Effect of Delayed Lifting After Topping on Certain Chemical Constituents of Sugar Beets

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A large amount of development work to aid in growing and harvesting sugar beets has been done. This work was further stimulated by the war emergency and the need for reducing man hours required to grow the crop. Harvesting machines have received much study. One *type* of machine used is equipped with knives that top beets in place in the soil. After the topping operation, the leaves and crowns are raked to one side with a side delivery rake and then the roots are lifted by means of a plow. This breaks the connection of root with the soil but leaves it in place. Lifting and operations of removal from the ground and loading are sometimes delayed for several days after the topping operation is completed.

The original purpose of the investigation reported here was to determine the effect of delays in lifting after topping upon certain constituents of sugar beets. It seemed advisable, however, to determine also the effect of delays in removal from the ground upon sugar beets that were both topped and immediately lifted. The effects of the two practices could not be compared on the same days because of the volume of work involved. Samples from the plots topped but. not lifted were taken at 2-day intervals; from plots topped and immediately lifted the samplings were at 3-day intervals.

The air temperature prevailing at. the time this work was done varied from a daily mean maximum of 106° to a mean minimum of 62° F., while the temperature at the surface of the soil was even higher during the day. These temperatures are extreme, as compared to temperatures of areas in which beets are harvested in the fall, and therefore the changes in constituents of the beets would be greater.

The practice, called delayed topping, of severing the beet roots from the soil several days in advance of topping and hauling them to the factory for processing, has been examined. It was found (*1*)[2] that this procedure results in a loss in sugar yield. This loss is due not only to a direct loss in the field but also to the increase in harmful nitrogen which interferes with recovery of sugar in processing.

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[2]Italic numbers in parentheses refer to literature cited.

Materials and Methods

A field of sugar beets of the variety U.S. 15 growing under favorable conditions near Brawley, Calif., was selected for these studies. The beets were planted on beds with two rows 14 inches apart on each bed. The space between rows of two adjacent beds was 28 inches. The fertility level of the soil in this field was equivalent to that of the better soils of Imperial Valley. The portion of the field chosen had an exceptionally good stand of uniform beets spaced approximately 12 inches apart in the row. The plan of experimentation involved use of a strip of 26 rows approximately 500 feet long. On July 4 all the sugar beets in the experimental area were topped and the crowns and leaves were raked from the top of the bed into the furrow. Eight of the rows were lifted with a beet lifter and the other 18 rows were left unlifted. The lifting operation severed the roots from the soil and lifted them slightly above their growing position. Immediately after lifting, 16 samples of 15 beets each were taken at random for analysis from the experimental area. These were divided into two groups of eight 15-beet sanrpies each. There was no significant difference in sucrose percentage between these two groups. It was, therefore, concluded that eight 15-beet samples constituted an adequate sample. Subsequent sampling was at random for the experimental area concerned, eight. 15-beet samples being taken at each sampling period. Samples were taken immediately and at intervals of 2, 4, 6, 8, and 10 days after topping for the test in which the beets were topped but not lifted, and at intervals of 3, 6, and 9 days in the test in which the beets were topped and lifted.

Chemical Analysis

In these studies harmful nitrogen is considered as the nitrogen not. precipitated by copper hydroxide minus the total ammonia nitrogen (ammonia plus amid). The met hods used for determining harmful nitrogen were essentially those developed by European investigators. These methods are as follows: Three hundred fifty milliliters of distilled water were added to 100 grams of beet pulp and placed in a water bath at 85° C. Fifty milliliters of copper sulphate solution (60 grams of copper sulphate in 1,000 ml. of water) and 50 milliliters of sodium hydroxide solution (12.5 grams of sodium hydroxide in 1,000 ml. of water) were added and thoroughly mixed. The samples were then allowed to digest 15 minutes, with frequent shaking. The samples were cooled to room temperature, the air expelled, made up to volume of 500 ml. and filtered through dry paper pulp. An aliquot of 50 ml. was removed for the determination of the nitrogen not precipitated by the copper hydroxide. Total nitrogen was determined by a standard method which does not include the nitrates. An aliquot of 125 ml. was removed for the determination of ammonia plus amid

nitrogen. The samples were made 1 normal with sulfuric acid and were hydrolized for 2 hours, cooled, then neutralized with sodium hydoroxide. The samples were made alkaline with 40 ml. of an alkaline borate mixture (0.5 normal sodium hydroxide in 5 percent borax) and the ammonia distilled off at atmospheric pressure.

To eliminate so far as possible errors due to differences in percentage dry matter between fresh and flaccid beets, all samples harvested after the first day having a higher percentage of dry matter than fresh beets were corrected to approximately the percentage dry matter of the fresh beets.

Determinations of sucrose percentages followed the procedure used by the Division of Sugar Plant Investigations, U. S. Department of Agriculture. Each 15-beet sample was washed and drained. Each root of the sample was split longitudinally and the pieces were passed under a circular rasp. A fine pulp was rasped from each half beet section and thrown from the circular rasp in a series of layers on a metal band. The entire mass of pulp was taken from the band and thoroughly mixed by an electrically operated mixer. Twenty-six grams of pulp were taken for determination of sucrose percentage. Extraction of sucrose was by the cold water digestion method of Krueger, us modified by Sachs and Le Docte. Two hundred grams of pulp) from each of the eight 15-beet samples were placed in a freezing chamber and kept frozen until analyzed for nitrogen constituents.

For reducing sugars, 10 grams of pulp were placed in a 100 ml. Kohlrausch flask and sufficient neutral lead acetate added to clear the extract before the volume was made up to mark. The filtered extract was deleaded with sodium oxalate and again filtered. Reducing sugars were determined on an aliquot, usually 50 ml., of the lead-free filtrate by the Munson-Walker method[3].

Raffinose was determined by an official method [3] for beet products, using hydrochloric acid to invert the sugars before the second polariscope reading.

Experimental Results

Changes in dry matter, harmful nitrogen, sucrose, reducing sugars, and raffinose of beets topped and lifted and topped but not lifted are presented in table 1. A summary of the results is presented in figure 1. A significant increase occurred in percentage of dry matter from the first to the ninth day of the exposure period in the

[3]Association of Official Agricultural Chemists 1934 Official and Tentative Method of Analysis, Washington, D. C.

Table 1.—Results of changes in chemical constituents of sugar beets when topped and left in place with and without lifting.‡

Time after topping	Harmful nitrogen		Sucrose		Dry matter		Reducing sugars	
	Lifted	Not lifted	Lifted	Not lifted	Lifted	Not lifted	Lifted	Not lifted
Days	Grams†	Grams†	Percentage*	Percentage*	Percentage*	Percentage*	Percentage*	Percentage*
0	2.438	2.438	16.0	16.0	23.46	23.46	0.08	0.08
2		2.597		16.0		22.38		0.16
3	3.586		16.6		25.22		0.15	
4		2.509		15.3		22.34		0.71
6	3.129	2.377	15.01	15.7	29.31	22.97	0.47	0.69
8		2.195		15.9		22.87		0.57
9	3.824		13.60		34.33		2.81	
10		2.994		15.2		22.05		0.98

‡Results are averages of eight 15-beet samples.
*Corrected to 22.68 percent dry matter.
†Grams nitrogen per 1,000 grams dry tissue.

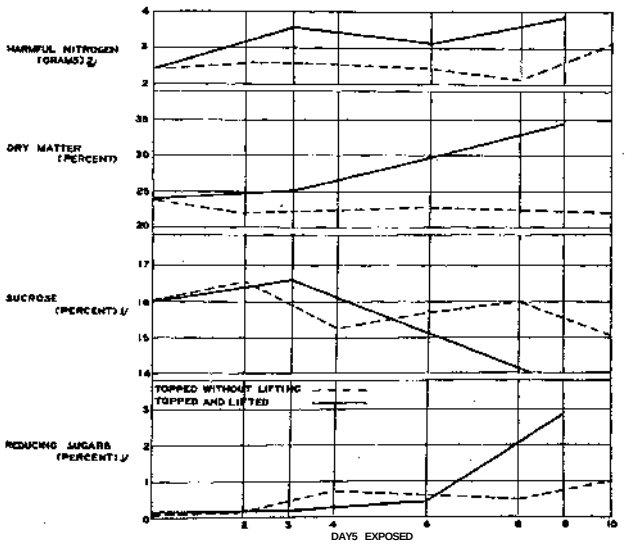

Figure 1.—Changes in chemical constituents of sugar beets when topped and left in place with and without lifting.

beets topped and lifted. In the beets topped but not lifted there was a gradual and significant decrease in percentage of dry matter. This decrease suggests that the beets absorbed moisture from the soil after the tops had been removed. In harmful nitrogen, beets topped and lifted showed a significant increase from the first to the ninth day of exposure. In beets topped but not lifted the harmful nitrogen showed a gradual decrease until the eighth day, and then there was a sharp rise on the tenth day that was statistically significant. Sucrose percentage in the lopped and lifted beds showed a gradual and significant decrease from the third to the ninth day. In beets topped but not immedialely lifted, the sucrose fluctuated somewhat but significant decrease occurred at the tenth day. In reducing sugars, beets topped and lifted showed a significant increase from the third to the ninth day of exposure. As the period in the soil increased, there was a gradual increase in reducing sugars in beets topped and not immediately lifted, with a sharp increase occurring at the tenth day of exposure.

Summary and Conclusions

A field test was conducted in the Imperial Valley of California in which comparisons were made of changes which took place in sugar beets topped and left undisturbed with those in which the sugar beets were topped and lifted. This test shows that sugar beets topped in place and left unlifted from 1 to 3 days did not change significantly in dry matter, harmful nitrogen, sucrose, or reducing sugars, while beets topped and lifted changed significantly in harmful nitrogen within a 3-day period after the lifting operation. This test also shows that changes occur more rapidly and to a grealer extent after the root connections with the soil are broken. It would therefore seem that, after lifting, prompt removal from the soil, loading, and hauling to the receiving station are advisable.

Literature Cited

1. Price, Charles et. al. Sucrose Loss and Changes of Nitrogen Constituents in Sugar Beets under Conditions of Delayed Topping. Jour. Amer. Soc. Agron. 33: 901-907. **1941.**