Practical Control of Date of Irrigation by Means of Soil-Moisture Blocks

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The need has long been felt for a practical method for determining when a given soil should be irrigated and how much water should be applied. The drought of the last 10 or 12 years has focused the attention of the practical irrigator and those engaged in irrigation investigations upon the need for water conservation through a more carefully controlled use of the water available.

From the point of view of the practical irrigator, 3 questions are involved. (1) When should water be applied ? (2) How much water should be applied .' ('0 When has the required amount of water been applied?

The method which will answer these questions with the necessary degree of accuracy, and with the smallest amount of labor, and in the shortest time is the one all are looking for.

After considering the several methods available, the Research Department of the Great Western Sugar Company decided io try the electrical-resistance method developed by Dr. G. J. Bouyoucos and his associates. This method is described in Technical Bulletin 172 of the Michigan Agricultural Experiment Station, by Bouyoucos and Mick.

Work with this method was begun in a small way by the Agricultural Research Department of the Great Western Sugar Company in 1940. The results were so promising that the work was expanded in 1941 to include all of the company's factory territories comprising parts of Colorado, Nebraska, WVoming, and Montana.

In 1911 three hundred and twenty-six fields were studied. These covered a wide range of soil types and fertility. In each, moisture determinations were made at 12, 24, and 36 inches below the surface.

No systematic effort was made to use resistance figures in the control of irrigation. For the most part water was applied as the grower's and fieldman's judgment dictated, and water supplies permitted. Resistance readings were made weekly throughout the season from June to October.

Bouyoucos and Mick found with the same percentage of moisture the ohms resistance varied within quite wide limits when soils of different types were compared.

Preliminary studies conducted by the research laboratory of the Great Western Sugar Company, in which several types of soil were

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used, show that where approximately 50 percent of the available moisture has been exhausted, the ohms resistance varied from 10,100 to 34,000.

Differences in the soluable-salt content and the temperature of the soil cause variations in ohms resistance. However, the salt content of soils suitable for crop production does not reach a point sufficiently high to interfere with the practical use of the resistance method.

Experience has shown that the use of resistance blocks less than 12 inches below the surface is impractical. At this depth soil temperatures vary so little that their effect may be ignored.

Bouyoucos and Mick state that where moisture trends only are being considered, resistances of 400 to 600 ohms represent field capacity, and as resistances approach 60,000 to 75,000 ohms, all available soil moisture is about exhausted. Observations to date indicate that many of our soils show lower resistances at field capacity than those of Bouyoucos and Mick, and that resistances may run considerably higher than 60,000 to 75,000 ohms before available moisture approaches exhaustion.

Recent soil studies have shown that many of the soils of the eastern slope of the Rocky Mountains contain so little available plant food iu the second and third foot below the surface that plant growth is almost impossible without the addition of plant-food elements, especially phosphorus and nitrogen.

Other studies covering a period of 10 years (1910 to 1919) show that the greatest growth of sugar-beet root takes place during the first half of August, and the next most important time is the last half of July. Therefore, in this study considerable attention has been paid to the moisture movements at the 12-inch level during July and August. Previous to July 1 and after August 31 soil moistures were quite constantly high in 1941 so that their inclusion tended to confuse the results of this study.

Realizing that unless soil-moisture movements as indicated by resistance can be associated with the yield of beets, the resistance method has no practical value, the yields of roots were secured on 262 of the fields studied in 1941.

The first question to be answered is, therefore, at what resistance does a measurable reduction in yield take place ?

Bouyoucos and Mick found that Miami silt loam had lost about one-half of its available moisture when the ohms resistance reached 2,500, and at 60,000 to 75,000 ohms resistance the wilting point had been reached.

To determine at what point reduction in yield of roots takes place, all fields under observation for which yields had been secured were grouped according to the resistances recorded for each.

Based somewhat on the statemenls of Bouyoucos and Mick, four resistance groups were used: (1) Fields the first foot of which never showed resistances as high as 2,500; (2) fields whose first-foot resistance readied points between 2.500 and 3,000; (3) fields having resistances in the first foot over 3,000 but under 10,000; and (4) fields the first foot of which dried to a point where the resistance reached points over 10,000.

These groups disregarded soil type which further study showed to be quite important. The results of this grouping are shown in table 1.

Table 1

Ohms Resistance	Tons Beets Per Acre
Below 2500	16.81
2,500 to 3.000	16.32
Over 3,000 Under 10.000	17.15
Over 10,000	16.85

These figures indicate quite clearly that if any relation exists between ohms resistance and yield of sugar beets, some other factor or factors are involved, or that our elasses are not correctly selected.

The effect of soil type has been suggested. To study this point all fields classed as sandy loam and clay loam were used. Based on ohms resistance, each soil type was divided into two groups: (1) Fields whose ohms resistance never reached 3,000 at the 12-inch level during 1 he season, and (2) those the resistance of which at the 12-inch level was over 10,000 at some time during the season. By this use of extremes it was hoped the confusion due to intermediate classes would be avoided. The results of this type of grouping are given in table 2.

Table 2

Ohms Resistance	Average Tons Per Acre
Sandy Loam	
Under 3,000	16.86
Over 10,000	18.80
Clay Loam	
Under 3,000	17.28
Over 10,000	17.37

Because of differences in their physical nature and field water-holding capacity, over-irrigation on sandy soils is more probable than on the heavier types.

In attempting to maintain a high-moisture content, especially at the 2 and 3-foot levels, more leaching would probably take place in sandy than in clay soils. This we believe to be the cause of the low yield on the sandy loam soils where the ohms resistance never reached 3,000 in the first foot.

The figures in table 2 emphasize the importance of soil type in using the resistance method.

So far subsoil moistures have not been considered in our study. In order to determine their influence, all fields were grouped as follows: (1) Fields whose second and third foot never reached 10,000 ohms resistance; (2) fields whose second foot reached 10,000 ohms resistance but the third foot never reached that point; (3) fields whose second and third foot both reached 10,000 ohms resistance but neither reached this point over 10 percent of the time; (4) fields in which the second foot reached 10,000 ohms resistance less than 10 percent of the time while the third foot reached 10,000 or over more than 10 percent of the time; and (5) fields the second and third foot of which reached 10,000 ohms resistance or over more than 10 percent of the time.

Table 3 gives the results of this grouping, the mean resistance for the first, second, and third foot, and the mean yield of beets for each group.

Table 3

Percentage of Time Resistance over. 10,000 ohms			
1st Ft.	2nd Ft.	3rd Ft.	Average Tons Beets Per Acre
2.2	O	0	15.31
10.1	11.0	0	16.06
10.7	5.3	3.6	17.23
2,6	5.8	18.7	19.65
22.2	32.1	14.6	20.81

The groups are arranged in the table in the order of their wetness during the season.

This phase of our study does not include all of the 262 fields represented by yields. Representative fields from each factory district, both high and low-yielding fields, and all soil types are represented.

Conclusions.—The results of 2 years' use of the electric-resistance method of studying soil-moisture movements lead to the conclusion that it furnishes a sufficiently accurate and speedy means of controlling the use of irrigation water to warrant its continued use.

The results of our studies indicate that soils may be grouped according to soil types, thus avoiding the calibrating of each field in using this method.

The results of the 1941 studies lead to the conclusion that especially on sandy soils much water can be saved through the use of this method of studying soil-moisture movements.

The soils of the eastern slope of the Rocky Mountains can be allowed to dry to the point of recording 10,000 or more ohms resistance for a considerable part of the time without loss of yield.