A Study of the Effect of Magnesium Sulfate on Yield and Sucrose Content of Sugar Beets

E. M. HOLST AND C. E. CORMANY[1]

I. Introduction

Apart from the role of being an integral part of the chlorophyll molecule, magnesium has a definite effect on rate of photosynthesis (3)[2]. In borderline cases of low magnesium in the substrate on which a plant is depending for nutrition, chlorophyll may be present in sufficient amounts so that no chlorosis is produced, yet photosynthesis proceeds at a slow rate. An increase of available magnesium in the substrate at this critical level increases photosynthesis with no marked further increase in chlorophyll (3).

Magnesium is believed by some workers to be intimately associated with movement of phosphates within the plant (4). Since many calcareous soils are notably deficient in phosphorus, it may be that an abundance of magnesium would increase the efficiency of phosphorus utilization within the plant.

There is some evidence that addition of magnesium sulfate to soils increases the availability of reverted phosphates and increases the uptake of phosphorus by plants (2).

It has been reported that magnesium sprayed on sugar beets in the Arkansas Valley of Colorado increased percent sucrose to a significant degree (1).

In view of these findings of other workers, it was believed that the subject of magnesium fertilization of sugar beets deserved some further study.

The objectives of the experiment were: 1—to determine whether magnesium sulfate at several rates of application would affect sugar percentage, and 2—to discover whether soil addition would have the same effects as foliage sprays.

II. Procedure

The experiment was carried out in the Arkansas Valley of Colorado, near Swink, on Rocky Ford clay loam. Ten treatments were designed as follows:

1. Check. Sidedresser used empty on these plots to get the effect of soil loosening which would occur on plots receiving magnesium sulfate.
2. 10 lbs./A magnesium sulfate sidedressed July 1, 1952, in water furrows, about six inches deep.
3. 20 lbs./A magnesium sulfate sidedressed as in 2.
4. 30 lbs./A magnesium sulfate sidedressed as in 2.
5. 40 lbs./A magnesium sulfate sidedressed as in 2.
6. Check. These plots sprayed with tap water.

[1] Associate Agronomist, Holly Sugar Corporation, Swink, Colorado, and Chief Agronomist, Holly Sugar Corporation, Sheridan, Wyoming, respectively.

[2] Numbers in parentheses refer to literature cited.

7. 10 lbs./A magnesium sulfate sprayed on foliage in four applications beginning July 1 at 14-day intervals.
8. 20 lbs./A magnesium sulfate sprayed as in 7.
9. 30 lbs./A magnesium sulfate sprayed as in 7.
10. 40 lbs./A magnesium sulfate sprayed as in 7.

The experimental design chosen was the split plot variation of randomized blocks, method of application (spraying vs. sidedressing) being the main plots, subdivided by rates of application to give the subplots.

Subplot size was four rows (22 inches) by 29 feet long.

Five replications were used.

Sugar beets of variety MW 111 were planted.

For magnesium sulfate source, commercial grade Epsom salt was used.

All plots received a uniform application of 20 lbs./A nitrogen as ammonium nitrate and 50 lbs./A phosphorus penta-oxide as concentrated superphosphate, sidedressed after thinning.

The inside two rows of each four row subplot were harvested for yield, percent sugar and root count data.

III. Results

Yield as tons of roots per acre and gross sugar per acre are reported in Table 1. Percent sucrose (based on two 15-beet samples from each plot) and number of beets per 100 feet of row also appear in Table 1. Some pertinent data on the analysis of variance appear in Table 2.

No differences in growth of tops, color and other visual characters were noted during the growing season.

Table 1.—Treatment and Acre Yield of Beets—Magnesium Sulfate Applied at Various Rates.

Treatment	Acre Yield		Percent Sucrose	Number of Beets per 100′ of Row
	Lbs. of Gross Sugar	Tons of Roots		
1. Zero $MgSO_4$ Sidedressed	4,270	12.07	17.6	94.4
2. 10 lbs./A $MgSO_4$ Sidedressed[1]	4,516	12.69	17.8	104.4
3. 20 lbs./A $MgSO_4$ Sidedressed	4,204	12.10	17.3	97.2
4. 30 lbs./A $MgSO_4$ Sidedressed	4,416	12.41	17.8	96.4
5. 40 lbs./A $MgSO_4$ Sidedressed	4,256	12.28	17.4	98.0
6. Zero $MgSO_4$ Sprayed[2]	4,532	12.91	17.5	110.4
7. 10 lbs./A $MgSO_4$ Sprayed	4,224	12.15	17.4	104.0
8. 20 lbs./A $MgSO_4$ Sprayed	4,500	12.68	17.7	105.2
9. 30 lbs./A $MgSO_4$ Sprayed	4,292	12.24	17.5	98.8
10. 40 lbs./A $MgSO_4$ Sprayed	4,876	13.42	18.2	110.8
General Mean	4,408.6	12.50	17.6	101.96
Sig. Diff. (5%)	NS[3]	NS	NS	NS

[1] Sidedressed in water furrows, 6 inches deep, on 7-1-52; sidedresser was used empty on check plot.
[2] Sprayed on foliage in four applications beginning 7-1-52 and repeated at 14-day intervals. Tap water alone used on check plot.
[3] No significant difference at the 5 percent level.

Table 2.—Variance Table for Data in Table 1.

Source of Variation	Degrees of Freedom	Mean Squares: Gross Sugar	Root Yield	Percent Sucrose	Beets per 100' of Row
Blocks	4	2853258.00	23.356	0.107	134.680
Method	1	290322.00	1.719	0.039	752.720
Error (a)	4	1625982.00	11.940	0.205	508.920
Total (a)	(9)				
Rate	4	81268.00	0.424	0.108	76.880
Rate x Method	4	328232.00	1.248	0.644	117.92
Error (b)	32	405010.00	3.372	0.256	83.05
Total	49				
Calculated "F" (Method)		(5.600)NS[1]	(6.946)NS	(5.256)NS	1.479 NS
Calculated "F" (Rate)		(4.984)NS	(7.952)NS	(2.370)NS	(1.080)NS
Calculated "F" (Rate x Method)		(1.284)NS	(2.702)NS	2.516 NS	1.419 NS

Note: "F" Values in parentheses indicate error mean square greater than the other mean square used to compute the ratio.

[1] Not significant.

IV. Discussion

Treatment 10 (40 lbs./A magnesium sulfate sprayed on the foliage) gave the largest increase in root yield, and the highest percent sucrose. Although these differences are not statistically significant, the problem of application of magnesium sulfate to beets is believed to deserve further study for two reasons:

1—The interaction variance for percent sucrose when compared with the error variance in the "F" test closely approached significance. It is possible that, with a few more replications, this interaction would have been significant. 2—The data presented here are not in agreement with the data presented in (1). Alexander and Cormany reported an increase in percent sucrose when magnesium sulfate in aqueous solution at 20 lbs./A was sprayed on the foliage. The work presented in this paper should be repeated with increased replication, to determine whether the results reported in (1) can be confirmed.

Three reasons which could help account for the disagreement on results between this paper and (1) are the use of a different variety of beets, differences in growing season between the two years, and differences in soil fertility and irrigation practices between the two experimental plots.

V. Summary

1. An experiment is outlined and data presented regarding the use of magnesium sulfate applied to sugar beets.

2. All data collected point to negative results with this chemical on sugar beets of variety MW 111 in the locale of Swink, Colorado, on Rocky Ford clay loam, for a growing season similar to 1952.

Literature Cited

(1) ALEXANDER, J. T. and CORMANY, C. E.
1950. Effects of growth-promoting substances on sugar beets. Am. Soc. Sugar Beet Tech., Proc. pp. 390-392.

(2) BARTHOLOMEW, R. P.
1933. The availability of phosphatic fertilizers. Ark. Agr. Expt. Sta. Bul. 289.

(3) CURTIS, D. F., and CLARK, D. G.
1950. An introduction to plant physiology. McGraw-Hill, New York, N. Y.

(4) MEYER, B. S. and ANDERSON, D. B.
1939. Plant Physiology. D. Van Nostrand. New York, N. Y.