TURFGRASS IRRIGATION

By Tensiometer-Controlled System

TRIALS WITH TENSIOMETERS to determine their usefulness in timing applications, as well as regulating amounts of irrigation water needed for turfgrass, were initiated by the University of California Agricultural Extension Service in Los Angeles County in 1960. The need for modifications was soon apparent. Subsurface installations were found necessary to avoid interference with recreational activities and cultural practices. Such installations required protective boxes to house the instruments and moisture-proof covers for the tensiometer gauges. These items are now available from commercial suppliers.

A thatch layer resulting in shallow rooting also interfered with the successful use of the tensiometer for determining irrigation needs. With so many of the roots located in the thatch, grass showed severe water stress by the time tensiometers located in soil just below the thatch indicated any moisture depletion. Data collected from several installations on golf greens indicated that mechanical aerification of the turf generally improves the ability of tensiometer readings to indicate a need for irrigation.

Trials were established on three golf greens at the Fox Hills Country Club in Culver City—all similar in age, turf condition, and management requirements. Previous to 1962, when these trials were initiated, all greens were on a spring and fall aerification schedule with ½-inch diameter spoons used, followed by top dressing with a soil mix.

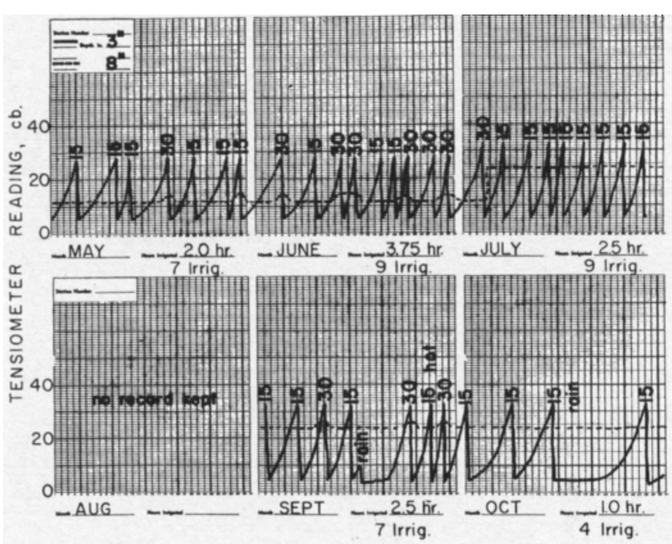
The greens were treated as follows: one green received the usual two aerifications; the second received the same plus one additional aerification in midsummer, using ¼-inch diameter spoons, with the holes left open; and the third had the same spring and fall treatments, with two additional summer aerifications. Tensiometers were installed at 2-inch and 5-inch depths in each of the greens.

Tensiometers can be used successfully to determine frequency and duration of turfgrass irrigations, according to the trials reported here on three established golf greens. Whether irrigation systems are manually controlled and merely guided by tensiometer readings, or completely automatic with tensiometers connected to a time-control system, this device—properly used—saves both time and water. Data are also included on tensiometers buried at two depths rather than one, and special emphasis is placed on the importance of even distribution of water from the sprinklers, a thatch control program, and regular soil cultivation with a mechanical aerifier to reduce the effects of soil compaction.

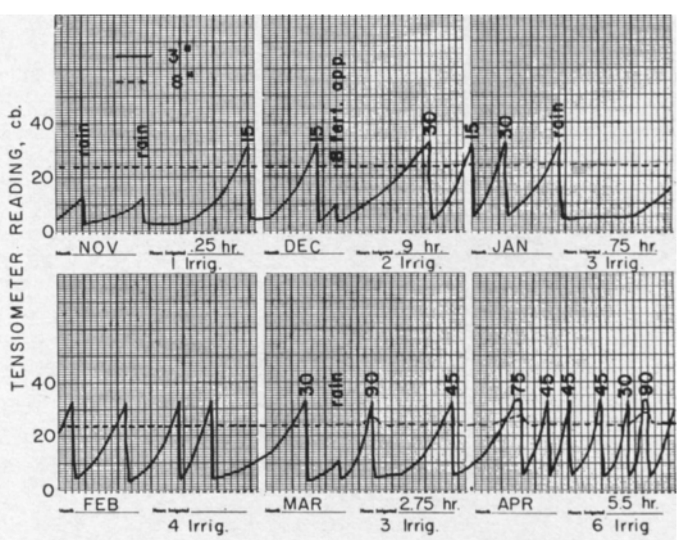
Summer aerification

The green receiving two additional summer aerifications showed no turf stress at tensiometer readings of 50 cb (centibars), the green with one summer aerification showed a need for irrigation at about 30 cb; but the green receiving only spring and fall aerifications became hard and showed wilt symptoms before a tensiometer reading of 10 cb was reached.

The golf course superintendent was so impressed with the beneficial effects of the summer aerification, that he asked to aerify all the greens before the trials could be completed. Therefore, the information received can be used only as an indication.



Graph 1. Tensiometer readings for first six months after installation of the completely automatic system at UCLA. Numbers above the readings indicate length of time sprinklers operated. The spaces between curves are the number of days between irrigations.



Graph 2. Tensiometers continue to respond to varying climatic conditions as shown by frequency of applications during second six months after installation at UCLA. The excessive lengths of irrigation during March and April were due to mechanical failure.

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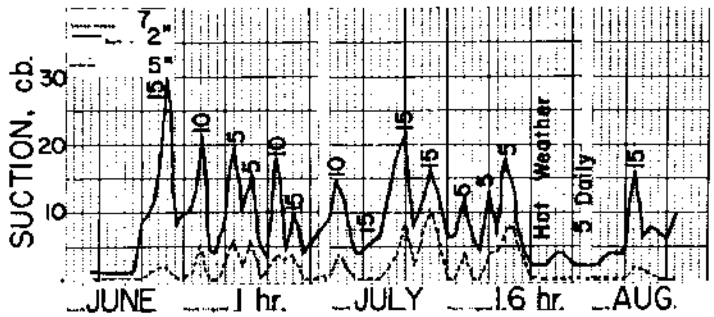

Graph 3. Readings from the tensiometers at Whittier Narrows Golf Course show how tensiometers can be used as a guide for regulating the frequency and time length of irrigation when tensiometers are not attached to automatic timing devices.

Uneven water distribution from inadequate sprinklers limits the use of tensiometers. Tensiometers installed in areas receiving appreciably more or less water than other areas will not adequately reflect irrigation needs of the entire area. Turf areas receiving low applications will show moisture stress before a tensiometer installed in a wetter area signals a need for water.

A completely automatic tensiometer-controlled irrigation system has been installed adjacent to Sproul Hall at the U. C. campus, Los Angeles, on a turf area containing a mixture of bluegrass and fescue. The soil is a clay loam, and the turf has been under a regular aerification program using ¼-inch spoons with the holes left open.

Two tensiometers were installed in a location typical of the turf in the test area —one at a depth of 3 inches and the other at 8 inches. A clock was attached to the control system to record the length of time the sprinklers operated.

Timing

The tensiometers were originally set to signal the controller for an irrigation when the shallow instrument reached a reading of 28 cb, or the deep instrument exceeded a reading of 12 cb. After receiving the signals, the controller would operate the sprinklers only at a preset time during the night when the turf was not in use and the water pressure was good. Irrigation would continue up to 15 minutes twice a night until the shallow instrument returned to a reading of 5 cb, or until the deep instrument returned to a reading of 12 cb. After two months, it became evident that too much water was being applied. To corret this, the signal point of the shallow tensiometer was raised to 33 cb and the deep instrument to 24 cb.

Correction

Following a 15-minute sprinkler application test, using catchment cans in June, 1964, surface water was observed to flow into a runoff drain for over one hour after the sprinklers had stopped operating. To correct this, the controller was adjusted to allow the sprinklers to operate for only seven minutes, twice a night, if the tensiometers signaled that water was needed.

Graphs

Graphs 1 and 2 show tensiometer readings from the UCLA installation and the effect of climatic conditions on the irrigation intervals. The weather in September and October of 1963 was extremely variable, with a 2-inch rain over the three-day period of September 16 to 18, and five consecutive days of over 100° F temperatures starting September 25. This was followed by some cool overcast periods. The lawn had been irrigated just prior to the rain and was not irrigated again for nine days. During the extremely hot weather that followed, there were three more irrigations in seven days.

Cool weather

The weather cooled during October, and only 17 irrigations were applied between that time and early April, according to the needs of the turfgrass in relation to varying climatic conditions.

The recording of more than 15 minutes of irrigation in one night is evidence that the deep tensiometers had a reading high enough to signal for more water after the first 15-minute application. The first 15 minutes will return the shallow tensiometer to a low reading. Drying of the soil at the lower depths indicates root activity in this lower root region. During March of 1964, a malfunction of the controller caused excessively long irrigations to be applied.

Output

According to the manufacturer's specifications, output for the 20 full-circle and 15 half-circle sprinklers covering the UCLA test area is 145 gallons per minute at the pressure used. Prior to these trials, irrigations were scheduled twice a week, 15 minutes at each setting, from about November to June and three times a week from June through October. At this frequency and duration, 10.5 hours or 91,350 gallons of water would have been applied from September through December of 1964. Under the completely automatic tensiometer-controlled system, only 4.5 hours or 39,150 gallons of water were applied. This represents about a 57% reduction in water use and cost.

A similar installation was established on a Seaside bentgrass golf green at the Deauville Country Club in Tarzana, California. A sprinkler application test showed one green to have a uniformity coefficient of 88.9% and a ratio of maximum-to-minimum application of 2 to 1. While these trials were being conducted, the green was aerified monthly from May through September, using ¼-inch spoons, with the holes left open. This installation was similar to that at UCLA, except that the tensiometers were installed at 2-inch and 5-inch depths at the edge of the green.

Irrigation was initiated when the shallow instrument rose to 23 cb and terminated when it dropped to 5 cb. Corresponding readings for the deep instrument were 28 cb and 10 cb. The termination reading for the deep instrument has since been raised to 20 cb, for it was decided that more water was being applied than necessary. When irrigation is needed, water is applied for 10 minutes each hour and up to eight times during the night.

Information available for the first three months' operations at the Deauville Country Club (March through May, 1964) shows that irrigation for 35 minutes every other night (under the old system) would have applied 95,400 gallons in 26.5 hours. Under the tensiometer-controlled system, only 16 hours or 57,600 gallons of water were used. This represents about a 40% reduction in water use. The superintendent at Deauville reported that after the first five to six weeks of automatic tensiometer-controlled irrigation, about 75 to 80% less hand watering was required 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 2⅔ hours during June and July, 1964 (graph 3). The previous schedule would have required 83,265 gallons in 15¼ 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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