Environmental Factors Influencing Storage Loss

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The Great Western Sugar Co. has studied the effect of several preharvest and post-harvest factors on storage losses. Procedures used to measure the effect of these factors on storage loss will be given later in the symposium on "Methods of measuring quality losses in the laboratory and commercial piles." Factors to be discussed in this paper including topping procedure, nitrogen fertility, freezing in field, agricultural chemicals, varieties, and length of storage. The majority of these factors have been studied in the laboratory; however, studies on the topping procedure have been expanded to pile studies.

TOPPING PROCEDURE

Investigators have reported that non-topped beets have lower storage losses than conventionally topped beets even though the non-topped beets have lower sugar and purity at harvest. Great Western initiated studies in 1970-71 to determine first of all whether losses were actually lower in flailed non-topped than in conventionally topped beets and second to determine the effect of topping procedure on quality of beets at harvest and after storage. In the initial study, a load of flailed non-topped beets was separated into two lots (Figure 1). One group was washed and put into respiration chambers without further topping, while the second group was topped to the lowest leaf scar and washed before being put into the chambers. Respiration was monitored daily and representative samples were analyzed at 0, 35, 92, and 182 days to determine sugar and recoverable sugar losses (Figure 2).

Throughout the entire study topped beets lost 15 to 20% more sugar and recoverable sugar than non-topped beets. The difference in sugar loss in the early phase of storage was caused by the high wound respiration on the cut surface of the topped beet. The rot and mold which grow on the cut surface of the topped beets, especially if a hollow crown is exposed, increase sugar and purity losses later in storage.

A similar laboratory study was carried out in 1971-72 except that five commercial or near commercial varieties were used in the study which was carried out for 106 days. With each variety the topped beets had a higher sugar loss than the non-topped. Overall, the topped beets lost an average of 18.3 % more sugar than the non-topped beets. The difference was significant at the 5% level of significance.

Laboratory studies give a good indication of how topping treatments affect storage loss. Pile conditions, however, may be somewhat different from the laboratory storage conditions and so ultimately a comparison of the storage of topped and non-topped beets must be made in commercial piles. In 1971 a load of machine flailed and harvested beets was divided into two lots. One lot was left non-topped and the other topped to the lowest leaf scar. Fifty samples from each lot weighing 25 to 30 pounds per sample were stored in nylon net bags in the Longmont factory pile for 98 days.

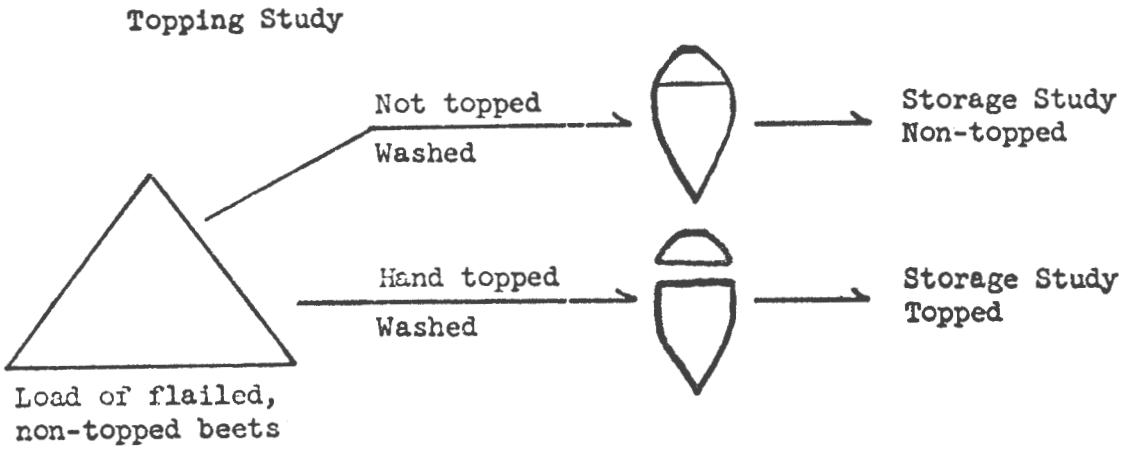

Figure 1.

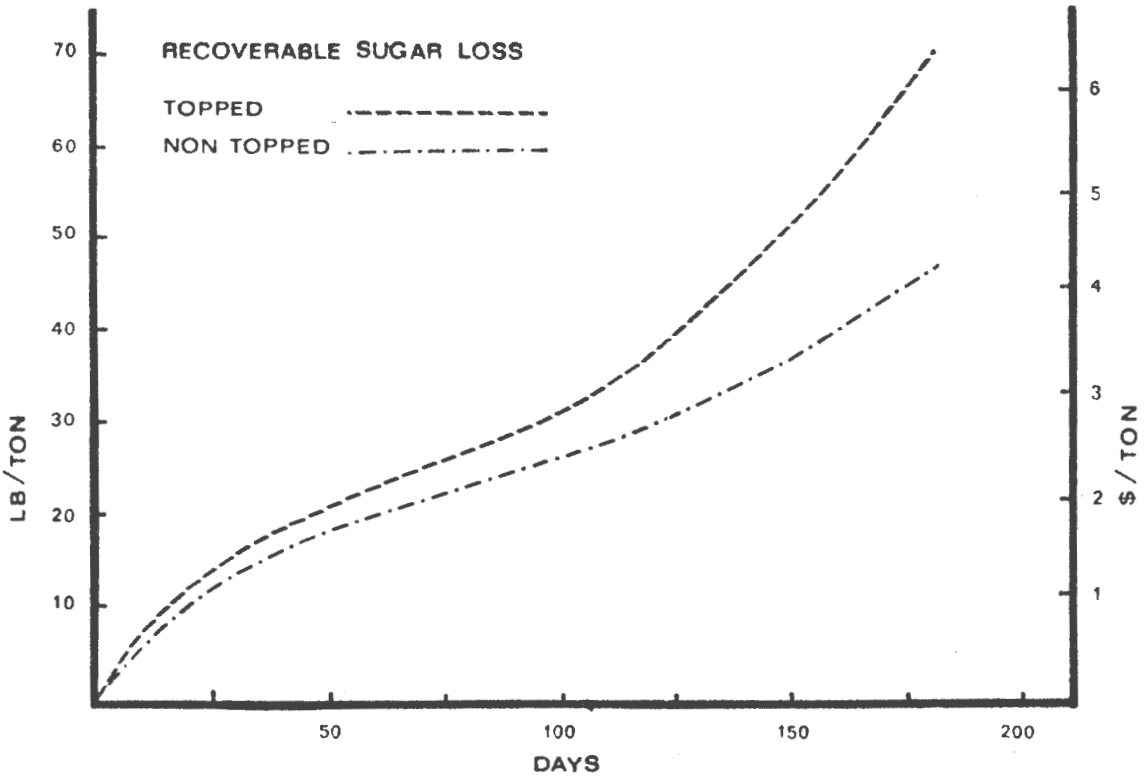

Figure 2.

The samples were recovered when the pile was reloaded and analyzed for sugar, purity and purity components. The same analyses were made on samples at harvest time. The loss of recoverable sugar was 22.7% less in the flailed non-topped beets than in the conventionally topped beets.

In addition to the higher sugar loss, we found that the topped beets which had been stored in the pile had about 23% more invert sugar than the non-topped beets. This higher level of invert sugar in the crown beets was apparently caused by the mold and rot which formed on the cut surface and around the hollow crown.

The non-topped beet, however, is a lower quality beet at harvest because of the lower sugar content and purity in the crown. A survey made in all Great Western districts during the 1971 harvest showed that sugar and purity of topped beets averaged 0.38 and 0.68% higher respectively than the non-topped beets at harvest time.

The principle advantages of flailed non-topped beets are less storage loss, cleaner harvest and more recoverable sugar per acre. The disadvantage is a lower quality beet at harvest. Extensive pile studies are being carried out in 1972-73 to confirm previously found results. We must determine whether the savings from decreased storage loss are greater than losses due to processing lower quality beets before a change in topping procedure can be recommended.

NITROGEN FERTILITY

A study was initiated in 1972 to determine effect of nitrogen fertility on processing quality. As a part of this study, we measured respiration for 96 days on beets of five different varieties grown at four levels of nitrogen fertilization - 0, 50, 100, 200 lb/A. Level of nitrogen fertilization has no effect on the respiration rate.

FREEZING IN THE FIELD

A large portion of the crop was frozen while still in the ground in 1969. If beets were dug and piled while partially frozen, the piles deteriorated and large storage losses occurred. On the other hand, if the beets were allowed to thaw while still in the field and then piled, the piles stored reasonably well. We conducted a test in 1970 to determine what effect freezing and thawing in the field has upon respiration. Beets were allowed to freeze in the field with a night temperature of 9° in mid-November. Tissue was frozen to about 1 inch below ground level. Warm weather the following day (70 F) thawed the beets and they were harvested 2 days after the initial freeze. Respiration measurements for 55 days showed that steady state respiration in the beets which had been partially frozen and thawed was nearly twice that observed in similar beets which had not frozen (Figure 3). Even though the frozen and thawed beets appear to store well, they were undergoing higher than normal storage losses.

CHEMICALS

Many attempts have been made to find growth regulators which would decrease storage loss. One such test which we carried out produced interesting

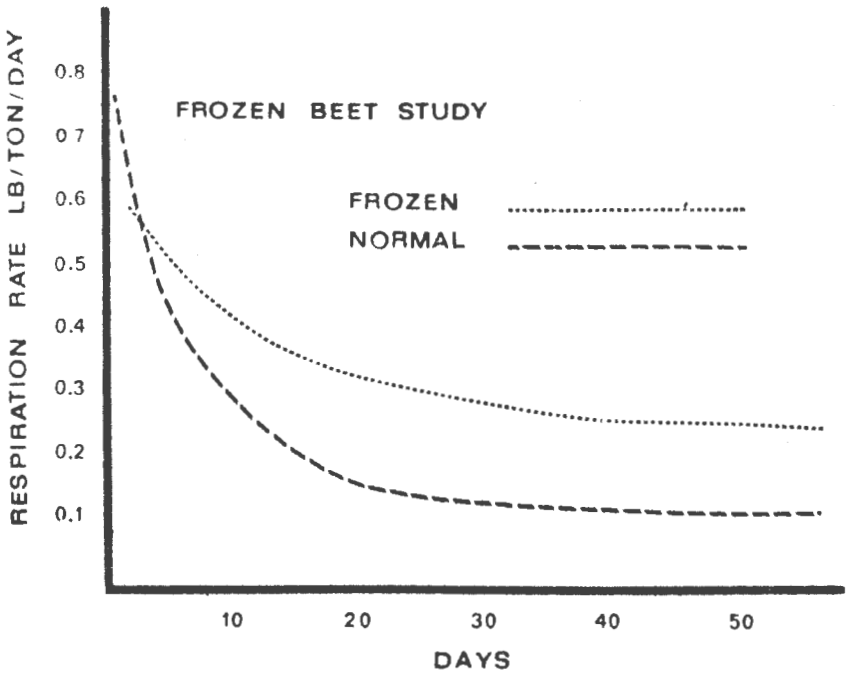

Figure 3.

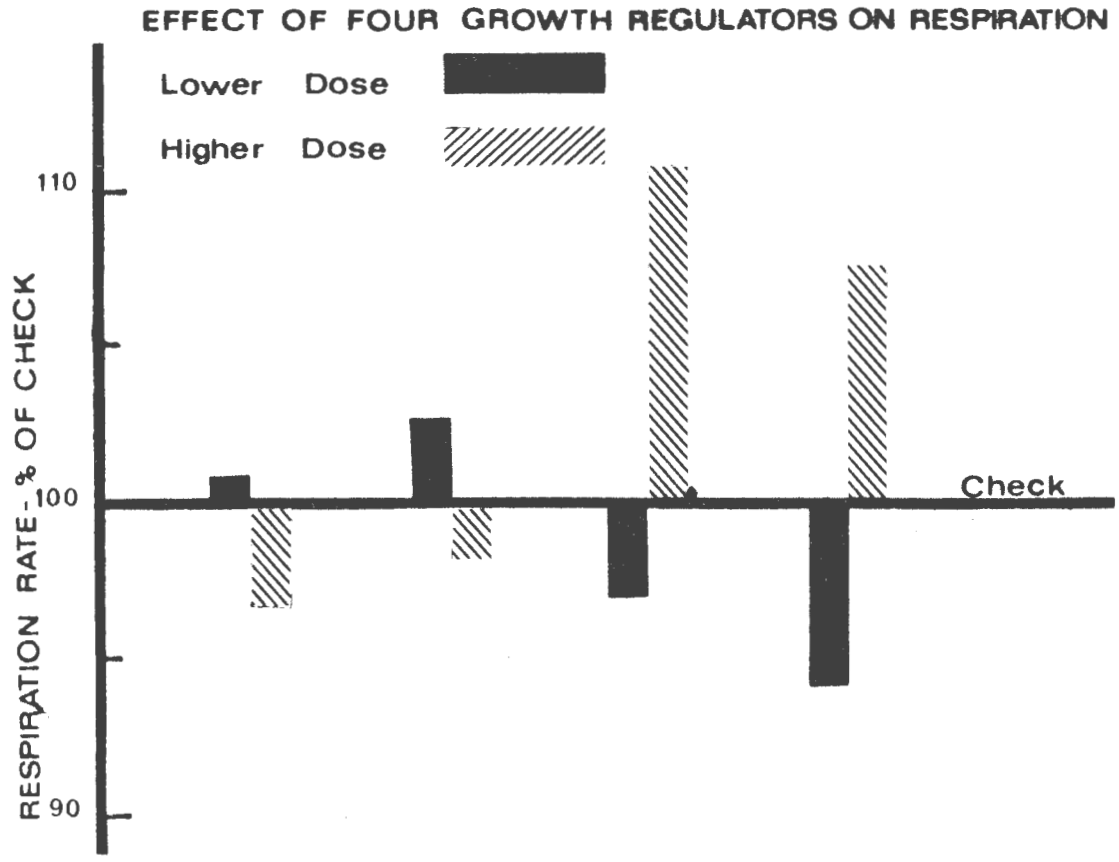

Figure 4.

results. In 1971 a test was conducted in which four different growth regulators were sprayed onto plots along with a check 18 days before harvest. The chemicals were each put on at two rates - the second being four times greater than the first. Results are summarized in Figure 4. Each pair of lines represents the relative respiration rate for the two dosages of the same chemical. None of the chemicals including Randox gave a significant reduction in respiration. Two of the chemicals, however, gave a statistically significant increase in respiration when applied at a higher dosage. Chemicals applied to the growing beet may under some conditions increase storage loss. Many agricultural chemicals are used in sugar beet production and the effect on storage loss of each chemical, applied in the recommended manner and rate, must be investigated. In 1972 we carried out studies to determine whether any of six herbicides or five nematicides affected respiration. Chemicals included in the study were both commercial and experimental. None of the chemicals applied at recommended dosages increased the rate of respiration. While these herbicides and nematicides produced no deleterious effect on storage, all new agricultural chemicals should be evaluated for their effect on storage losses.

LENGTH OF STORAGE

The factors discussed to date involve the effect of preharvest environmental factors on storage loss. Post-harvest environmental factors have as great or greater effect on storage loss. Sugar loss occurs continuously during storage (Figure 5). The loss is very high during the first few days after harvest, often exceeding 1 pound of sugar per ton of beets per day. The rate of loss decreases until a steady state respiration rate is reached. The steady state respiration is less than one-fifth as much as the initial rate of respiration. If no freezing and thawing or dehydration occurs, respiration remains on about the same level for 180 days. Under normal conditions in conventional piles freezing and thawing and dehydration increase the rate of sugar loss with time.

VARIETY

Difference between varieties in sugar loss are genetic differences. The expression of these genetic differences may be influenced by environmental factors. Storage tests on varieties began in 1970. In this test respiration was monitored for about 100 days on 12 single-cross hybrids. A 50% difference existed between the low and high respiring individuals. A relationship existed between genotype and respiration rate.

In 1971-72 we made respiration measurements for 100 days on 27 commercial and semi-commercial hybrids as indicated by individual bars on the graph in Figure 6. The center line is the average respiration rate of the 27 varieties. The relative deviation from the average respiration rate is shown on the vertical axis. The points of significance are first that a 50% difference existed between high and low respiring individuals. Second, seven of the eight highest respiring hybrids have a common parent. Thus there may be a genetic basis for the difference in respiration.

Respiration rate and direct sugar loss are not the only criteria in evaluating the storage qualities of hybrids. We found a 300% difference in the rate that the 27 varieties accumulated invert sugar (Figure 7).

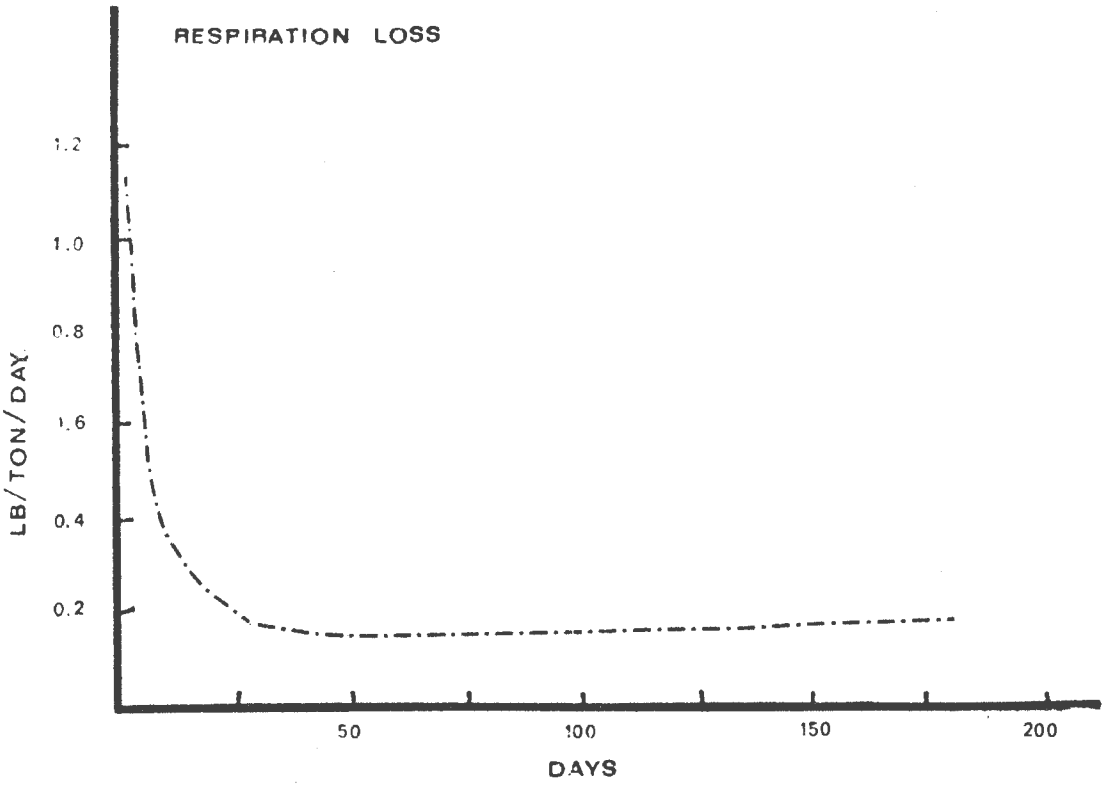

Figure 5.

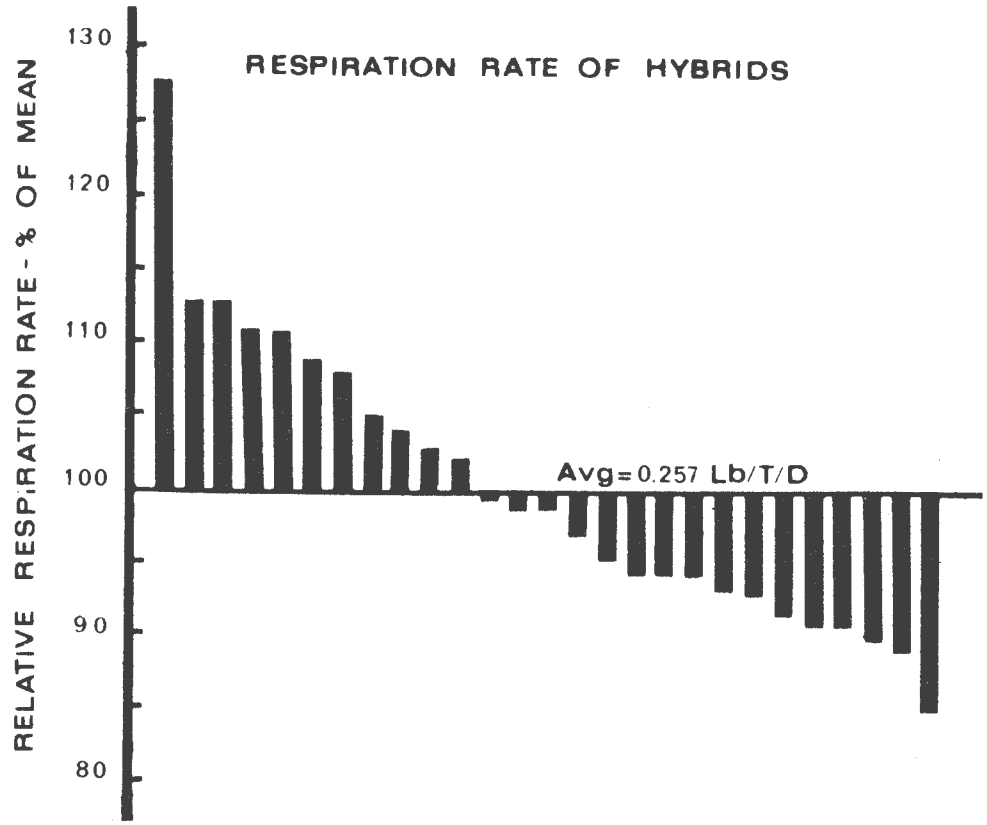

Figure 6.

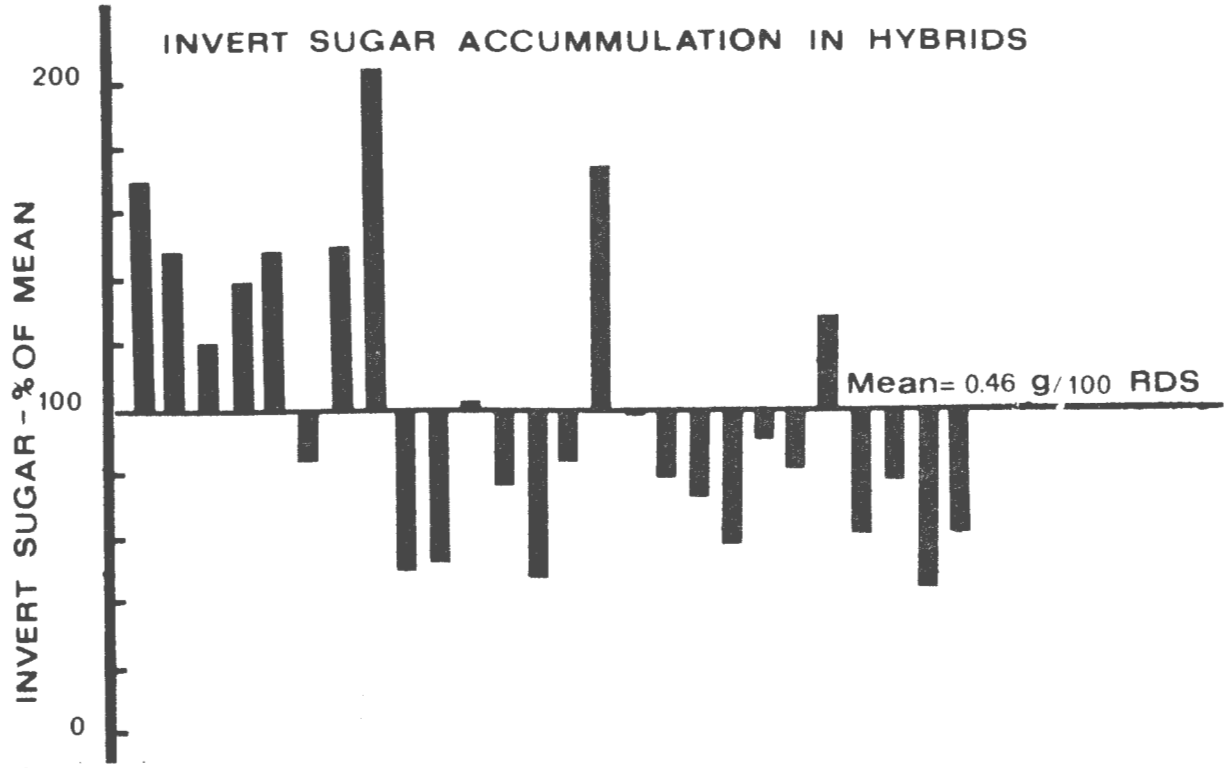

Figure 7.

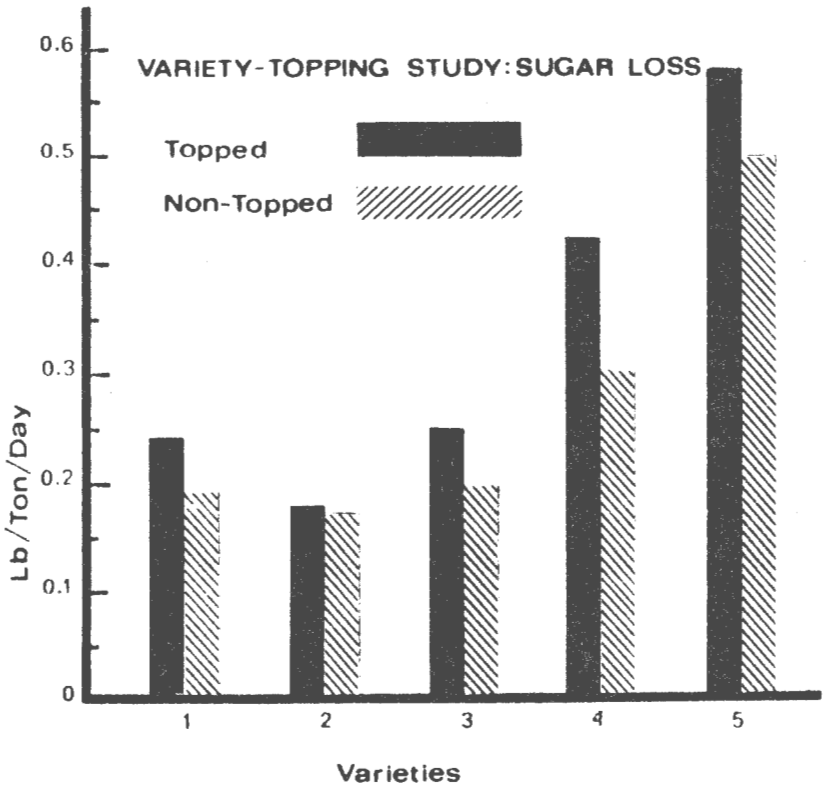

Figure 8.

A study was carried out to determine if any interaction existed between variety and topping procedure with regard to sugar loss, (Figure 8). Non-topped beets of each of the five varieties were flailed to remove leaf and petiole material but not topped. The topped beets were topped to the lowest leaf scar. With each variety the topped beets lost more sugar than the flailed non-topped beets. Varietal differences were greater than differences due to topping procedure.

Similar results were found in the same study regarding invert sugar accumulation (Figure 9). More invert sugar accumulated in the topped beets, but differences due to variety are greater than those due to topping procedure.

Of all the factors discussed in this paper varietal differences appear to have the greatest effect on storage loss. All hybrids should be evaluated for storage characteristics before being approved for commercial production in order to avoid releasing a variety which would increase storage losses. Finally there appears to be a potential for selection and breeding for varieties with lower storage losses.

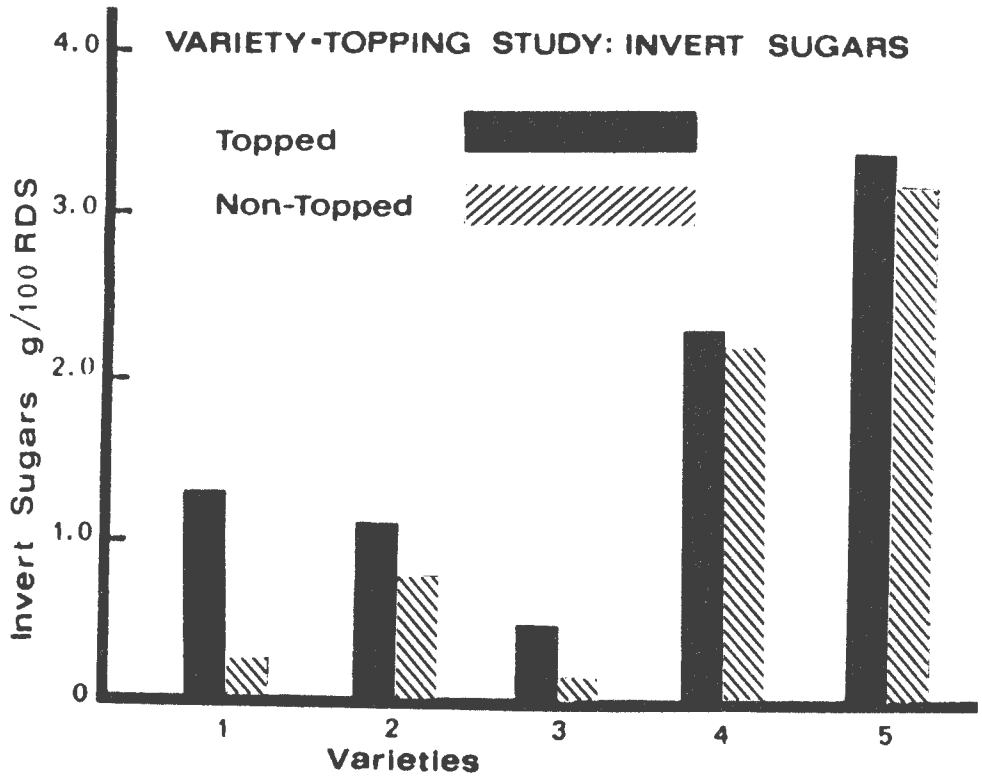
VARIETY-TOPPING STUDY: INVERT SUGARS
Topped
Non-Topped
Invert Sugars g/100 RDS
4.0
3.0
2.0
1.0
0
1
2
3
4
5
Varieties

Figure 9.