Effects of Preharvest Sprays of Maleic Hydrazide on Sugar Beets

F. H. PETO[1] W. G. SMITH[2] AND F. R. LOW[3]

A study of 20 years results from the Canadian Sugar Factories at Raymond, Alberta, (1)[4] shows that killing frosts occurring prior to harvest almost invariably cause a drop in sugar in the root. Sugar losses are most severe when rapid regrowth of tops occurs after freezing. Wittwer and Hansen (2) checked regrowth of tops in pile storage and reduced sugar losses by preharvest applications of maleic hydrazide.

Preliminary small scale experiments conducted at Vancouver, B. C., were designed to determine whether foliar sprays of maleic hydrazide prior to freezing would check regrowth of leaves after freezing and thereby conserve sugar. Controlled freezing in the field was achieved by the use of dry ice in an insulated box which was placed over the plants. A large scale field experiment was conducted at Taber, Alberta, to study the effects of preharvest sprays of maleic hydrazide on yield and sugar content at harvest, and the sugar and weight shrink during a storage period of 34 days.

Materials and Methods for Preliminary Experiments

A Naugatuck formulation of maleic hydrazide (M. H.) of 30 percent concentration was used in all of the experiments. This was diluted to one part per 100 and applied at approximately 50 gallons per acre.

Experiment 1.

In order to study the effects of midsummer M.H. treatments, beets were planted in the greenhouse March 20 and transplanted to the field in early May at Vancouver with beets spaced 8 inches apart. Each plot was limited to four beets to facilitate freezing in the field. There were four treatments replicated seven times as follows: 1. check, 2. M. H., 3 M. H. + Freeze, 4. Freeze. The M. H. was applied July 30 and the tops were frozen off August 16. The method of freezing consisted of covering four beets in the field with an insulated box 40 x 14 x 16 inches. Wire mesh trays containing about 60 pounds of dry ($C0_2$) ice were placed on a rack in the upper portion of the box. A 15-minute treatment period with such an apparatus was used to destroy the tops without noticeable damage to the crown.

The beets were harvested September 4. The tops, including the crowns, were weighed separately from the roots and the sugar content of the latter was determined.

Experiment 2

The same four treatments were used in this instance as in Experiment 1, but this experiment differed mainly in the fact that both planting and treatment were six weeks later, although the beets were approximately the same size at time of treatment. Another minor difference was the reduction in the number of replicates from seven to six. The M. H. treatments were applied September 18, and freezing treatments October 2 and the experiment was harvested October 18.

[1] Director, Agric. Res., B. C. Sugar Refining Co., Vancouver, B.C.
[2] Agronomist, Canadian Sugar Factories Ltd., Taber, Alberta.
[3] Agronomist, B. C. Sugar Refining Co. Ltd., Vancouver, B. C.
[4] Numbers in parentheses refer to literature cited.

Table 1.—The Effect of Maleic Hydrazide Without Frost.

Experiment	Date of Treatment M.H.	Date of Treatment Freeze	Interval Between M.H. Treatments and Harvest	Date of Harvest	Percent Sugar Ck.	Percent Sugar M.H.	Percent Sugar % Change	Ave. Root Wt. Gms. Ck.	Ave. Root Wt. Gms. M.H.	Ave. Root Wt. Gms. % Change	Ave. Top Wt. Gms. Ck.	Ave. Top Wt. Gms. M.H.	Ave. Top Wt. Gms. % Change
1	July 30		36 days	Sep. 4	13.43	15.14	+12.6[1]	195	139	—28.7	178	97	—45.5[1]
2	Sep. 18		30 days	Oct. 18	14.0	14.5	+ 3.5	163	178	+ 9.2	298	275	— 8.4
3	Oct. 2		15 days	Oct. 17	13.6	13.9	+ 2.2	174	160	— 8.0	343	313	— 8.7
3	Oct. 2		22 days	Oct. 24	14.2	14.7	+ 3.5	162	198	+22.2	295	309	+ 4.7
3	Oct. 2		29 days	Oct. 31	15.3	15.2	— 0.6	177	159	—10.2	272	242	—11.0

Effect of Freezing Without Maleic Hydrazide

					Percent Sugar Ck.	Percent Sugar Freeze	Percent Sugar % Change	Ave. Root Wt. Gms. Ck.	Ave. Root Wt. Gms. Freeze	Ave. Root Wt. Gms. % Change	Ave. Top Wt. Gms. Ck.	Ave. Top Wt. Gms. Freeze	Ave. Top Wt. Gms. % Change
1		Aug. 16	—	Sep. 4	13.43	12.0	—10.6[1]	195	138	—29.2	178	55.7	—69.9[1]
2		Oct. 2	—	Oct. 18	14.0	11.7	—16.4[1]	163	156	— 4.3	298	220	—26.2

Effect of Freezing on Maleic Hydrazide Treated Plots

					Percent Sugar M.H.	Percent Sugar M.H.+Fr.	Percent Sugar % Change	Ave. Root Wt. Gms. M.H.	Ave. Root Wt. Gms. M.H.+Fr.	Ave. Root Wt. Gms. % Change	Ave. Top Wt. Gms. M.H.	Ave. Top Wt. Gms. M.H.+Fr.	Ave. Top Wt. Gms. % Change
1	July 30	Aug. 16	36 days	Sep. 4	15.14	12.72	—16.0[1]	139	130	— 6.5	97	41	—57.7[1]
2	Sep. 18	Oct. 2	30 days	Oct. 18	14.5	12.6	—13.1[1]	178	163	— 8.4	275	231	—15.4

Effect of Maleic Hydrazide Treatments Prior to Freezing Tops

					Percent Sugar Freeze	Percent Sugar M.H.+Fr.	Percent Sugar % Change	Ave. Root Wt. Gms. Freeze	Ave. Root Wt. Gms. M.H.+Fr.	Ave. Root Wt. Gms. % Change	Ave. Top Wt. Gms. Freeze	Ave. Top Wt. Gms. M.H.+Fr.	Ave. Top Wt. Gms. % Change
1	July 30	Aug. 16	36 days	Sep. 4	12.0	12.73	+ 6.1[1]	138	130	— 5.8	55.7	41.0	—26.6
2	Sep. 18	Oct. 2	30 days	Oct. 18	11.70	12.60	+ 7.7[1]	156	163	+ 4.5	220	231	+ 5.0

[1] Difference significant to the 5% point

A comparison of Experiments 1 and 2 should give some indications of the influence of rate of growth on the effectiveness of M. H. treatments, since the growth rate would be much more rapid on July 30 than September 18.

Experiment 3

The objective in this experiment was to compare 2-, 3- and 4-week intervals between M. H. treatment and harvest.

Six plots were sprayed with M.H. and these were randomized with six check plots. The treatment was applied October 2 and on each of the harvest dates four beets were harvested from each treated and check plot.

Discussion of Preliminary Experiments

The data from three preliminary experiments have been consolidated in Table 1.

Effect of Maleic Hydrazide Without Frost

The results demonstrate that the July 30 application of M. H. checked root and top development and increased the sugar content to a much greater extent than did the September 18 and October 2 treatments. It appears likely that environmental conditions favoring rapid growth are those which result in maximum response to M. H. There would not be an economic advantage from the early treatments since the increase in sugar content did not compensate for the loss of weight.

In Experiment 3, there was no significant difference between the M. H. treatment and check in regard to percent sugar, root weight or top weight. Therefore, no conclusions can be drawn from effect of the interval between treatment and harvest.

Effect of Freezing Without Maleic Hydrazide

Freezing caused large and significant losses in sugar content of the root in both experiments. The late frost of October 2 caused larger losses in percent sugar than the early frost. The reduction in top weight was particularly striking in Experiment 1, but less so in Experiment 2 when the beet leaves would naturally be more frost-resistant. Reduction in root weight from frost was proportionally less than top weight in both experiments, and although the earlier frost treatment caused greater root weight reductions than the latter, the diffffferences were not statistically significant because of wide variability in root size in a four-beet sample.

Freezing in the field with dry ice is a very promising experimental method, but the size of the freezing box or the number of replicates must be increased to yield significant differences in weight of roots and tops.

Effect of Freezing on Maleic Hydrazide-treated Plots

Freezing caused large and significant losses of sugar in M. H.-treated plants in both Experiments 1 and 2. The freezing also caused a significant reduction in top weight in Experiment 1. There was a very small and insignificant reduction in root weight from the freezing.

Effect of Maleic Hydrazide Treatments Prior to Freezing Tops

The main objective of these particular treatments was to determine whether the serious losses in sugar resulting from freezing could be reduced by application of M. H. prior to freezing.

M. H. applications prior to freezing increased significantly the sugar content by 0.73 and 0.9 percent above the frozen plots. In experiments 1 and 2 freezing without M. H. caused reductions in sugar content of 1.43 and 2.3 percent respectively. M. H. treatments prior to freezing in the same experiments reduced these losses to 0.7 and 1.4 percent respectively. Thus, the average losses from frost were reduced 46 percent by M. H. treatments prior to freezing.

The M. H. applications prior to freezing had no apparent effect on root weight, but they reduced the amount of top regrowth in Experiment 1. In Experiment 2, there was no indication of reduction of top regrowth, but the M. H. treatment nevertheless conserved sugar.

Table 2.—Maleic Hydrazide Field Experiment, Taber.

Date Sampled		Acre Yield Sugar Lbs.	Acre Yield Beets Tons	Percent Sugar	Purity	Beets per 100 ft row
Oct. 5	Check	3,562	12.78	14.04	85.67	92
	Treated	3,578	13.00	13.82	85.20	87
	Diff.	16	.22	.22	.47	
	L.S.D.	428	1.97	.71	1.93	
Oct. 16	Check	3,526	12.19	14.58	84.44	88
	Treated	3,580	12.02	15.00	84.64	87
	Diff.	54	.17	.42	.20	
	L.S.D.	450	.63	.80	.90	
Nov. 2	Check	3,661	13.89	13.20	83.64	88
	Treated	3,494	13.37	13.14	83.26	93
	Diff.	167	.52	.06	.38	
	L.S.D.	450	1.93	.63	.90	

Field Experiment, Taber

This was a field scale experiment conducted at Taber, Alberta, on commercial beets. Four strips of one-half acre each were treated September 22, 1951 with approximately 50 gallons per acre of one part per 100 of M. H. 30. These strips were alternated with check strips of equal size. One-half inch of snow fell between 14 and 21 hours after treatment. Night frosts and light snow were reported September 24-27, with a minimum temperature of 26° F. on the latter date. The beets recovered from these early frosts and made slight growth in early October, but severe weather was encountered again on October 15 with 15 inches of snow between October 15 and 21 with minimum temperatures as low as 10° F. which, of course, largely destroyed the tops and damaged many of the crowns to a depth of two inches. Intermittent heavy frosts with occasional snow storms continued until the beets were dug and placed in storage November 12 and 13. Although the beets were not frozen on being placed in storage, about 90 percent showed discoloration for a depth of two inches in the crown and would normally be considered unsuitable for storage. About ten percent of the beets appeared frost-resistant.

Preharvest samples were taken October 5, October 16 and November 2 from the treated and check plots. A single sample consisted of the beets harvested from 50 feet of row, 20 samples were harvested on each date, 10 from each of the treated and untreated plots. The yield and sugar content were determined on each sample.

The remainder of the experiment was harvested and placed in bin storage November 12 and 13. The beets were stored to a depth of 90 inches in bins 8 x 10 feet. A sample of 20 beets was taken from each 10-inch level from both the treatment and check bins on filling the storage bins and similar samples were taken on removal from storage December 17. The storage temperatures at the center of each pile were recorded throughout the storage period with a two-pen recording thermometer.

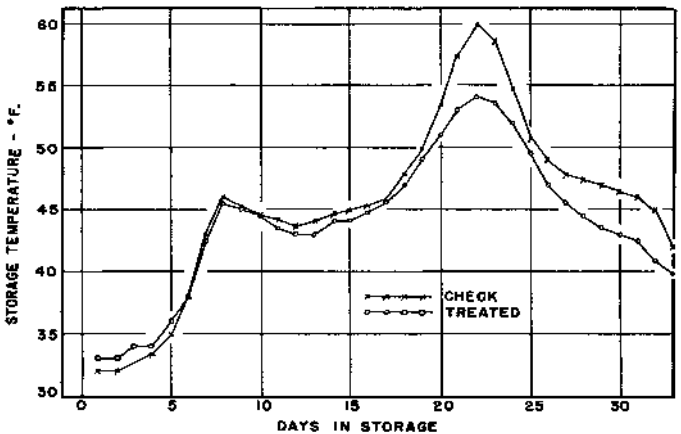

Figure 1. Effect of preharvest spray of maleic hydrazide on storage temperatures.

The beets from the check and treatment plots were weighed before and after storage, but the mud tare present under such difficult harvest conditions probably reduced the accuracy of the weight and total sugar data.

Discussion of the Taber Field Experiment

The field treatments of maleic hydrazide were applied September 22 and the results from the samples harvested on October 5, 16 and November 2 are shown in Table 2. The treatment had no apparent effect on tonnage, percent sugar or purity. While intermittent frosts and snow subsequent to treatment may have reduced the effectiveness of the treatment, nevertheless, the results are in agreement with preliminary experiment 3 conducted at

Vancouver under more favorable conditions and with those obtained by Wittwer and Hansen.

The temperatures recorded during the storage period are plotted in Figure 1. There was very little difference betwen the treatment and check temperatures for the first 17 days of storage, but during the remainder of the storage period, the treated beets remained consistently cooler. During this period, the temperature differences were similar to those obtained by Wittwer and Hansen and indicate that the M. H. may have had a depressing effect on the respiration rate.

On removal from storage, approximately one-third of the beets in each bin was partially rotted. This condition was worse in the crowns and in some cases it extended to a depth of two inches below the crown. There was very little regrowth during storage, and there were no observable differences between treatment and check in this regard.

A summary of the data obtained from the storage experiment is shown in Table 3. The treated beets contained 0.25 percent more sugar than the check at the commencement of storage and 0.38 percent more at the completion of storage. The latter difference was not statistically significant. The treated beets lost slightly less sugar during storage than the untreated beets, but again the small difference of only 0.13 percent was not significant.

Table 3.—Storage Test, Taber

	Untreated	Treated
Sugar Content (Mean of 9 samples)		
Initial	15.11%	13.36%
Final	12.42%	12.80%
Loss during storage	.69%	.56%
Purity (mean of 9 samples)		
Initial	83.17%	83.27%
Final	81.43%	82.00%
Loss during storage	1.74%	1.27%
Weight		
Initial	21,599 lbs.	20,711 lbs.
Final	19,349 lbs.	18,701 lbs.
Shrink during storage	2,250 lbs.	2,010 lbs.
Shrink during storage	10.42%	9.71%
Total Sugar		
Initial	2,832 lbs.	2,767 lbs.
Final	2,405 lbs.	2,394 lbs.
Loss during storage	429 lbs.	373 lbs.
Loss during storage	15.15%	13.48%

At the completion of the storage period, there were slight differences in favor of the treated lot with regard to purity, shrink in weight during storage and loss of total sugar in storage. All the differences recorded in Table 3 show a trend in favor of the treatment and, while they are not statistically significant, they are sufficiently encouraging to justify further and more extensive experiments with maleic hydrazide.

Summary

In preliminary experiments, mid-summer foliage spraying of sugar beets with maleic hydrazide increased significantly the sugar content above the

untreated, but severely checked plant growth. Later treatments had no significant effects on either sugar content or root weight.

Freezing of beets caused severe reductions in sugar content.

The average losses in sugar content through frost damage were reduced 46 percent by M. H. applications prior to freezing.

M. H. treatments applied September 22 with a power sprayer to four strips of commercial beets at Taber, Alberta, failed to alter significantly either the sugar content or yield from sample plots harvested October 5, 16 and November 2.

Ten ton lots of treated and untreated beets with a heavy dirt tare were held in storage bins for 34 days. For the first 17 days of storage, the temperatures in the two lots were very similar. Subsequently, the temperature in the check bin rose to a maximum of 6° F. above the treated bin. The treatment exceeded the check by 0.25 percent sugar at the beginning of storage and 0.38 percent at the termination of storage, but these differences were not statistically signifificant.

Literature Cited

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