16.5°C (62°F), respectively. The refrigerated corn for both 'How Sweet It Is' and 'Silver Queen' cooled to a lower temperature than the well water cooled corn; 11.5°C (53°F), and 15°C (59°F), respectively. Temperatures of the control corn increased on the harvest day due to heat build up among the corn ears in the crates, which coincided with the ambient air temperature increase. The control corn for postharvest days two, four, and six fluctuated with the ambient air temperatures. The corn ears of the three cooling treatments in cold storage tended to remain close to the same temperature, varying slightly with crate location within the cooler.

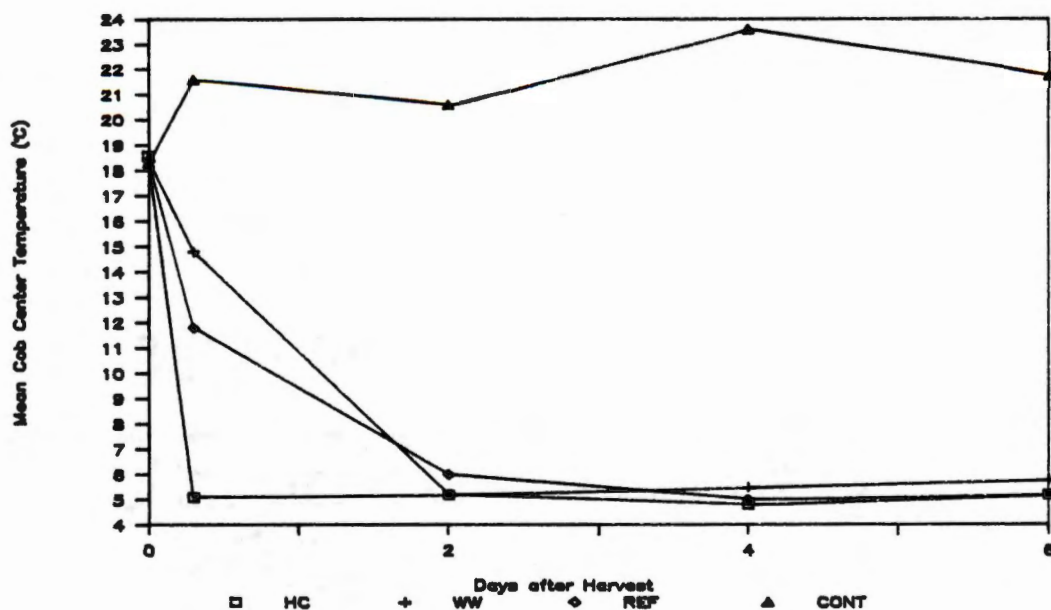


Figure IV-1. Mean change in sweet corn cob center temperatures of 'How Sweet It Is' versus time for one typical test period and all treatments (HC=hydrocooled; WW=well water cooled; REF=refrigerated; CONT=control).

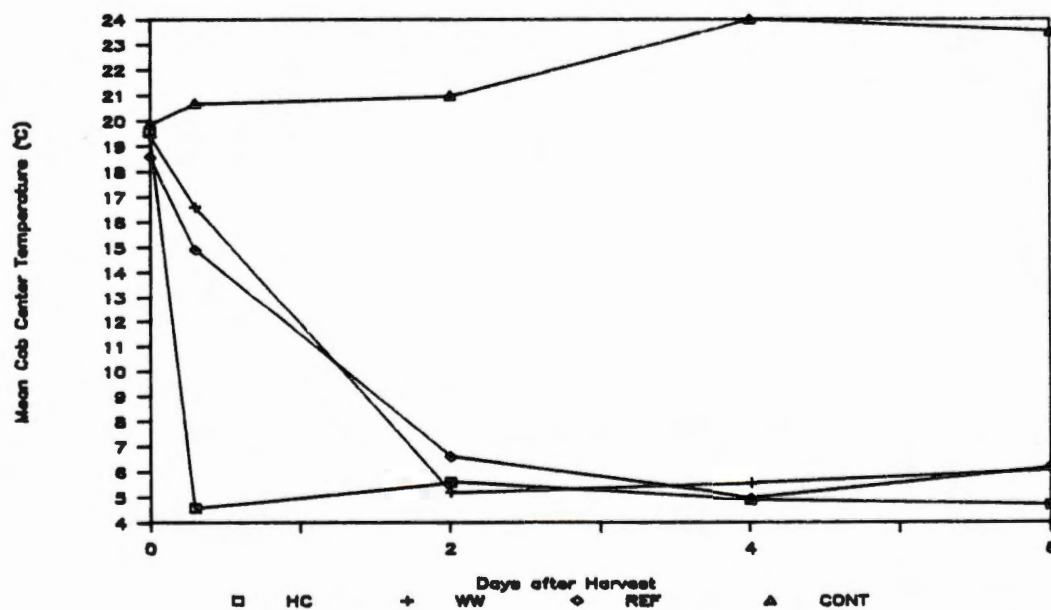


Figure IV-2. Mean change in sweet corn cob center temperatures of 'Silver Queen' versus time for one typical test period and all treatments (HC=hydrocooled; WW=well water cooled; REF=refrigerated; CONT=control).

Weight

Results of ear weight measurements are summarized in Table IV-1. Ear weight was unaffected by harvest date or cultivar while treatment method influenced ear weight at two, four, and six days after harvest.

Hydrocooled treatments had significantly higher ear weights for all measurements after harvest than the other storage methods. Well water cooled ears retained significantly more weight than did the refrigerated and control ears at two and four days after harvest. No significant difference was measured between well water cooled corn and refrigerated corn at six days after harvest, but both were significantly higher than the control corn. Measurements on days two, four, and six after harvest indicated greater weight loss in the control corn ears than in the cooled corn ears, regardless of cooling method.

Figures IV-3 and IV-4 illustrate the mean changes in weight for each cultivar at all four harvest dates. Note the increase in weight from harvest to two days after harvest in hydrocooled and well water cooled ears resulting from water retention during treatment application. The increase in weight due to water retention accounts for the increased weight on the sixth day after harvest from the initial harvested weight. Ear weight loss from day two to days four and six was not significantly different among cooling methods, but the weight losses were significantly lower than the control corn ears (Table IV-2).

These results indicated that cooling the ears by any method tested significantly decreased weight loss. Hydrocooled and well water cooled treatments resulted in higher initial corn ear weights due to the added water, but did not significantly reduce the weight loss during cold storage, after initial treatment.

Table IV-1. Effect of harvest date, cultivar, and treatment method on ear weight of sweet corn.

Method	Weight (g)			
	Day 0 ¹	Day 2 ¹	Day 4 ¹	Day 6 ¹
<u>Date</u>				
1	266.2a ²	265.2a	261.9a	254.7a
2	239.1a	242.5a	236.4a	232.5a
3	243.2a	244.8a	240.0a	236.9a
4	244.5a	243.5a	240.0a	236.9a
<u>Cultivar</u>				
'How Sweet It Is'	236.7a	236.8a	233.6a	230.3a
'Silver Queen'	259.8a	261.2a	255.6a	250.2a
<u>Treatment</u>				
Hydrocooled	257.5a	272.9a	271.8a	269.9a
Well Water Cooled	243.2a	255.2b	253.6b	249.2b
Refrigerated	241.7a	239.9c	236.8c	235.3b
Control	250.7a	228.0c	216.2d	206.7c

¹ Number of days after harvest.

² Means in a column within methods followed by the same letter are not significantly different at the 0.05 level of probability.

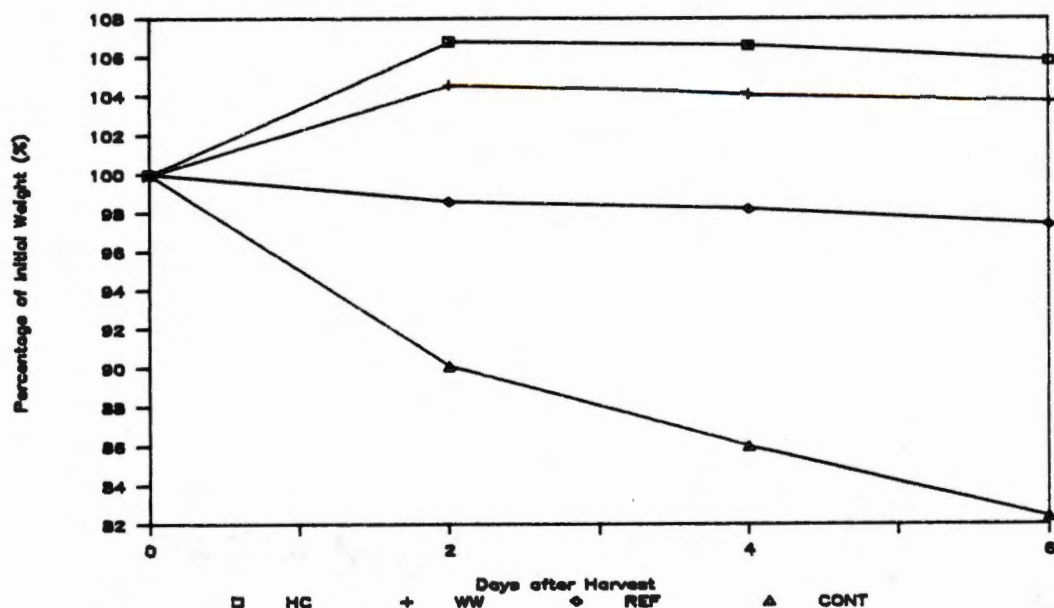


Figure IV-3. Mean change in sweet corn ear weight of 'How Sweet It Is' versus time for all four harvest dates and all treatments (HC=hydrocooled; WW=well water cooled; REF=refrigerated; CONT=control).

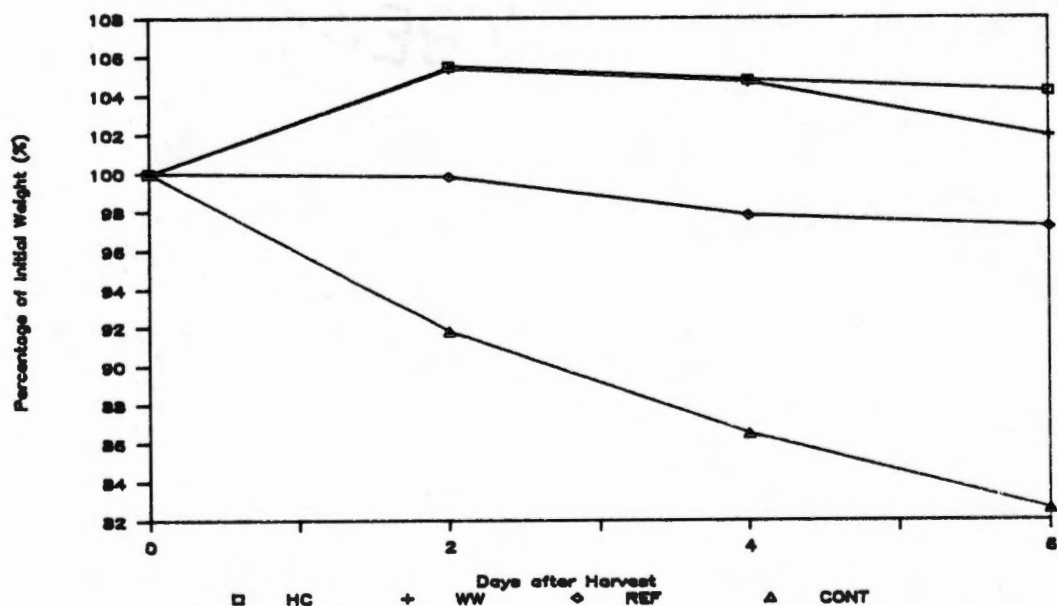


Figure IV-4. Mean change in sweet corn ear weight of 'Silver Queen' versus time for all four harvest dates and all treatments (HC=hydrocooled; WW=well water cooled; REF=refrigerated; CONT=control).

Table IV-2. Effect of harvest date, cultivar, and treatment method on percentage change in ear weight of sweet corn.

Method	% Change in Weight	
	Day 2 ¹ - Day 4 ¹	Day 2 ¹ - Day 6 ¹
<u>Date</u>		
1	1.18a ²	3.76a
2	2.59a	4.30a
3	2.11a	3.45a
4	1.47a	2.82a
<u>Cultivar</u>		
'How Sweet It Is'	1.43a	2.89a
'Silver Queen'	2.25a	4.27a
<u>Treatment</u>		
Hydrocooled	0.39b	1.08b
Well Water Cooled	0.62b	2.15b
Refrigerated	1.22b	1.87b
Control	5.12a	9.23a

¹ Number of days after harvest.

² Means in a column within methods followed by the same letter are not significantly different at the 0.05 level of probability.

Moisture

No interaction effects were found in corn kernel moisture loss among treatments. Corn kernel percentage moisture was affected by harvest date for measurements taken two, four, and six days after harvest (Table IV-3). Measurements two, four, and six days after harvest showed that the sweet corn from the first and second harvests was significantly lower in moisture content than that of the third and fourth harvests. These differences in percentage moisture can most likely be explained by a difference in maturity among the harvest dates, with the corn from the first two harvests being slightly more mature than that from the last two harvests that were in the cooler temperature of a late growing season.

Cultivar had no effect on percentage of moisture, but treatment method reduced moisture loss on ears for the fourth and sixth days after harvest. No differences were found among cooling treatments, but all three cooling treatments reduced kernel moisture loss when compared to the control treatment (Table IV-3). Percentage of moisture of kernels increased slightly when ears were immersed in water and then decreased with storage time (Figure IV-5 and IV-6). Cooling by any of the methods used in this study appeared adequate to prevent excess moisture loss in this experiment.

Color

Luminosity ("L") was affected by a harvest date by treatment method within cultivar interaction at the 0.01 level of probability on

Table IV-3. Effect of harvest date, cultivar, and treatment method on moisture content of sweet corn kernels.

Method	Moisture (%)			
	Day 0 ¹	Day 2 ¹	Day 4 ¹	Day 6 ¹
<u>Date</u>				
1	75.76a ²	74.03b	73.02b	73.12b
2	75.91a	76.81ab	74.63b	74.60b
3	80.91a	81.15a	80.86a	80.68a
4	79.99a	80.60a	81.14a	80.47a
<u>Cultivar</u>				
'How Sweet It Is'	77.78a	77.99a	77.12a	77.16a
'Silver Queen'	78.50a	78.31a	77.71a	77.27a
<u>Treatment</u>				
Hydrocooled	77.95a	78.85a	78.59a	77.93a
Well Water Cooled	78.11a	78.78a	78.05a	77.95a
Refrigerated	77.99a	77.94a	77.37a	77.54a
Control	78.52a	77.03a	75.64b	75.45b

¹ Number of days after harvest.

² Means in a column within methods followed by the same letter are not significantly different at the 0.05 level of probability.

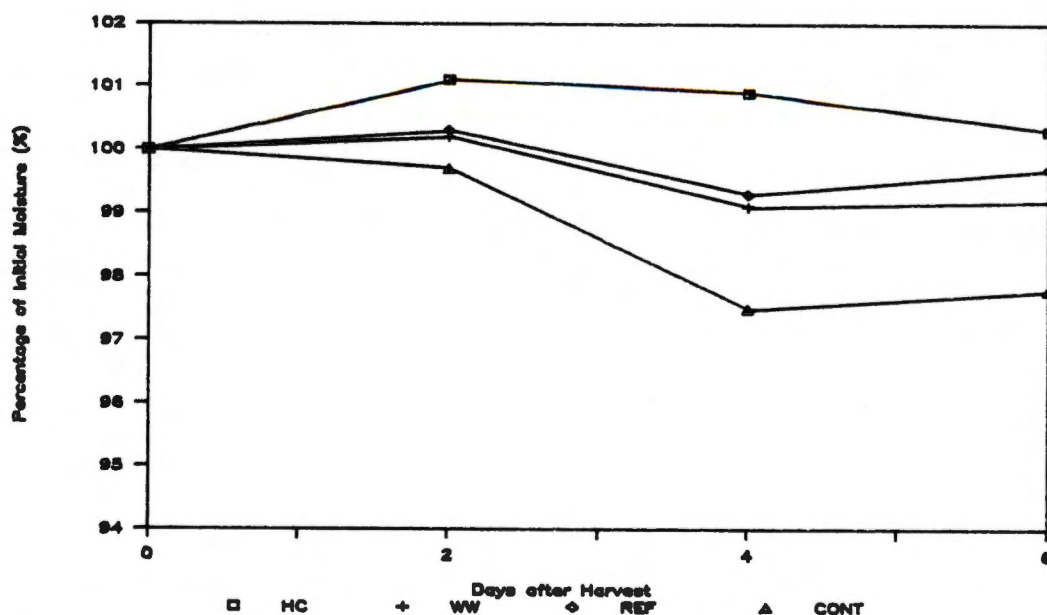


Figure IV-5. Mean change in sweet corn kernel moisture content of 'How Sweet It Is' versus time for all four harvest dates and all treatments (HC=hydrocooled; WW=well water cooled; REF=refrigerated; CONT=control).

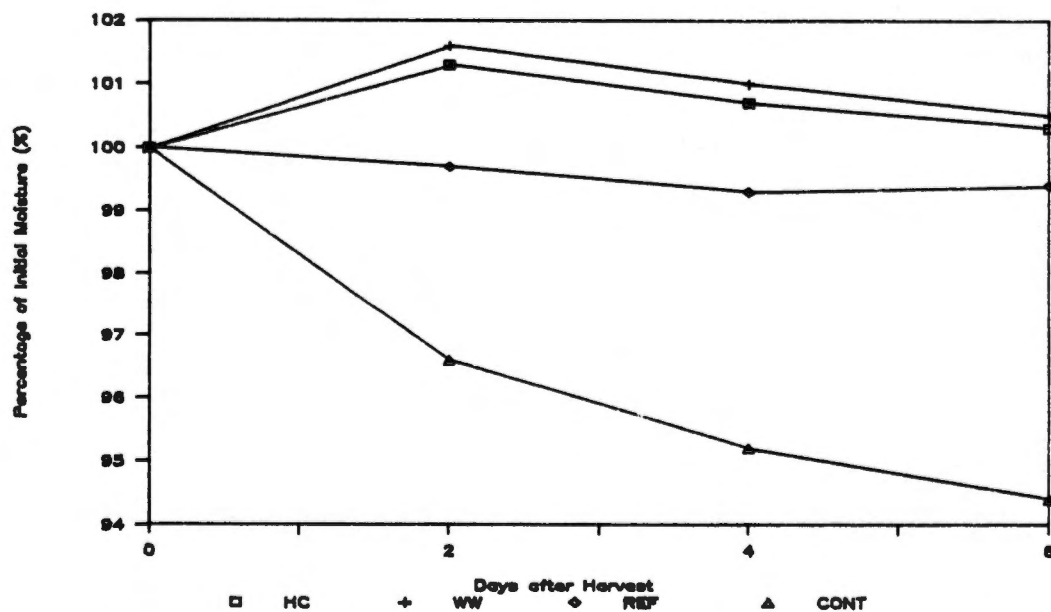


Figure IV-6. Mean change in sweet corn kernel moisture content of 'Silver Queen' versus time for all four harvest dates and all treatments (HC=hydrocooled; WW=well water cooled; REF=refrigerated; CONT=control).

four and six days postharvest (Table IV-4). Harvest date on day six, and cultivar on day two affected luminosity, but cooling treatments had no effect on this factor (Table IV-5). No significant differences in luminosity were found among the tested methods of cooling. Figures IV-7 and IV-8 illustrate that the luminosity was different among the cultivars. All three of the 'How Sweet It Is' cooled corn tended to eventually decrease more (become darker) from the initial color by the sixth day after harvest than did the 'Silver Queen' cooled corn. However, the control corn color on the sixth day after harvest for both cultivars tended to be approximately the same as the initial color.

Sweet corn kernel color "a" had no significant interactions. In addition, date, cultivar, and treatment method had no significant effect at the 0.05 level of probability on sweet corn kernel color "a" ("a" = redness; "-a" = greenness) (Table IV-6).

Color "b" (yellowness) on postharvest day six was affected at the 0.05 level of probability by a cultivar by treatment interaction. Color "b" on postharvest day six was also affected by a date by treatment within cultivar interaction at the 0.01 level of probability (Table IV-7). Date on day four, cultivar on days two, four, and six, and treatment method on days two and four after harvest affected corn color "b" (Table IV-8). Figures IV-9 and IV-10 illustrate that the color "b" changes were different among the cultivars. Initial color was not different among the two white eared cultivars in the tests. Corn for all four treatments on 'How Sweet It Is' tended to increase above (become more yellow) the initial color for postharvest days two, four, and six, while for 'Silver Queen' they all tended to decrease below

Table IV-4. Interaction effects among harvest dates, between cultivars, and among treatments on color "L" (luminosity) of sweet corn kernels.

Interaction	Color "L"			
	Day 0 ¹	Day 2 ¹	Day 4 ¹	Day 6 ¹
Cultivar x Treatment	NS	NS	NS	NS
Date x Treatment (Cultivar)	NS	NS	**	**

¹ Number of days after harvest.

** Indicates significance at the 0.01 level of probability.

Table IV-5. Effect of harvest date, cultivar, and treatment method on color "L" (luminosity) of sweet corn kernels.

Method	Color "L"			
	Day 0 ¹	Day 2 ¹	Day 4 ¹	Day 6 ¹
<u>Date</u>				
1	79.5a ²	76.4a	76.8a	76.5a
2	75.7a	75.1a	76.5a	74.7b
3	75.0a	75.0a	75.4a	75.6a
4	75.3a	75.9a	75.9a	75.8a
<u>Cultivar</u>				
'How Sweet It Is'	77.1a	76.3a	76.6a	75.9a
'Silver Queen'	75.7a	75.0b	75.7a	75.4a
<u>Treatment</u>				
Hydrocooled	76.5a	75.3a	76.0a	75.6a
Well Water Cooled	76.1a	75.6a	76.1a	75.3a
Refrigerated	76.7a	75.7a	76.1a	75.6a
Control	76.3a	75.9a	76.4a	76.1a

¹ Number of days after harvest.

² Means in a column within methods followed by the same letter are not significantly different at the 0.05 level of probability.

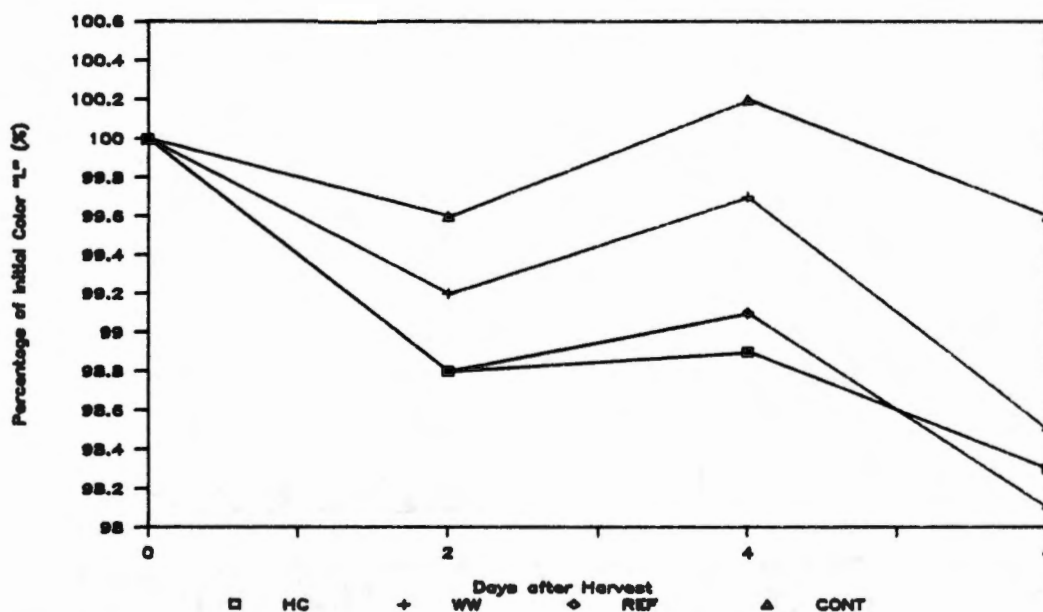


Figure IV-7. Mean change in sweet corn kernel color "L" (luminosity) of 'How Sweet It Is' versus time for all four harvest dates and treatments (HC=hydrocooled; WW=well water cooled; REF=refrigerated; CONT=control).

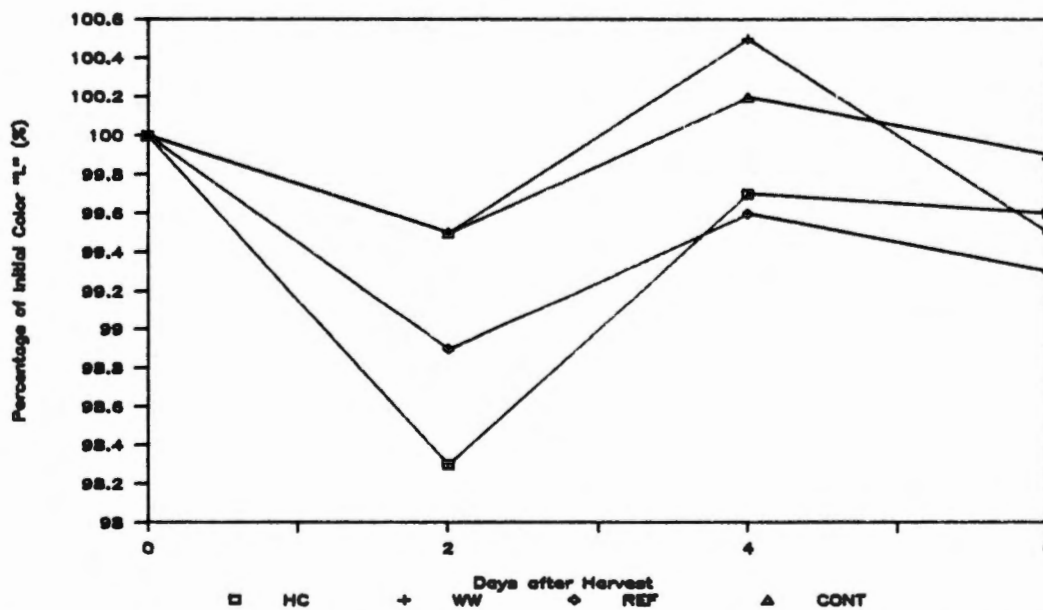


Figure IV-8. Mean change in sweet corn kernel color "L" (luminosity) of 'Silver Queen' versus time for all four harvest dates and treatments (HC=hydrocooled; WW=well water cooled; REF=refrigerated; CONT=control).

Table IV-6. Effect of harvest date, cultivar, and treatment method on color "a" of sweet corn kernels.

Method	Color "a"			
	Day 0 ¹	Day 2 ¹	Day 4 ¹	Day 6 ¹
<u>Date</u>				
1	-0.62a ²	0.28a	-0.04a	0.13a
2	-0.00a	-0.21a	-0.08a	0.28a
3	-0.73a	-0.54a	-0.49a	-0.55a
4	-1.41a	-0.36a	-0.50a	-0.18a
<u>Cultivar</u>				
'How Sweet It Is'	-0.41a	-0.13a	-0.38a	0.11a
'Silver Queen'	-0.96a	-0.28a	-0.18a	-0.27a
<u>Treatment</u>				
Hydrocooled	-0.90a	-0.13a	-0.25a	-0.18a
Well Water Cooled	-0.42a	-0.38a	-0.42a	-0.15a
Refrigerated	-0.77a	-0.20a	-0.21a	-0.10a
Control	-0.66a	-0.12a	-0.23a	0.11a

¹ Number of days after harvest.

² Means in a column within methods followed by the same letter are not significantly different at the 0.05 level of probability.

Table IV-7. Interaction effects among harvest dates, between cultivars, and among treatments on color "b" of sweet corn kernels.

Interaction	Color "b"			
	Day 0 ¹	Day 2 ¹	Day 4 ¹	Day 6 ¹
Cultivar x Treatment	NS	NS	NS	*
Date x Treatment (Cultivar)	NS	NS	NS	**

¹ Number of days after harvest.

* Indicates significance at the 0.05 level of probability.

** Indicates significance at the 0.01 level of probability.

Table IV-8. Effect of harvest date, cultivar, and treatment method on color "b" of sweet corn kernels.

Method	Color "b"			
	Day 0 ¹	Day 2 ¹	Day 4 ¹	Day 6 ¹
<u>Date</u>				
1	23.4a ²	27.2a	25.9ab	26.2a
2	26.2a	26.4a	24.6b	26.4a
3	28.1a	27.9a	27.7a	27.6a
4	28.1a	27.8a	27.3a	27.4a
<u>Cultivar</u>				
'How Sweet It Is'	27.1a	28.8a	28.1a	28.8a
'Silver Queen'	25.8a	25.9b	24.7b	25.0b
<u>Treatment</u>				
Hydrocooled	26.2a	26.7b	25.7c	26.4a
Well Water Cooled	26.7a	27.4ab	26.1bc	26.7a
Refrigerated	26.7a	27.5ab	26.7ab	27.1a
Control	26.3a	27.8a	27.0a	27.3a

¹ Number of days after harvest.

² Means in a column within methods followed by the same letter are not significantly different at the 0.05 level of probability.

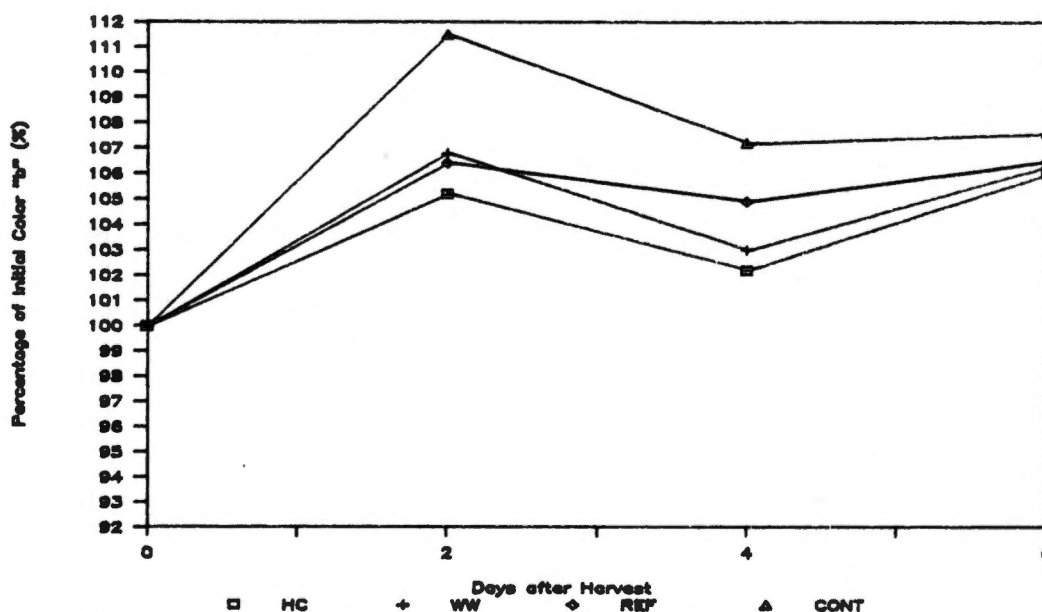


Figure IV-9. Mean change in sweet corn kernel color "b" of 'How Sweet It Is' versus time for all four harvest dates and treatments (HC=hydrocooled; WW=well water cooled; REF=refrigerated; CONT=control).

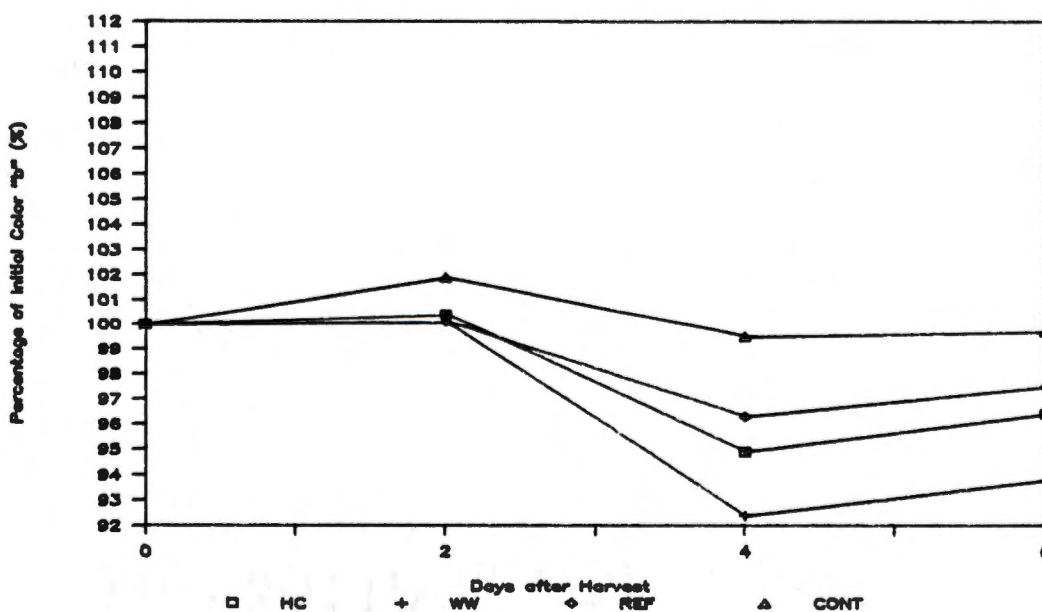


Figure IV-10. Mean change in sweet corn kernel color "b" of 'Silver Queen' versus time for all four harvest dates and treatments (HC=hydrocooled; WW=well water cooled; REF=refrigerated; CONT=control).

(become less yellow) the initial color. However, the 'How Sweet It Is' control corn changed more than the cooled corn, and the 'Silver Queen' control changed less than the cooled corn.

Firmness

Significant date by treatment method within cultivar interaction at the 0.01 level of probability was found for firmness of corn kernels four and six days after harvest (Table IV-9). This interaction was most likely the result of differences in maturity of the two cultivars at the different harvest dates, as well as such environmental factors as harvest ambient air temperature. Date and cultivar had no effect on kernel firmness, but two, four, and six days after harvest sweet corn kernels of all three cooling treatments were significantly more tender than kernels of the control treatment (Table IV-10).

Firmness of kernels on control ears increased due to excessive moisture loss, a factor that was not present in the cooled ears. Figures IV-11 and IV-12 illustrate the continual increase in the firmness of kernels from control ears, while cooled ears became softer and then gradually became more firm for both cultivars. However, the corn kernel firmness increase for the control was greater for 'How Sweet It Is' than for 'Silver Queen'.

Soluble Solids

Sweet corn soluble solids, as indicated by °Brix, was affected by a date by treatment method within cultivar interaction at the 0.05 level of probability on four day after harvest. Soluble solids was also

Table IV-9. Interaction effects among harvest dates, between cultivars, and among treatments on firmness of sweet corn kernels.

Interaction	Firmness (MPa)			
	Day 0 ¹	Day 2 ¹	Day 4 ¹	Day 6 ¹
Cultivar x Treatment	NS	NS	NS	NS
Date x Treatment (Cultivar)	NS	NS	**	**

¹ Number of days after harvest.

** Indicates significance at the 0.01 level of probability.

Table IV-10. Effect of harvest date, cultivar, and treatment on firmness of sweet corn kernels.

Method	Firmness (MPa)			
	Day 0 ¹	Day 2 ¹	Day 4 ¹	Day 6 ¹
<u>Date</u>				
1	3.2a ²	2.9a	3.0a	3.5a
2	3.1a	3.1a	3.2a	4.2a
3	3.2a	3.3a	3.2a	3.4a
4	3.4a	3.1a	3.3a	3.3a
<u>Cultivar</u>				
'How Sweet It Is'	3.2a	3.1a	3.4a	3.7a
'Silver Queen'	3.2a	3.1a	3.0a	3.5a
<u>Treatment</u>				
Hydrocooled	3.2a	3.0b	2.9b	3.2b
Well Water Cooled	3.3a	3.0b	3.1b	3.3b
Refrigerated	3.1a	3.0b	3.0b	3.3b
Control	3.3a	3.4a	3.8a	4.6a

¹ Number of days after harvest.

² Means in a column within methods followed by the same letter are not significantly different at the 0.05 level of probability.

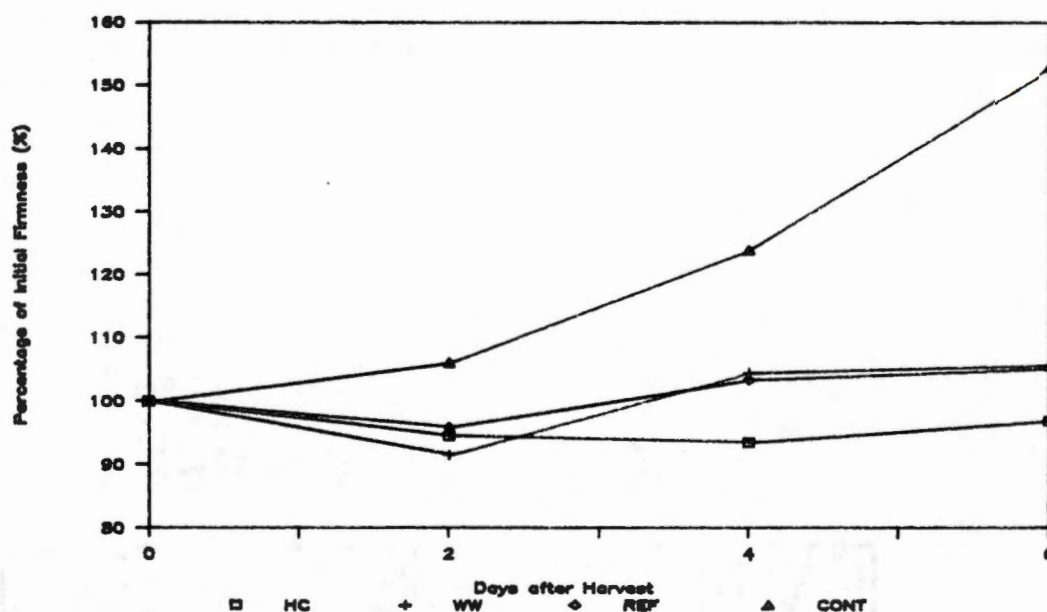


Figure IV-11. Mean change in sweet corn kernel firmness of 'How Sweet It Is' versus time for all four harvest dates and treatments (HC=hydrocooled; WW=well water cooled; REF=refrigerated; CONT=control).

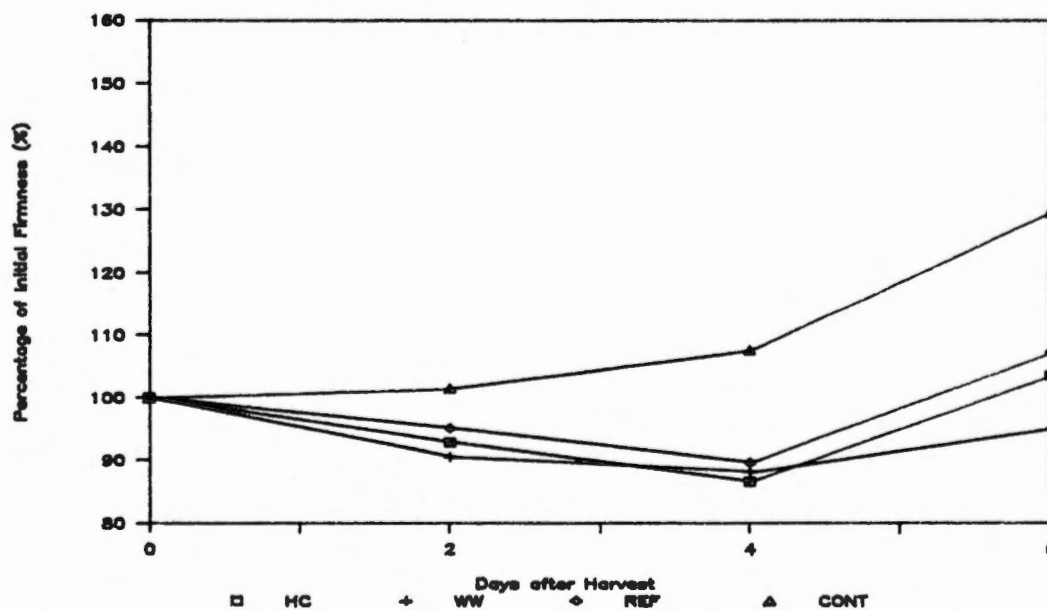


Figure IV-12. Mean change in sweet corn kernel firmness of 'Silver Queen' versus time for all four harvest dates and treatments (HC=hydrocooled; WW=well water cooled; REF=refrigerated; CONT=control).

affected by the same interaction at the 0.01 level of probability on the sixth day after harvest (Table IV-11).

Harvest date and cultivar had no effect on corn soluble solids, but treatment method on postharvest days four and six affected corn soluble solids (Table IV-12). These changes showed that the soluble solids of the hydrocooled and well water cooled sweet corn were significantly different from the soluble solids of the refrigerated and control sweet corn on postharvest day four. They also showed that only the control sweet corn was different (lower °Brix) on the fourth and sixth day after harvest. Figures IV-13 and IV-14 show that the sweet corn from all treatments decreased in soluble solids as time after harvest increased, but the 'Silver Queen' sweet corn soluble solids decreased less than the 'How Sweet It Is' sweet corn soluble solids. The 'Silver Queen' sweet corn tended to retain soluble solids better than the 'How Sweet It Is' sweet corn. The sweet corn of the control treatment lost more soluble solids for both cultivars than did the sweet corn of the three cooled treatments.

Table IV-11. Interaction effects among harvest dates, between cultivars, and among treatments on soluble solids of sweet corn kernel extract.

Interaction	Soluble Solids (°Brix)			
	Day 0 ¹	Day 2 ¹	Day 4 ¹	Day 6 ¹
Cultivar x Treatment	NS	NS	NS	NS
Date x Treatment (Cultivar)	NS	NS	*	**

¹ Number of days after harvest.

* Indicates significance at the 0.05 level of probability.

** Indicates significance at the 0.01 level of probability.

Table IV-12. Effect of harvest date, cultivar, and treatment method on soluble solids of sweet corn kernel extract.

Method	Soluble Solids (°Brix)			
	Day 0 ¹	Day 2 ¹	Day 4 ¹	Day 6 ¹
<u>Date</u>				
1	20.6a ²	20.5a	18.6a	18.1a
2	17.5a	15.8a	14.5a	15.6a
3	15.4a	14.8a	14.4a	13.1a
4	16.2a	15.3a	15.1a	14.0a
<u>Cultivar</u>				
'How Sweet It Is'	15.9a	15.0a	13.6a	13.0a
'Silver Queen'	18.9a	18.2a	17.7a	17.4a
<u>Treatment</u>				
Hydrocooled	17.8a	16.9a	15.7ab	15.4a
Well Water Cooled	17.6a	16.7a	15.6ab	15.4a
Refrigerated	17.0a	16.8a	16.7a	16.4a
Control	17.3a	16.0a	14.6b	13.6b

¹ Number of days after harvest.

² Means in a column within methods followed by the same letter are not significantly different at the 0.05 level of probability.

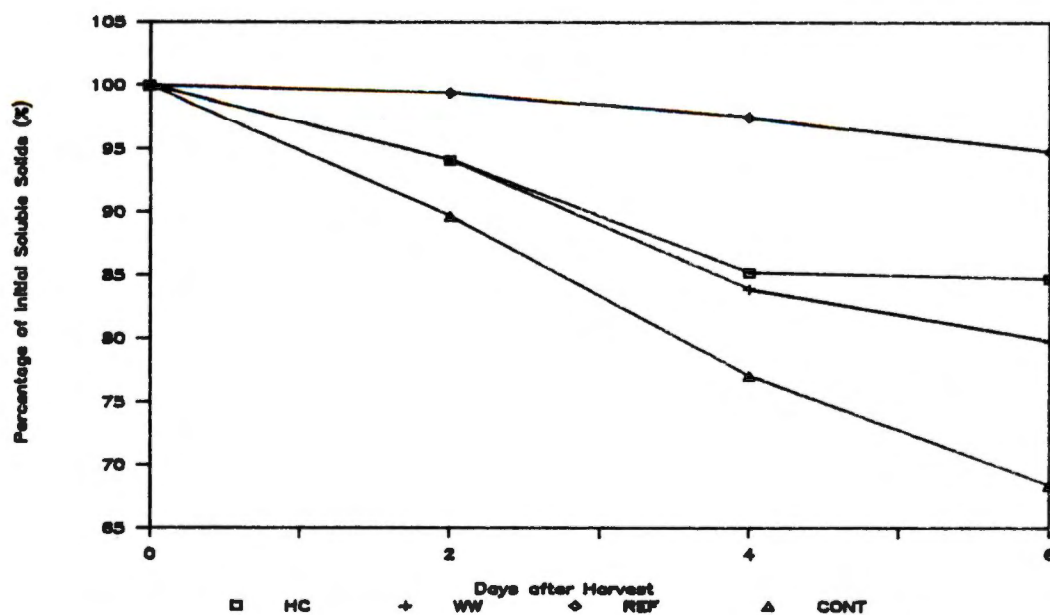


Figure IV-13. Mean change in sweet corn kernel extract soluble solids of 'How Sweet It Is' versus time for all four harvest dates and all treatments (HC=hydrocooled; WW=well water cooled; REF=refrigerated; CONT=control).

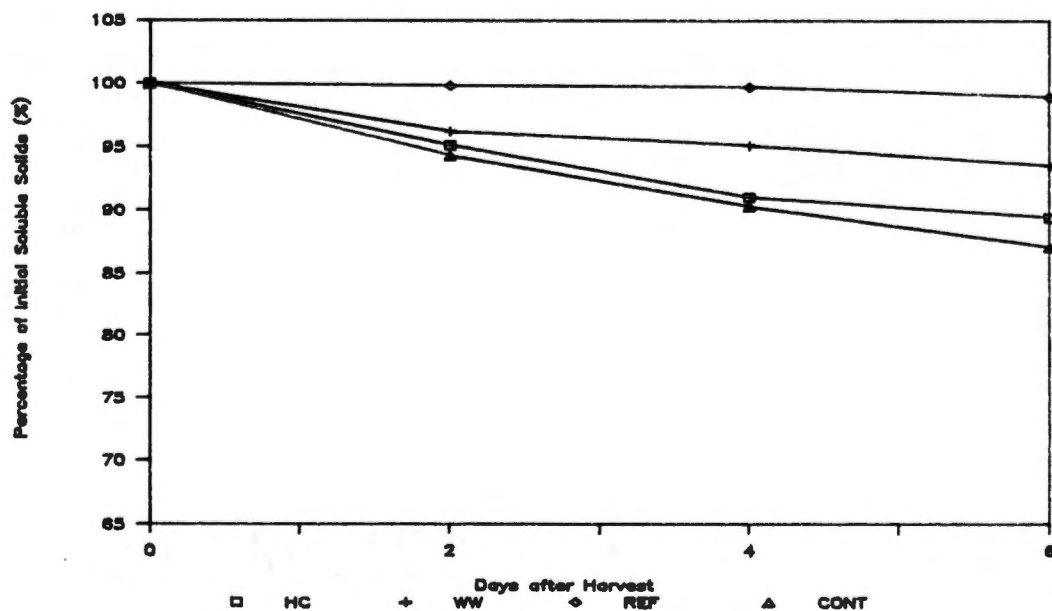


Figure IV-14. Mean change in sweet corn kernel extract soluble solids of 'Silver Queen' versus time for all four harvest dates and all treatments (HC=hydrocooled; WW=well water cooled; REF=refrigerated; CONT=control).

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

Fresh sweet corn from two cultivars, 'How Sweet It Is' and 'Silver Queen', was harvested in the summer of 1987 at the Plateau Experiment Station. The mature corn was harvested during the early morning hours.

The fresh corn ears were prepared for a series of four treatment methods to be conducted for determination of postharvest cooling effects on quality of the sweet corn ears. The four treatments were hydrocooling, well water cooling, refrigeration, and a control in which no cooling was performed.

After the initial treatments were completed, the cooled corn was placed in 0°C (32°F) cold storage. Cob center and ambient air temperatures were also monitored for each treatment. Tests for ear weight gain/loss, moisture content, color, texture (firmness), and soluble solids (°Brix) were performed on selected untreated sample ears from each treatment. These tests were also performed on selected treated sample ears on the second, fourth, and sixth day after harvest. Results of these tests were analyzed statistically.

Graphical analysis of cob center temperature showed that hydrocooling cooled the corn ears to the desired temperature more quickly than did the other treatments on harvest day. The control temperatures for both cultivars fluctuated with the ambient air

temperature for the test duration. The cooled ears tended to stay approximately at the same temperatures after harvest while in cold storage.

No interaction effects were found for ear weight. Ear weight was not affected by harvest date or cultivar, but it was affected by the treatment method on two, four, and six days after harvest. Ear weights of the hydrocooled treatments were significantly higher than those of the other treatments due to water retention during the initial treatment. There was a greater weight loss for the control ears than for ears of the other treatments as time after harvest increased. The weight loss from day two to days four and six was not significantly different among cooling methods, but the losses were significantly lower than those of the control treatment.

No interactions were found in moisture content. Moisture content was affected by date of harvest. Results indicated that sample ears of the first two harvest dates contained less moisture than sample ears from the last two harvest dates. The corn ears from the last two harvest dates was probably less mature than the corn ears from the first two dates. The cultivars had no effect on moisture content.

There was significant harvest date by treatment within cultivar interaction at the 0.01 level of probability for color "L" on days four and six and for color "b" on day six after harvest. Also there was a significant cultivar by treatment method interaction at the 0.05 level of probability for color "b" on day six. Harvest date affected sweet corn color "L" on day six and color "b" on day four. Cultivar affected color "L" and color "b" as time after harvest increased. The 'Silver

Queen' corn tended to be darker than the 'How Sweet It Is' on the second day after harvest. 'How Sweet It Is' tended to be more yellow than 'Silver Queen' on the second, fourth, and sixth days after harvest. Treatment affected color "b" on days two and four. The refrigeration treated corn and the control corn tended to be more yellow than the hydrocooled and well water treated corn.

There were significant harvest date by treatment method within cultivar interactions at the 0.01 level of probability for firmness and soluble solids of corn kernels four and six days after harvest. This finding was probably due to maturity differences as well as ambient air harvest date temperatures. Date and cultivar had no effect on sweet corn kernel firmness or soluble solids. No differences were found among the tested cooling methods, but all three treatments had sweet corn ears with significantly softer kernels than the ears of the control.

Conclusions

These results indicated that cooling fresh sweet corn ears by any of the methods tested in this study decreased ear weight loss, kernel moisture content loss, kernel extract soluble solids loss, and the rate of increase in firmness. Overall, no particular tested cooling method excelled the others in maintaining the quality attributes of ear weight, kernel moisture content, kernel color, kernel firmness, and kernel extract soluble solids. These same cooling treatment methods and quality tests, along with others, should be replicated several more times under various conditions to possibly separate effects of the cooling methods.

MISSOURI BOTANICAL GARDEN
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APPENDIX

Table A-1. Raw data for mean cob center temperatures of sweet corn.

REP ¹	CUL ²	TRT ³	Temperature (°C)				
			Day 0 ⁴	Day 0.3 ⁴	Day 2 ⁴	Day 4 ⁴	Day 6 ⁴
1	1	1	24.4	4.3	4.1	5.7	5.6
1	1	2	24.8	24.7	4.8	6.0	7.2
1	1	3	24.4	19.3	9.1	8.3	8.2
1	1	4	26.0	27.1	29.1	26.6	25.1
1	2	1	27.8	5.6	3.4	4.2	3.4
1	2	2	26.9	19.9	5.7	4.4	4.0
1	2	3	27.5	21.1	5.2	5.0	4.9
1	2	4	26.8	28.7	28.5	26.8	25.0
2	1	1	27.7	4.9	7.0	6.3	6.2
2	1	2	28.2	19.5	5.5	8.2	7.9
2	1	3	27.8	21.4	7.1	6.4	6.6
2	1	4	27.1	27.9	27.3	19.0	17.7
2	2	1	23.7	5.6	5.6	6.0	5.1
2	2	2	24.0	17.6	6.3	7.1	6.1
2	2	3	24.1	17.6	6.2	6.4	5.3
2	2	4	23.9	26.5	24.7	17.8	17.2
3	1	1	14.1	7.2	6.2	5.1	5.4
3	1	2	14.8	14.2	5.8	6.4	6.2
3	1	3	14.2	12.3	6.7	6.0	6.5
3	1	4	14.5	17.6	19.7	23.0	22.3
3	2	1	25.2	4.3	5.3	5.1	5.0
3	2	2	30.7	17.3	5.7	5.5	6.1
3	2	3	25.1	20.5	7.6	5.8	6.1
3	2	4	27.0	22.5	20.2	22.0	20.9
4	1	1	18.6	5.1	5.2	4.8	5.2
4	1	2	18.4	14.8	5.2	5.5	5.8
4	1	3	18.4	11.8	6.0	5.0	5.2
4	1	4	18.3	21.6	20.6	23.6	21.8
4	2	1	19.6	4.6	5.6	4.9	4.7
4	2	2	19.4	16.6	5.2	5.6	6.1
4	2	3	18.6	14.9	6.6	5.0	6.2
4	2	4	19.9	20.7	21.0	24.0	23.5

¹ REP-harvest dates: 1-7/31/87(CUL 1), 8/3/87(CUL 2); 2-8/26/87 (CUL 1 and 2); 3-9/2/87(CUL 1 and 2); 4-9/3/87(CUL 1 and 2).

² CUL-cultivars: 1-'How Sweet It Is'; 2-'Silver Queen'.

³ TRT-treatments: 1-hydrocooled; 2-well water cooled; 3-refrigerated; 4-control.

⁴ Number of days after harvest.

Table A-2. Raw data for mean ambient air temperatures.

REP ¹	LOC ²	Temperature (°C)				
		Day 0 ³	Day 0.3 ³	Day 2 ³	Day 4 ³	Day 6 ³
1	1	26.5	28.6	22.2	21.9	24.7
1	2	26.8	30.2	29.4	25.8	28.3
2	1	26.5	32.2	25.0	16.2	17.4
2	2	27.1	32.2	25.0	16.2	17.4
3	1	22.6	25.9	20.6	19.8	20.9
3	2	25.4	25.9	20.2	22.0	23.4
4	1	24.3	26.5	21.5	22.6	21.2
4	2	25.6	26.5	21.5	22.6	21.2

¹ REP=harvest dates: 1=7/31/87(CUL 1), 8/3/87(CUL 2); 2=8/26/87 (CUL 1 and 2); 3=9/2/87(CUL 1 and 2); 4=9/3/87(CUL 1 and 2).

² LOC=Location of thermocouples: 1=1 meter (3.3 feet) from the ground; 2=3 meters (9.8 feet) from the ground.

³ Number of days after harvest.

Table A-3. Raw data for sweet corn ear weight.

REP ¹	CUL ²	TRT ³	CRT ⁴	Weight (g)			
				Day 0 ⁵	Day 2 ⁵	Day 4 ⁵	Day 6 ⁵
1	1	1	1	228.7	241.6	241.9	239.4
1	1	1	2	229.5	235.3	243.3	241.7
1	1	2	1	231.2	238.4	238.9	236.9
1	1	2	2	229.9	235.6	235.6	238.2
1	1	3	1	253.8	246.8	246.4	243.5
1	1	3	2	205.6	198.8	199.7	197.7
1	1	4	1	254.7	233.2	225.3	214.4
1	1	4	2	220.1	202.9	197.9	192.4
1	2	1	1	306.1	319.6	318.4	315.0
1	2	1	2	316.1	331.6	327.5	326.0
1	2	2	1	297.5	310.1	308.2	256.6
1	2	2	2	283.0	293.5	290.5	290.0
1	2	3	1	301.9	298.6	294.4	291.9
1	2	3	2	304.8	298.8	295.8	295.0
1	2	4	1	310.6	293.3	276.4	261.2
1	2	4	2	286.4	265.7	250.9	235.6
2	1	1	1	235.1	254.4	252.2	250.4
2	1	1	2	223.5	255.7	254.1	252.1
2	1	2	1	247.8	261.0	259.1	257.7
2	1	2	2	249.1	268.9	265.3	263.5
2	1	3	1	237.7	230.5	229.0	227.6
2	1	3	2	205.1	210.2	199.7	198.4
2	1	4	1	228.6	202.8	193.8	186.1
2	1	4	2	267.1	233.6	221.5	209.0
2	2	1	1	282.3	299.4	297.6	295.3
2	2	1	2	216.9	235.9	233.9	232.3
2	2	2	1	232.8	247.3	245.7	243.9
2	2	2	2	200.5	217.7	215.8	212.9
2	2	3	1	235.7	254.7	227.1	225.6
2	2	3	2	265.6	265.7	264.4	262.2
2	2	4	1	274.9	244.0	229.5	219.8
2	2	4	2	223.1	207.7	193.9	182.8
3	1	1	1	254.7	271.0	268.3	266.9
3	1	1	2	249.5	267.5	265.3	262.6
3	1	2	1	234.1	247.7	246.3	244.5
3	1	2	2	292.2	305.2	303.6	302.1
3	1	3	1	248.1	253.0	251.0	249.3
3	1	3	2	236.5	241.7	239.9	238.4
3	1	4	1	252.9	229.8	214.3	205.3
3	1	4	2	244.1	219.3	201.9	194.0
3	2	1	1	256.4	267.9	266.8	265.7
3	2	1	2	282.1	297.6	296.2	294.6
3	2	2	1	199.9	209.7	208.8	207.6

Table A-3. (Continued).

REP ¹	CUL ²	TRT ³	CRT ⁴	Weight (g)			
				Day 0 ⁵	Day 2 ⁵	Day 4 ⁵	Day 6 ⁵
3	2	2	2	204.1	218.7	216.5	215.1
3	2	3	1	260.0	255.5	253.9	252.2
3	2	3	2	206.9	204.0	203.2	202.5
3	2	4	1	253.3	235.6	222.7	214.4
3	2	4	2	216.3	192.6	181.3	175.5
4	1	1	1	225.1	237.9	235.6	233.7
4	1	1	2	270.6	281.8	280.5	278.8
4	1	2	1	211.1	217.6	216.4	215.3
4	1	2	2	225.1	236.1	234.4	233.1
4	1	3	1	209.9	203.7	202.3	201.0
4	1	3	2	219.7	217.3	216.2	214.9
4	1	4	1	208.2	187.3	181.3	174.9
4	1	4	2	246.0	221.0	214.3	205.5
4	2	1	1	281.9	295.3	293.6	292.4
4	2	1	2	261.5	274.2	272.9	271.3
4	2	2	1	274.0	284.4	283.0	281.5
4	2	2	2	278.3	291.1	289.4	287.5
4	2	3	1	246.9	242.9	241.4	240.3
4	2	3	2	228.9	225.3	224.5	223.5
4	2	4	1	230.1	212.5	203.9	196.2
4	2	4	2	295.0	267.4	250.7	240.6

¹ REP-harvest dates: 1-7/31/87(CUL 1), 8/3/87 (CUL 2); 2-8/26/87 (CUL 1 and 2); 3-9/2/87(CUL 1 and 2); 4-9/3/87(CUL 1 and 2).

² CUL-cultivars: 1-'How Sweet It Is'; 2-'Silver Queen'.

³ TRT-treatments: 1-hydrocooled; 2-well water cooled; 3-refrigerated; 4-control.

⁴ CRT-crates (two per treatment per cultivar).

⁵ Number of days after harvest.

Table A-4. Raw data for sweet corn kernel moisture content.

REP ¹	CUL ²	TRT ³	CRT ⁴	Moisture (%)			
				Day 0 ⁵	Day 2 ⁵	Day 4 ⁵	Day 6 ⁵
1	1	1	1	75.52	73.27	73.25	73.58
1	1	1	2	71.06	73.52	73.91	72.92
1	1	2	1	79.75	72.38	65.29	72.73
1	1	2	2	79.24	79.55	76.55	70.32
1	1	3	1	77.76	74.99	74.54	74.14
1	1	3	2	78.70	74.37	70.96	68.63
1	1	4	1	76.11	73.79	69.48	72.26
1	1	4	2	79.90	78.73	74.41	74.71
1	2	1	1	75.32	72.82	74.22	75.36
1	2	1	2	74.87	71.94	73.95	75.96
1	2	2	1	73.14	78.37	77.22	74.98
1	2	2	2	75.46	71.65	75.59	75.30
1	2	3	1	72.66	69.92	71.11	73.30
1	2	3	2	74.49	77.90	75.38	72.39
1	2	4	1	75.95	70.36	72.30	71.00
1	2	4	2	72.20	70.94	70.18	72.34
2	1	1	1	73.97	79.39	79.52	75.14
2	1	1	2	79.32	78.59	77.93	78.60
2	1	2	1	73.12	74.47	71.38	74.41
2	1	2	2	76.20	78.23	79.86	78.59
2	1	3	1	79.34	76.77	74.89	72.49
2	1	3	2	75.59	76.57	77.09	78.09
2	1	4	1	72.97	75.59	70.42	74.45
2	1	4	2	79.27	75.78	72.93	72.44
2	2	1	1	74.14	77.32	78.07	78.21
2	2	1	2	73.36	80.37	73.93	73.04
2	2	2	1	77.42	77.39	74.56	74.57
2	2	2	2	73.70	78.27	74.94	76.14
2	2	3	1	77.39	74.55	74.34	72.34
2	2	3	2	75.69	75.08	73.53	74.33
2	2	4	1	75.85	74.60	70.67	69.61
2	2	4	2	77.23	76.02	69.99	71.13
3	1	1	1	81.56	82.71	79.45	80.17
3	1	1	2	79.06	79.15	80.33	80.52
3	1	2	1	78.22	81.55	81.63	80.67
3	1	2	2	78.08	77.99	79.16	80.47
3	1	3	1	79.80	78.22	78.43	80.81
3	1	3	2	70.56	79.76	79.90	80.90
3	1	4	1	80.12	78.08	79.08	79.17
3	1	4	2	78.75	81.19	78.24	78.77
3	2	1	1	82.48	84.78	86.22	80.75
3	2	1	2	84.12	82.60	82.34	81.31
3	2	2	1	82.46	83.36	81.86	80.60

Table A-4. (Continued).

REP ¹	CUL ²	TRT ³	CRT ⁴	Moisture (%)			
				Day 0 ⁵	Day 2 ⁵	Day 4 ⁵	Day 6 ⁵
3	2	2	2	86.60	85.88	85.55	85.86
3	2	3	1	83.03	80.27	80.83	82.59
3	2	3	2	83.03	83.85	84.40	81.87
3	2	4	1	83.03	79.08	80.14	76.33
3	2	4	2	83.69	80.31	76.16	79.02
4	1	1	1	79.35	79.33	79.95	80.81
4	1	1	2	78.93	79.27	80.49	78.91
4	1	2	1	79.20	79.39	82.53	80.54
4	1	2	2	80.33	82.17	81.56	80.96
4	1	3	1	78.60	81.61	79.74	81.68
4	1	3	2	80.10	79.19	79.30	80.96
4	1	4	1	79.89	78.80	83.05	80.07
4	1	4	2	78.66	81.69	82.44	80.13
4	2	1	1	82.32	83.61	81.01	81.29
4	2	1	2	81.78	82.96	82.80	80.33
4	2	2	1	78.05	80.62	80.81	81.34
4	2	2	2	78.82	79.57	80.34	78.70
4	2	3	1	79.31	81.85	82.99	80.54
4	2	3	2	81.80	82.12	80.50	85.53
4	2	4	1	81.95	80.76	81.49	77.31
4	2	4	2	80.76	76.74	79.32	78.42

¹ REP=harvest dates: 1=7/31/87(CUL 1), 8/3/87 (CUL 2); 2=8/26/87 (CUL 1 and 2); 3=9/2/87(CUL 1 and 2); 4=9/3/87(CUL 1 and 2).

² CUL=cultivars: 1='How Sweet It Is'; 2='Silver Queen'.

³ TRT=treatments: 1=hydrocooled; 2=well water cooled; 3=refrigerated; 4=control.

⁴ CRT=crates (two per treatment per cultivar).

⁵ Number of days after harvest.

Table A-5. Raw data for sweet corn kernel color "L".

REP ¹	CUL ²	TRT ³	CRT ⁴	Color "L"			
				Day 0 ⁵	Day 2 ⁵	Day 4 ⁵	Day 6 ⁵
1	1	1	1	82.3	76.3	77.8	77.3
1	1	1	2	82.3	77.1	78.6	76.8
1	1	2	1	82.3	77.3	76.0	75.8
1	1	2	2	81.6	78.2	76.8	76.4
1	1	3	1	83.3	77.4	76.9	76.6
1	1	3	2	81.6	78.0	78.5	77.0
1	1	4	1	82.0	77.2	77.9	76.9
1	1	4	2	82.8	77.9	77.6	76.7
1	2	1	1	78.6	75.7	76.2	78.2
1	2	1	2	76.3	75.7	76.1	78.1
1	2	2	1	76.4	74.6	75.8	74.2
1	2	2	2	76.5	74.4	76.0	76.7
1	2	3	1	76.7	76.1	76.5	75.4
1	2	3	2	75.6	75.2	76.2	76.1
1	2	4	1	76.4	75.1	75.9	76.6
1	2	4	2	76.7	76.9	76.0	75.8
2	1	1	1	75.4	75.3	75.8	75.3
2	1	1	2	76.3	76.1	75.7	73.6
2	1	2	1	75.7	74.8	80.3	75.3
2	1	2	2	76.1	76.3	78.0	74.2
2	1	3	1	76.0	75.7	77.5	73.9
2	1	3	2	75.1	76.6	75.9	74.4
2	1	4	1	75.2	75.9	77.6	75.5
2	1	4	2	74.6	74.9	76.1	75.9
2	2	1	1	76.3	72.7	77.1	73.4
2	2	1	2	76.4	74.2	77.3	74.6
2	2	2	1	75.5	75.0	75.5	75.8
2	2	2	2	75.7	74.6	76.0	75.1
2	2	3	1	76.6	75.5	76.5	74.8
2	2	3	2	75.7	73.7	75.9	74.2
2	2	4	1	75.6	74.9	75.0	74.9
2	2	4	2	75.3	75.9	74.3	74.2
3	1	1	1	74.3	76.0	75.7	74.9
3	1	1	2	75.3	75.5	75.5	74.5
3	1	2	1	74.8	75.6	75.3	76.7
3	1	2	2	75.5	74.8	75.5	76.4
3	1	3	1	76.4	75.8	75.7	74.6
3	1	3	2	75.6	75.3	77.2	77.3
3	1	4	1	74.6	74.4	76.6	76.7
3	1	4	2	75.3	77.2	76.5	77.8
3	2	1	1	75.2	74.7	74.1	74.2
3	2	1	2	74.3	73.6	74.4	75.2
3	2	2	1	75.6	74.7	75.4	74.9

Table A-5. (Continued).

REP ¹	CUL ²	TRT ³	CRT ⁴	Color "L"			
				Day 0 ⁵	Day 2 ⁵	Day 4 ⁵	Day 6 ⁵
3	2	2	2	71.8	74.2	74.9	72.5
3	2	3	1	75.1	75.0	75.1	76.3
3	2	3	2	75.0	73.5	73.0	75.6
3	2	4	1	75.7	76.1	75.8	76.7
3	2	4	2	75.9	74.3	76.2	76.0
4	1	1	1	75.6	76.2	75.4	75.6
4	1	1	2	74.4	74.9	75.0	76.4
4	1	2	1	74.0	77.3	75.7	74.7
4	1	2	2	75.3	75.2	74.8	75.7
4	1	3	1	75.5	77.9	77.3	76.5
4	1	3	2	76.3	75.2	75.4	77.1
4	1	4	1	74.9	76.7	76.7	76.8
4	1	4	2	75.2	77.0	76.2	75.1
4	2	1	1	75.1	75.6	75.5	75.5
4	2	1	2	75.6	75.3	75.3	76.3
4	2	2	1	75.2	76.1	75.1	75.9
4	2	2	2	74.8	76.0	76.2	74.2
4	2	3	1	75.7	75.5	75.4	75.2
4	2	3	2	76.2	75.3	75.3	75.0
4	2	4	1	75.1	75.6	77.1	76.3
4	2	4	2	75.9	74.7	77.5	75.7

¹ REP-harvest dates: 1-7/31/87(CUL 1), 8/3/87 (CUL 2); 2-8/26/87 (CUL 1 and 2); 3-9/2/87(CUL 1 and 2); 4-9/3/87(CUL 1 and 2).

² CUL-cultivars: 1-'How Sweet It Is'; 2-'Silver Queen'.

³ TRT-treatments: 1-hydrocooled; 2-well water cooled; 3-refrigerated; 4-control.

⁴ CRT-crates (two per treatment per cultivar).

⁵ Number of days after harvest.

Table A-6. Raw data for sweet corn kernel color "a".

REP ¹	CUL ²	TRT ³	CRT ⁴	Color "a"			
				Day 0 ⁵	Day 2 ⁵	Day 4 ⁵	Day 6 ⁵
1	1	1	1	-1.2	0.8	-0.1	-0.2
1	1	1	2	-1.1	0.4	-0.7	0.8
1	1	2	1	-1.2	0.1	-0.6	0.5
1	1	2	2	-0.5	0.0	0.3	1.5
1	1	3	1	-1.4	0.6	0.3	0.1
1	1	3	2	-1.2	0.1	-0.5	-0.1
1	1	4	1	-0.6	0.5	-0.3	0.0
1	1	4	2	-0.8	0.0	-0.5	0.3
1	2	1	1	-0.4	0.2	0.3	0.1
1	2	1	2	-1.2	0.4	0.5	-0.3
1	2	2	1	-0.1	0.0	-0.5	-0.6
1	2	2	2	0.5	0.4	-0.1	-0.5
1	2	3	1	-1.0	0.2	-0.1	0.3
1	2	3	2	-0.1	0.5	0.3	0.2
1	2	4	1	0.0	0.3	0.5	-0.1
1	2	4	2	0.4	0.0	0.5	0.1
2	1	1	1	0.6	0.0	-0.2	0.1
2	1	1	2	0.0	-0.3	0.0	0.0
2	1	2	1	1.1	-0.1	-0.7	0.0
2	1	2	2	0.3	-0.8	-0.4	0.4
2	1	3	1	0.0	-0.2	-0.5	0.5
2	1	3	2	0.1	-0.4	0.0	0.2
2	1	4	1	0.7	-0.4	-0.5	0.1
2	1	4	2	0.2	-0.1	-0.2	0.0
2	2	1	1	-0.5	0.8	-0.4	0.2
2	2	1	2	0.1	-1.0	0.2	-0.1
2	2	2	1	-0.4	-0.3	0.1	0.2
2	2	2	2	-0.3	-0.9	-0.1	-0.1
2	2	3	1	-0.5	-0.1	-0.2	0.7
2	2	3	2	0.0	0.3	0.2	0.4
2	2	4	1	-0.3	0.1	0.7	0.9
2	2	4	2	-1.1	0.1	0.8	0.9
3	1	1	1	-0.6	-0.5	-0.3	-0.5
3	1	1	2	0.0	0.0	-0.3	0.2
3	1	2	1	0.1	-0.6	-0.5	-0.5
3	1	2	2	0.7	-0.3	-0.6	-0.1
3	1	3	1	0.0	-0.1	-0.2	0.0
3	1	3	2	0.0	-0.1	-0.5	0.2
3	1	4	1	-0.6	0.0	-0.6	-0.2
3	1	4	2	0.5	-0.6	-0.6	-0.2
3	2	1	1	-1.1	-1.2	-0.9	-1.0
3	2	1	2	-1.5	-0.5	0.0	-1.1
3	2	2	1	-1.1	-0.7	-0.3	-1.4

Table A-6. (Continued).

REP ¹	CUL ²	TRT ³	CRT ⁴	Color "a"			
				Day 0 ⁵	Day 2 ⁵	Day 4 ⁵	Day 6 ⁵
3	2	2	2	-1.9	-1.4	-1.1	-1.5
3	2	3	1	-1.1	-0.7	-0.4	-0.6
3	2	3	2	-1.1	-1.1	-0.6	-1.3
3	2	4	1	-1.9	-0.8	-0.8	-0.3
3	2	4	2	-2.0	-0.1	-0.1	-0.5
4	1	1	1	-2.2	-0.1	-0.6	-0.4
4	1	1	2	-0.7	0.6	-0.5	-0.1
4	1	2	1	-1.0	-0.3	-1.1	0.6
4	1	2	2	-0.9	-0.6	-0.4	0.0
4	1	3	1	-0.8	-0.5	0.0	0.0
4	1	3	2	-1.1	-0.1	0.0	-0.2
4	1	4	1	-1.5	-0.5	-0.7	-0.3
4	1	4	2	-0.1	-0.7	-0.6	0.8
4	2	1	1	-2.5	-1.0	-0.1	-0.6
4	2	1	2	-2.1	-0.6	-0.9	0.0
4	2	2	1	-0.8	-0.3	-0.5	-0.6
4	2	2	2	-1.2	-0.3	-0.2	-0.3
4	2	3	1	-1.4	-0.7	-1.2	-0.7
4	2	3	2	-2.7	-0.9	0.1	-1.3
4	2	4	1	-1.8	-0.2	-0.7	0.1
4	2	4	2	-1.7	0.5	-0.6	0.1

¹ REP=harvest dates: 1=7/31/87(CUL 1), 8/3/87 (CUL 2); 2=8/26/87 (CUL 1 and 2); 3=9/2/87(CUL 1 and 2); 4=9/3/87(CUL 1 and 2).

² CUL=cultivars: 1='How Sweet It Is'; 2='Silver Queen'.

³ TRT=treatments: 1=hydrocooled; 2=well water cooled; 3=refrigerated; 4=control.

⁴ CRT=crates (two per treatment per cultivar).

⁵ Number of days after harvest.

Table A-7. Raw data for sweet corn kernel color "b".

REP ¹	CUL ²	TRT ³	CRT ⁴	Color "b"			
				Day 0 ⁵	Day 2 ⁵	Day 4 ⁵	Day 6 ⁵
1	1	1	1	22.9	28.8	29.1	27.2
1	1	1	2	23.4	30.7	24.8	29.1
1	1	2	1	22.1	29.5	26.6	30.2
1	1	2	2	22.7	30.0	29.6	30.6
1	1	3	1	22.6	27.6	30.0	28.9
1	1	3	2	23.1	28.8	26.7	28.7
1	1	4	1	21.7	29.5	28.4	28.3
1	1	4	2	21.6	28.7	27.6	29.5
1	2	1	1	19.9	24.1	23.3	21.2
1	2	1	2	25.6	23.5	23.7	21.7
1	2	2	1	26.5	25.4	22.6	22.6
1	2	2	2	25.0	25.7	23.6	22.1
1	2	3	1	25.7	25.7	24.1	23.7
1	2	3	2	25.1	25.9	24.5	24.0
1	2	4	1	23.9	26.4	25.1	25.8
1	2	4	2	23.1	25.4	24.5	25.5
2	1	1	1	29.0	26.4	26.4	28.3
2	1	1	2	26.4	25.7	26.3	28.9
2	1	2	1	28.0	28.3	26.4	26.4
2	1	2	2	27.9	27.3	26.8	28.2
2	1	3	1	26.5	27.7	26.1	28.6
2	1	3	2	28.5	27.9	27.3	29.0
2	1	4	1	28.9	27.7	25.7	28.9
2	1	4	2	27.3	29.8	27.3	28.8
2	2	1	1	23.9	25.5	21.0	24.1
2	2	1	2	23.6	24.2	21.1	23.7
2	2	2	1	25.5	25.9	20.7	23.3
2	2	2	2	24.1	25.5	23.4	23.3
2	2	3	1	25.8	25.9	23.6	24.6
2	2	3	2	25.0	25.7	22.9	24.8
2	2	4	1	24.6	25.2	24.6	25.9
2	2	4	2	24.8	24.7	23.5	25.2
3	1	1	1	28.4	28.2	28.1	28.4
3	1	1	2	28.7	27.6	28.9	28.9
3	1	2	1	29.3	28.8	28.6	28.8
3	1	2	2	29.5	30.0	29.0	28.2
3	1	3	1	29.1	28.8	28.2	28.1
3	1	3	2	29.1	29.6	28.2	28.7
3	1	4	1	29.7	31.4	30.8	28.8
3	1	4	2	29.1	29.2	30.2	28.5
3	2	1	1	27.6	25.1	25.9	27.0
3	2	1	2	27.1	26.5	24.9	26.9
3	2	2	1	26.1	26.8	25.4	27.3

Table A-7. (Continued).

REP ¹	CUL ²	TRT ³	CRT ⁴	Color "b"			
				Day 0 ⁵	Day 2 ⁵	Day 4 ⁵	Day 6 ⁵
3	2	2	2	27.7	26.5	27.1	27.4
3	2	3	1	26.8	26.9	26.7	26.0
3	2	3	2	28.3	26.8	26.9	27.4
3	2	4	1	26.5	27.2	27.4	25.0
3	2	4	2	26.7	26.4	27.3	25.6
4	1	1	1	28.1	28.7	28.7	28.9
4	1	1	2	30.4	29.9	28.0	28.7
4	1	2	1	28.8	27.7	29.0	29.7
4	1	2	2	29.7	27.8	28.6	29.7
4	1	3	1	29.4	28.2	29.5	27.7
4	1	3	2	28.5	30.1	29.2	28.8
4	1	4	1	27.8	30.6	28.3	29.3
4	1	4	2	30.1	30.6	30.2	30.6
4	2	1	1	26.9	26.4	23.9	26.6
4	2	1	2	27.7	26.0	27.0	22.8
4	2	2	1	26.4	26.4	24.2	25.1
4	2	2	2	27.5	26.8	25.9	24.8
4	2	3	1	27.1	26.8	26.8	28.0
4	2	3	2	26.2	26.8	26.9	26.3
4	2	4	1	27.0	27.4	24.2	25.4
4	2	4	2	27.7	24.8	26.1	25.3

¹ REP=harvest dates: 1-7/31/87(CUL 1), 8/3/87 (CUL 2); 2-8/26/87 (CUL 1 and 2); 3-9/2/87(CUL 1 and 2); 4-9/3/87(CUL 1 and 2).

² CUL=cultivars: 1-'How Sweet It Is'; 2-'Silver Queen'.

³ TRT=treatments: 1-hydrocooled; 2-well water cooled; 3-refrigerated; 4-control.

⁴ CRT=crates (two per treatment per cultivar).

⁵ Number of days after harvest.

Table A-8. Raw data for sweet corn kernel firmness.

REP ¹	CUL ²	TRT ³	CRT ⁴	Firmness (MPa)			
				Day 0 ⁵	Day 2 ⁵	Day 4 ⁵	Day 6 ⁵
1	1	1	1	3.16	2.95	3.15	2.42
1	1	1	2	3.28	2.91	2.79	2.73
1	1	2	1	3.43	3.31	3.28	2.42
1	1	2	2	3.68	3.42	3.18	3.61
1	1	3	1	2.97	2.63	2.97	2.38
1	1	3	2	3.15	2.93	3.04	2.83
1	1	4	1	3.55	3.80	4.45	4.78
1	1	4	2	3.39	3.99	4.78	4.70
1	2	1	1	2.68	2.32	2.79	2.82
1	2	1	2	2.81	2.52	2.52	2.97
1	2	2	1	3.42	2.67	2.43	3.31
1	2	2	2	3.22	2.73	2.38	3.59
1	2	3	1	3.15	2.42	2.45	3.49
1	2	3	2	3.15	2.38	2.24	3.88
1	2	4	1	2.86	2.81	2.97	4.88
1	2	4	2	3.15	2.23	3.01	5.44
2	1	1	1	3.08	2.87	3.11	3.95
2	1	1	2	2.72	3.02	2.83	3.87
2	1	2	1	3.82	3.05	4.43	5.89
2	1	2	2	3.16	2.64	4.25	3.84
2	1	3	1	2.67	2.56	3.23	4.37
2	1	3	2	3.23	2.73	3.39	3.09
2	1	4	1	3.75	3.65	4.49	7.81
2	1	4	2	2.56	2.90	4.07	7.78
2	2	1	1	2.78	3.24	2.21	3.61
2	2	1	2	3.25	3.51	2.60	3.32
2	2	2	1	3.17	3.12	2.89	3.24
2	2	2	2	2.80	2.82	2.56	2.79
2	2	3	1	3.02	3.71	2.64	3.15
2	2	3	2	3.03	3.06	2.78	3.19
2	2	4	1	3.45	3.26	2.78	3.64
2	2	4	2	3.45	3.60	2.97	4.06
3	1	1	1	3.38	3.16	2.76	3.10
3	1	1	2	3.20	3.09	2.97	3.15
3	1	2	1	3.28	3.09	2.92	3.12
3	1	2	2	2.90	3.34	2.92	3.17
3	1	3	1	2.80	3.26	2.98	3.26
3	1	3	2	3.05	3.25	3.15	3.12
3	1	4	1	3.50	3.69	4.04	4.13
3	1	4	2	2.97	3.64	3.90	4.07
3	2	1	1	3.49	2.95	3.22	3.45
3	2	1	2	3.66	2.98	2.31	3.42
3	2	2	1	3.26	3.21	2.92	2.79

Table A-8. (Continued).

REP ¹	CUL ²	TRT ³	CRT ⁴	Firmness (MPa)			
				Day 0 ⁵	Day 2 ⁵	Day 4 ⁵	Day 6 ⁵
3	2	2	2	3.01	3.01	3.37	3.28
3	2	3	1	3.12	3.49	3.08	3.40
3	2	3	2	2.97	3.17	3.24	3.25
3	2	4	1	2.92	3.41	3.69	3.62
3	2	4	2	3.25	3.59	3.82	3.82
4	1	1	1	3.68	3.29	3.14	3.12
4	1	1	2	3.15	2.96	2.93	2.53
4	1	2	1	3.31	2.59	2.93	2.81
4	1	2	2	2.91	2.81	2.81	3.16
4	1	3	1	3.27	2.93	3.06	3.05
4	1	3	2	3.06	2.89	3.12	3.33
4	1	4	1	3.92	3.48	3.94	3.96
4	1	4	2	3.19	3.32	3.59	3.81
4	2	1	1	3.07	3.27	3.09	3.50
4	2	1	2	3.71	2.84	3.28	3.24
4	2	2	1	3.73	3.32	3.17	3.37
4	2	2	2	3.95	3.15	3.68	2.86
4	2	3	1	3.45	3.23	3.15	3.52
4	2	3	2	3.57	2.77	3.22	3.41
4	2	4	1	3.03	3.12	4.05	3.68
4	2	4	2	3.29	3.75	4.04	3.77

¹ REP-harvest dates: 1-7/31/87(CUL 1), 8/3/87 (CUL 2); 2-8/26/87 (CUL 1 and 2); 3-9/2/87(CUL 1 and 2); 4-9/3/87(CUL 1 and 2).

² CUL-cultivars: 1-'How Sweet It Is'; 2-'Silver Queen'.

³ TRT-treatments: 1-hydrocooled; 2-well water cooled; 3-refrigerated; 4-control.

⁴ CRT-crates (two per treatment per cultivar).

⁵ Number of days after harvest.

Table A-9. Raw data for sweet corn kernel extract soluble solids.

REP ¹	CUL ²	TRT ³	CRT ⁴	Soluble Solids (°Brix)			
				Day 0 ⁵	Day 2 ⁵	Day 4 ⁵	Day 6 ⁵
1	1	1	1	18.6	18.6	17.8	15.6
1	1	1	2	18.2	17.8	12.2	15.0
1	1	2	1	17.6	16.0	13.4	15.2
1	1	2	2	18.0	17.6	16.2	15.6
1	1	3	1	17.2	17.4	17.4	17.6
1	1	3	2	17.6	17.0	18.2	16.0
1	1	4	1	16.8	16.4	13.2	12.2
1	1	4	2	15.8	16.2	15.8	11.8
1	2	1	1	24.2	25.2	23.4	21.8
1	2	1	2	23.6	24.8	24.0	21.0
1	2	2	1	24.2	23.6	20.0	22.8
1	2	2	2	25.2	24.2	20.0	21.6
1	2	3	1	24.0	24.0	25.6	25.2
1	2	3	2	22.6	23.8	21.8	22.0
1	2	4	1	21.6	22.4	19.0	18.0
1	2	4	2	23.8	22.6	20.0	18.8
2	1	1	1	17.2	13.2	10.0	12.4
2	1	1	2	13.0	11.4	10.4	11.2
2	1	2	1	14.8	14.0	11.2	9.8
2	1	2	2	15.4	14.2	11.4	10.2
2	1	3	1	12.6	14.4	11.8	13.8
2	1	3	2	16.4	13.0	10.8	14.4
2	1	4	1	14.6	12.0	10.8	10.6
2	1	4	2	15.0	14.2	10.8	9.8
2	2	1	1	24.6	19.8	16.6	19.0
2	2	1	2	20.2	18.6	18.2	17.8
2	2	2	1	18.4	17.0	19.4	23.2
2	2	2	2	21.0	18.2	17.8	20.8
2	2	3	1	17.0	19.0	18.8	21.6
2	2	3	2	19.2	18.8	18.6	17.4
2	2	4	1	20.8	19.0	17.6	18.6
2	2	4	2	19.6	15.8	17.6	18.6
3	1	1	1	14.4	13.8	15.0	13.0
3	1	1	2	16.6	14.4	14.6	12.8
3	1	2	1	15.8	14.6	13.0	11.8
3	1	2	2	16.2	15.4	14.6	14.0
3	1	3	1	14.8	16.0	15.4	14.0
3	1	3	2	14.0	15.8	14.4	13.8
3	1	4	1	16.4	15.0	13.2	11.0
3	1	4	2	16.8	14.6	12.4	10.8
3	2	1	1	15.0	13.0	12.0	13.4
3	2	1	2	15.2	15.0	14.0	14.0
3	2	2	1	15.6	14.8	14.8	13.0

Table A-9. (Continued).

REP ¹	CUL ²	TRT ³	CRT ⁴	Soluble Solids (°Brix)			
				Day 0 ⁵	Day 2 ⁵	Day 4 ⁵	Day 6 ⁵
3	2	2	2	14.6	14.6	16.4	12.0
3	2	3	1	15.4	15.8	16.8	15.6
3	2	3	2	15.0	14.6	13.2	13.0
3	2	4	1	15.2	13.0	15.0	13.6
3	2	4	2	15.0	16.0	15.2	13.4
4	1	1	1	16.0	16.6	15.0	14.8
4	1	1	2	15.0	15.6	14.2	14.0
4	1	2	1	15.4	15.0	14.2	14.0
4	1	2	2	15.8	14.6	14.4	12.8
4	1	3	1	16.2	14.0	16.4	14.2
4	1	3	2	15.6	15.0	16.8	13.6
4	1	4	1	15.0	14.0	10.6	10.0
4	1	4	2	16.0	11.0	10.8	10.2
4	2	1	1	16.2	15.8	16.6	15.8
4	2	1	2	17.0	16.2	16.6	15.6
4	2	2	1	17.2	16.2	16.2	14.4
4	2	2	2	15.8	17.0	17.0	14.8
4	2	3	1	17.4	15.8	14.8	15.0
4	2	3	2	16.2	15.0	17.0	15.8
4	2	4	1	17.2	16.6	16.2	15.0
4	2	4	2	17.8	17.0	15.4	14.0

¹ REP-harvest dates: 1-7/31/87(CUL 1), 8/3/87 (CUL 2); 2-8/26/87 (CUL 1 and 2); 3-9/2/87(CUL 1 and 2); 4-9/3/87(CUL 1 and 2).

² CUL-cultivars: 1-'How Sweet It Is'; 2-'Silver Queen'.

³ TRT-treatments: 1-hydrocooled; 2-well water cooled; 3-refrigerated; 4-control.

⁴ CRT-crates (two per treatment per cultivar).

⁵ Number of days after harvest.

Table A-10. ANOVA table used in analysis of data.

Source of Variation	Degrees of Freedom	Test*
Date	3	
Cultivar	1	
Date x Cultivar	3	
Treatment	3	
Cultivar x Treatment	3	
Date x Treatment (Cultivar)	18	
Crate (Date x Treatment x Cultivar)	32	

* Date x Cultivar tests the Cultivar and Date sources of variation. Date x Treatment (Cultivar) tests the Cultivar x Treatment and Treatment sources of variation. Crate (Date x Treatment x Cultivar) tests the Date x Treatment (Cultivar) source of variation.

VITA

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