Effect of Complete Crown Removal on Quality of Sugarbeets*

D. F. COLE

Received for publication June 28, 1979

Sugarbeet roots normally are crowned before harvest to remove petiole and crown tissue which has a higher concentration of impurities and lower sucrose content compared to the main tap root. Cole and Seiler (5) found in a 1975 grower survey that only a small amount of the sugarbeet crown material was removed during the harvest operation. Bugbee and Cole (3) indicated that 23% of the roots entering one factory had no crown material removed. Halvorson and co-workers (8) showed that sucrose extracted from crown tissue can represent up to 20% of the total sucrose produced per acre, depending upon the level of nitrogen fertilization.

This study was designed to determine the amount of crown delivered to the factories in the Red River Valley of North Dakota and Minnesota, and its effect on root quality.

MATERIALS AND METHODS

Sugarbeets were sampled at 6 piler locations (5 to 46 truckloads/location) in 1975 and at 18 piler locations (15 truckloads/location) in 1976. Fifty truckloads were sampled at the Moorhead factory in 1977 and 1978 and at the Moorhead factory in 1978. Two samples (7-

---

*Cooperative investigation of Agricultural Research, Science and Education Administration, U. S. Department of Agriculture, and the Agricultural Experiment Station, North Dakota State University, Fargo, ND 58105. Published with the approval of the Director of the North Dakota Agricultural Experiment Station as Journal Paper No. 987 . The author is Research Plant Physiologist and Adjunct Professor of Agronomy.

11 kg each) were obtained with the automatic piler sampler from each load, washed and weighed. One sample from each load was used to determine the weight of the crown material above the lowest leaf scar and quality of the sample after complete crown removal (topped). The second sample was used to measure root quality as delivered (control) The 1975 and 1976 samples were analyzed for sucrose, nitrate, and conductivity grade in the laboratory of American Crystal Sugar Company, East Grand Forks, MN.† Samples from the 1977 and 1978 crop were analyzed for sucrose and thin juice purity (7) at North Dakota State University. Recoverable white sugar per ton of roots (RWST) was calculated with an assumed factory loss of 0.3% sucrose and a molasses purity of 62.5% (7).

The effect of flailing (removal of petiole material only) vs. crowning on sugarbeet yield and quality was investigated in 1978 A uniform field of 168 rows, 0.8 km long, was divided into 3 sections. Section 1 contained 56 rows which were defoliated and crowned using a 3-drum commercial defoliator (crowned treatment). Section 2 contained 64 rows which were defoliated with a 2-drum commercial defoliator which went over the rows in two directions (flailed treatment). Section 3 contained 48 rows which were defoliated and crowned as in section 1. Beets of each section were harvested with a 4-row harvester Nine truck loads from section 1 were delivered and sampled by the routine procedure of American Crystal Sugar Co., i.e. two loads were sampled for sugar, two for tare, and five were not sampled. Sugar and tare samples were taken alternately from the 10 loads obtained from section 2 and 8 loads from section 3. Samples were analyzed for tare, sucrose, nitrate and

†Mention of a trademark, proprietary product, or vendor does not constitute a guarantee or warranty of the product by the U. S. Department of Agriculture and does not imply its approval to the exclusion of other products or vendors that may also be suitable.

conductivity grade, in the laboratory of American Crystal Sugar Company, East Grand Forks, MN.

A survey was conducted at the Moorhead, MN, factory in 1977 to determine the diameter of the cut surface of the crown. Over 1,000 roots were selected from the "picking table" and measured over a 2-hour period.

RESULTS AND DISCUSSION

Crown material accounted for over 20% of the tonnage delivered to the piler and/or factory locations each year (Table 1). Soil moisture varied greatly among the

Table 1. Effect of complete crown removal on sugar, nitrate and conductivity grade, purity, and recoverable white sugar per ton (RWST) over a 4-year period at various locations.

				1978	
	1975	1976	1977	Moorhead	Wahpeton
Number of samples	89	270	50	50	50
Crown tissue removed after harvest, %	20.5	20.8	20.8	23.3	23.4
		Sugar, %			
Control (as delivered)	16.0	17.0	15.6	16.2	15.4
Topped	16.2	17.1	15.9	16.7 a/	16.0 a/
	Nitrate grade			Purity, %	
Control	3.8	3.0	94.1	92.5	90.7
Topped	3.6	3.0	94.3	92.8	91.7 a/
	Conductivity grade			RWST, lbs	
Control	4.6	4.4	274	276	251
Topped	4.5	4.3	281	286	267 a/

a/ Significantly different from control, "F" test.

18 locations sampled in 1976. The amount of crown material delivered to the factories tended to be less from the drier locations. The range in percent crown delivered to the pilers in 1976 varied from 17.1 to 24.5%.

Removal of the remaining crown material from commercially harvested sugarbeets did not affect percent sucrose in 1975, 1976, or 1977. However, crown removal increased percent sucrose at both Moorhead and Wahpeton in 1978. The primary purpose of crowning is to reduce the impurity load in the factory. However, on a large-scale test in a commercial field in 1978, no differences in yield or quality were observed when the sugarbeets were flailed compared to crowned (Table 2). Complete crown

Table 2. Quality and yield of flailed and crowned sugarbeets from a commercial field in 1978.

Sample	n	Sugar	Nitrate	Conductivity	Tare	Yield Gross	Yield Net	Gross Sugar
		%	grade	grade	%	T/A		T/A
Flailed	5	16.8±.4 [a/]	4.2±.4	5.2±.5	3.8±.3	20.7	20.0	3.4
Crowned	6	16.4±.2 [a/]	4.0±.4	4.5±.2	3.7±.4	21.0	20.2	3.3

a/ Standard error of mean, yield based on total tonnage of all loads delivered from each section of field.

removal did not affect purity or RWST at Moorhead in 1977 or 1978, but a significant change was noted at Wahpeton in 1978 (Table 1).

Complete crown removal does not consistently improve quality. Cole and Seiler (5) indicated that growers were removing only a small amount of the crown tissue by crowning before harvest. The amount of crown tissue removed by crowning can be estimated by measuring the diameter of the cut surface of the crown (6). Data from a survey at the Moorhead factory in 1977 indicated that the average diameter of the cut surface of the crown was 60 mm. Thus, growers removed 20% of the crown tissue or 5% of the total root by crowning before harvest (6).

The data presented indicated that complete crowning does not substantially reduce the impurity load and that an additional 20% of crown tissue or 5% of the whole root would not decrease overall root quality. However, research (1,2,4,9,10) has showed that crowning and damage increases respiration and rot losses in sugarbeets during storage. In view of these results, the practice of partial crowning sugarbeets at harvest should be reevaluated.

SUMMARY

Over 20% of the material delivered to the sugarbeet factories was crown tissue. Complete removal of all crown tissue did not consistently improve quality as determined by sucrose content, nitrate and conductivity grade, and thin juice purity. Crowning during harvest operations did not substantially reduce the impurity load of the factory. However, other research has shown that crowning and mechanical damage increases respiraton and rot losses. These studies suggest that there is no advantage to crowning of sugarbeets at harvest. Therefore, to reduce sucrose loss in storage piles due to increased respiration and increased rotting, I recommend that only flailed sugarbeets be delivered for storage.

ACKNOWLEDGEMENT

I thank Mr. Gerald Seiler for his assistance in collecting the samples and chemical analysis.

LITERATURE CITED

(1) Akeson, W. R., S. D. Fox, and E. S. Stout. 1974. Effect of topping procedure on beet quality and storage losses. J. Am. Soc. Sugar Beet Technol. 18:125-135.

(2) Akeson, W. R. and E. L. Stout. 1978. Effect of impact damage on sucrose loss in sugarbeets during storage. J. Am. Soc. Sugar Beet Technol. 20:167-174.

(3) Bugbee, W. M. and D. F. Cole. 1976. Sugarbeet storage rot in the Red River Valley, 1974-75. J. Am. Soc. Sugar Beet Technol. 19:19-24.

(4) Cole, D. F. 1977. Effect of cultivar and mechanical damage on respiration and storability of sugarbeet roots. J. Am. Soc. Sugar Beet Technol. 19:240-245.

(5) Cole, D. F. and G. J. Seiler. 1976. Effect of crown material on yield and quality of sugarbeet roots: a grower survey. J. Am. Soc. Sugar Beet Technol. 19:130-137.

(6) Cole, D. F. and G. J. Seiler. 1978. Regression techniques for estimating percent crown removal in scalping sugarbeet roots. J. Am. Soc. Sugar Beet Technol. 20:127-132.

(7) Dexter, S. T., M. G. Frakes, and F. W. Synder. 1967. A rapid and practical method of determining extractable white sugar as may be applied to the evaluation of agronomic practices grower deliveries in the sugarbeet industry. J. Am. Soc. Sugar Beet Technol. 14:433-454.

(8) Halvorson, A. D., G. P. Hartman, D. F. Cole, V. A. Haby, and D. E. Baldridge. 1978. Effect of N fertilization on sugarbeet crown tissue production and processing quality. Agron. J. 876-880.

(9) Mumford, D. L. and R. E. Wyse. 1976. Effect of fungus infection on respiration and reducing sugar accumulation of sugarbeet roots and use of fungicides to reduce infection. J. Am. Soc. Sugar Beet Technol. 19:157-162.

(10) Wyse, R. E. 1978. Effect of harvest injury on respiration and sucrose loss in sugarbeet roots during storage. J. Am. Soc. Sugar Beet Technol. 20:193-202.