Effect of Agronomic Practices on Apparent Sucrose and Invert Sugar Levels During Storage of Sugarbeets (Beta Vulgaris L.)

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The objectives of this study were to determine the effects of chemicals, supplemental irrigation, nitrogen, and cultivars on invert sugar accumulation and apparent sucrose loss in sugarbeet roots stored for 150 days at 5 C. The data indicate the importance of controlling several agronomic practices that affect quality of sugarbeet roots during storage.

INTRODUCTION

The quality of sugarbeet *(Beta vulgaris* L.) roots stored in open piles deteriorates due to a buildup of impurities (6). Sucrose is lost because of respiration and inversion to glucose and fructose. Invert sugar (glucose and fructose) constitutes a major portion of the increase of impurities during storage. Storage temperatures affect invert sugar buildup (4). Other variables affecting sucrose loss and invert sugar accumulation are variety, date of harvest and various chemicals (3, 5, 6). These experiments were conducted to evaluate the effects of chemicals, cultivar, supplemental irrigation and fertilizer nitrogen on invert sugar accumulation and apparent sucrose loss in sugarbeet roots stored at 5°C for 150 days.

MATERIALS AND METHODS

Sugarbeet plants from three separate experiments were harvested manually in the fall of 1973, leaf petioles were trimmed at the base and the terminal buds were removed. Samples of 10 beets were stored in a perforated plastic bag (38 x 75 cm) at 5°C for 150 days. At harvest and 50-day intervals thereafter, samples from each treatment were removed, and pulp was obtained by sawing with a "spreckle's" saw. Pulp samples were frozen immediately and stored at -20°C for later analyses. Apparent sucrose was determined with a polarimeter by the cold digestion method (2) and invert sugars by 3,5-dinitrosalicylic acid (1) method, and values were corrected for weight loss in storage. No corrections were made for optical effects of raffinose, glucose or fructose on polarimeter values.

Chemicals

This experiment was conducted at the North Dakota Agricultural Experiment Station research plots, Fargo. Biuret, to be evaluated as a growth regulator (L-102), and three herbicides were used. Trichloracetic acid (TCA) was applied to soil surface as a preemergence spray (May 15) at 8.9 kg/ha. Phenmedipham (methyl m-hydroxycarbanilate m-methylcarbanilate) was applied as a postemergence spray (June 20) at 1.1 kg/ha, and EPTC (S-ethyl dipropylthiocarbamate) was incorporated before planting at 3.3 kg/ha. Biuret was applied as a spray 45 days prior to harvest at 57 kg/ha. All plots were hand-weeded throughout the growing season. Seed of 'American 2 Hybrid B' were planted on May 15, 1973. Soil test data showed a residual of 363 kg NO_3-N/ha to a depth of 60 cm. Six samples of 10 beets from each treatment were analyzed at each sampling period during storage.

Irrigation and Nitrogen Fertilization

Seed of 'HH-10' were planted on April 24, 1973, at the Oakes Research Site at Oakes, ND. Phosphorus and potassium were plowed down according to soil test results at 165 kg/ha of P_2O_5 and 82 kg/ha of K_2O, respectively. Nitrogen was applied at 0 and 114 kg/ha. Main plots were water levels replicated three times, with nitrogen levels as subplots. The main plots were irrigated by a sprinkler system. Water level 1 was a dryland condition with no irrigation water added. Water levels 1 and 3 were irrigated when soil water tensions were 660 and 550 millibars, respectively, at 30 cm. Water level 3 was considered the optimum level. It rained 26.4 cm during the growing season. Water levels 2 and 3 received an additional 23.6 and 31.8 cm of water, respectively. Seven samples of 10 beets of each treatment were analyzed at each sampling period during storage, except at harvest.

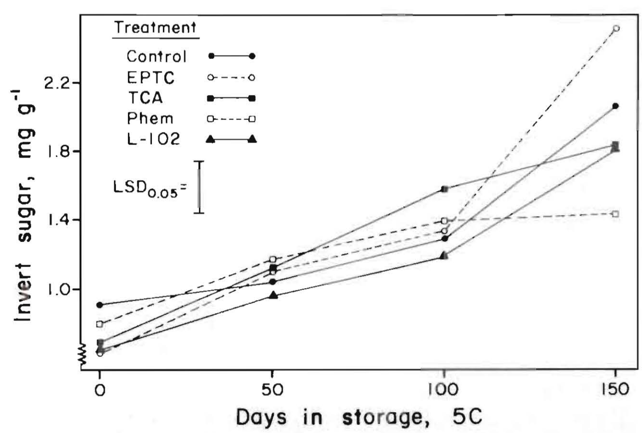

Figure 1. Effect of chemicals on invert sugar content of sugarbeet roots during a 150-day storage.

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Nitrogen and Cultivar

The experiment was conducted at Fargo, ND, and· planted on May 8, 1973. The experimental design was a split-plot (six replications) with nitrogen as main plots and cultivars as subplots. Nitrogen (ammonium nitrate) was broadcast at 0 and 330 kg N/ha. The residual soil nitrogen level was 165 kg NO_3-N/ha. 'American 4 Hybrid A' and 'Bush-Mono' were the cultivars tested. Six samples of 10 beets of each treatment were analyzed at each sampling period during storage.

RESULTS AND DISCUSSION

Chemicals

Sugarbeets treated with EPTC during the growing season were significantly higher in invert sugar than control sugarbeets after the 150-day storage, whereas invert sugar in roots from sugarbeets treated with phenmedipham was significantly lower than invert sugar in control roots (Fig. 1). Invert sugars of all treatments increased during the 150-day storage. Apparent sucrose was significantly higher in all treatments compared to the control when averaged over the storage period (Table 1). Sugarbeets treated with the herbicides and the growth regulator did not show a decrease in apparent sucrose, whereas the control sugarbeets showed a 14.2 per cent decrease during the storage period.

Table 1. Effect of three herbicides and a growth regulator on apparent sucrose of sugarbeet roots averaged over a 150-day storage.

Treatment	Apparent sucrose, %
Phenmedipham	13.9 a*
L-102	13.8 ab
EPTC	13.5 bc
TCA	13.3 c
Control	12.7 d

**Values followed by the same letter do not differ significantly according to Duncan's multiple-range test. Values represent means of six samples at each of four sampling dates (0, 50, 100, and 150 days).*

Irrigation and Nitrogen Fertilization

Sugarbeet roots grown under moisture stress had a higher invert sugar content after storage than did roots grown under more optimum moisture when averaged over nitrogen treatments (Fig. 2). Nitrogen fertilization did not significantly affect invert sugar content of roots grown under the different moisture levels when averaged over the storage period. However, under optimum moisture, sugar-

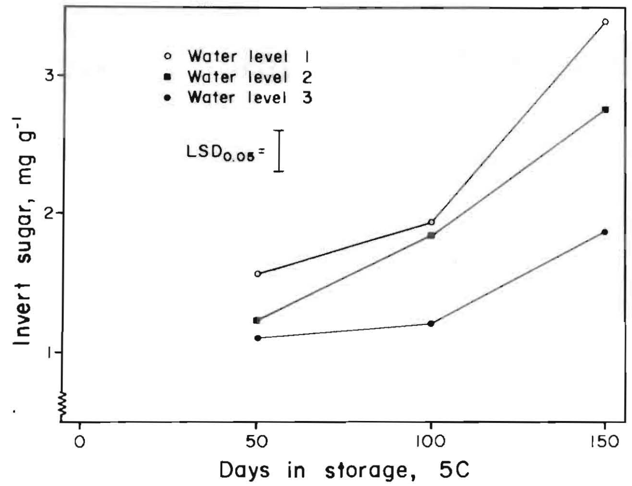

Figure 2. Effect of moisture stress on invert sugar content of sugarbeet roots during a 150-day storage.

beet roots grown with additional nitrogen were 31 per cent lower in invert sugar content than the control nitrogen treatment at the end of storage. Sugarbeet roots grown under the two moisture-stress levels were only 6 per cent lower in invert sugars, due to nitrogen application. Apparent sucrose was reduced significantly by nitrogen fertilization (Table 2). Sugarbeets grown under moisture stress were significantly lower in apparent sucrose. Interactions among storage time, water levels and nitrogen rates were nonsignificant.

Table 2. Effect of irrigation and fertilizer nitrogen (N) on apparent sucrose of sugarbeet roots averaged over a 150-day storage.

Fertilizer nitrogen (N)	Water level 1	2	3	Mean
		%		
0	13.5	14.2	14.6	14.1 a*
114 kg/ha	12.7	13.3	14.2	13.4 b
Mean	13.1 c	13.7 b	14.4 a	

**Means followed by the same letter in a column or row do no differ significantly according to Duncan's multiple-range tes Values represent means of seven samples at each of three sampling dates (50, 100, and 150 days).*

Nitrogen and Cultivar

The application of 330 kg/ha of fertilizer nitrogen did not significantly alter invert sugar levels of two cultivars of sugarbeets stored for 150 days. The storage date by cultivar interaction was the only interaction that significantly affected invert sugar. Invert sugar increased significantly in

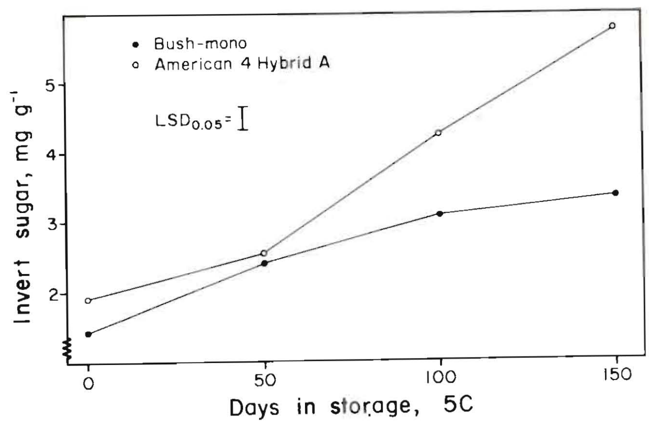

Figure 3. Effect of cultivars on invert sugar content of sugarbeet roots during a 150-day storage.

both cultivars with time in storage, especially after 50 days (Fig. 3) when averaged over nitrogen rates. American 4 Hybrid A was significantly higher than Bush-Mono in invert sugar when averaged over all storage dates.

Application of 330 kg/ha of nitrogen significantly reduced apparent sucrose averaged over cultivars (Table 3). American 4 Hybrid A and Bush-Mono were reduced 15.9 and 13.1 per cent, respectively, in apparent sucrose, due to the addition of nitrogen. American 4 Hybrid A was significantly higher than Bush-Mono in apparent sucrose at harvest and after 150 days of storage.

Table 3. Effect of fertilizer nitrogen (N) and cultivars on apparent sucrose of sugarbeet roots averaged over a 150-day storage.

	Nitrogen, N		
Cultivar	Residual 165 kg/ha	330 kg/ha	Mean
Bush-Mono	12.2	10.6	11.4 b*
American 4 Hybrid A	13.2	11.1	12.2 a
Mean	12.7 a	10.8 b	

**Means followed by the same letter within a row or column do not differ significantly according to Duncan's multiple-range test. Values represent means of six samples at each of four sampling dates (0, 50, 100, and 150 days).*

SUMMARY

Apparent sucrose was significantly higher in sugarbeet roots treated with three herbicides and a growth regulator when averaged over all sampling dates during storage of the roots. Irrigation significantly increased apparent sucrose content, and nitrogen fertilization in the field lowered the sucrose content. 'American 4 Hybrid A' was significantly higher in apparent sucrose than 'Bush-Mono', and fertilization lowered sucrose content of both varieties. Invert levels during storage were affected significantly by time in storage, herbicides, cultivar and irrigation.

The results reported indicate that nitrogen, cultivars, chemicals and moisture stress can significantly affect apparent sucrose and invert sugar levels during storage of the sugarbeet roots. These practices become increasingly important when temperature increases within the storage piles, since the beets deteriorate faster at higher temperatures (3). An increase in invert sugars reduces the amount of sucrose that can be extracted from the roots. Therefore, it becomes critical that all factors affecting the storability of sugarbeet roots be evaluated and managed to produce high quality roots for storage.

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