Preharvest Water Stress For Valley Sugar Beets

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Moderate water stress prior to sugar beet harvest did not significantly reduce sugar production in Kern County tests. Higher sugar content of roots and lower production costs could make this practice profitable, if stress is not prolonged.

IN THE SOUTHERN portion of the San Joaquin Valley sugar beets are harvested in July and August when maximum temperatures are often above 100° F. Under these conditions, sugar beets grown on soils of low water-holding capacity show water stress by wilting only a few days after an irrigation. Increases in sugar concentration occur when beets are allowed to continue wilting for a period of time before harvest. However, it has been assumed that such wilting will curtail root production to the extent that stressed plants will produce less sugar per acre than plants irrigated to within a few days of harvest. This experiment to evaluate this assumption was conducted in 1963 near Famoso, Kern County.

The sugar beet crop was grown by M. L. Ritchey on a Hesperia fine sandy loam soil. During the major part of the growing season, the crop was irrigated every five or six days. Terminal irrigations were planned to provide three degrees of water stress prior to harvest. To accomplish this, three sets of plots were irrigated for the last time 30, 20 and 10 days prior to harvest on August 1.

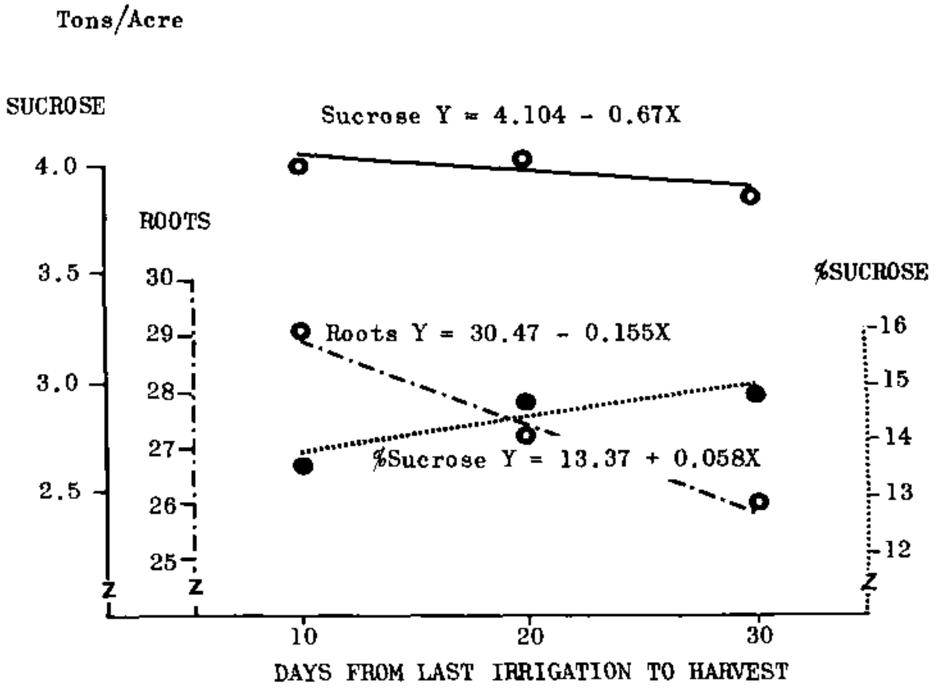
Electrical resistance blocks were installed at several locations. They were placed in the center of the 30-inch beds at depths of 18 and 36 inches. The blocks showed little change following irrigations, indicating limited lateral movement of water from furrows, and that the plants obtained water mostly from shallower depths or from zones directly beneath the furrows. The limited water movement in this soil and the consequent failure of irrigation to resupply a portion of the water removed by the crop probably explains the necessity for frequent irrigation to keep plants from wilting.

An additional objective of the experiment was to test the effect of water stress under different levels of nitrogen fertility. The field was quite fertile, however, and 80 lbs of nitrogen per acre (the lowest rate used) provided ample nitrogen for maximum growth. Consequently, there was no opportunity to determine if responses to water stress would be different for beets deficient in nitrogen. The four nitrogen rates used—80, 160, 240 and 320 lbs per acre—provided a wide range of high fertility conditions and the conclusions drawn from the experiment are therefore more widely applicable than they would be if a single fertilizer rate had been used.

The sugar beets responded to water stress in the same manner regardless of the level of nitrogen fertilization. The results presented in the graph are averages of all nitrogen rates. Differences in water stress at harvest were indicated by the appearance of tops. Plants not irrigated for 30 days had lost many leaves and averaged 11.7 tons of tops (fresh weight of leaves and crowns) per acre. Those not irrigated for 20 days were visibly wilted and produced 14.9 tons of tops per acre. Some of the plants irrigated 10 days prior to harvest had begun to wilt; this treatment produced 21.1 tons of tops per acre.

The sucrose concentration of roots was 1.2 percentage points higher for severely wilted plants (not irrigated for 30 days) than for those just beginning to wilt (not irrigated for 10 days). The increase in sucrose concentration with increasing water stress was essentially linear—increasing 0.06 percentage point for each additional day of stress. The fresh weight of roots decreased about 0.16 ton per acre with each additional day of water stress, resulting in a loss of 3.1 tons per acre for

Moisture stress before harvest increased per cent sucrose, decreased root yields but only slightly decreased gross sugar production as shown in graph below.



plants not irrigated for 30 days as compared with those irrigated 10 days before harvest.

The loss in root tonnage was largely due to dehydration, but dry matter was also reduced — that is, less sugar and other cell constituents accumulated in the roots of the more severely stressed plants. The net effect was a gradual decrease in sugar produced—about 13 pounds per acre for each additional day of water stress. The value of this lost production would probably be more than compensated for by reduced costs of irrigation, harvesting and hauling. It appears, therefore, that stressing sugar beets for water just prior to harvest, to the extent experienced in this trial, will not result in a net loss of income.

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CREDIT CORRECTION

It has been called to our attention that the article, "Aspects of Citrus Fruit Growth Studied in Tissue Cultures" (*California Agriculture:* Vol. 14, No. 4, pp. 10–11) included a photograph (without acknowledgment) that had been previously published in the article, "Proliferation of Excised Juice Vesicles of Lemon in Vitro" (*Science* 129: pp. 779–780), by Herbert A. Kordan.

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MICROBES Affect Physical Properties of Soil

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These studies indicate that some of the microbial polysaccharides are relatively resistant to decomposition by soil organisms and, therefore, may well be contributing influences to the favorable effects of organic residues on soil physical properties.

Organic residues in the form of manure, composts, plant roots, or cover crops often exert a favorable influence on soil physical properties by promoting water-stable granulation or aggregation. The favorable effects generally depend upon decomposition of the residues by soil microbes. During rapid decomposition, microbial filaments may bind soil particles together, but more often the binding of soil into aggregates is brought about by organic substances synthesized by the soil microbes, or formed as decomposition waste products.

Most soil organisms synthesize polysaccharides. These consist of sugar or related molecules which are polymerized or chemically joined to form very large molecules. Starch and cellulose are common plant polysaccharides. The microbial polysaccharides, in comparison with other natural organic substances, are relatively effective in binding soil particles. The aggregating action of these substances, however, is believed to be of short duration because most of them are presumed to decompose readily in the soil. Nevertheless, polysaccharides constitute a substantial portion (10 to 20%) of the more stable soil humus—indicating that some may be relatively resistant to attack by soil microbes or may become resistant by combining with other soil constituents.

INFLUENCE OF TWO BACTERIAL POLYSACCHARIDES AND THEIR IRON AND COPPER SALTS AND OF THE SOIL CONDITIONER VAMA (KRILIUM) ON AGGREGATION AND HYDRAULIC CONDUCTIVITY OF RAMONA SANDY LOAM

Treatment	Concentration in soil	Aggregation of silt, clay particles	Hydraulic conductivity
	%	%	cm/hr.
None	...	13	0.2
C. violaceum polysaccharide	0.02	35	1.3
	0.05	53	2.2
Iron salt of C. violaceum polysaccharide	0.05	19	0.4
Copper salt of C. violaceum polysaccharide	0.05	40	1.4
A. indicus polysaccharide	0.02	25	0.1
	0.05	37	0.1
Iron salt of A. indicus polysaccharide	0.05	15	0.2
Copper salt of A. indicus polysaccharide	0.05	43	0.2
VAMA (Krilium)	0.02	43	2.0

In studies at Riverside, a number of microbial polysaccharides were prepared by growing specific soil organisms on appropriate media, separating out the polysaccharides, and adding them to soils to evaluate their effects on physical properties. In some cases, relatively small amounts resulted in marked effects on soil aggregation and on hydraulic conductivity or water transport by soil. In order to establish the duration of some of the measured effects, rates of decomposition of the materials were measured and compared with certain plant polysaccharides and complex organic residues. Typical results are indicated in the graph.

The rates of decomposition of the polysaccharides varied greatly. *Azotobacter indicus* polysaccharide was more resistant to decomposition than almond shells and two additional bacterial polysaccharides as shown by the lower curve in the figure. Other data, not shown, indicate that its decomposition was also slower than for Rhodes grass, bean straw, orange leaves, and seven different plant poly-