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CALIBRATION OF THE CELL SAP CONCENTRATION AS AN INDEX OF THE NEED FOR IRRIGATION OF COTTON VARIETY D-9

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Introduction

Proper irrigation scheduling has been well-recognized to be one of the central problems of efficient irrigation (Arnon, 1972). It is now established that plant responses are related to water-status in the plant tissues and the plant must be watered before serious internal water deficits develop (Kramer, 1969; Shimshi, 1973). These plant internal water deficits can be measured by several plant physiological indices which in turn can be used to schedule irrigation (Hagan & Laborde, 1966; Ahmad & Yasmin, 1975).

Irrigation of cotton has been successfully scheduled on the basis of several physiological indices viz., on stomatal aperture measurements using a 1:2 paraffin-turpentine mixture (Ophir & Putter, 1959); by using a field porometer (Alvim, 1966) or on the basis of the leaf-relative turgidity measurements (Namken, 1965). Cell sap concentration as measured by its refractive index has also been successfully used to schedule cotton irrigation (Lobov, 1951, 1959; Filippov, 1965, 1970).

As regards the use of refractive index as a practical guide to irrigation scheduling, Filippov (1959) found the cell sap concentration of cotton leaves, as measured by a field refractometer to vary 2-3% diurnally and to range from 11-12% in wet soil and from 22-23% in dry soil. A concentration of 15% was usually accompanied by wilting. His calculations indicated that the correlation factor between the leaf sap concentration and leaf water potential varied from 0.74 to 0.83. He recommended the cell sap concentration values to be held below 12% for optimum growth.

For Pakistani cotton varieties, the size of the refractive index of the cell sap under different soil-moisture conditions needs to be locally determined before we can practically schedule irrigation based on refractive index values. It is this aspect which has been studied for a Pakistani cotton variety D-9.

Materials and Methods

The experiment was carried out in soil in pots in a greenhouse. Bitumin-coated and polythene lined pots were placed inside enamelled dishes and mounted on galvanized iron-stands. The soil in the pots was a mixture of 2 parts field soil, 1 part sand and 1 part well-decomposed organic matter. Each pot contained 7200 g soil. The soil field capacity as determined by the laboratory method was found to be 35%. Each pot was given 2.8 g each of NH_4NO_3 and KH_2PO_4 as fertilizers by dissolving them in water and watering the pots upto field capacity. The pots were divided into 3 parts; in each lot the soil moisture was held constant by daily weighing and making up any loss by watering (Belik, 1960). Establishment of 3 soil-moisture ranges viz., 40-50 %, 60-70 % and 80-90 % of field capacity was aimed at, representing, on a % soil basis, a soil-moisture content in range 14-17.5 %, 21-24.5 % and 28-31.5 % respectively. However, the actual soil-water content levels, expressed on % soil basis, as determined gravimetrically at the end of the experiment, were found to be 25 %, 29 % and 34 % respectively. In fact it has only been possible to test the plant's response to different cycles of soil-moisture depletion at 3 different levels of soil moisture; it being very difficult to hold soil-moisture level constant (Veihmeyer, 1927; Kramer, 1969).

The experiment was started on July 25,1973 when 10 seeds of cotton variety D-9 were sown in each pot keeping 13 replicates for each treatment. On September 1,1973 the plants were thinned and 5 plants were left in each pot. After 108 days of sowing the entire tops from 3 pots of each treatment were harvested and their oven-dry weights determined.

From the remaining 10 pots of each treatment, at 9 a.m. on October 21, 1973, the 4th and 5th fully expanded leaves were sampled. Sixteen leaves from each treatment, in duplicate, were inserted into large Pyrex glass test tubes which were immediately tightly closed by rubber bungs. These tubes were heated in a water-bath at 100°C for 20 minutes till the leaves were killed as indicated by a change in colour from green to brown. The tubes were allowed to cool, their contents wrapped in linen cloth which was placed in a pressure vessel. The sap was extracted by applying pressure from a hydraulic press and 2 or 3 drops of the cell sap were used to determine the refractive index using a laboratory refractometer. (Table 1).

TABLE 1. Effect of Soil-Moisture regime on Oven-Dry Weights of tops and the Refractive Index of the expressed leaf cell sap of Cotton Variety D-9.

Soil-Moisture Regime (% of Field Capacity)	Oven-Dry Weights of Tops (g/pot)	Refractive Index
80—90	20.1±2.2	1.3437
60—70	16.9±3.0	1.3457
40—50	9.9±0.81	1.3496

Results and Discussion

The oven-dry weights of the tops in the 80-90 %, 60-70 % and 40-50 % soil-moisture levels are 20.1, 16.9 and 9.9 g/pot respectively. This indicates the growth of cotton to be directly related to the soil-moisture level. This is in line with the finding that the total vegetative growth of the cotton plant is largely proportional to the availability of the soil-moisture and thus the controlled applications of the irrigation water are the tools by which vegetative growth can be encouraged or suppressed (Bielorai, 1973).

The refractive index values of the expressed leaf cell sap for the 3 soil-moisture levels viz., 80-90 %, 60-70 % and 40-50 % of the field capacity is 1.3437, 1.3457 and 1.3497 respectively. Refractive index is therefore quite sensitive index of cell sap concentration and can be used to determine the need for water of cotton variety

D-9. An increase in the concentration of the cell sap above a refractive index value of 1.3457 is a warning for indequate soil mosisture and the demand of the plants for water. Thus the size of the refractive index of the cell sap of the cotton variety D-9 for indequate soil-moisture has been calibrated and this information could be used in practical scheduling of cotton irrigation.

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