Sugarbeet Storage Rot in the Red River Valley, 1974-75

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Each season rot of sugarbeets in storage accounts for losses of sugar. Estimates of the amount of this loss have not been based on sample data. Our objectives were to sample and examine roots as they began the factory process, to determine the amount of rotted tissue, identify the causal pathogens and, on the basis of the data, to estimate losses in the Red River Valley.

Materials and Methods

The survey was made from November 6, 1974, through March 12, 1975, at the American Crystal Sugar Company factory, Moorhead, MN. Samples were removed from the picking table on alternate days. Two samples were taken at randomly selected 12-h intervals on each sample day. Sample size was a standard tare bag of 10-17 kg (22-37 lbs). Samples from 6 factories in the Red River Valley were compared on January 24, 1975. During a 10-minute period four samples were obtained at the picking table of each factory.

The roots were returned to the laboratory, weighed, quartered longitudinally, divided into topping classes, and the decayed portions removed and weighed. Frozen tissue also was removed and weighed. The roots were classified into those with no crown tissue removed, all crown tissue removed, or partial crown removed. Rotted or frozen tissue was expressed as percent by weight. The tons of rotted tissue that were processed daily was determined by multiplying the percent rot derived from the sample times the tons of production for that particular day. This same sample percent also was used for estimating rot on the following day when no sample was taken.

Rotted tissues from the crown, pith, body, and tail of the root were examined for pathogens. Rotted tissue samples of uniform size were removed with a cork borer and eight slices from each portion of the root were plated on potato-dextrose agar.

Results

When this survey began on November 6, 1974, 10 tons of rotted sugarbeet tissue was being processed daily at Moorhead. The daily

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[2]Numbers in parentheses refer to literature cited.

tonnage of rotted root tissue that was sliced gradually increased to nearly 100 tons at the end of the campaign (Fig. 1). The amount of rotted sugarbeet tissue that entered the factory during the 128-day survey period was 1.22% of the total tons that were processed. Of this amount, 0.18% was body, 0.10% tail, 0.36% crown, and 0.58% pith tissue. During the early part of the survey much of the rot tended to be associated with wounds on the tap root. The amount of rot remained low in the tap root and tail portions, but increased in the crown and pith as the season progressed (Fig. 2). Rot was 1.5 times as great in pith as in crown tissue.

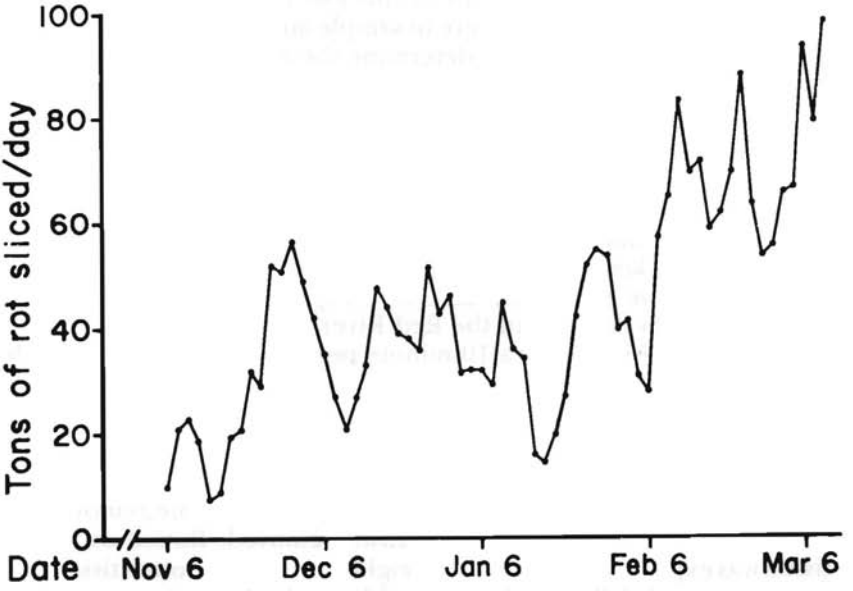

Figure 1. — Running average of the estimated daily amount of rotted sugarbeet tissue entering the Moorhead factory.

A 1-day comparison among the six factories showed the amount of rot ranged from 0.5 to 2.1% by weight with no statistical difference (Table 1).

Phoma betae (Oud.) Frank and *Penicillium claviforme* Bainier were the most prevalent pathogens. *P. betae* was more abundant than *P. claviforme* in pith tissue, but the prevalence of both fungi was comparable in other rotted tissues. Incidence of *Fusarium* spp. was much lower than of *Phoma* or *Penicillium*. *Botrytis cinera* Pers. was least frequent and was restricted to pith, crown and body tissue (Table 2).

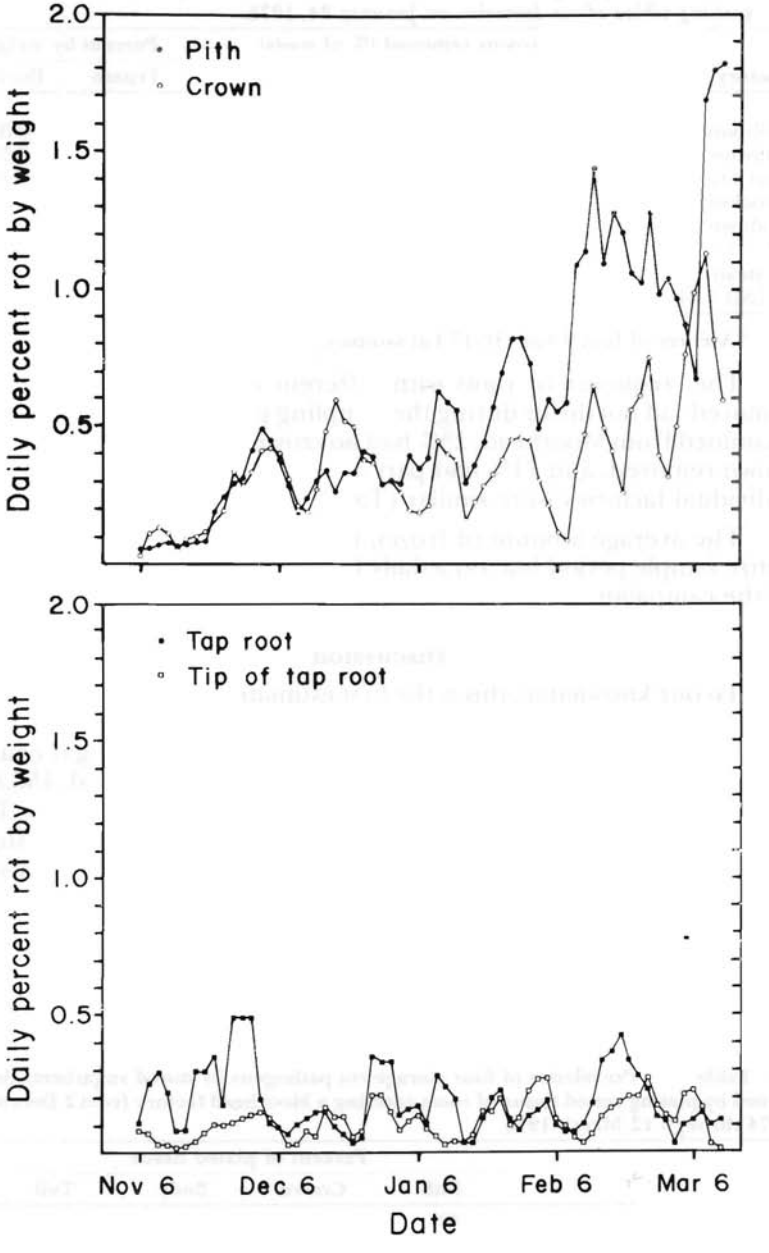

Figure 2. — Running average of the daily amount of rot occurring in the crown, pith, tap root, and tail of tap root at the Moorhead factory.

Table 1. — Topping classification, frozen tissue, and decay in beets selected from the picking tables of six factories on January 24, 1975.

Factory	Crowns removed (% of roots)			Percent by weight	
	None	Partial	All	Frozen	Decay
	%	%	%	%	%
Hillsboro	11[a]	83	6	55	2.0
Drayton	16	82	2	51	0.7
East Grand Forks	13	79	7	8	1.2
Crookston	14	78	8	58	0.5
Wahpeton	10	86	5	86	2.1
Moorhead	19	75	6	12	1.5
Mean	14	80	6	45	1.2
LSD 0.01	ns	ns	ns	28	ns

[a]Average of four 1-bag (10-17 kg) samples.

The frequency of roots with different amounts of crown tissue removed did not differ during the sampling period. Of the 2,246 roots examined from Moorhead, 23% had no crown removed, 6% had all the crown removed, and 71% had part of the crown removed. Data from individual factories were similar (Table 1).

The average amount of frozen tissue processed was 34% for the entire sample period but, on a daily basis, approached 75% at the end of the campaign.

Discussion

To our knowledge, this is the first estimate in the United States of losses of sugarbeets from decay that has been based on experimental data. From these loss data, we have estimated the loss of sugar caused by the decay of sugarbeets. During the 128-day survey period, 456,820 tons of sugarbeets were processed at the Moorhead factory. This tonnage times 1.22% equals 5,583 tons of rot, having a potential sugar yield of 1,113,240 lb. Much of the invert sugar in this rotted tissue probably was metabolized by microorganisms to non-melassigenic constituents. The melassigenic factor for the Moorhead factory after this campaign was 1.6. Undoubtedly, rotted tissue has a melassigenic factor higher than 1.6. A conservative estimate then would be that an additional 1,781,184 lb (1,113,240 × 1.6) of sucrose went to molasses

Table 2. — Prevalence of four storage rot pathogens in stored sugarbeets determined by plating rotted tissue of roots entering a Moorhead factory from 2 December 1974 through 12 March 1975.

	Percent of plated tissue			
	Pith	Crown	Body	Tail
Phoma betae	32	23	12	10
Penicillium claviforme	21	18	14	18
Fusarium spp.	4	8	8	11
Botrytis cinerea	0.4	0.9	1	0

Total pieces plated: 2,656.

because of the melassigenic properties of the rotted tissue. Therefore, the total sugar loss was estimated at 2,894,424 lb. Sugar losses probably were comparable at the other five factories in our region. The total sugar loss for the Red River Valley then could be estimated at 17,366,544 lb. At 20-45 cents per pound the loss would represent $3,473,308 to $7,814,945 minus a return from the molasses sold. This loss also could be expressed as 0.0495 lb of sugar lost/ton/day, or 10% of the 0.5/lb/ton/day loss which is considered average for our region.

These results support earlier observations that *P. betae* is the most important pathogen that causes decay of sugarbeets in the Red River Valley. The newly recognized pathogen *P. claviforme* (2)[2] was nearly as prevalent as *P. betae* but does not decay root tissue as rapidly as *P. betae*. The low incidence of *B. cinerea* probably was due to the antagonistic ability of *P. claviforme* (Bugbee, unpublished data).

Partially crowned roots decay faster than uncrowned or completely crowned roots because the exposed pith tissue is very susceptible to attach by *P. betae* (1). This survey has shown that 71% of the roots examined were partially crowned and that rot in the crown and pith was 2-6 times as great as in the tail or body. This suggests sugar loss from decay might be reduced if roots were uncrowned.

A Russian report more than 35 years ago referred to the susceptibility of the central core of the crown and suggested that crowns be cut cone-shaped rather than straight across to reduce losses from storage rot (3).

Summary

Sugarbeet roots were sampled from the picking table at a Moorhead, MN, factory from November 6, 1974, through March 12, 1975. During this 128-day period 1.22% by weight of roots processed were rotted. This amounted to an actual sugar loss of 1,113,240 lb plus another loss estimated at 1,781,184 lb of sucrose going to molasses (1.6 melassigenic factor). About 71% of the roots were partially crowned. This practice probably contributed to rot development. A sampling of roots from the Red River Valley showed that the amounts of crown removed and decay were similar among six factories. Three fungal pathogens were involved: *Phoma betae*, *Penicillium claviforme*, and *Botrytis cinerea*. The prevalence of *P. betae* was slightly greater than of *P. claviforme*. Both were much more prevalent than *B. cinerea*.

There was slightly more rot, associated with wounds, on the tap root than on the crown early in the storage period. Rot in the crown region developed slowly but eventually accounted for the greatest portion of rotted tissue compared to the tap root or tip of the tap root.

Literature Cited

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