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A Further Evaluation of the Vertical Mulching Method of Improving Old Greens

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Greenskeepers find it difficult to maintain a uniform turf area of desirable grass species on established bowling and putting greens. These types of turf often are subjected to heavy foot traffic when soils are wet. Their specific use requires that they be mowed closely at frequent intervals. In time, periodic top-dressing causes thatch buildup and stratification of soil layers. Water penetration typically is poor, and low infiltration rates make it difficult to irrigate properly. Such soils tend to remain near saturation in the shallow soil layers.

These conditions favor the growth of annual grasses rather than the desirable perennial grass species. The desirable grasses often succumb to disease, die out, or lose vigor. Weedy annuals, particularly *Poa annua,* subsequently invade the turf, often replacing large portions of it. *Poa annua* does not withstand traffic and disease. The turf tends to lose color and become thin or bald, particularly during warm weather.

If the turf becomes inadequate to serve the purpose for which it was planted, one of several procedures generally is followed to return the grass to a playable condition. The most costly is to remove the old sod, replace or modify the soil, and establish a new turf. Another approach is to renovate the old turf by cultivation, fumigation, and reseeding. Deep verticutting and overseeding also are used. If the green is not completely unplayable, a change in management practices, such as improved fertilization, proper use of cultural equipment, better water management, and re-scheduling of play, may be all that is necessary to improve the condition of the turf.

Vertical mulching is a different approach to turf renovation which recently has been given consideration. This consists of removing l-inch cores of soil to a depth of about 6 inches at relatively close spacings. The holes then are back-filled with a stable soil mix, usually consisting of fine sand and organic matter. This is a report of tests undertaken to further evaluate this practice.

The site selected for the study was the Henderson Bowling Green, a 40-year-old green maintained by the City of Berkeley Park Department. The original grass was Seaside bent, but the present turf is predominantly Poa annua. The original soil mixture was a 12-inch layer of Dublin clay loam and coarse sand placed over a crushed rock base. Table I shows the textural analysis of the top 6 inches of soil.

Table 1
ORGANIC MATTER CONTENT AND MECHANICAL ANALYSIS OF MINERAL FRACTION OF TOP 6 INCHES OF SOIL - WEIGHT BASIS (average of 3 composite samples)

DEPTH (INCHES)	ORGANIC MATTER	COARSE SAND	FINE SAND	SILT	CLAY
0-1	20.0	--	--	--	--
1-2	12.3	16.6	51.5	21.1	9.8
2-3	5.6	18.9	64.3	9.9	6.9
3-4	4.6	18.2	51.9	18.7	11.2
4-5	6.0	12.9	24.1	39.1	23.9
5-6	6.3	13.0	20.7	41.9	24.9
MA**	12.6	17.8	55.0	18.2	9.0

* Organic matter fraction removed before making mechanical analysis.

** Composite of 2 1/2 inches deep cores of soil removed by a mechanical aerifier.

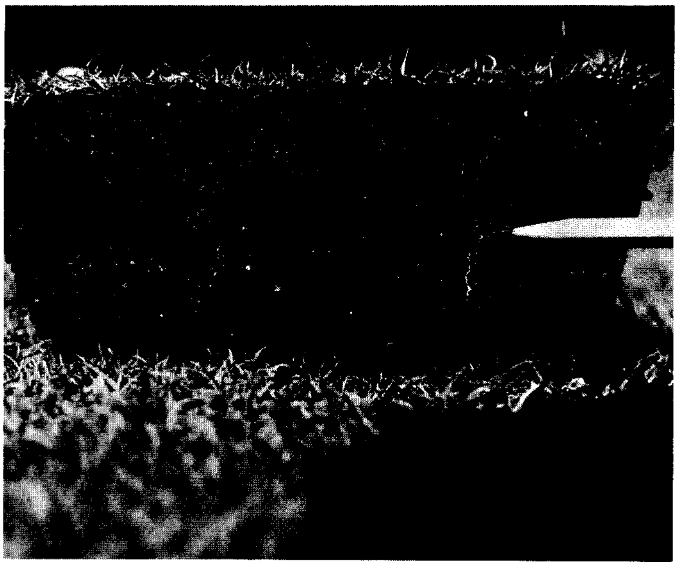

Figure 1. A soil profile through the putting green showing the vertical mulch holes on 3-inch centers. Note the vigorous, healthy root system. A portion of the backfill material bas been washed out of these holes to better illustrate the root growth. This soil profile also shows the stratification or layering which is found in most all old bowling and putting greens. This layering is due to topdressing with materials different from the original soil mix.

Topdressing over the years has stratified this soil with alternate layers of organic matter and coarse sand. There is a layer of, coarse sand about lb-inch thick at a depth of about 3 1/2 inches throughout the green. The origin of this layer is not known. The stratification of the soil can be seen in Figure 1.

An area of turf 12 feet wide and 120 feet long on the east side of the bowling green was used for this experiment. Two adjacent strips of 20 plots, each 5 feet by 5 feet square, were marked out and the following treatments were appliedon April 9 and 10, 1964:

1. No treatment.
2. Aerification in two directions with a mechanical aerifier (Greensaire) which removed l/4 inch cores 2 1/2 inches deep.
3. Vertical mulch by hand on 3-inch centers, using a l-inch diameter Oakfield soil tube to a depth of 6 inches.
4. Same as treatment 3 except on 6-inch centers.
5. Same as treatment 3 except on 9-inch centers.

Treatments were randomized and replicated four times within each strip. All soil cores were removed from the area, and the l-inch holes were backfilled by hand with a mixture of 1 part organic matter (Loamite Soil Amendment) and 2 parts fine sand. The soil mix was lightly tamped into each hole, using a l/2 inch dowel to insure that the hole was filled completely. After treatment, the entire test area was verticut in three directions. Seaside bentgrass was sown at the rate of 5 pounds per 1000 square feet, and then the area was topdressed with 1 1/2 yards of the same soil mix per 1000 square feet. Calcium nitrate at the rate of l/2 pound of nitrogen per 1000 square feet was applied at 2-week intervals following treatment. No changes were made in the usual irrigation practices.

Plots were visually rated on May 9, 4 weeks after treatment, and again on June 10. There were no apparent differences among treatments. The turf showed excellent recovery, and bowling was resumed on June 11. No increase in the percentage of Seaside bent plants was noted - the stand was still predominantly *Poa annua*.

May 21 Infiltration Tests:

Water was withheld from the treated area for 6 days prior to making infiltration tests. A single infiltration measurement was taken in each plot in one strip. A depth of 9 inches of water was placed in the ring infiltrometers. Measurements of the drop in water surface were taken at lo-minute intervals over a period of 1 hour. The accumulated infiltration after 1 hour is shown in Table 2,

There was considerable variation within replicates. The differences among treatments were not significant. Infiltration rates in all treatments were relatively high.

Table 2
ACCUMULATED INFILTRATION IN INCHES DURING ONE HOUR ON MAY 21

TREATMENT	1	2	3	4	5
Rep. I	1.03	1.78	3.84	2.47	2.57
Rep. II	1.19	1.17	1.55	1.26	2.31
Rep. III	1.43	1.98	1.96	1.84	.87
Rep. IV	2.21	.91	1.23	1.79	2.88
Average	1.46	1.46	2.15	1.84	2.16

Figure 2. The plot of ring infiltrometers and the book gauge used to record the level of water within the ring infiltrometer.

June 15 Infiltration Tests:

Water was withheld from the test area for 3 days. Two infiltration measurements were taken in each plot in one strip. A depth of 9 inches of water was placed in the ring infiltrometers. Measurements of the drop in water surface were taken at lo-minute intervals over a period of 1 hour. The accumulated infiltration after 1 hour is shown in Table 3.

Table 3
ACCUMULATED INFILTRATION IN INCHES IN 1 HOUR ON JUNE 15. AVERAGE OF 2 MEASUREMENTS.

TREATMENT	1	2	3	4	5
Rep. I	.71	.72	1.98	1.35	1.24
Rep. II	1.06	1.06	2.60	1.48	.93
Rep. III	I.82	1.60	1.66	.97	1.18
Rep. IV	.60	.57	1.26	.64	1.26
Average	1.05	.99	1.88*	1.11	1.15

$LSD_{.05}$ = 0.61* $LSD_{.01}$ – 0.86

Infiltration for the 3-inch vertical mulch treatment was significantly higher than all other treatments. The 6-inch and 9-inch treatments did not differ significantly from the mechanically aerified treatment or the check. There was a decrease in average infiltration rates since the May 21 tests.

September 29-30 Infiltration Tests:

The treated area was irrigated the day before infiltration tests were made. High application rate sprinklers ran for 2 hours at each setting, and there was considerable runoff. Four infiltration measurements were taken in each plot in one strip. Two gallons of water were placed in each ring infiltrometer which was equal to a depth of 1 1/2 inches of water. Measurements of the drop in water surface were taken at l0-minute intervals over a period of 1 hour The accumulated infiltration after 1 hour is shown in Table 4.

Table 4
ACCUMULATED INFILTRATION IN INCHES IN 1 HOUR ON SEPTEMBER 29-30.
AVERAGE OF 4 MEASUREMENTS.

TREATMENT	1	2	3	4	5
Rep. I	.14	.12	.37	.21	.17
Rep. II	.12	.14	.54	.18	.13
Rep. III	.18	.16	.28	.16	.17
Rep. IV	.17	.20	.44	.39	.16
Average	.15	.16	.41**	.24	.16

$LSD_{.05} = .11$ $LSD_{.01} = .15^{**}$

Analysis of the data indicates that vertical mulching improved infiltration and that this effect was linear with closeness of spacing. When holes were spaced as far as 9 inches apart, the infiltration rate was no better than that of the check. There was no measurable effect on infiltration from the mechanical aerification. This lack of response was probably related to the limited depth of soil penetrated by the aerifier. The infiltration rates on all treatments were considerably lower than at the time of previous tests. This decrease in infiltration rates was partly due to depth of water in the infiltrometers. However, supplementary tests, using 9-inch depths of water, increased infiltration rates only about 20 per cent as compared to the l/2-inch depths used in this test.

Discussion:

Low infiltration rates of water into soils is one of the major problems on turf areas subjected to heavy use. Vertical mulching has been proposed as a means of overcoming this problem.

The results of this study indicate that closely spaced vertical mulch holes will increase infiltration rates. This increase is linearally related to the closeness of spacing of the holes. In these tests, the infiltration rates on all plots decreased as the season progressed. This decrease is a characteristic of most soils, in California. In late September, the rates were less than 1/2 inch per hour for the 3-inch spaced holes; and less than 1/5 inch per hour for the widely spaced holes, mechanically aerified plots, and nontreated areas. Infiltration rates were found to be quite variable even within a small area. This points out the desirability of having a large number of replicated infiltration measurements in studies of this type.

Vertical mulching or mechanical aerifying did not increase the percentage of bentgrass over *Poa annua* as indicated by visual observation. Vertical mulch holes and mechanically aerified holes backfilled with sand and organic matter provided an excellent environment for vigorous growth of grass roots.

The soil on which these tests were conducted was a 12-inch layer of clay loam and sand mix overlying a crushed rock base. The vertical mulch holes did not penetrate the full depth of the soil material. Different results might be expected where the vertical mulch holes penetrate through a dense or stratified surface layer into a more previous soil beneath.

Good growth of any plant is related to several interdependent factors. Although close spaced vertical mulching does significantly increase water infiltration, this practice by itself does not appear to be the complete solution to the problem of improving old greens. Further information on the interrelationship between vertical mulching and other cultural practices is needed.

It is quite possible that a better irrigation system coupled with vertical mulching would take better advantage of the improved root environment provided by vertical mulch holes filled with an improved soil mix. Further studies are in progress to determine if this is true.

New Irrigation and Aerification Methods

Proceedings, Nursery Landscape Tree and Turf Conference February 3-5, 1965 – University Theater, University of California, Riverside

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The questions of frequency and length of irrigation have confronted turfgrass managers since these special-use grasses were first utilized for turf purposes.

Most turf authorities have long advocated deep, infrequent irrigation as being the most beneficial. With turfgrasses being subjected to close clipping, traffic, and other conditions in direct conflict with those desirable for healthy plant growth, the result is that soil compaction often occurs and only a very shallow root system develops. Under such conditions, frequent irrigations are then necessary for the survival of the grass plants.

Turfgrass aerification for the mechanical breaking of compacted surface soil and matted turf has been an accepted and regular practice on many golf courses and other turfgrass areas for many years.

A reduced oxygen supply resulting from soil compaction and overwatering can limit the growth of grass roots severely. Under low oxygen conditions, potassium and phosphorus in the plant shoot is decreased. Sodium accumulation in high concentration, which is undesirable, was found in the shoots of plants growing under low soil oxygen.

'Soil compaction decreases the large pore space in soils resulting in restricted water penetration. Alternate layers of soil and organic material on old golf greens may build up to 4 to 6 inches deep, and will reduce the movement of water through the surface soil. The information presented in this paper will be the results of two experimental projects conducted by the University of California Agricultural Extension Service in Los Angeles County.

Tensiometer Controlled Irrigation

A good program of turfgrass irrigation is one that allows water to be applied only as often as the grass is in need of it, and in amounts sufficient to wet that area of the root zone where additional water will be beneficial.

Several factors affect the frequency that water is needed by grass. These include soil texture, soil compaction, thatch, depth of rooting, vigor of the turf and requirements of the grass species. Set irrigation scheduling is inadequate and often results in wasteful use of water.

Roots will not grow where it is too dry. Neither will they seek out moisture. Roots will not grow where it is too wet. They only grow where there is a favorable soil-air-water relation. If the deeper soil area where it is possible to grow roots is dry from insufficient amounts of water being applied or if it remains too wet from excess water being applied, shallow rooting will result.

Trials to see if tensiometers could be used as a guide for determining when to apply water and the length of irrigation needed were first started in 1960. The first installations were partially successful but it was apparent that modifications of the design of tensiometers would be necessary. They would need to be installed beneath the turf surface to avoid interference with play and cultural practices. This further necessitated the need for protection boxes to house the instruments and moistureproof covers for the tensiometer gauges. These requirements have been satisfied by the tensiometer manufacturers.

From the early trials, it was learned that a thatch layer or insufficient aerification interfered with the successful use of the tensiometers for determining irrigation needs. Dry areas of the turf resulting from uneven water distribution from the sprinklers also limited the use of tensiometers.

An example of a successful tensiometer installation on a golf green can be taken from the Whittier Narrows Golf Course (owned by the Los Angeles County Park Department). Instruments were installed at 2- and 5-inch depths in early June of **1964.**

Before the trials began, irrigation was scheduled for 15 minutes nightly. For the first 7 days after the tensiometers were installed, no water was applied to the green. Frequency of irrigation for the remainder of June and July varied from daily to 6-day intervals. Length of irrigation varied from hand watering to 5 to 15 minutes.

A completely automatic tensiometer controlled irrigation system was established near Sproul Hall on the U.C.L.A. campus during the fall of 1963. Two tensiometers were installed in a location typical to the area and located so that one was at a depth of 3 inches and the other at 8 inches. The system is regulated so that when either tensiometer indicates water will be needed, the controller will have the sprinklers operate at a predetermined time. Originally the sprinklers were scheduled to run for two 15-minute periods during the night. When a sprinkler can test was conducted in June of 1964, it was noticed that runoff water flowed into a surface drain for some time after a 15-minute watering. The controller has since been changed to allow only two 7-minute irrigations a night, if needed.

The number of irrigations is determined by the tensiometer which activates the controller. The second irrigation will only be applied if insufficient water has been applied to infiltrate to the desired soil depth.

The weather in September and October was extremely variable as there was a 2-inch rain over the 3 day period of September 16 to 18, and 5 consecutive days of over 100-degree temperature starting September 25. This was followed by some cool, overcast periods. The irrigation frequencies and length of irrigation varied according to different climatic conditions during this time, as they have since the trials began. (See Fig. 1 and 2).

Deauville Country Club

A system similar to that at U.C.L.A. was installed in March 1964 on a Seaside bentgrass golf green at the Deauville Country Club in Tarzana, California. Tensiometers were placed at 2-inch and 6-inch depths on the edge of this green. When irrigation is needed, water is applied for 10 minutes each hour, until enough water has been applied to reach to the depths of the tensiometer signaling for water.

Unfortunately, most of the information obtained from the Deauville installation was lost when a theft occurred there and the container where the records were kept was one of the items taken. Information available from regular visits made to the green during the trial by the author and that supplied by the course superintendent showed how irrigation for March through May varied from 7-day intervals to daily watering when temperatures rose above 100° F. Length of irrigations were from 10 minutes to 40 minutes, if needed.

Deep Aerification of Turfgrass

During the winter of 1961, Hemstreet and Dorman of the University of California Agricultural Extension Service in San Bernardino County, successfully tested a new technique – – "deep aeration" -- for the renovation of

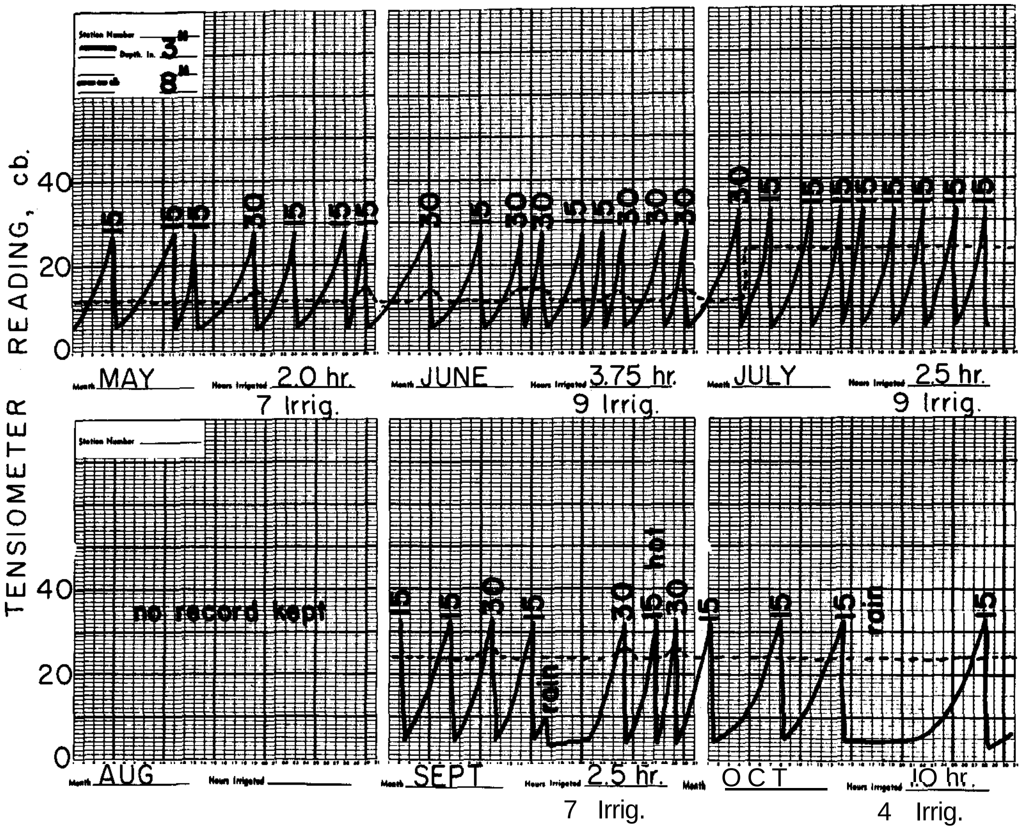

Figure 1

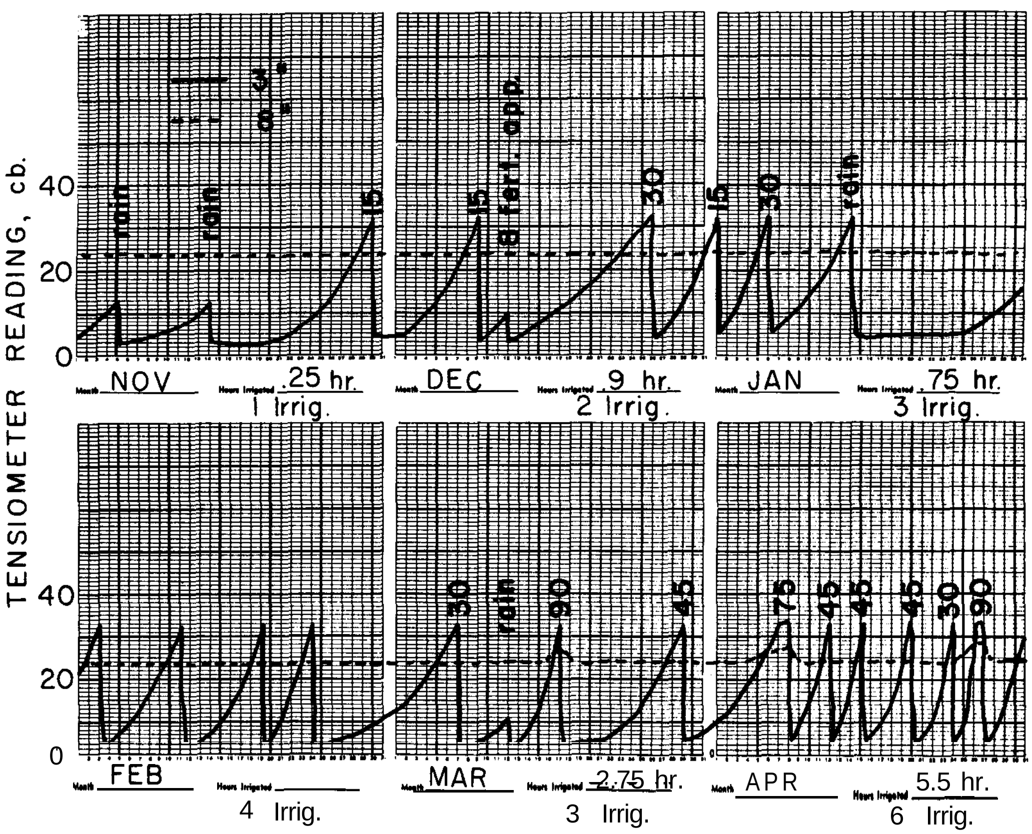

Figure 2

old, weak golf greens. Results of this trial showed increases in turf vigor, appearance, rooting depths and water infiltration. Water puddling on the green was reduced, as was the frequency of irrigation and total amount of water used.

At the Santa Anita Golf Course in Arcadia (owned by Los Angeles County), an old, weak green which had been removed from play every summer for the past 7 years, was selected to further test this new method of deep aerification in 1964.

Before aeration water remained on the green for over one hour when the sprinklers were operated for 15 minutes. When the trials were completed, the superintendent reported that even when water was applied for45 minutes, there was no water standing on the deeply aerified areas.

Plugs of soil on 3-inch centers were removed with a l-inch diameter soil tube to a depth of 6 inches. Treatments consisted of backfilling the holes with a soil mix containing 6 parts fine sand, 1 part nitrohumus, and 3 parts peat moss, lignified redwood sawdust or calcine clay. These treatments were compared to mechanical aerification with 1/4-inch thatch spoons, holes left open, at 4 week intervals from May through August.

The green was overseeded with Seaside bentgrass at the completion of the work. Approximately 2 weeks after the holes were backfilled, the turf had completely filled over the holes. The green was reopened to play in early June following completion of the work. Within 3 weeks, the green had to be closed again as the superintendent of the golf course said the turf in the check and machine aerated plots was dying. There was no weakening of the turf observed in the deep aerification treatments.

Soil samples taken for rooting depths about 3 months after the work was completed revealed that there were dense masses of roots to the full depth of the deep aerification holes. There didn't appear to be any significant differences in rooting with any of the deep aerification treatments. Numerous new roots were noticed in the 1/4-inch machine aerified holes that were left open, but very few roots were found in the undisturbed columns which were similar to the rooting of the turf before the trials began.

Measurements to determine the oxygen status within the soil were made. The results indicated insufficient oxygen for healthy root growth and development in all of the turf soil except where the deep aerification was done. This should explain the poor root growth, but does not necessarily eliminate the physically impeded soil as an additional factor restricting root development. This is the maximum oxygen in the soil that could be obtained as the turf was to be irrigated that night after a longer-than-usual dry period.

Water infiltration measurements showed there was a significant increase in the water infiltration rates of the deep aerification holes when compared to the mechanically aerified plots.

An observation that may be of significant value is that pertaining to the amount of annual bluegrass, *Poa annua*, in the green. Before treatments were begun, it was estimated that greater than 50 percent of the green was *Poa annua*. After the deep aerification treatments and overseeding with Seaside bentgrass, the bentgrass could be seen first growing over the deep aerification holes, and by mid-August there was a significant decrease in the *Poa annua* with a corresponding increase in bentgrass.

Discussion

The tensiometer installation at the Whittier Narrows Golf Course can emphasize how tensiometers can be beneficial without completely automatic controls. Using the records for June and July 1964, irrigations according to previous practice would have resulted in 915 minutes of operation at 910 G.P.M., or 83,265 gallons (11,102 cu. ft.) of water being applied. The G.P.M. calculations are arrived at by multiplying the manufacturer's specified output for the sprinklers by the number of sprinklers. Using tensiometers as a guide for scheduling frequency and duration of irrigation, only 160 minutes of operation or 14,560 gallons (1,941 cu. ft.) of water was applied. This is an 82 percent reduction in water use.

If we can assume a cost of 25c/100 cu. ft. (these are the costs prevailing at a southern California community and will be used for illustration, although it is known that water costs may vary greatly) the water costs from their normal practice on this green for the 2 months of June and July would have been $27.80. Under tensiometer controlled irrigation, it was only approximately $4.85.

Previous to the trials at U.C.L.A., irrigations were scheduled twice a week, 15 minutes each setting, during the cool months from about November to June and 3 times a week from June through October. According to the manufacturer's specifications, output for the sprinklers covering the test area is 145 gallons per minute at the pressure used. For the months September through December 1964, this means 630 minutes or 91,350 gallons (12,180 cu. ft.) of water would have been applied. At the illustration costs described, this would have been $30.45. Under the completely automatic tensiometer controlled system, only 270 minutes or 39,150 gallons (5,220 cu. ft.) was applied at a cost of $13.05. This represents about a 57 percent reduction in water use.

Although most of the records at the Deauville Country Club were lost, the information available for the irrigation on Green #4 from March through May 1964, is significant.

Prior to this installation the watering schedule for this green had been approximately 35 minutes every other night. However, in cases of extreme heat and during the summer, water was applied every night with supplemental syringing during the day.

At 35 minutes every other night, for the period mentioned, 26.5 hours of irrigation would have been applied. This represents 95,400 gallons of water at an approximate cost of $31.80, using the same illustration costs. Under the tensiometer controlled system, only 16 hours or 57,600 gallons of water was used at a cost of $19.26. This means about a 40 percent reduction in water use.

The figures at Deauville will become even more significant for the tensiometers have since been changed to start irrigation at drier readings. The superintendent at Deauville reports that after the first 5 to 6 weeks of completely automatic tensiometer controlled irrigation there has been a definite reduction of about 75 percent to 80 percent in hand watering required on this green in comparison to other nearby greens.

Prices vary so much for the installation of new golf greens, it is difficult to arrive at an average figure. The size of the green, sprinkler system requirements and drainage needs all must be considered. If the work is to be all contracted, if partly contracted, or if all work is to be done by the regular work force at the course also figures in costs of the green.

Let's assume that an average green to rebuild entails a cost of about $2,500 for a 5,000 square foot green. If deep aerification will cost approximately 5c a square foot, this would only be about 1/10 of the cost to rebuild the green.

When a golf or bowling green is being rebuilt, it requires that the green be taken out of play for up to 5 months. With deep aerification, the turf can be used again as soon as the work is finished, although it would probably be beneficial to allow the turf 2 to 3 weeks to completely fill in.

Savings of water costs may contribute substantially to help pay for the deep aerification. It is entirely possible that with a deeper root system less frequent watering could result in water savings from 25 to 50 percent or greater. If watering is done manually, there could also be a substantial savings in irrigation labor costs. Other savings from fertilization, disease and weed control may also be possible.

Conclusion

It has been shown that tensiometers can be used successfully as a guide for determining frequency and duration of irrigation for turfgrass areas. This can be either from installations associated with manual control or from completely automatic systems. For such systems to operate successfully, there must be complete irrigation management. This means good distribution of water from the sprinklers with application rates not greatly in excess of the water infiltration capacity of the soil, and a regular program of thatch control and soil aerification where needed. This is basic, good management.

An important benefit from the use of tensiometers arises from creating a greater awareness of better irrigation practices among turfgrass superintendents. If properly installed tensiometers fail to reflect the water needs of the turf, correction of some other management operations is indicated. A program should include checking and correcting water distribution and application rates. Thatch control and soil aerification may be needed. Complete good management is necessary to have the benefit of using tensiometers as a guide to better irrigation.

In analyzing the results, savings in water and money have been realized. This is not to imply that similar, if any, savings will result in all installations, although most turf authorities agree that over-irrigation is the rule rather than the exception.

Often the beauty of turfgrasses for recreational use is more important than savings in water and money. In the tensiometer trials being reported, the turf was maintained in a healthy and beautiful condition. There has been no interference or detrimental effects on the playing conditions of the golf greens. In many instances where tensiometers have been used as a means of determining turfgrass irrigation, including golf and bowling greens, deeper rooting has developed with a greater vigor and beauty of the turf.

It appears that the new method of deep aerification as a means for restoring weak turfgrasses to a healthy condition offers considerable promise. This work can be done at a fraction of the cost and time involved for rebuilding the green.

Provided drainage is adequate, deep aerification may be better than the rebuilding of the turf area. The old, compacted columns can remain as mechanical support of the turf and will take the wear while the holes can remain porous for a growing medium for the faster infiltration of the water into the soil and exchange of gases between the soil environment and the atmosphere.

Several companies have indicated that they are working on machines to do the deep aerification work. One of the companies has reported that it has a model almost ready for doing this work.

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Scientific reviews on this subject were presented at the American Society of Agronomy meetings in Kansas City, November 1964. Extracts of information contained in those reports are included throughout this article. Papers presented were: Turfgrass Renovation by Deep-Aerification, by Wayne C. Morgan, J. Letey, and L. H. Stolzy, and Turfgrass Irrigation by Tensiometer Controlled System by Wayne C. Morgan and Albert Marsb.

Annual Bluegrass, Poa annua

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Annual bluegrass, *Poa annua,* has long been both a curse and a blessing to nearly all who must care for turf, particularly bowling or putting greens. Like crabgrass annual bluegrass appears to be everywhere present, from the mountains to the desert, from the tropics to the sub-Arctic. Many a lawn in southern California consists primarily of crabgrass in the summer and annual bluegrass during the fall, winter and spring. A little bermuda and a scattering of dichondra might also be observed with close inspection.

Many home owners would have no lawn and many golf courses no green if Poa annua were suddenly destroyed. It often thrives where nothing else will and for all its faults it does provide a green, attractive cover and a satisfactory putting surface.

There is good reason for this similar ubiquity of the two grasses. Annual bluegrass like crabgrass grows in compacted soil and surface moisture. It thrives even though nutrient levels may be low. The principal factor in its wide distribution in lawns, however, is the ability to flower and produce seed even under very close and frequent clipping. A single Poa annua plant established in an area will propagate thousands of offspring and soon its progeny will completely dominate all other grasses during the cool season.

Annual bluegrass is an extremely variable species with a great range in growth habit, shade of green, flowering behavior, leaf width, and rate of growth. Not all annual bluegrass is even strictly annual, as in many old golf and bowling greens perennial types several years in age are frequently found. Some of these have been selected, propagated and studied as strains of possible superior turf value. These perennial types are characteristically fine-textured, dense and dark green, making excellent putting or bowling surfaces. Frequently they are surprisingly free of seed heads and may even be sterile. Unfortunately no disease tolerance has been observed.

Normally in subtropical regions annual bluegrass seed germinates in the fall as soon as cool weather arrives. Seed germination may continue through the fall, winter and early spring. By mid-spring, however, the germination period is usually over.

Plants may begin to flower within six to eight weeks after seedling emergence. Flowering is not governed by day length and is only slightly affected by temperature within the range of 50 to 80°F. Therefore flowering proceeds with little fluctuation through the winter and spring and even well into the summer. This seed will not germinate immediately but lies dormant in the soil until the fall. Many of the plants die during the hot summer weather unless special care is given.

In temperate climates the life cycle is similar except for modifications induced by the cold winter season. Plants from fall germinating seed will over-winter in a dormant condition, continue development in the spring, and produce most of their seed in late spring and early summer. In these areas of cold winters, however, most of the seed germinates in the spring in contrast to fall germination where the climate is mild.

If annual bluegrass is to be maintained throughout the summer special care must be given it. Since it is a very shallow rooted grass frequent watering will be necessary. Annual bluegrass is susceptible to many fungus diseases necessitating the use of fungicides during warm weather when many disease organisms are most active. Regular aerification during spring, summer and fall are essential even though it can be grown on compacted soils.

Light syringing of greens is frequently necessary to prevent wilt of Poa annua during periods of extremely high temperature when water loss from the plant through transpiration is excessive. The main reason annual bluegrass is not used more generally for turf is that it is not a dependable species. An entire turf of Poa annua may be lost in a day of hot dry weather or during a night of warm humid weather. It is highly susceptible to injury from salts which may be concentrated on the soil surface by light frequent irrigations.

In annual bluegrass then we have a species which on one hand invades and dominates many turf areas while on the other hand it cannot be depended upon to form an acceptable turf throughout the year.

How then can we best handle it and keep it under control? The first step is to give your desirable turf grasses the good care that they need. Deep-rooted grasses such as bluegrass and fescue do not need the frequent light watering required by annual bluegrass. Even dichondra can be maintained well throughout most of the year with only one deep watering a week. Thus good watering practices will go a long way towards helping your turfgrasses keep annual bluegrass out.

Poa annua with its shallow root system can grow in soils so badly compacted that other turfgrasses will fail. Regular aerification must therefore accompany the good watering practices. Since Poa annua seed germination in California is heaviest in the fall and early winter it may be better to aerify in later summer before the germination period and in the spring after the peak germination period. Maintenance of adequate levels of nutrients by a regular fertilization program is also required. Any maintenance practice that encourages a vigorous healthy turf will indirectly aid in the control of Poa annua.

Several herbicides such as Betasan, trifluralin and Dacthal are useful for the preemergence control of annual bluegrass. They must be applied in the early fall before the seed germinates if they are to be fully successful. Spring applications in California may be of little value. Diphenamid is an excellent material for the control of annual bluegrass in dichondra and is available in a number of formulations. It is toxic to many grasses so should not be used on grass lawns. At the present time there are no safe chemicals for the control of mature Poa annua in bentgrass greens.

Any material used for Poa annua control in bentgrass putting greens should be tested under the specific conditions of each course before a general application is made. The extreme cultural practices of putting greens produces a turf highly susceptible to chemical injury so proceed with caution. Slight variations in soil, climate or maintenance from one golf course to another can make the difference between injury or non-injury.

Annual bluegrass is very useful as a winter grass for bermudagrass lawns. Once it is established it will come back year after year. It is necessary however to renovate or remove the bermuda thatch each fall if an even stand of Poa is to be obtained. Fine winter fairway turf can be had this way without the cost of overseeding.

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