Effect of Soil Moisture, Nitrogen Fertilization, Variety, and Harvest Date on Root Yields and Sucrose Content of Sugar Beets[1]

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Received for publication May 24, 1962

The effect of soil moisture on sugar beet yields has been a subject of considerable controversy. Doneen (2)[3] reported that the yields of roots and sucrose were independent of soil moisture when the soil in contact with the roots was maintained above the permanent wilting percentage. Marcum *et al.* (7) maintained soil moisture at several levels above the wilting percentage and were unable to demonstrate differences in root yields. These conclusions are supported by Dahlberg and Maxson (1) and Edlefsen *et al.* (3).

Nuckols (8) increased sugar production substantially by maintaining soil moisture above the 50% available level. With an application of three inches of water in each of six irrigations, he obtained the greatest efficiency in water and soil use. Haddock and Kelly (5) and Haddock (4) obtained marked differences in yield and quality of sugar beets under several soil moisture regimes. Sucrose percentage increased with heavy, frequent irrigations and a deficiency of available nitrogen. Light irrigation and heavy nitrogen fertilization depressed the sucrose percentage.

Hills *et al.* (6) delayed harvest 34 days beyond normal and increased root and sugar yields 4.7 and 0.84 tons per acre, respectively. Sucrose percentage was increased 0.8 percent.

Materials and Methods

A field experiment was conducted at North Logan, Utah, to determine the effects of soil moisture, nitrogen fertilization, harvest date, and variety on the root yields, sucrose, and glutamic acid content of sugar beets. The glutamic acid data are reported elsewhere (11) and the reader is referred there for details of the experiment and the methods used in procuring the data.

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[1] Contribution from Agronomy Department, Utah Agricultural Experiment Station, Logan, Utah. Journal Paper No. 256. Part of a thesis submitted by Dr. Woolley in partial fulfillment of the requirements of an M.S. degree at Utah State University. The work carried out in cooperation with Western Utilization and Research Division, ARS.

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[3] Numbers in parentheses refer to literature cited.

Table 1.—Effects of moisture levels, nitrogen levels, varieties, and harvest dates on sugar beet root and sucrose yields, Logan, Utah, 1955.

Treatment	Root yields tons per acre	Sucrose %	Sugar tons per acre
Moisture			
M_0	22.33	15.34	3.43
M_1	23.21	15.90	3.69
M_2	24.14	16.10	3.89
L.S.D. (.05)	1.06	0.53	0.19
Nitrogen			
N_0	22.61	16.21	3.67
N_1	23.52	15.74	3.70
N_2	23.55	15.39	3.62
L.S.D. (.05)	0.81	0.29	0.08
Varieties			
SP 53104-0	22.77	15.46	3.52
US 22/3	23.69	16.10	3.81
L.S.D. (.05)	0.87	0.31	0.13
Harvest Dates			
Oct. 8	21.20	15.26	3.24
Nov. 11	25.25	16.30	4.12
L.S.D. (.05)	0.55	0.23	0.05

Sucrose content was determined in accordance with the Official Methods of Analysis (9) and with the digestion procedure as suggested by Osborne (10). Sucrose percentages were determined polariscopically.

Results and Discussion

The effects of the various treatments on the root and sucrose yields are shown in Table 1. The M_2 level (80% available moisture) was the only moisture treatment that significantly increased root yields. The M_1 (50% available moisture) and M_2 treatments significantly increased the sucrose percentage over the M_0 (25% available moisture) treatment. Each increase in soil moisture produced a significant increase in total sugar production. The root yields, sucrose percentage, and sugar yields all responded in a linear manner with increasing soil moisture.

The application of 80 pounds of nitrogen (N_1) increased root yields and reduced the sucrose percentage significantly. The N_2 (250 pounds per acre) treatment significantly increased root yields over the N_0 (no nitrogen applied) treatment, reduced percent sucrose compared to the N_0 and N_1 treatments, and reduced the total sugar production compared to the N_1 treatment.

The use of a moderate amount of nitrogen fertilizer with an irrigation schedule that allowed the soil moisture to be maintained near field capacity produced the highest yield of roots and sugar. Increasing soil moisture above the 50% available level increased root and sugar yields more than did the application of additional nitrogen fertilizer.

Variety US 22/3 was significantly superior to SP 53104-0 in root and sugar production. This result was expected because US 22/3 had been developed for commercial use in the intermountain region, whereas variety SP 53104-0 had been selected primarily for resistance to foliar diseases.

The marked increase in root and sugar production due to the delayed harvest is worthy of consideration. The average increase of 4.05 tons of roots and 0.88 tons of sugar per acre agrees favorably with the results of Hills *et al.* (6) and should warrant a practical appraisal of the risks involved in a delayed harvest. Over the 34-day period, these increases represent average increases of 0.12 tons of roots and 0.026 tons of sugar per acre per day.

The combined effects of the moisture and nitrogen treatments on root and sugar yields are shown in Figures 1 and 2. Both

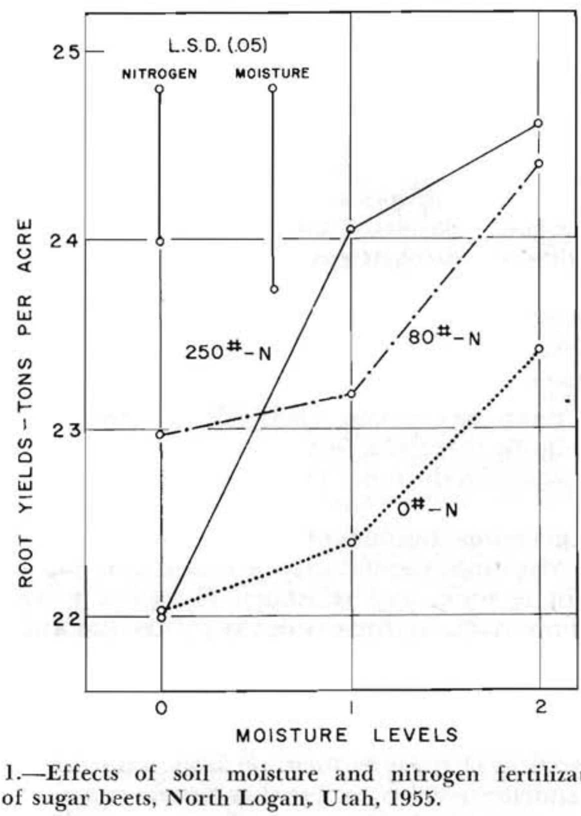

Figure 1.—Effects of soil moisture and nitrogen fertilization on the root yields of sugar beets, North Logan, Utah, 1955.

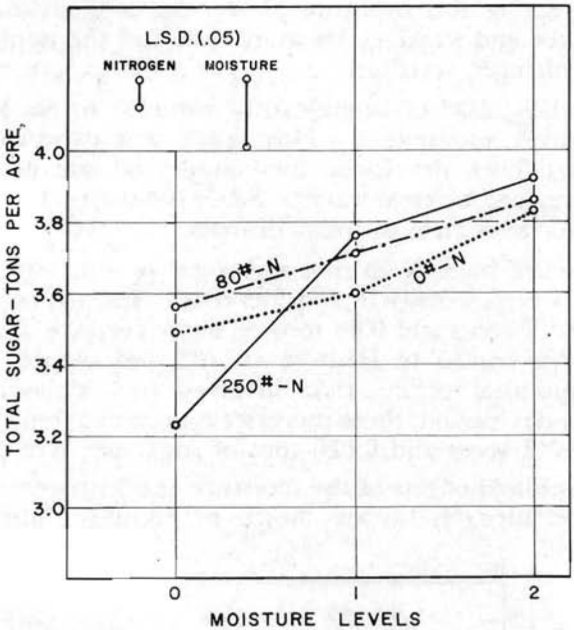

Figure 2.—Effects of soil moisture and nitrogen fertilization on the total sugar production of sugar beets, North Logan, Utah, 1955.

figures point up the importance of the moisture treatments in determining the reaction to the nitrogen treatments. The use of 250 pounds of nitrogen per acre depressed yields below the check when the moisture level was allowed to drop to 25% available before each irrigation. Applying 80 pounds of nitrogen per acre increased root yields at all moisture levels but significantly increased sugar yields at the M_1 level only.

These results agree with Haddock (4) that for any given irrigation regime there is a nitrogen level best calculated to give maximum sugar producton. The 27 inches of water applied in the M_0 treatment was sufficient to produce an above average beet crop, yet increasing the amount to 34 inches and tripling the number of irrigations significantly increased root and sugar yields. The amount of water applied above 27 inches does not appear to be as important in increasing yields as the timing of the water applications.

Summary

Two varieties of sugar beets were subjected to three irrigation schedules and three nitrogen fertility levels, and were harvested

on two dates, one month apart. Varieties and harvest dates accounted for significant differences in root and sucrose yields. Specific moisture treatments significantly increased root yield, percent sucrose, and total sugar production. Nitrogen fertilization increased root yields and total sugar but depressed percent sucrose.

The interaction of soil moisture and nitrogen fertilization suggest that some specific nitrogen level will give best results for any given soil moisture treatment.

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