Turf test plot showing ring infiltrometers and hook gauge used to record the level of water during irrigation.

VERTICAL MULCHING FOR IMPROVEMENT OLD GOLF

. . . a further evaluation

The practice of close-spaced vertical mulching does not appear to be the complete solution to the problem of improving old golf greens. Better irrigation systems are also needed to take advantage of the new root environment provided by the improved soil mix in the vertical mulch holes. The interrelationship between vertical mulching and other cultural practices is also being studied.

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 also requires that they be mowed closely at frequent intervals. In time, periodic top-dressing causes thatch buildup and stratification of soil layers. Water penetration is typically 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 and often replace 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 is generally followed to restore 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 rescheduling 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 1-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 report summarizes tests undertaken recently 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 1 shows the textural analysis of the top 6 inches of soil.

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 ½-inch thick at a depth of about 3½ inches throughout the green. The origin of this layer is not known. The stratification of the soil can be seen in the photo of soil profile from the test putting green.

An area of turf 12 × 120 ft, on the east side of the bowling green was used for this experiment. Two adjacent strips of 20 plots, each 5 × 5 ft square, were marked

TABLE 1. PERCENTAGES OF ORGANIC MATTER CONTENT AND MECHANICAL ANALYSIS OF MINERAL FRACTION OF TOP 6 INCHES OF SOIL
(Weight basis, average of three composite samples)

Depth	Organic matter*	Coarse sand	Fine sand	Silt	Clay
Inches			Per cent		
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 2½-inch-deep cores of soil removed by a mechanical aerifier.

out, and the following treatments were applied on April 9 and 10, 1964: (1) no treatment; (2) aerification in two directions with a mechanical aerifier (Greensaire) which removed ¼-inch cores 2½ inches deep; (3) vertical mulch by hand on 3-inch centers, using a 1-inch diameter Oakfield soil tube to a depth of 6 inches; (4) same as treatment three except on 6-inch centers; and (5) same as treatment three 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 1-inch holes were backfilled by hand with a mixture of one part organic matter (Loamite soil amendment) and two parts fine sand. The soil mix was lightly tamped into each hole, using a ½-inch dowel to fill the hole completely. After treatment, the entire test area was verticut in three directions. Seaside bentgrass was sown at the rate of 5 lbs per 1,000 sq ft; then

OF GREENS

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the area was top-dressed with 1½ yards of the same soil mix per 1,000 sq ft. Calcium nitrate at the rate of ½ lb of nitrogen per 1,000 sq ft was applied at two-week intervals following treatment. No changes were made in the usual irrigation practices.

Plots were visually rated on May 9, four 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*.

Water was withheld from the treated area for six 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 10-minute intervals over a period of one hour. The accumulated infiltration after one hour is shown in table 2.

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

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

Water was withheld from the test area for three days. Two infiltration measurements were taken in each plot in one strip. A depth of nine inches of water was placed in the ring infiltrometers. Measurements of the drop in water surface were taken at 10-minute intervals over a period of one hour. The accumulated infiltration after one hour is shown in table 3.

TABLE 3. ACCUMULATED INFILTRATION IN INCHES IN ONE 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	1.82	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.

Sept. 29–30 infiltration tests

The treated area was irrigated the day before infiltration tests were made. High application rate sprinklers ran for two 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 1½ inches of water. Measurements of the drop in water surface were taken at 10-minute intervals over a period of one hour. The accumulated infiltration after one hour is shown in table 4.

TABLE 4. ACCUMULATED INFILTRATION IN INCHES IN ONE HOUR ON SEPTEMBER 29–30 (Average of four 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

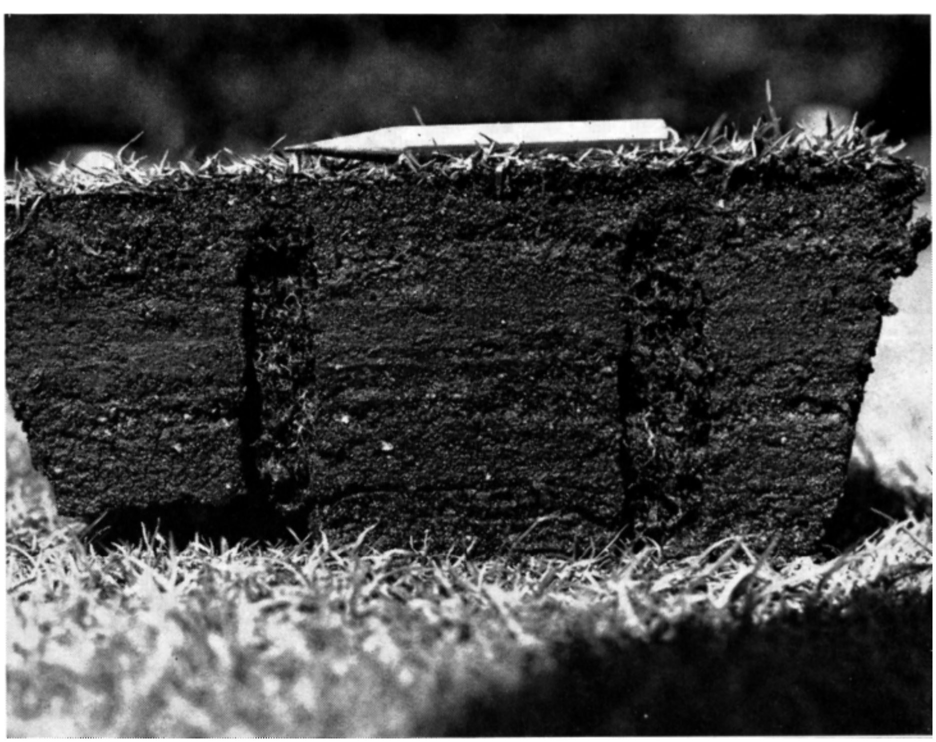
$LSD_{.05} = .11$ $LSD_{.01} = .15$

Results

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% as compared to the 1½-inch depths used in this test.

Low infiltration rates of water into soils are one of the major problems on

Soil profile through the test putting green with vertical mulch holes on 3-inch centers showing vigorous, healthy root system. A portion of the backfill material has 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.



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 linearly 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 ½ inch per hour for the 3-inch spaced holes; and less than ⅕ 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.

Vigorous growth

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 pervious 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.

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Pasture and greenchop performance comparisons . . .

PIPER SUDANGRASS AND SUDAN HYBRIDS UNDER IRRIGATION

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Many trials comparing the yielding ability of some of the sudan hybrids with Piper sudangrass have failed to show any significant differences in pasture production when based upon dry matter produced. Greenchop operators in California utilize these summer annuals in every stage of growth from near 20 inches in height to near maturity. The height at which these crops are harvested as greenchop depends upon how often the stand must be recut to keep material moving to the feeding operations. The data presented here suggests that if greenchop operators harvest their crop at about 5 to 6 ft or less in height, there is little or no advantage in using hybrids. If, however, greenchopping is confined to plant material, 7, 8, or 9 ft in height, there is a definite yield advantage from using the excellent sudan hybrids.

AGRICULTURE IS BEING offered a number of hybrid varieties of sudangrass for use as annual summer pasture and greenchop. These hybrids originate from crosses between two sudangrass varieties, sudangrass and grain sorghums, forage sorghums, or sorgos. These cultivars produce well and provide feed of good quality. The sorghum-sudan hybrids generally retain some characteristics of both parents; most being thick stemmed, late maturing, and tall.

For the past three years Piper sudangrass and cultivars representing some of the hybrid types were tested in comparative yield trials under irrigation at Davis. Piper sudangrass was used as the standard in these trials—not because it is more productive than other sudangrass, but it is popular and widely used in California.

In 1961, Piper sudangrass, SX-11 (grain sorghum × sudangrass), and NK-300 (a hybrid forage sorghum normally used for silage) were tested for pasture and greenchop yield. Pasture conditions were simulated by harvesting these cultivars when each reached 2 ft in height. Greenchop conditions were simulated by harvesting each variety at the 50% late-boot stage (when 50% of booted tillers have heads already emerged or starting to emerge; could also be designated as very early heading).

Pasture trials showed a higher percentage of moisture and protein for SX-11 and NK-300 at the same height as Piper sudan, while at the greenchop stage of development—when the cultivars were near the same stage of maturity—there was less difference in protein values. However, the hybrids still contained a greater percentage of moisture. When used as pasture, there was no significant difference in dry matter yield between a sudangrass, a sorghum-sudan hybrid, and a hybrid forage sorghum. Under greenchop conditions, the hybrid forage sorghum was significantly lower yielding than the other two. This can be attributed to a slower recovery rate after harvest, slower growth prior to the last cutting

TABLE 1. COMPARISON OF PASTURE AND GREENCHOP DRY MATTER AND GREEN WEIGHT YIELDS OF SUDANGRASS, A SORGHUM-SUDANGRASS HYBRID, AND A SUDAN HYBRID—1962

	Season D.M.	Total green weight	% Ave. moisture	Ave. plant height (in.)
PASTURE Harvested when Piper sudan reached near 30 inches in height (Average of 10 replications)				
Piper	9.63	63.67	84.82	30.2
SX-11	9.55	70.61	86.42	27.8
Suhi-1	9.15	66.79	86.26	26.6
LSD (.05)	NS	3.14		
(.01)	NS	4.31		
GREENCHOP Harvested when Piper reached 50% late boot				
Piper	58.36	79.34	12.06	54.7
SX-11	77.46	85.06	11.58	50.3
Suhi-1	69.31	84.49	10.75	47.6
LSD (.05)	4.45		0.49	
(.01)	6.13		0.67	