

Effect of Crown Material on Yield and Quality of Sugar Beet Roots: A Grower Survey¹

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Received for publication March 22, 1976

Summary

A survey of commercial sugar beet growers in the Red River Valley of North Dakota and Minnesota was conducted to determine the change in tonnage and root quality that would occur if sugar beets were flailed rather than topped conventionally at harvest. The data indicated that the growers removed only 20% of the crown material by topping, which reduced tonnage by 5%.

Removal of all the crown material by hand resulted in a 1.2% increase in sucrose and a 7.1% reduction in nitrate grade. Sugar beet crown material accounted for 20.5% of the tonnage delivered to the factory.

Introduction

Sugar beets are normally flailed and scalped before harvesting. The purpose of scalping is to remove a portion of the crown, which is the area above the lowest leaf scar. Crown material is known to be higher in impurities and lower in sucrose relative to the main body of the sugar beet root. More sugar per acre can be recovered from beets which are only flailed before harvesting (1, 6).³ This increase can come about for several reasons: sugar can be extracted from the crown material, respiration losses during storage would be reduced by not cutting the crown, and the amount of rot would be reduced by not exposing the most susceptible tissue, the center portion of the crown.

If sugar beets were only flailed at harvest, an increase in tonnage and a reduction in percent sucrose would be expected. However, no data are available to indicate the anticipated change in either tonnage or percent sugar. A survey at one location in the Red River Valley in the 1974-75 processing campaign indicated that only 6% of the sugar beets were topped at the lowest leaf scar, 71% were partially topped, and 23% were only flailed (2). Thus, a considerable amount of crown tissue is being processed at the present time.

A survey of commercial sugar beet growers was conducted during the week of September 29 to October 3, 1975, in the Red River Valley to determine the change in tonnage and root quality that would occur if sugar beets were only flailed at harvest.

¹Cooperative investigation of the Agricultural Research Service, U.S. Department of Agriculture, and the Agricultural Experiment Station, North Dakota State University, Fargo, ND 58102. Published with the approval of the Director of the North Dakota Agricultural Experiment Station as Journal Paper No. 727.

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³Numbers in parentheses refer to literature cited.

Materials and Methods

Sugar beet samples were obtained from randomly selected growers in each of the six factory districts in the Red River Valley. Four 10-beet samples were harvested from each grower and/or location in a field. In each field, samples were obtained from rows adjacent to where the grower had temporarily stopped scalping. From the row which had not been flailed or scalped, two 10-beet samples were manually harvested. The leaves were removed from both samples at the base of the petiole with a knife. The crowns were removed from one sample at the lowest leaf scar and weighed. The 10 topped roots and the 10 untopped roots were then placed into a "tare bag" for further analysis. Two 10-beet samples were manually harvested from the adjacent row where the grower had flailed and scalped the sugar beets. The remaining crown tissue on one sample was removed and weighed. Roots of both samples were placed into tare bags. Length of row harvested for each 10-beet sample was determined. Row width was 22 inches in all fields and 68 locations were sampled. Flailed samples were obtained from an additional six fields in the East Grand Forks, Minnesota area. Grower-scalped samples were not obtained on these six fields because the factory was not receiving beets at the time of the survey.

The tare bags were transported to the tare laboratory of American Crystal Sugar Company at East Grand Forks, Minnesota. At the tare laboratory, the roots were washed, weighed, and sawed to obtain pulp for determination of sucrose, nitrate grade, and conductivity grade. Percent crown tissue was calculated using the weight of the crown material removed as a percentage of the original root weight.

Two samples of sugar beet roots were obtained from grower trucks at each of six piling stations in the valley. Samples obtained at Crookston factory, Midway, Hillsboro factory, Drayton factory, and Hamilton consisted of 10 roots selected at random from a loaded truck. Samples were obtained from the Moorhead factory by using the sample bucket on the piler to catch two samples per truck load. One sample from each load was topped to the lowest leaf scar to determine the weight of the crown material that was delivered to the factory by the grower. Sucrose, nitrate grade, and conductivity grade were measured on both samples at the East Grand Forks tare laboratory.

Results and Discussion

Average length of row to harvest 10 sugar beets varied from 11.6 to 12.1 ft (Table 1), indicative of an average population of 19,721 to 20,434 plants per acre. Sugar beet roots harvested from the grower-scalped row were lower in sucrose than were sugar beets harvested from the row with intact leaves used to simulate flailing. The reduced sucrose levels probably resulted from normal respiration which is increased by scalping; also the leaves had been removed from the grower-scalped sugar beet roots for an undetermined time period, thereby eliminating photosynthesis and preventing further sucrose storage. The flailed sugar beets were capable of

Table 1. Length of row to harvest 10 beets, sucrose, nitrate, conductivity, percent crown, and yield averaged over all growers.

Sample†	n	Row length ft	Sucrose %	Nitrate	Con- duct- ivity	Crown %	Yield		
							Crown	Root	Total
1	74	11.6±.5††	16.4±.1	2.8±.1	4.0±.2				18.8±.4
2	74	11.7±.3	16.6±.1	2.6±.1	3.8±.2	19.4±.4	3.7±.2	15.3±.5	19.0±.6
3	68	11.8±.3	16.1±.2	2.9±.1	4.1±.2				18.0±.6
4	68	12.1±.4	16.4±.2	2.8±.1	3.8±.2	15.5±.6	2.8±.1	15.2±.4	18.0±.5

†1) Flailed; 2) flailed, crown removed manually; 3) grower-topped; 4) grower-topped, remaining crown removed manually.

††Mean with standard error of the mean.

photosynthesis and storage up to harvest. The lower sucrose percentage in the grower-scalped row may have resulted from water uptake by the roots after scalping.

Removal of the entire crown (sample 2, Table 1) resulted in a 1.2% increase in sucrose, a 7.1% reduction in nitrate grade, a 5% reduction in conductivity grade, and an 18.6% reduction in yield compared to sugar beet roots with intact crown (sample 1, Table 1). Removal of the crown material remaining on sugar beet roots after scalping by the grower (sample 4, Table 1) resulted in a 1.9% increase in sucrose, a 3.4% reduction in nitrate, a 7.3% reduction in conductivity, and a 15.5% reduction in yield compared to grower-scalped sugar beet roots (sample 3, Table 1).

Sugar beet crown material accounted for 19.4% of the total yield for the flailed roots and 15.5% of the total yield for the grower-scalped roots (Table 1). This indicates that a considerable amount of the crown material is harvested and delivered to the factory. These data support those of Bugbee and Cole (2) concerning the percentage of sugar beet roots scalped to the lowest leaf scar.

Hobbis (5) observed an inverse relationship between sucrose content and nitrate grade. Similar data were obtained in this survey (Fig. 1). Flailed and grower-scalped sugar beet roots exhibited similar trends in sucrose reduction with nitrate grade.

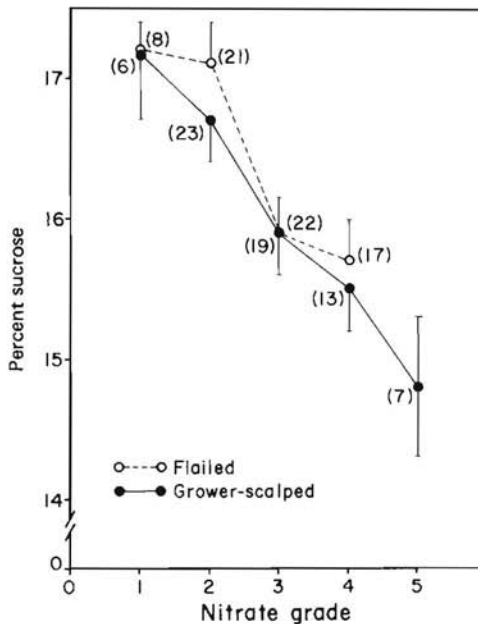


Figure 1.—Relationship between percent sucrose and brei nitrate grade in flailed and grower-scalped sugar beet roots. Numbers in parentheses indicate the number of samples in each mean.

Cole et al. (4) showed that a positive relationship exists between soil nitrate levels and percent crown tissue. A similar relationship was observed between brei nitrate grade and percent crown (Fig. 2). This relationship indicates that the amount of crown material produced can be regulated by nitrogen management. Nitrogen management can result in an increase in sucrose content and a reduction in crown material.

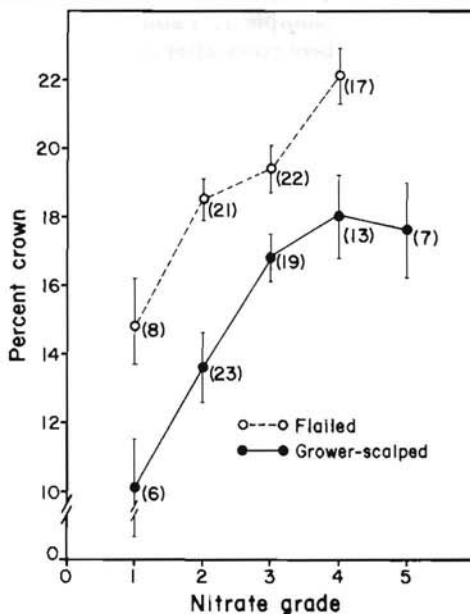


Figure 2.—Relationship between percent crown and brei nitrate grade in flailed and grower-scalped sugar beet roots. Numbers in parentheses indicate the number of samples in each mean.

Sucrose content showed a decline as percent crown material increased in both flailed and grower-scalped sugar beet roots (Fig. 3 and 4). A highly significant negative correlation was observed between sucrose content and percent crown material. This relationship can be partially explained by the differential between sucrose level of root vs. crown material, since the difference becomes larger as nitrogen increases. Nitrogen causes a reduction in sucrose and an increase in the amount of crown produced.

The data reported above were obtained from manually harvested roots where the tap root and lateral roots remained primarily intact. However, sugar beet roots harvested mechanically rarely have lateral roots and the main tap root may be broken or cut by the lifter wheels. Therefore, differences in percentages of crown material would be expected when comparing manually harvested to mechanically harvested roots.

Crown material accounted for 20.5% of the tonnage delivered to the piler and/or factory station by the growers (Table 2). Removal of all the remaining crown material resulted in a 1.2% increase in sucrose, a 5.3%

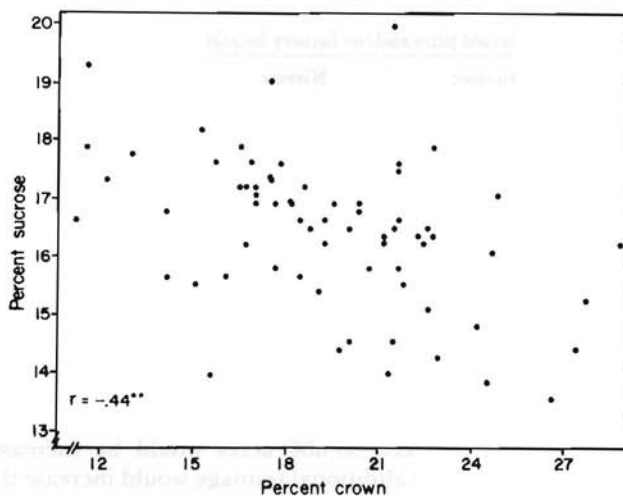


Figure 3.—Relationship between percent sucrose and percent crown in flailed sugar beet roots.

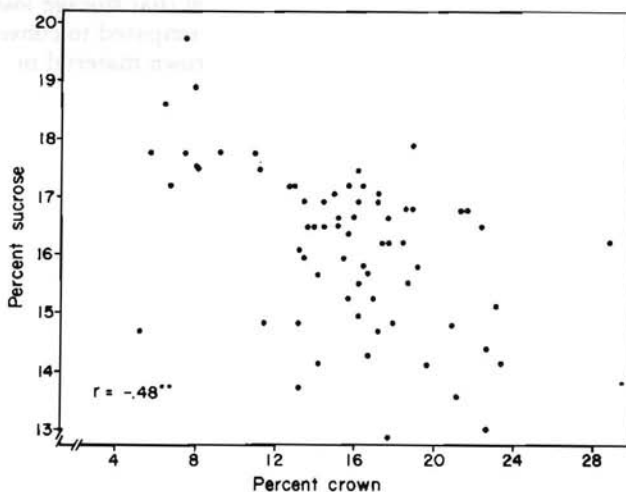


Figure 4.—Relationship between percent sucrose and percent crown in grower-scalped sugar beet roots.

reduction in nitrate grade, and a 2.2% reduction in conductivity grade (Table 2) averaged over all locations.

Our results indicate that the factories are processing at least 15.5% of all crown material produced, which accounts for 20.5% of the total tonnage processed. Growers remove only 20% of the crown material produced. Assuming a 13.5 T/A yield, the grower could expect an additional 0.7 T/A from crown material if he flailed rather than scalped the beets. This would increase the amount of crown material being processed

Table 2. Sucrose, nitrate, conductivity and percent crown of sugar beet roots selected from grower-trucks at selected piles and/or factory locations in the Red River Valley.

Location	n	Sucrose		Nitrate		Conductivity		Percent Crown
		1†	2	1	2	1	2	
Crookston	5	16.4	16.4	3.4	3.4	3.4	3.4	15.3
Midway	11	16.7	16.9	3.7	3.5	5.0	4.7	17.8
Hillsboro	10	17.1	17.6	3.2	2.8	4.5	4.6	15.7
Hamilton	7	17.5	17.6	2.6	2.7	2.7	2.6	13.8
Drayton	10	16.4	16.8	3.4	3.2	4.3	3.9	17.8
Moorhead	46	15.2	15.4	4.2	4.1	5.0	5.0	24.4
Mean		16.0±.1	16.2±.2	3.8±.1	3.6±.1	4.6±.1	4.5±.1	20.5±.6

†1 = Analysis of sugar beet roots as delivered by grower.

2 = Analysis of sugar beet roots with crown material removed to lowest leaf scar.

by the factory to 24.6% of the total tonnage processed. The total tonnage processed by the factory from 50,000 acres would be increased from 675,000 to 710,000 tons. The additional tonnage would increase the slicing campaign 7 days for a 5,000 ton per day factory.

Zielke (6) showed that a ton of crown material contained 217 lbs of recoverable sucrose. Akesson, et al. (1) indicated that storage losses would be 10 to 15 percent less for flailed sugar beets compared to conventionally topped sugar beet roots. With an increase in crown material processed by the factory, a reduction in percent sucrose extraction would be expected. However, assuming the changes in yield and sucrose levels reported herein, sucrose extraction by the factory would have to drop over 3% to offset the gain in additional sugar extracted from the crown material.

Sucrose extraction by the factory drops during the latter part of the processing campaign due to physical deterioration of the roots, loss of sugar by respiration, and an increase in the amount of rot. Factory extraction should not drop as rapidly or to the same levels for flailed beets compared to extraction from conventionally topped roots because respiration and rotting during storage would be less (1, 3).

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