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Kikuyugrass *(Pennisetum clandestinum ex. Chiov.)* Cultural Practices: I. Response to Nitrogen Fertilization and Sports Traffic

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Introduction

Kikuyugrass *(Pennisetum clandestinum ex.* Chiov.) is well adapted to the coastal and adjacent inland areas of California and has come to predominate in many turfgrass sites. It is found in highly trafficked areas as well as in areas that receive no traffic. Turfgrass quality is often an issue. Managers of golf courses and sports fields that are invaded by kikuyugrass are faced with the decision of controlling the grass or managing it. Even when maintained as an acceptable turf, the coarse texture and light green color are often objectionable. Therefore, it was the objective of the study reported here to examine the performance of kikuyugrass to nitrogen fertilization under simulated trafficked and nontrafficked conditions.

Methods and Materials

Nitrogen was applied one time, in June, to four replications of kikuyugrass turf as 16-16-16 at the rates of 0.25, 0.5, 1.0, and 2.0 lbs. N/1000 ft^2 (12, 24, 48, and 96 kg N/ha) in a randomized complete block design. Plots were mowed at 5/8 inch (1.6 cm.). Visual turf score evaluations were made at 2,4,6, 8, and 10 weeks after treatment (WAT)

The next step was a two-year field study to evaluate nitrogen (N) fertilizer applications and traffic on turf quality of kikuyugrass. The first year, ammonium sulfate was applied at 0.5, 1.0, and 2.0 lbs. N/1000 ft^2 (24, 48, and 96 kg N/ha), as described in Table 1. Plots were vertical mowed in May and October. All plots were mowed at a height of 0.5 in. (1.3 cm.). Traffic was applied with a Brinkman Traffic Simulator (1) and, the first year, consisted of three football game equivalents per week during spring, four game equivalents per week in summer and two game equivalents per week in the fall, which would be heavy golf traffic. The second year traffic was limited to two game equivalents per week, which would be moderate golf traffic. The experimental design was randomized complete block replicated four times. Visual color ratings and turf scores were used to evaluate traffic and recovery. A Clegg Impact Tester was used to compare the biomass differences among the treatments (2).

Results and Discussion

A one-time application of nitrogen of 0.5 lb. N/1000 ft^2 to kikuyugrass turf that was not subjected to traffic provided adequate turf quality for up to 10 weeks, (Table 2). Application of less nitrogen will still last up to 4 weeks after application. Nevertheless, as expected, kikuyugrass turf will respond to high nitrogen application rates.

In the first year of a two-year study of nitrogen application timing, nitrogen applied once in the spring at 1.0 lb. N/1000 ft^2 produced a slight improvement in kikuyugrass traffic tolerance and an increase in turf quality in the fall. Applied at 2.0 lb./1000 ft^2, nitrogen decreased trafficked, turf quality by fall, (Table 3). Three applications at 1.0 lb.N/l000 ft^2 produced the highest quality kikuyugrass turf with and without traffic. No traffic treated turf was significantly better than all treatments. The next highest quality turf was the N treated trafficked turf. No nitrogen (control) trafficked turf exhibited the poorest quality.

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[2]**Extension Environmental Horticulturist, Dept. of Botany and Plant Sciences, University of California, Riverside.**

Table 1. Nitrogen Application Treatments (two-year study).

lbs. N/l000 ft2	Year 1 Treatments	Year 2 Treatments
0.5	Apr., Jun., Jul., Aug., Sep.	May, Jun., Jul., Aug.
1.0	Apr.	May
1.0	Apr., Jun., Aug.	May, Jun., Aug.
2.0	Apr.	May
Control	None	None

Table 2. Kikuyugrass Response to Fertilizer Application (no traffic) (Turf Score*).

Treatment	Weeks After Treatment				
lbs. N/1000 ft^2	2	4	6	8	10
2.0	8.0	7.7	7.0	7.0	7.0
1 .0	7.7	7.3	6.3	6.3	6.8
0.5	6.7	6.3	5.3	6.3	6.8
0.25	6.3	6.0	5.0	5.0	5.3
Control	5.3	6.0	5.0	5.0	5.0
LSD**			1.1		

*Turf Score: 1 = poor turf quality; 9 = excellent turf quality.
**LSD for all columns.

Table 3. Summary of Nitrogen Treatments on Kikuyugrass (with and without traffic) (Turf Scores*).

lbs. N/1000 ft2	APR.		MAY		JUN.		JUL.		AUG.		SEPT.	
	T	NT	T	NT	T	NT	T	NT	T	NT	T	NT
1 .O-Apr.	5.8	7.0	5.5	6.5	4.8	5.8	4.5	6.3	4.8	6.0	4.8	6.3
2.0-Apr.	5.5	7.0	6.0	7.0	6.0	6.8	4.5	6.3	4.5	6.0	4.5	6.3
1 .O-Apr., Jun., Aug.	6.3	6.8	5.3	6.8	5.8	6.0	5.8	7.0	5.0	6.3	5.8	7.0
0.5-Apr., Jun., Aug., Jul., Sep.	5.5	7.0	5.3	6.8	4.8	5.5	5.3	5.3	5.3	6.3	5.5	7.0
Control	5.3	6.5	5.3	6.0	4.5	5.5	4.5	5.3	4.3	5.5	4.5	5.5
LSD***	0.7		0.7		0.7		0.8		0.6		0.7	

*Turf Score: 1 poor turf quality; 9 = excellent turf quality.
**T= traffic; NT = no traffic.
***LSD = for both T and NT columns of each monthly rating, respectively.

Five applications at 0.5 lb. N/1000 ft^2 improved kikuyugrass turf quality significantly over all treatments in the no traffic treatment. In the traffic treatment the quality increase from five applications was significant only over the trafficked no nitrogen control. The five application trafficked turf was as good as, and not significantly different, from the no traffic, no nitrogen (control).

In the second year of the study, the non-trafficked kikuyugrass turf responded to the five applications at 0.5 lb.N/ 1000 ft^2 the same as to the three 1.0 lb. N/1000 ft^2 treatments. The trafficked turf response was similar to Year 1 with the three applications of 1.0 lb. N/1000 ft2 treatment rating highest. Kikuyugrass treated with five applications at 0.5 lb. N/1000 ft^2 under traffic began to respond with improved turf quality by Fall.

The Clegg Impact Tester showed the trafficked kikuyugrass turf to be significantly harder with a higher impact (Gmax) rating than the no traffic turf, (Table 4). Three applications at 1.0 lb. N/1000 ft^2 and five applications of 0.5 lb.N/l000 ft2 provided the greatest impact absorption capability. Those treatments also produced the greatest accumulation of biomass.

Conclusions

Kikuyugrass turf that is not trafficked can be adequately

Table 4. Kikuyugrass Fertilizer Timing x Traffic. (Clegg Impact Tester (gMax))*

Treatment	Traffic	No traffic
0.5-May, Jun., Jul., Aug.	54.6	37.2
1 .O-May	58.7	51.7
1 .O-May, Jun., Aug.	52.7	44.8
2.0-May	60.8	46.0
Control	69.4	51.4
LSD**	3.2	

*gMax = higher values reflect firmer surface.
**LSD for both columns.

maintained with an application of 0.5 lb. N/1000 ft^2 once per year. For higher turfgrass performance, three applications of nitrogen at 1.0 lb./1000 ft^2 provided the highest quality kikuyugrass turf with or without traffic. A single application at 2.0 lbs.N/l000 ft^2 reduced turf quality.

Good quality kikuyugrass turf was maintained with five applications of 0.5 lb.N/l000 ft^2. Biomass accumulated with increasing N, particularly with no traffic. Increased biomass production reduced soil compaction caused by traffic.

References:

(1) Cockerham, S. T. and D. J. Brinkman. 1989. A simulator for cleated-shoe sports traffic on turfgrass research plots. *California Turfgrass Culture, 39(3&4): 9-12.*

(2) Rogers, J. N. III, and D. V. Waddington. 1990. Portable apparatus to assess impact characteristics of athletic field surfaces. In: R.C. Schmidt *et al* (eds.), Natural and artificial playingfields: characteristics and safety features, ASTM STP 1073, ASTM, Philadelphia, p. 96-l 10.

Kikuyugrass *(Pennisetum clandestinum* ex. Chiov) Cultural Practices: II. Response to Vertical Mowing and Sports Traffic

Stephen T . Cockerham[1], Rudy A. Khan[1], and Victor A. Gibeault[2]

Introduction

Kikuyugrass *(Pennisetum clandestinum ex.* Chiov.), exhibits an aggressive, turf-like growth habit accumulating vegetative biomass including thatch. As a golf course turf kikuyugrass tends to form a spongy, deep mat unacceptable for fairway playability. On sports fields the entangled, tough stolons become a tripping hazard to players wearing cleated shoes, and, the spongy surface tends to be slippery for non-cleated shoes. Managers of golf courses and sports fields covered by kikuyugrass must use an efficient method to reduce the accumulated plant material. This study explored the use of vertical mowing to address the aggressive nature of the grass and to produce a quality turf, whether subjected to traffic or not.

Methods and Materials

The effects of vertical mowing on kikuyugrass were evaluated with and without sports traffic. Traffic was applied with a Brinkman Traffic Simulator (1). The first year treatment consisted of three football game equivalents per week during spring, four game equivalents per week in summer and two game equivalents per week in the fall. This would be heavy golf traffic. In the second year, the traffic treatments were limited to one game equivalent per week, which would be moderate golf traffic (Table 1). All plots were fertilized every 4 weeks at 1.0 lb. N/1000 ft2 (48 kg. N/ha) and were mowed at 0.5 in. (1.3 cm.). The experimental design was randomized complete block, replicated four times. Visual ratings (turf scores) were used to evaluate turf quality, traffic tolerance, and recovery from vertical mowing. A Clegg Impact Tester was used to compare the biomass differences among the treatments (2).

Results and Discussion

In the first year, the kikuyugrass was well established and quite spongy due to a heavy accumulation of biomass. Due to thick turf mat, the vertical mowing and traffic treatments started in the spring severely reduced turf quality, (Table 2).

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[2]Extension Environmental Horticulturist, Dept. of Botany and Plant Sciences, University of California, Riverside.

Table 1. Vertical Mowing Treatments (traffic and no traffic).

	Year 1 Treatments Month	Year 2 Treatments Month
Vertical mow	April	May
Vertical mow	Sept.	Sept.
Vertical mow	April, Sept.	May, Sept.
Vertical mow	April, July, Sept.	May, Jul., Sept.
Vertical mow	April, Jun., Jul., Aug., Sept.	May, Jun., Jul., Aug., Sept.
Control	None	None

The later vertical mowing treatments, particularly under traffic, resulted in significantly lower turf quality for some time after the application of the treatments. The kikuyugrass was tom and shredded by the vertical mower, thus downgrading the appearance. By fall the quality of the vertical mowed treatments had increased to that of the non-vertical mowed, or was higher. The spring vertical mowing treatment with traffic eventually recovered to be higher quality than either non-vertical mowed treatment. Vertical mowing three times per season with traffic produced high quality kikuyugrass turf. Turf that was vertical mowed three times without traffic or was trafficked without vertical mowing, possessed good quality. Vertical mowing monthly during the growing season, with and without traffic, reduced the biomass, but did not improve the quality.

In the second year, the kikuyugrass turf was less spongy and had less biomass in all treatments except the untreated control. Quality reduction only showed immediately after and as a result of vertical mowing treatments, and only for a short time. Turf scores among treatments were generally not significantly different indicating little damage from the treatments.

Surface hardness measured with the Clegg Impact Tester (2.5 kg. missile) increased with traffic or vertical mowing, probably due to biomass reduction. Removing the biomass and increasing the surface firmness by increasing the frequency of the vertical mowing was similar to that of the action from traffic, (Table 3).

Conclusions

There is no advantage to vertical mowing kikuyugrass turf more than three times per season. If the turf surface is still too spongy after vertical mowing three times, increasing vertical mowing frequency will further reduce kikuyugrass turf biomass resulting in an increase in surface hardness. Traffic appears to reduce turf biomass so vertical mowing may not be required where traffic is significant.

Kikuyugrass golf fairway and sports field playability can be improved with vertical mowing. Where traffic would be insufficient to reduce biomass, vertical mowing would be necessary.

References:

(1) Cockerham, S. T. and D. J. Brinkman. 1989. “A simulator for cleated-shoe sports traffic on turfgrass re-

Table 2. Kikuyugrass vertical mowing x traffic. (Turf Scores* Summary)

Treatment	June		August		October	
	T	NT	T	NT	T	NT**
April	5.0	5.0	6.3	7.0	7.0	6.3
September	5.5	7.0	6.5	6.8	5.8	5.6
April, September	5.0	5.0	6.3	6.8	6.0	5.0
April, July, Sept.	5.5	5.0	5.5	6.0	6.0	5.8
April, June, July, Aug., Sept.	5.3	5.3	5.3	6.3	5.6	6.0
Control	5.0	6.8	6.0	6.0	5.6	5.8
LSD***	0.5		0.6		0.6	

*Turf Score visual rating: 1 = very poor, 5 = acceptable; 9 = excellent.
** T = traffic; NT = no traffic.
***LSD = for both T and NT columns of each monthly rating, respectively.

search plots", California Turfgrass Culture, 39(3&4): 9-12.

(2) Rogers, J. N. III, and D. V. Waddington. 1990. "Portable apparatus to assess impact characteristics of athletic field surfaces", In R.C. Schmidt et al (eds.) Natural and artificial playingfields: characteristics and safety features, ASTM STP 1073, ASTM, Philadelphia, p. 96-l 10.

Table 3. Kikuyugrass vertical mowing x traffic. Clegg Impact Tester (gMax) *

Treatment	Traffic	No traffic
May	42.5	35.1
September	38.4	34.5
May, September	40.5	35.7
May, July, September	53.5	43.0
May, June, July, Aug., Sept.	59.1	52.8
Control	46.3	35.0
LSD**	3.3	

*gMax = higher values reflect firmer surface
**LSD = for both columns

Golf Green Construction-A Review of the University of California Method

M. Ali Harivandi [1]

During the mid 1960's, Dr. John Madison and Mr. Bill Davis, from the University of California, Davis, began to look at the problems associated with heavy use of golf greens, including the failure of these greens due primarily to compaction of the growing media. They studied all types of amendments with various sand gradations and concluded that the "right" sand, unamended, can produce the most acceptable golf greens.

There are two potential problems with the pure-sand green concept which must be addressed before superintendents and golf course architects are willing to accept it. First, sands are droughty and do not hold sufficient water to make them suitable as a field-growing medium. Secondly, sands have very poor cation exchange and, therefore, do not hold nutrients needed for plant growth. These two objections to the concept, found in every agricultural soils textbook, are valid for sand as a general soil medium. However, the sand recommended for golf green construction is a specific sand that, under conditions of extensive use, will not compact: uniform sand particles on the fine side, which retains sufficient moisture in the rooting zone to carry turf for 2 to 3 days between irrigations at normal summer evapotranspiration rates. Such a sand should drain excess water from the surface root zone in less than 15 minutes, no matter how much water it receives in a short period of time. As for nutrients, problems of fertility management are no greater for pure-sand greens than they are for other putting-green media. However, during the grass establishment period, greater attention to a good, balanced fertility program is required.

Sands that meet the above specifications may or may not be readily available at the closest sand and gravel company. Being a coastal state, California had many natural sand deposits quite suitable for golf green construction without being screened or washed. California also has many river sands that can be processed to meet the aforementioned requirements. Fortunately, these readily available sand deposits are relatively weed free, and sterilization is rarely recommended before seeding greens.

[1] Area Environmental Horticulture Advisor, San Francisco Bay Area, University of California Cooperative Extension.

The accompanying table shows 10 sands which have been used for construction of golf greens in Northern California over the past 30 years, as well as the recommended particle size range. The real key to selection of the "right" sand is a medium in which 90 to 100 percent of the particles are no larger than 1 mm in diameter and no finer than 0.1 mm. with the dominant fraction between 0.5 mm and 0.25 mm.

Construction of a putting surface is quite simple. The contouring or raised area around the green is of the parent soil. Only the apron and the green proper have a 12-inch (30-cm) depth of sand. Most greens are graded evenly at the subbase so that they have a 2 to 4 percent slope from back to front. No subsurface contouring is necessary. Surface sand can have added contour if the raised areas do not change the total depth of sand at the highest point more than 3 inches (7.5 cm). There is no need to establish surface drainage in different directions because all water reaching the green will readily move into the green.

At most construction sites, the parent soil has a very low water infiltration rate of less than an inch (2.5-cm) per hour. The infiltration rate of sand can vary from 10 to 50 inches (25 cm to 125 cm) or more per hour when compacted with a soil-kneading compactor in the laboratory. A sand green does not depend on surface drainage to remove water, since all water reaching the green moves into and through it. At the interface between the sand and the subbase soil, however, a perched water table can be produced during heavy rains, or by excessive irrigation. Therefore, a tile system is recommended to remove this excess water. The most important drain tile location on the green is the lowest area, generally the front of the green. Water must be removed so that it does not produce a soft approach into the green. The spacing and need for additional tile depend on the size of the green, the slope of soil around it, and the rate of excess water falling on the green.

A tile line leaving a green, must carry the water into a storm sewer or surface drainage outlet. Nutrients in sand vary depending on whether or not the sand contains any secondary minerals or is pure quartz. Thirty-five suitable sands for golf green construction have been tested by the University of California based on the pot test method, where one essential element (N, P, K, or S) was removed from each sample. All sands were deficient in nitrogen, and turf would die shortly after germination without N supplements. The same was true of sulfur: Seedling growth was stunted and yellow, dying within the first 2 weeks. As for phosphorus, 50 percent of the sands were well supplied with available phosphorus, and only 9 percent of the sands had a severe deficiency when supplemental phosphorus was withheld. Fifty-three percent of the sand had a naturally adequate supply of potassium, 38 percent showed moderate deficiency, and only 3 percent was severely deficient. Even though many of the sands may appear to need only nitrogen and sulfur, a starter fertilizer containing phosphate and potassium is recommended. Nitrogen and sulfur should be supplied every 2 to 3 weeks until the green is well established.

After many years of study and observation of sand greens, it appears that they are effective solutions to problems associated with high-use putting greens, particularly when coupled with a light, frequent sand top-dressing management program. Like any green, a sand green can be mismanaged by daily irrigation during periods of low evapotranspiration, causing excess leaching of nitrogen and potassium. Overuse of all nutrients produces excess thatch. Use of natural organic fertilizers (particularly sewage sludges) can seriously reduce infiltration, and overuse of herbicides and fungicides can be toxic to roots. Diseases are generally reduced due to the rapid drainage characteristics of sand greens.

Properly managed sand greens are firm, fast greens when cut at normal height and frequency. For the golfer, from beginner to professional, sand greens can provide a quality putting surface 365 days per year, even under high use.

Acknowledgments.

The author particularly wishes to thank Mr. Davis, Environmental Horticulturist Emeritus, University of California, Davis, whose years of research, publications and personal communications, are the basis of this article.

A comprehensive booklet co-authored by Mr. Davis -"The Sand Putting Green Construction and Management" detailing the construction and management of pure sand greens can be ordered from:

ANR Communication Services
University of California
6701 San Pablo Avenue
Oakland, CA 94608

Telephone: (800) 994-8849
Fax: (5 10) 643-5470

Price: $10.00
Publication #: 21448

Analysis of Representative Sand Samples According to Particle Diameter (mm) from Northern California Putting Greens (and Recommended Proportions)

Source	Gravel (2.0 <)	Very coarse sand (2.0 - 1.0)	Coarse sand (1.0 - 0.5)	Medium Sand (0.5-0.25)	Fine sand (0.25 -0.1)	Very fine sand (0.1 - 0.05)	Silt	Clay	Key fraction	Compacted infiltration (cm/hour)
					PERCENT					
Dillon Beach	0.0	0.0	29.9	52.4	13.6	0.3	1.7	1.1	95.2	81.3
Presidio Shoals	1.0	1.8	7.0	74.0	15.0	0.3	0.4	0.0	97.8	138.8
Santa Cruz 1070	0.0	0.0	11.7	62.7	23.6	1.0	1.5	0.5	97.0	69.0
Olympic Club	0.0	0.0	1.5	58.0	35.5	2.0	1.5	2.0	95.0	33.8
Pacific Grove	0.0	0.5	34.0	62.0	2.2	0.1	0.4	0.8	98.2	236.3
Monterey Dune	0.0	0.4	22.1	61.2	15.1	0.2	0.8	0.2	98.4	166.8
Manteca	0.0	1.4	18.4	49.0	27.7	1.8	1.1	0.6	95.1	68.8
Fortuna	0.0	0.0	0.5	74.5	23.3	0.1	1.0	0.0	98.9	65.8
Mendocino	0.0	0.0	0.0	49.2	49.0	0.5	0.5	0.8	98.2	93.8
Gordon	0.0	0.0	0.7	88.5	6.9	0.3	0.5	3.1	96.1	178.5

Recommended proportions for construction

Acceptable = [1.0 to 2.0 mm (0 to 10%)] + [0.1 to 1.0 mm (80 to 90%)] + [Clay to 0.1 mm (5 to 10%)]

Desirable = [1.0 to 0.5 mm (0 to 15%)] + [0.1 to 0.5 mm (80 to 95%)] + [Clay to 0.1 mm (4 to 8%)]

Recommended proportions for topdressing

Acceptable = [1.0 to 0.5 mm (0 to 15%)] + [1.0 to 0.5 mm (75%)] + [Clay to 0.1 mm (0 to 8%)]

Desirable = [0.1 to 0.5 mm (100%)]

WARNING ON THE USE OF CHEMICALS

Pesticides are poisonous. Always read and carefully follow all precautions and safety recommendations given on the container label. Store all chemicals in their original labeled containers in a locked cabinet or shed, away from food or feeds and out of the reach of children, unauthorized persons, pets, and livestock.

Recommendations are based on the best information currently available, and treatments based on them should not leave residues exceeding the tolerance established for any particular chemical. Confine chemicals to the area being treated. THE GROWER IS LEGALLY RESPONSIBLE for residues on his crops as well as for problems caused by drift from his property to other properties or crops.

Consult your County Agricultural Commissioner for correct methods of disposing of leftover spray material and empty containers. **Never burn pesticide containers.**

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NOTE: Progress reports give experimental data that should not be considered as recommendations for use. Until the products and the uses given appear on a registered pesticide label or other legal, supplementary direction for use, it is illegal to use the chemicals as described.

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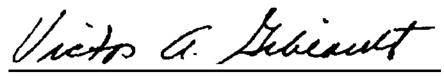

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