Winter Protection of Piled Sugar Beet Roots[1]

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In Michigan and Ohio, sugar beet processing in recent years has been concentrated in about one half of the factories in operation a few years ago. This has resulted in a significant lengthening of the processing period and increasing difficulty in the processing of the last 10 to 15% of the beets. Not only has there been an increase in raffinose, which reduces extraction, but complete loss of a considerable volume of beet roots in the more unfavorable seasons.

In abnormally warm storage seasons, wilting may be prominent in beets on the outside or near the edges of the piles. In average seasons, freezing and thawing of beets to a depth of several feet is expected on the west slopes of the piles. In colder seasons, very deep freezing during cold periods is often followed by thawing in warm periods, particularly when beets remain in the piles much past the first of the year. In the process of fluming and washing, some of these thawed beets disintegrate entirely, and others are removed by discarding the soft beets in the process of loading them into trucks when transporting from the pile to the flumes. In any case, the problem of satisfactorily disposing of the spoiled beets is a formidable one, whether in the settling pond or in the piling area.

Experimental method in Michigan

In an attempt to reduce this apparent loss, financial and otherwise, parts of two piles of beets were covered with plastic sheets from November 28, 1960, to January 27, 1961, at Sebewaing, Michigan. Experience had shown that the prevailing westerly winds caused the greatest losses on the west slopes of piles running north and south. Such a pile was selected for most of the experiment. The pile was the standard truncated pyramid, about 600 × 120 feet on the base, 560 × 80 on the top and 19 to 20 feet deep. Plastic sheets 40 feet wide were used, both clear and black, in a thickness of 6 mils. Plastic was used on the west face only, except in one trial when a strip of plastic was used on the south face of a pile running east and west.

In some cases, straw, in various amounts, was used under the plastic. In one trial, straw only was used. In another trial, the

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plastic extended from the top to about 10 feet from the ground. The plastic was held in position by old tires and/or discarded twine fish nets. In each case, an uncovered strip was left adjacent to the covered one. In each segment of the pile, both covered and not covered thermometers were buried in three positions:

1. Six feet deep in the center of the top of the pile (never covered);
2. Six feet deep in the beets, about one-third of the way down the side, in both covered and not covered beets;
3. Six feet deep in the beets, about two-thirds of the way down the side, in both covered and not covered beets.

Other thermometers, outside the piles, gave air temperatures. All thermometers were read at 8 A.M. each day.

Results in Michigan

Figure 1 shows an over-all view of the experiment at Sebewaing. Figure 2 shows one segment of the pile (40 feet wide) covered with plastic. In order to condense the volume of data,

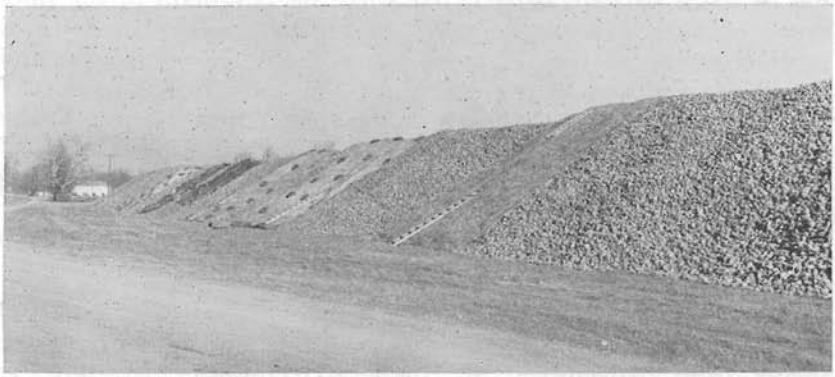

Figure 1.—An overall view of the experiment, Sebewaing, Michigan.

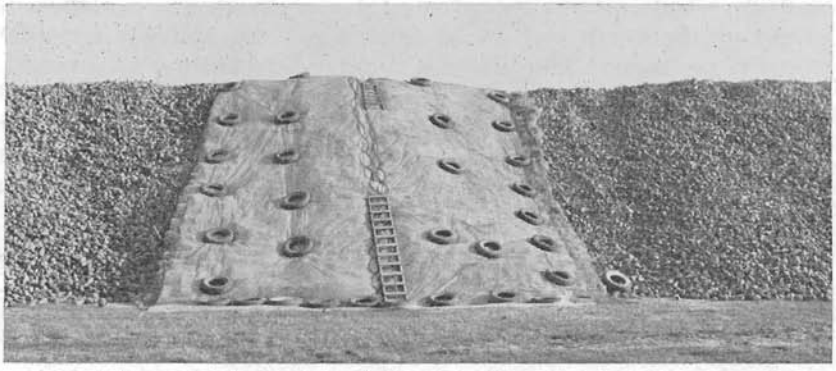

Figure 2.—A close-up of plastic over a covering of straw.

temperature readings for about every fifth day are given in Table 1. The days were selected to show the minimum temperatures attained in the "body" of the beets. "Body" temperatures are the average of the two side temperatures, 6 feet deep. "Top" temperatures are those taken 6 feet deep in the center of the uncovered top of the pile. For brevity, average temperatures for 5 closely agreeing checks are given, for 4 plastic-covered strips—two with and two without straw—and for one strip with straw only.

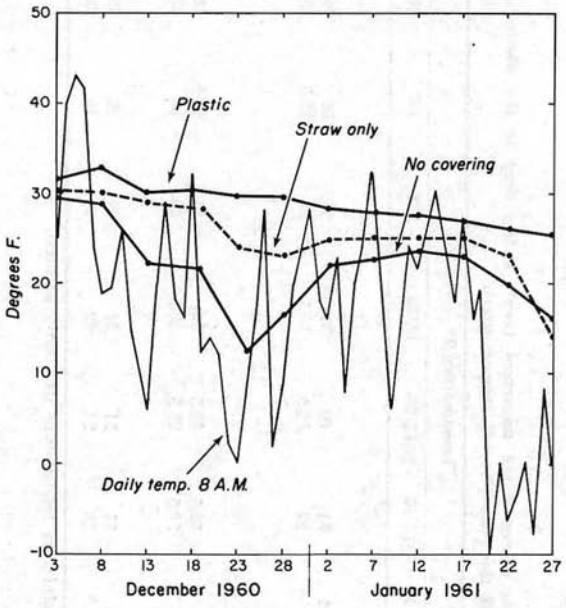

Figure 3.—Daily air temperatures at 8 A.M., Sebewaing, Michigan, and temperatures on the west side of the beet pile, six feet deep in the uncovered beets, six feet deep in the beets covered with straw only, and six feet deep in the beets covered with plastic.

In Figure 3, daily air temperatures are shown, together with (1) average "body" temperatures for the 4 strips fully covered with plastic, whether or not straw and twine were used, since these made almost no difference, (2) "body" temperature under straw only and (3) average "body" temperature of the 5 uncovered check strips.

The body temperatures of the plastic covered area and in the top of the pile running east and west were regularly from 2 to 3 degrees higher than that in the pile running north and south (Data not shown).

Table 1.—Temperatures (F°) 6 feet deep in the center of the uncovered "top", 6 feet deep in the uncovered beets ("body" temperatures) and 6 feet under the coverings on the west sides of the piles ("body" temperatures).

	Temperature F°												
Date*	11/28	12/3	12/6	12/13	12/18	12/24	12/28	1/3	1/7	1/2	1/17	1/22	1/27
Average 5 checks													
Top	47	32	32	30.5	31	29	31	29	30	29	29	28	27.5
Body	45	29.5	29	22	22	12.5	16.5	22	22.5	23.5	23	20	16
Average 4 plastic-covered													
Top	47	33	32	31	30.5	30.5	30	31	30.5	30	32	29	29
Body	44	32	33	30	30.5	29.5	29.5	28.5	28	27.5	27	26	26
Straw only													
Top	50	37	35	32	31	31	31	32	32	32	33	30	30
Body	44	30	30	29	28	24	23	25	25	25	25	23	14

* Temperatures at 5 day intervals, or on days of minimum temperature in "body" of beets.

Discussion

From Table 1 it can be seen that all top temperatures were within a degree or two of 30°F, no matter what the daily temperature, until the end of the experiment. This was due to convection of warmer air from the interior of the pile.

From figure 3, it is plain that covering with plastic held the beets at a rather uniform "body" temperature that gradually fell to 26°F by January 27. The uncovered body area is shown to vary widely in temperature, depending upon the weather, and to be from about 5 degrees to 18° F colder than when covered with plastic. The straw covered strip was intermediate in body temperature, and was readily affected by air temperatures. When plastic reached only to within about 10 feet of the base, effectiveness was greatly reduced (Data not shown).

The fact that uncovered strips interrupted the covering probably somewhat reduced the effectiveness of the coverings. Even so, the covered beets were frozen to not nearly the extent as those not covered, approximately 2 to 3 feet in the plastic covered vs. 12 to 14 feet in the uncovered check. Alternate freezing and thawing was equally reduced. We are informed that frozen beets can be sliced and extracted without appreciable trouble. If this is the case, protection from weather damage was almost complete with plastic covering.

Method in Ohio

In a similar trial at Fremont, Ohio, from November 9 to December 23, 1961, a strip about 100 feet long and 30 feet wide on one side of a pile of beets was covered with 4 mil clear plastic, and held in place by blowing asphalt-impregnated straw on top of the plastic. A machine used for stabilizing grass seedings along highways was rented for use in this experiment. One ton of straw was used in a layer 4 to 10 inches thick, together with 30 gallons of asphalt. This treatment proved adequate to hold the plastic in place even in heavy winds. Costs for labor ($15), straw ($12), asphalt and machine rent ($22) and plastic ($26) totaled $75, or about 1½ cents per ton of beets on approximately 5000 tons covered. It is felt that this could be reduced to something like 1 cent per ton, if operating on a larger scale, since the blower could cover a much larger pile area (75,000 tons of beets) at the same rental in an 8-hour day. Removal of the plastic and straw layer was rapid and easy.

Previous to covering the pile, 27 weighed beet samples, in numbered nylon mesh bags, were placed at depths of 4, 8 and 12 feet in the pile. On November 9, 27 duplicate samples were analyzed with the crown on the beet, for comparison with the

buried samples when they were removed from the pile 47 days later.

Results in Ohio

All except 2 of the 27 buried samples were recovered, weighed and analyzed for sugar. Since all samples were from one farmer's field, sugar percentage and shrinkage were remarkably constant. In averaging the results from the 25 recovered samples and their duplicates, the following results were obtained:

Avg Wt when placed in pile	Removed	Weight Shrinkage	Percentage sugar		Percentage total sugar apparently lost
			into pile	removed	
233.8 oz	230.8 oz	1.28%	13.82	13.78	1.57%

A portion of the pile was sliced as follows on December 23. The covered beets were handled in the first shift, and the two following shifts continued on the same pile with uncovered beets.

	First shift covered beets	Second shift not covered	Third shift not covered
Tons sliced	588	580	528
Avg purity	85.0	84.3	84.6
Avg sugar content	14.10	13.94	13.50
Total recovery per ton beets	239.6	235.0	228.4
Lb sugar per shift	140906	136300	120595

It is recognized that these plant operation figures are not adequate for accurate cost accounting. Since the calculated recovery of sugar per ton was 239.6 pounds for the covered beets and 231.7 pounds for those not covered, there appears to have been about 8 pounds extra recoverable sugar per ton in the covered beets. But, assuming a cost of about 1 cent per ton for the plastic protection, these figures indicate a recovery of perhaps 800 pounds of sugar per dollar expended in this experiment.

In this season in Ohio, the weather was never severely cold before the beets were removed from the piles and no freezing occurred. In the 47 day period, only three minimum night temperatures were below 20°F and only 8 were below 25°F. In contrast with the experiment in Michigan in 1960, where protection from deep freezing and thawing was a problem, here the main observable difference was in the degree of wilting of beets near the edges of the pile. The daily temperature of the covered beets averaged about 39°F during the last month, while the uncovered beets were about 4 degrees cooler, although with much greater fluctuation than was found in the covered beets.

Covering with plastic, while preventing penetration of rain and melted snow water into the pile, may also concentrate this water in limited areas, and in depressions in the plastic. This should be avoided. In these experiments molding of the beets was a very minor problem, but had the temperatures been higher, ventilation of the beets might have been advisable.

Summary of Ohio Experiment

Sugar beets in large piles were covered on one side with plastic sheets to protect the beets from wilting and freezing. It was found convenient to hold the plastic in position with asphalt-impregnated straw, blown into place. Costs, for labor and materials in covering about 5000 tons approximated 1½ cents per ton, but could be lowered if on a larger scale. Such covering reduced wilting of beets, and gave great protection from freezing and thawing. Factory operation for one day, indicated a slightly (8 pounds per ton) greater recovery of sugar from the covered beets.

Conclusions

These two "pilot plant" experiments in the use of plastic to prevent undue weather damage to piled sugar beets show considerable promise. Larger scale experiments in which factory operations could compare covered and uncovered beets for longer periods would yield valuable data on costs and sugar recovery and could lead to refinements in the technique. While, in these two experiments, the emphasis was mainly on protection from damage from prolonged freezing weather, it might be discovered that protection from dehydration, from mid-day warm winds, or from excessive rainfall might be of equal or greater importance in the conservation of sugar beet quality.