Gibberellin and Maleic Hydrazide as Growth Regulators in Sugar Beets[1]

K. SCHREIBER AND A. C. FERGUSON[2]

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Earlier experiments conducted in Manitoba during the years 1960, 1961, 1963 and 1964 (4)[3] demonstrated that foliar applications of gibberellic acid at the rate of 250-500 ppm in 15 gallons of water per acre consistently increased yield and decreased sugar content, while maleic hydrazide (MH-30), when applied at a concentration of 0.3% (W/v) in 15 gallons of water per acre, consistently increased sugar content, but decreased yield of sugar beets.

Although the two regulators produce opposite effects, the critical time of application for each appears to be in late August or approximately 5 weeks prior to harvest (4).

In 1965, two experiments were conducted: a) to study the effect of several new growth regulators on sugar beets; and b) to determine, whether an increased yield of sugar per acre could be obtained by combining gibberellin and maleic hydrazide.

Materials and Methods

In the first experiment, materials were tested in a randomized block test with 9 treatments in 4 blocks as follows: gibberellic acid; maleic hydrazide; phosphamidon, a systemic insecticide, supplied by CIBA in Basle (Switzerland); ortho-phaltan, a product of the California Chemical Company; a combination of phosphamidon and ortho-phaltan; NIA 8198 and B-995, both new experimental plant growth regulators of the Niagara Brand Chemicals; and "TIBA", a 2, 3, 5-triiodobenzoic acid ($I_3C_6H_2COOH$).

Maleic hydrazide (0.3%) and gibberellic acid (500 ppm), applied at three dates (August 9, 18 and 27) and an untreated check were tested in a factorial experiment of 8 replications.

On August 9, 18 and 27, 100 beets were sampled from controls and the following ratios of the weight of tops (including crowns) to the weight of roots were determined: August 9 - 2.45; August 18 - 1.36; August 27 - 1.23.

While the impact of frost on an immature crop cannot be positively specified, the results of both tests must be assessed in the light of a frost period which lasted from September 15 to October 4, dipping on September 25 and 26 to a low of 19° F.

[1] Contribution No. 125 of The Department of Plant Science, University of Manitoba, Winnipeg, Canada.

[2] Research Associate and Professor of Horticulture, University of Manitoba, Winnipeg, Manitoba, respectively.

[3] Numbers in parentheses refer to literature cited.

The following features were identical in both experiments: 1) monogerm seed (treated with Captan) of the variety CS-7 was used; 2) plots consisted of four rows 60-feet long spaced 22" apart and beets were thinned 12 to 15 inches apart in the rows; 3) the two center rows, trimmed to 50 feet were used for all determinations; 4) all foliage treatments were sprayed at the rate of 15 gallons of solution per acre, with a non-ionic surface active agent (Atlox sticker spreader) added to sprays according to the manufacturer's recommendations; and 5) both experiments were planted on May 28 and harvested on October 14, 1965.

Results and Discussion

Details of treatment, yields per acre and sugar data for the first experiment are given in Table 1.

The only significant treatment effect was the reduction in sugar content by gibberellic acid. The difference of approximately 2 tons in yield in favor of G. A. treated beets compared with the control, concurs with our previous reference (1) even though no significant level is reached. In spite of a depressed sugar percentage, beets treated with G. A. had the highest thin

Table 1.—Test with various growth regulators.

Treatments	Pounds sugar per acre	Tons per acre	% sugar	Thin juice purity
1. Gibberellic acid at 500 ppm	5295a[1]	17.66a	15.20b	93.88a
2. Phosphamidon at 0.4 litre P/A	5729a	17.33a	16.52a	93.77a
3. Phosphamidon plus ortho-phaltan at 0.4 litre and 0.8 kg P/A resp.	5713a	17.33a	16.47a	93.76a
4. Ortho-phaltan at 0.8 kg P/A	5654a	17.00a	16.63a	93.64a
5. Maleic hydrazide at 0.3%	5670a	16.95a	16.75a	93.60a
6. Niagara 8198 at 400 ppm	5213a	15.97a	16.38a	93.45a
7. TIBA at 400 ppm	5187a	15.86a	16.35a	93.42a
8. Control	5197a	15.59a	16.65a	93.41a
9. B-995 at 500 ppm	5156a	15.53a	16.60a	93.09a
General mean	5424	16.58	16.39	93.56
Coefficient of variability (%)	9.16	10.07	2.20	0.58
S. E. of mean	248	0.84	0.13	0.29

[1] Means not followed by a common letter are significantly different at the 5% level.

juice purity. Maleic hydrazide failed to affect either yield or sugar content of sugar beets. The same applies to all newly tested regulators.,

In the second experiment, the effect of treatments on yields, percent sugar, gross sugar, percent extractable sugar and pounds extractable sugar per acre is presented in Table 2.

Table 2.—The effect of gibberellic acid and maleic hydrazide sprays on yield and quality of sugar beets.

	Tons per acre					1965 Percent sugar					Lbs sugar per acre				
	Mo	M1	M2	M3	Avg.	Mo	M1	M2	M3	Avg.	Mo	M1	M2	M3	Avg.
Go	11.23	11.36	10.89	11.21	11.17	17.32	17.22	17.18	17.20	17.23	3893	3908	3743	3855	3849
G1	11.80	10.89	11.70	11.98	11.59	16.25	16.78	16.82	16.48	16.58	3832	3656	3971	3946	3851
G2	12.67	11.05	13.14	11.48	12.08	15.93	15.83	15.77	16.12	15.91	4036	3503	4134	3710	3846
G3	12.59	12.27	13.47	13.22	12.89	15.62	15.80	15.75	15.82	15.75	3929	3878	4244	4176	4057
Avg.	12.07	11.39	12.30	11.97	11.93	16.28	16.41	16.38	16.40	16.37	3922	3736	4023	3922	3901

	Percent extractable sugar					Lbs extractable sugar per acre				
	Mo	M1	M2	M3	Avg.	Mo	M1	M2	M3	Avg.
Go	15.03	15.09	15.01	14.88	15.00	1687	1711	1633	1668	1675
G1	13.99	14.65	14.61	14.07	14.33	1641	1595	1710	1678	1656
G2	13.57	13.44	13.07	13.86	13.49	1720	1486	1707	1593	1627
G3	13.31	13.70	13.59	13.61	13.55	1676	1680	1825	1779	1740
Avg.	13.98	14.22	14.07	14.10	14.09	1681	1618	1719	1680	1675

The following treatment-notation is used:

G = Gibberellic acid — No application—affix "0"
M = Maleic hydrazide — Application August 9—affix 1
" 18 " 2
" 27 " 3

Example: M1G3 = maleic hylrazide applied August 9 and gibberellic acid applied August 27.

Variance table

Source of Variation	Degrees of freedom	Mean Squares: Tons beets	% sugar	Lbs sugar per acre	% extractable sugar	Lbs extractable sugar per acre
Total	95					
Blocks	5	12.26	0.45	1,235.16	0.49	181.37
Gibberellin	3	12.97	11.18	259.12	12.39	61.73
Maleic hydrazide	3	3.56	0.10	342.98	0.24	43.09
Gibberellin × maleic hydrazide	9	1.88	0.16	173.13	0.45	29.44
Error	45	1.59	0.11	179.99	0.29	31.11
L.S.D. 5% - G. A.		0.72	0.60	n.s.	0.30	n.s.
L.S.D. 5% - M. H.		0.72	n.s.	n.s.	n.s.	n.s.
L.S.D. 5% - G. A. × M. H.		n.s.	n.s.	n.s.	n.s.	n.s.

Gibberellic acid significantly increased tonnage and lowered sugar and extractable sugar percent when applied on August 27.

In contrast to the results in other years, maleic hydrazide had a rather erratic effect on tonnage. In earlier experiments (1), maleic hydrazide tended to lower the yield and increase the sugar percent, when applied in late summer. In this connection it should be pointed out, that the foliage:root ratio in late August 1965 indicated an unusually lush vegetative development. Two weeks later the crop was subjected to an extended frost period which seriously damaged the foliage. It is conceivable that this severe growth check interfered with or masked the effect of this treatment.

Combinations of gibberellic acid and maleic hydrazide had no effect on either pounds sugar per acre or pounds extractable sugar per acre.

The lack of a significant interaction between gibberellic acid and maleic hydrazide on pounds sugar per acre, may indicate that these treatments can not be combined in such a manner as to increase the recovery of sugar per acre although frost could have interfered with their manner of reaction. The data on percent extractable sugar or pounds extractable sugar per acre did not aid in evaluating treatment effects.

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Literature Cited

(1) SCHREIBER, K. and A. C. FERGUSON. 1966. Effect of growth regulators on yield and quality of sugar beets. J. Am. Soc. Sugar Beet Technol. 14 (1): 67-74.