

quired on this green as compared with other nearby greens.

Without automation

Tensiometers can also be beneficial without completely automatic controls, as demonstrated at the Whittier Narrows Golf Course in El Monte. Prior to installation of the instruments at 2- and 5-inch depths, irrigations were set for 15 minutes every night. During the summer, even longer irrigations were applied. Tensiometers were installed on June 1, 1964. With tensiometers to schedule frequency and duration of irrigations, only 14,560 gallons of water were applied in 2 $\frac{2}{3}$ hours during June and July, 1964 (graph 3). The previous schedule would have required 83,265 gallons in 15 $\frac{1}{4}$ hours. This is a reduction of 83% in water use.

Often the beauty of turfgrasses used for recreational purposes is more important than savings in water and money. However, in the trials reported here, the turf remained healthy and beautiful, and the golf greens continued in good playing condition. Also, in many instances, deeper, more vigorous rooting resulted where tensiometers were used to determine turfgrass irrigation.

Irrigation management

Tensiometers, therefore, can be used successfully as a guide to determine frequency and duration of irrigation for turfgrass areas—either from installations associated with manual control or from completely automatic systems. Also, savings in both money and water are possible in varying degrees, since most turf authorities agree that overirrigation is the rule rather than the exception.

For such systems to operate successfully, however, complete irrigation management must include good distribution of water from the sprinklers with application rates not in great excess of the water infiltration capacity of the soil, a regular program of thatch control and soil aeration where needed. Turfgrass superintendents are usually encouraged by the use of tensiometers to improve their irrigation practices.

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POTASSIUM- Interrelationships

RECENT FIELD EXPERIMENTS have demonstrated that certain soils in the San Joaquin Valley need to be fertilized with heavy applications of potassium (K) to obtain maximum production. The question of what effect these high K additions have on the nutritional status of other plant-essential elements for cotton has never been answered, but K-induced magnesium (Mg) deficiencies had been demonstrated for a number of crops by previous investigators. A greenhouse experiment to evaluate the effect of K on the Mg status of the cotton plant, under California conditions, was conducted at Riverside. Distinct K- and Mg-deficiency symptoms, along with the associated plant tissue analyses, were developed.

Cotton (Acala S442) was grown for three months in sand cultures. Each unit consisted of a 100-liter reservoir for the nutrient solution and four 3-gallon crocks filled with sand to support the plants. The assembly was equipped so that each sand-filled pot could be periodically irrigated with the nutrient solution. The nutrient solutions percolated through the sand and drained back into the reservoirs.

Concentrations

Potassium and magnesium were added in a factorial design in amounts necessary to produce solution concentrations of 1, 10, and 50 ppm. All other nutrients were added in amounts sufficient for plant growth. The solution concentrations in the reservoirs were maintained by periodic additions. After a three-month growth period, the plants were weighed, the bolls were counted, and the petioles were separated for chemical analyses.

A summary of the main effects of K and Mg nutrition on the plant weight, number of bolls, and levels of K and Mg in the petioles is shown in the table. An increase in yield, as indicated by plant weight and boll count, occurs as the level of K in the nutrient solution is increased from 1 to 50 ppm. For Mg, an increase in yield is observed as the concentration of the nutrient solution is increased from 1

to 10 ppm, but further increase in Mg levels did not result in increased yield. Symptomatology and chemical analyses demonstrated that those plants grown on substrate levels of 1 and 10 ppm K were deficient in K, and those plants grown on the 1-ppm Mg substrate level were deficient in Mg.

A mutually antagonistic effect of K and Mg on the uptake of each element is indicated by the plant analysis data presented in the table. At 50 ppm Mg in the substrate, the petiole contents of Mg drop from 1.9 to 0.3% as the K level in the substrate is increased from 1 to 50 ppm. Similar antagonistic effects of Mg on K are indicated. For example, at the 10-ppm K level (as the concentration of Mg in the substrate is increased from 1 to 50 ppm), the K content of the petioles is decreased from 2.2 to 0.9%.

Visual symptoms

Visual symptoms of plants known to be deficient in K and Mg are illustrated in the photos. Leaf symptoms indicative of K and Mg deficiencies are sufficiently different to be distinguished from one another. Leaves from the K-deficient plants exhibit leaf marginal chlorosis and

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MAGNESIUM

in Cotton

A. L. PAGE • F. T. BINGHAM

necrosis, while leaves from Mg-deficient plants show interveinal chlorosis with very prominent green-colored veins and midribs. Potassium-deficient plants are more sparse due to premature leaf drop.

Tissue analysis

Symptoms alone usually are not sufficient for diagnostic purposes, and one should seek additional confirmatory evidence through plant tissue analysis. Analysis of the K-deficient plants in this study indicated that where the K content in the petioles (from a recently mature, fully expanded leaf) of the cotton plant at the boll stage is less than 1.5 to 2.0%, a K-deficient condition is likely. This level is in accord with those published by other researchers in California. Our data for Mg indicate that where the level of Mg is below 0.1 to 0.2% in the petiole, yield reductions due to Mg deficiency are possible.

This study indicates that continuous, heavy applications of K may have an adverse effect upon the Mg nutritional

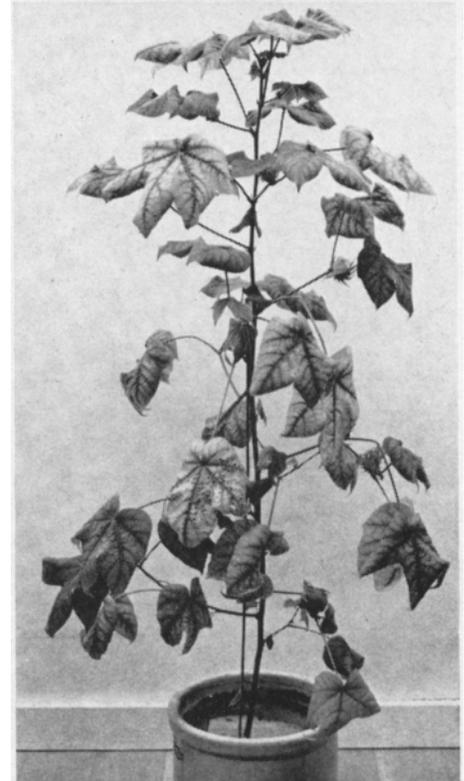
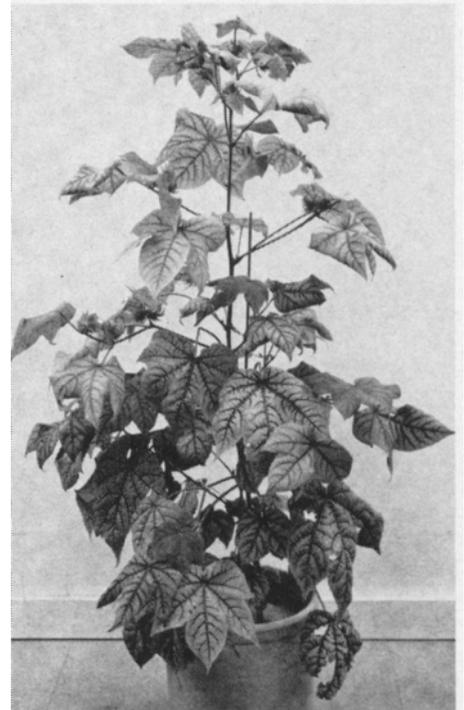
status of the cotton plant. The plant analysis data and symptoms described here provide a guide for evaluating the Mg nutritional status of cotton in the field.

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GROWTH, BOLL PRODUCTION, AND TISSUE COMPOSITION OF COTTON PLANTS IN RELATION TO VARIABLE POTASSIUM AND MAGNESIUM TREATMENTS*

Treatment		Plant weight†	Bolls per plant	Petiole composition	
K	Mg			K	Mg
ppm	ppm	gm	no.	%	%
1	1	29	2.5	0.7	0.12
10	1	78	4.0	2.2	0.11
50	1	85	0.0	3.5	0.15
1	10	83	7.0	0.3	1.2
10	10	194	16.3	1.4	0.7
50	10	353	27.3	3.3	0.5
1	50	87	5.7	0.4	1.9
10	50	170	14.0	0.9	1.2
50	50	345	23.7	3.0	0.3

* At 95 days post-emergence.
† Oven-dry (65°C).



Top right photo, Mg deficiency in a cotton plant; bottom right photo, K deficiency. Lower photo (top row of cotton leaves), Mg deficiency; (bottom row of leaves), K deficiency.

