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Buffalograss Performance in California's Central Coast

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Buffalograss *[Buchloe dactyloides* (Nutt) Engelm.] is a native warm-season grass species found on range lands of the mid-western and western United States. Originating directly from these natural stands, 'Common' buffalograss is a short-stalked grass with good drought resistance and low nutritional requirements. These characteristics have focused attention on its potential as a low-input, low maintenance turfgrass. Accordingly, during the past decade several breeding projects in the United States have focused on developing turf-type cultivars suitable for a range of climatic and use conditions. In 1991, the National Turfgrass Evaluation Program (NTEP), affiliated with the United States Department of Agriculture, sponsored a national buffalograss evaluation program to assess performance of all commercial and experimental buffalograsses available at that time. As part of the NTEP program, a trial was initiated at the UC Bay Area Research and Extension Center (BAREC) in Santa Clara, California, to evaluate the performance and suitability of buffalograss cultivars under California's Central Coast environmental conditions. The trial site lies in a "transition zone" climate.

Vegetative plugs of 22 buffalograss cultivars (Table 1) supplied by NTEP were planted on June 17,199 1, in 64 ff plots and replicated three times in a randomized complete block design. Analysis of the soil, a silt loam, at the beginning of the study indicated favorable pH, a safe salinity level and adequate phosphorus and potassium. At the time of planting, oxadiozon (Ronstar G) was applied at label rate to prevent annual weed competition during establishment. Routine maintenance of plots consisted of a total annual application of 4 lb N/1000 ft^2 (ammonium nitrate or ammonium sulfate), mowing at 2-2 1/2 inches with a rotary mower, and irrigation as needed. Plots were not exposed to any appreciable traffic, and no fungicide or insecticide was applied. Herbicides (Roundup and Ronstar G) were applied between plots to keep cultivars from invading each other and to prevent annual weed invasion. The trial ran for three years ending in December 1994.

During the evaluation period, plots were visually rated monthly or seasonally, as relevant, for color, density, leaf texture, winter dormancy, and overall quality. Table 1 summarizes combined data for the three-year evaluations.

At the trial site, average monthly soil temperatures ranged from a low of 47°F in January to a high of 71°F in August, with measurements taken at a depth of 4 inches. Average monthly air temperatures were lowest in December at 45°F; the highest average monthly air temperature was 70°F in June. According to temperatures given in Table 2, this is a moderate temperature area.

Overall quality ratings combined all turfgrass quality components in one turf score. Cultivars were evaluated for their performance as "general purpose" turf. Accordingly, close attention was paid to the effect of rotary mowing of the cultivars. All cultivars responded equally well to rotary mowing and no scalping injury occurred on any of the cultivars.

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Table 1. Turf quality and quality component ratings for buffalogmss cultivars grown in Santa Clam, California[1] (19914994).

	COLOR					Leaf	DENSITY			OVERALL QUALITY								
	Genetic	Winter	Oct.	Nov.	Apr.	Texture	Spring	Summer	Fall	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Mean
BUFFALAWN	6.5	3.0	3.3	2.0	7.0	7.2	7.1	7.4	6.3	3.3	6.3	6.5	7.3	7.1	6.8	6.9	6.3	6.4
HIGHLIGHT 25	5.7	4.0	4.7	2.0	6.7	7.3	7.4	7.2	6.6	3.5	6.0	6.0	7.5	7.0	6.7	6.7	6.3	6.3
HIGHLIGHT 15	6.3	3.0	4.3	1.7	7.7	7.5	6.3	6.9	6.1	3.3	5.7	6.5	6.2	6.8	6.2	6.6	6.0	6.0
PRAIRIE	6.7	2.0	3.7	1.3	8.3	6.5	7.2	7.3	5.9	3.3	5.7	6.5	6.3	6.4	6.0	6.6	8.2	5.9
609 (NE 84-609)	6.3	2.0	4.7	2.0	9.0	6.3	7.1	6.4	5.8	3.3	5.7	6.7	6.3	6.6	6.2	6.1	5.6	5.8
HIGHLIGHT 4	6.8	2.3	3.7	1.0	7.7	7.3	6.7	6.1	5.9	2.8	4.7	6.0	5.7	6.1	6.3	6.7	5.8	5.7
RUTGERS	5.8	2.0	3.7	1.7	7.0	7.2	6.9	6.8	6.3	3.0	5.7	5.5	5.8	6.3	6.3	8.4	5.7	5.7
BISON	6.0	1.0	3.0	1.0	9.0	6.2	6.3	6.6	5.4	4.2	5.7	6.3	5.8	6.0	5.7	6.0	4.9	5.5
PLAINS (BAM 202)	5.8	1.0	3.0	1.0	8.3	5.8	6.3	6.3	5.7	3.8	5.7	6.0	5.7	5.9	5.5	5.8	4.9	5.4
SHARPS IMPROVED	5.8	1.0	3.3	1.0	9.0	5.8	6.3	6.6	5.4	4.0	5.7	8.2	5.8	5.7	5.7	5.7	4.8	5.4
315 (NE 84-315)	5.7	1.0	2.3	1.0	8.7	6.3	6.4	6.2	5.2	3.2	6.3	7.5	5.8	5.8	5.8	5.4	4.1	5.3
NTG-4	5.8	1.0	2.7	1.0	9.0	5.8	6.6	6.1	5.4	3.7	6.0	6.7	5.7	5.9	5.7	5.7	4.2	5.3
TATANKA (NTF-1)	6.0	1.0	2.7	1.0	8.7	6.5	6.4	6.7	5.0	3.0	6.0	6.5	5.7	6.1	5.7	5.4	4.9	5.3
TEXOKA	5.8	1.0	2.7	1.0	9.0	6.2	6.1	5.9	5.2	3.0	5.3	6.3	5.5	5.9	5.8	5.8	4.8	5.3
TOP GUN (BAM 101)	6.0	1.0	3.0	1.0	8.7	5.8	6.3	6.3	5.3	3.0	5.3	6.3	5.7	5.9	5.7	5.8	4.8	5.3
AZ 143	5.7	1.0	2.0	1.0	7.7	6.2	6.1	6.4	5.3	3.3	6.3	6.0	5.3	6.0	5.8	5.3	3.9	5.1
NTG2	5.8	1.0	2.3	1.0	9.0	6.2	6.2	6.4	4.6	3.3	6.0	6.5	5.3	6.0	5.5	5.2	4.2	5.1
NTG3	5.7	1.0	2.7	1.0	8.0	6.3	6.1	6.6	5.2	2.8	6.0	6.2	5.5	6.1	5.7	5.3	4.1	5.1
NTG-5	5.5	1.0	2.3	1.0	8.3	6.0	6.2	6.2	5.1	3.0	6.0	6.7	6.0.	8.0	5.7	5.3	3.9	5.1
NE 85-378	5.5	1.0	2.3	1.0	8.3	6.3	6.4	6.7	5.6	2.7	6.0	7.2	5.8	5.8	5.7	4.9	3.9	5.0
NE 84-436	6.0	1.0	2.0	1.0	7.3	6.2	6.1	6.6	5.4	3.3	5.0	4.8	5.5	5.7	5.7	5.4	3.9	4.8
NE 84-45-3	5.0	1.0	2.3	1.0	7.7	6.2	5.4	6.2	4.6	2.7	5.3	5.2	4.8	5.0	5.3	5.1	3.9	4.5
LSD VALUE[2]	0.6	0.5	1.1	0.3	1.0	1.0	0.8	1.0	1.0	4.1	0.9	1.1	0.8	0.8	0.8	0.4	1.2	0.5

1 The value are averages of monthly or quarterly ratings. The rating scales are:

- Color: l-9; 9 = Darkest green color for genetic colors or the highest amount of "green" tissue for the rest.
- Leaf texture: 1-9; 9 = the most dense stand of grass.
- Overall quality (turfscore): l-9; 9 = ideal turf.

2 LSD Value: To determine statistical differences among cultivars, subtract one cultivar's mean from another cultivar's mean. Statsticl differences occur when this value is larger than the corresponding LSD value. If the difference between the mean for two cultivars within the same column is not greater than the corresponding LSD. then the two cultivars are statistically the same for the specific quality component.

Almost all the cultivars exhibited their highest quality during the warmest months of the year (June-August). Most of the cultivars produced only a medium density stand.

Although significant differences in genetic color occurred among the buffalograss cultivars, none produced the deep green color seen in most Kentucky bluegrass or turf-type tall fescue cultivars. There was, however, a significant variation in color: from light grey-green to lime-green. All cultivars lost color during the winter and went dormant. Although winter color ratings in Table 1 indicate significant difference in the amount of “greenness” evident, even the highest rating was not sufficient to categorize any of the cultivars as “green” in winter. Dormancy period color ratings reveal that all cultivars entered dormancy in October, all were dormant through March, and all had emerged from dormancy by April. These observations indicate that along the Central Coast of California, buffalograss will have a dormancy of 4.5 to 5 months.

No disease or insect activity was detected/isolated on any of the cultivars during this study. Minor weed invasion occurred on a few of the plots. Although no thatch measurements were made, visual evaluations found no thatch buildup in any of the cultivars.

Results of this trial indicate that despite buffalograss’s documented positive attributes in the areas of drought and heat resistance, as well as fast rate of establishment, its long (4.5-5 months) dormancy period in climates like that of Central Coast of California makes it a less desirable grass for general purpose turf in those areas than cool-season grasses such as turf-type tall fescue.

If long winter dormancy is not an issue in a given situation, then several of the top performers (note the overall quality ratings) could provide a low input, low maintenance, and moderate visual quality alternative to high maintenance, manicured lawns. Since significant buffalograss breeding and research continues at several institutions, several buffalograss cultivars with improved quality and winter color retention will most likely be available in the near future.

Acknowledgements:

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Table 2. Average monthly air and soil temperatures in Santa Clara, CA (1991-1994).

Month	Air Temperature °F			Soil Temperature °F*		
	Ave. Max	Ave. Min.	Mean	Ave. Max.	Ave. Min.	Mean
January	56.9	40.3	48.6	51	43	47.0
February	62.3	45.6	54.0	55	47	51.0
March	60.3	44.3	52.3	59	51	55.0
April	68.4	45.8	57.2	63	56	59.5
May	73.6	51.3	62.5	68	62	65.0
June	77.1	53.6	70.4	70	65	67.5
July	80.5	56.3	68.4	73	69	71.0
August	80.6	56.7	68.7	74	69	71.5
September	79.0	52.3	65.7	72	68	70.0
October	76.6	51.1	63.8	69	62	65.0
November	64.2	40.4	52.3	62	51	56.5
December	54.8	36.8	45.8	53	46	49.5

*Soil temperature measured 4 inches below surface. Maximum and minimum are highest and lowest for the months.

The Black Turfgrass Ataenius Is a Problem for Golf Courses in Lower Desert Region of California

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History

The black turfgrass ataenius (BTA), *Ataenius spretulus* (Haldeman), is an insect native to North America and has been reported in Southern California. The first descriptions of turfgrass damage caused by this insect were from Minnesota in 1932 (Hoffman, 1935). Subsequent damage to turf includes records from 23 states in the United States and the province of Ontario, Canada (Cartwright, 1977; Niemczyk and Wegner, 1977). The first reports of injury to turf in California were from golf courses in the Coachella Valley in the low desert region in 1987. Courses in this region continue to suffer injury caused by the insect. Additional occurrences of damaging populations of BTA have now been reported from all southern and three central California counties.

Description of Insect

The mature adult is a small reddish-brown to shiny-black beetle with a mean length of 4.9 mm and a mean width of 2.2 mm. BTA eggs, shiny white and difficult to see, are deposited in clusters of 11-12 within a cavity formed by the female in the soil (Wegner and Niemczyk, 1981). The eggs hatch and the immature insects go through three larval or white grub instars which are the damaging stages. The larvae feed on roots of grass plants, reducing the total amount of root surface and limiting the ability of the turf to absorb water and maintain an adequate moisture balance under stressful conditions. Extensive root loss through insect feeding can allow the injured turf to be rolled back easily.

Seasonal Cycles and Generation

There appear to be two and possibly three generations each year of black turfgrass ataenius in the lower desert region of California. Three generations were recorded in 1994, with oviposition beginning in March and April. First-generation adults emerged between May and June; second-generation adults in August; and third generation in October. Temperature regulates the development rate of insects; completion of three generations in the Coachella Valley in 1994 may have been due to extended periods of high temperatures through the summer months and into the fall. *There* appeared to be only two generations in 1995 (a cooler year): first generation adults emerged in July and August; the second generation appeared in late September.

Threshold levels

The lowest threshold for damaging populations of BTA in the California low desert golf courses is 5-7 larvae per sq. ft. on bentgrass. Bermudagrass appears not to be a favored host for BTA. The lower pest populations and better adaptation of bermudagrass to desert conditions may explain why we have not seen it damaged. Threshold levels for bentgrass grown under desert conditions are much lower than those established for the Midwest and East. For example, Tashiro (1986) suggests 30 larvae per sq. ft. as the lowest threshold and reports no damage to turf with population densities of approximately 100 larvae per sq. ft. in western New York. The differences in damage threshold levels between regions most likely results from differences in agronomic adaptation of turf varieties to regional temperatures and humidity. We observed BTA populations exceeding 150 per sq. ft. not to cause visible damage to bentgrass in coastal San Diego County in 1993. We attribute the lack of damage at this site to conditions that would favor reduced stress to a cool-season grass, higher mowing height (it was in a practice tee area), lack of play, cool temperatures, and adequate irrigation.

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The extremely hot and dry desert conditions can place turf under tremendous moisture and temperature stress, especially bentgrass. Turf must be able to absorb a large amount of water to balance the moisture lost to transpiration under dry, hot conditions. Therefore, plants are less capable of tolerating as much direct injury to their root systems before exhibiting signs of damage. Early warm spring temperatures may be a critical factor for determining the extent of injury because BTA may become active early and injure the plants before they can establish a good root system. Subsequent feeding by even small populations on the limited roots could result in visible damage when the temperatures approach summer conditions. Thus, control of the early generations may be particularly important to limit damage to turf grown in the stressful low desert environment.

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Zoysiagrass Performance in California's Central Coast

M. Ali Harivandi and William L. Hagan[1]

Zoysiagrass *(Zbysia spp.)*, is a warm-season, drought-tolerant grass which requires less fertilizer and mowing than most other turfgrasses. Due to limited market availability it is currently planted only occasionally in home lawns.

Three closely related species of zoysiagrass are grown in the United States: *Zbysia tenuifolia,* Korean wheatgrass or Mascarenegrass; *Z. japonica,* Japanese lawngrass; and *Z. matrella,* Manillagrass. The three vary in texture from the very fine (narrow leaf blades) *Z. tenuzjblia* to the very coarse (wide leaf blades) *Z. japonica,* with *Z. matrella* in between. It appears that cold tolerance directly correlates with leaf textures. While a few degrees below freezing may kill Z. *tenuifolia, Z. matrella* will survive at 0 ° to 5 ° F and *Z. japonica,* the most cold resistant, survives temperatures of -8° to 10°F. All zoysiagrasses, however, go dormant and turn brown when the soil temperature drops below 55° to 60°F, as happens during winter in most of California's Central Coast. Of the three distinct zoysiagrass species, *Z. tenuifolia* is not well adapted to mowing as turf and is used primarily as a non-mowed ground cover. The other two species, or their hybrids with *Z. tenuifolia,* are produced and maintained as mowed turf in various parts of the world.

Zoysiagrasses are tolerant of heat, drought, salinity, and heavy trafftc. They have relatively few disease problems. Insect problems are rare and, because of high density, weeds seldom invade an established

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turf. Nematodes, however, have been a pest of zoysiagrass in some parts of the world and could conceivably occur in Central Coastal California as well.

Despite its many positive characteristics, zoysiagrass has not yet achieved the popularity of other turfgrasses. This may be due to its slow rate of establishment, long winter dormancy and a tendency to produce thatch. On the other hand, zoysiagrass's desirable "minimum maintenance" characteristics have led to improvement programs at various research institutions in the United States.

Several zoysiagrass cultivars have been available in the United States for some time, among which are 'Meyer', 'Emerald', and 'Belair'. A few years ago 'El Toro', a *Z. japonica*, was developed at the University of California, Riverside, and released to the market. Two other zoysiagrass cultivars recently released from UC Riverside, 'De Anza' and 'Victoria', should soon be available in the market.

Although zoysiagrasses have been available and in use in Southern California for several years, their use in Northern California has been limited. To evaluate the suitability and performance of zoysiagrasses and develop related information for Northern California, a series of trials were begun in 1987 at the UC Bay Area Research and Extension Center in Santa Clara, California.

One six-year trial, was initiated in June 1987, and evaluated six commercial cultivars, 'Belair', 'El Toro', 'Emerald', 'Korean Common', 'Meyer' and 'Sunburst', and five experimental cultivars, BK-7, DALZ 8501, 9502, 8508, and 8516. All of the cultivars were vegetatively propagated with the exception of 'Korean Common', that was seeded at the 2 rates of 1 and 2 lb/l000 ft^2. El Toro was sodded; all other cultivars were plug planted. At planting time (June through August 1987) all plots, except the 'El Toro' (sodded) and 'Korean Common' (seeded) plots, received oxadiazon (Ronstar G) at the rate of 5 lb/l000 ft^2 to prevent annual weed competition. Plots were fertilized and irrigated as needed until full establishment (complete ground over) of all cultivars. Thereafter, plots were maintained and evaluated for their performance as general purpose turf. They received 0.5 lb N/l000 ft^2 (ammonium nitrate or ammonium sulfate) per growing month, were mowed weekly at 2.5 inches with a rotary mower, and were watered as needed. Soil chemical analysis showed desirable levels of all chemical constituents. The following conclusions are based on six years of observations and evaluations.

- Korean Common, the only seeded cultivar, was slow to germinate and establish. During the establishment period (almost 2 years) plots were severely infested with summer and winter annual weeds. Seeding rate did not appear to make a difference in either weed invasion or the rate of establishment and time to full coverage. Nevertheless, the few seedlings that initially developed were very aggressive growers and by the end of the second season almost covered the entire plot. This cultivar produced a very coarse and low quality stand of grass, which could not be considered an acceptable lawn.

- With the exception of 'El Toro' which was sodded, weed control was the major problem during the establishment period. Since annual weeds are common and plentiful in California, unless a zoysiagrass is sodded, any other vegetative establishment will be best accomplished with the aid of preemergent herbicides.

- Scalping could be a problem if a rotary mower is used to mow zoysiagrasses. In this trial, scalping was directly correlated with the cultivar's leaf texture, i.e. scalping was more severe on fine textured zoysiagrass cultivars than on the coarse textured ones. Scalping also correlated with a cultivar's thatch production: fine textured cultivars developed thicker and denser thatch than coarse textured ones.

- On average, cultivars entered dormancy toward the end of October, and were completely dormant (brown) through mid-March. Although there were minor variations among the cultivars in duration of dormancy, in Central Coastal California a 4 to 4.5 month winter dormancy can be expected from the zoysiagrass types included in this study.

- Considering all the turfgrass quality components (color, density, texture, winter dormancy and scalping) and based on 6 years of observations, the following cultivars consistently produced better quality grass than the rest. They are ranked from highest to lowest quality:

Emerald > Sunburst > BK-7 > Meyer > El Toro

All other cultivars in this trial proved unsuitable for use as general-use turf (mowed weekly at 2-2 1/2 inches with a rotary mower, 1/2 lb N/1000 ft^2/growing month, and irrigation based on evapotranspiration requirements) in Central Coastal California. It must be noted that under different maintenance regimes (e.g., close mowing using a reel mower), these cultivars may have performed differently.

To further study the best performers of this trial, as well as several other experimental zoysiagrass cultivars, another trial was initiated in July 1991 at the UC Bay Area Research and Extension Center (BAREC) in Santa Clara, California. Cultivars were tested for turfgrass suitability in the Central Coastal California, an area of "transition zone" climate. With the exception of BK-7, UCR Z88-l1, 'De Anza', and 'Victoria', other cultivars were supplied by the National Turfgrass Evaluation Program, sponsored by the United States Department of Agriculture. The University of California, Riverside, zoysia breeding program provided UCR Z88-11, 'De Anza' and 'Victoria', and BK-7 was transplanted from the initial trial at BAREC.

All 28 cultivars were plug planted on June 17, 199 1, in 64 ft^2 plots and replicated three times in a randomized complete block design. Analysis of the soil, a silt loam, at the beginning of the study indicated favorable pH, a safe salinity level and adequate phosphorus and potassium.

Routine maintenance of the plots consisted of a total annual application of 4 lb N/1000 ft^2 (ammonium nitrate or ammonium sulfate), mowing at 2 - 2% inches with a rotary mower, and irrigation as needed. Plots were not exposed to any appreciable trafftc, and no fungicide or insecticide was applied. Herbicides (Roundup and Ronstar G) were applied between plots to keep cultivars from invading each other and to prevent annual weed invasion. The trial ran for three years ending in December 1994.

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At the trial site, average monthly soil temperatures ranged from a low of 47.0°F in January to a high of 71.5°F in August, with measurements taken at a depth of 4 inches. Average monthly air temperatures were lowest in December at 45.8°F; the highest average monthly air temperature was 70.4°F in June. According to temperatures given in Table 2, the trial site is a moderate temperature area.

Overall quality ratings combine all turfgrass quality components into one turf score. As indicated by overall turf score, the old cultivar 'Emerald' produced a significantly higher quality turf than did many of the newly developed, experimental varieties. A few experimental varieties (DALZ 8507, DALZ 9006, DALZ 8508, OT 2004 and TC 2033) also rated high and statistically similar to 'Emerald'. Scalping caused by a rotary mower was included in our quality ratings and had a positive correlation with the scores received: cultivars with higher quality ratings exhibited much less scalping injury than did the lower quality cultivars. Also, generally speaking, cultivars with coarser texture (wide-leaved) were less prone to scalping than the fine textured (narrow-leaved) cultivars, which translated to a higher visual turf quality (Table 1). Almost all the cultivars exhibited their highest quality during the warmest months of the season (June-August). With few exceptions, all cultivars produced high density turf stands.

Significant variations in genetic color exist among these cultivars. Some (e.g., 'De Anza', CD 2013, and 'Emerald') possess a dark green color, while

Table 1. Turf quality and quality component ratings for zoysiagrass cultivars grown In Santa Clara', California (1991- 1994).

	COLOR							DENSITY			OVERALL QUALITY								
	Genetic	Winter	Oct.	Nov.	Feb,	March	Leaf Texture	Spring	Summer	Fall	March	April	May	June	July	Aug.	Sept.	Oct.	Mean
EMERALD	8.7	2.3	6.7	2.7	**2.0**	9.0	8.3	7.8	**9.0**	**9.0**	5.2	6.7	7.8	8.3	8.0	6.8	**6.9**	7.1	7.1
DALZ 8507	8.5	3.3	7.0	2.3	**2.0**	9.0	8.5	8.1	**8.9**	**8.9**	4.5	7.0	7.8	8.0	8.2	6.8	6.7	6.9	6.9
DALZ 9006	8.7	2.0	7.0	2.0	**2.0**	9.0	9.0	7.8	**8.9**	**9.0**	5.2	5.7	8.7	8.0	7.5	7.0	7.0	6.6	8.8
DALZ 8508	8.3	2.3	6.3	2.0	**2.0**	9.0	9.0	7.8	**9.0**	**9.0**	5.5	6.0	7.3	8.0	7.3	7.0	8.4	6.3	8.7
QT 2004	6.2	2.3	6.3	1.7	**1.0**	9.0	8.3	8.0	**8.9**	**8.9**	4.7	6.0	6.7	7.3	7.3	6.8	6.9	6.1	6.6
TC 2033	8.3	2.0	6.0	1.7	**2.0**	9.0	8.2	8.1	**9.0**	8.6	5.3	8.3	6.8	8.0	7.5	6.5	6.8	8.3	6.6
DALZ 8502	6.5	3.0	7.0	3.0	**1.7**	9.0	9.0	7.3	8.6	8.8	3.2	6.0	7.5	8.0	6.8	5.8	6.2	6.3	8.4
BK-7	6.3	1.3	5.0	1.0	**1.0**	9.0	8.0	7.6	8.8	8.7	4.3	5.7	6.8	7.7	7.7	6.5	6.8	6.0	8.4
CD 2013	6.7	2.0	6.3	1.7	**1.0**	9.0	7.8	7.9	8.6	8.6	4.2	8.0	6.5	6.7	7.2	8.8	6.7	6.4	6.3
DALZ 8518	7.2	4.7	7.3	2.7	**3.0**	9.0	6.3	7.3	9.0	9.0	5.3	5.7	6.7	5.7	6.7	6.2	6.7	6.7	6.3
DE ANZA	7.8	4.0	8.0	3.0	**2.0**	9.0	6.5	7.6	8.4	8.8	3.3	5.3	6.3	5.7	6.8	6.3	6.7	7.1	6.2
VICTORIA	6.8	4.0	6.7	2.7	**2.0**	9.0	7.5	7.4	8.4	8.9	4.3	5.3	8.2	6.0	6.0	6.3	8.8	6.3	8.1
DALZ 8501	5.8	2.0	6.7	2.0	**1.0**	8.3	9.0	6.9	8.8	8.7	3.3	4.0	5.2	7.0	5.8	6.2	6.1	6.3	5.8
MEYER	6.3	1.3	5.0	1.3	**1.0**	9.0	6.3	7.9	8.7	8.7	4.2	6.0	6.3	6.3	6.5	6.0	6.1	5.8	5.8
TC 5018	6.0	1.0	5.3	1.3	**1.0**	9.0	5.2	8.3	8.4	8.6	4.7	5.0	5.8	4.0	6.2	5.8	5.7	5.0	5.4
CD 259-l 3	6.3	1.0	5.0	1.0	**1.0**	9.0	6.0	8.4	8.7	8.2	4.3	5.0	6.0	5.0	6.3	5.5	5.8	5.0	5.3
DALZ 8512	5.8	3.0	6.3	1.7	**1.3**	9.0	4.3	8.1	8.4	7.9	4.0	5.3	5.8	4.0	6.3	5.7	5.4	5.4	5.3
SUNBURST	5.7	1.7	5.7	1.0	**1.0**	9.0	5.8	8.6	8.7	8.7	5.0	5.0	5.5	4.0	5.7	5.2	5.7	5.7	5.3
BELAIR	8.3	1.0	4.7	1.0	**1.0**	9.0	5.5	8.4	8.3	8.4	4.2	5.0	5.7	4.7	6.5	5.5	5.3	5.0	5.2
DALZ 8514	8.5	2.0	6.3	2.0	**1.0**	8.7	5.3	8.2	8.7	9.0	4.0	4.3	5.3	4.0	5.7	5.5	5.9	5.8	5.2
UCR 288-l 1	6.2	2.0	5.7	1.0	**1.3**	8.0	7.2	8.0	7.6	8.1	2.7	4.3	4.7	5.7	5.7	5.7	8.0	6.1	5.2
QT 2047	5.5	1.6	5.7	1.0	**1.0**	9.0	8.2	8.6	8.6	9.0	3.7	4.3	8.0	5.0	5.8	5.5	5.4	4.7	5.1
EL TORO	5.7	2.0	5.3	1.3	**1.0**	8.7	4.8	8.8	8.4	8.8	4.2	5.0	5.0	4.3	5.5	5.7	5.4	5.0	5.0
JZ-1	5.5	1.0	4.7	1.0	**1.0**	9.0	3.7	8.9	7.0	7.6	3.7	4.3	4.3	3.3	5.2	5.0	5.2	5.0	4.7
TGS-Bl 0	5.8	1.0	5.0	1.0	**1.0**	9.0	4.2	7.2	7.4	7.7	3.7	4.3	4.5	3.7	5.0	4.7	4.8	4.7	4.4
KOREAN COMMON	5.8	1.0	4.7	1.0	**1.0**	9.0	3.8	7.2	7.6	7.4	3.8	4.7	4.3	3.3	4.8	4.7	4.8	4.0	4.3
DALZ 8701	5.7	**1.3**	4.3	1.3	**1.0**	2.7	8.0	4.4	5.8	7.1	2.5	**3.3**	2.5	**3.0**	3.5	5.2	**4.9**	**4.7**	4.2
TGS-Wl 0	5.2	**1.0**	4.3	1.3	**1.3**	7.7	4.2	6.4	6.9	6.9	3.2	**4.7**	3.8	**3.0**	5.2	4.8	**4.3**	**3.9**	4.1
LSD **VALUE²**	**1.0**	**0.7**	1.8	0.6	**0.4**	**0.9**	0.8	1.8	0.8	0.9	1.8	**1.0**	**0.9**	**1.0**	**1.0**	**1.0**	**1.0**	**1.1**	0.6

1 The values are averages of monthly or quarterly ratings. The rating scales are:

- Color: l-9; 9 = Darkest green color for genetic color, or the highest amount of "green" tissue for the rest.
- Leaf texture: l-9; 9 = the narrowest (most fine) leaf blade.
- Density: l-9; 9 = the most dense stand of grass.
- Overall quality (turfscore): l-9; 9 = ideal turf.

2 LSD Value: To determine statistical differences among cuitivars, subtract one cultivar's means from another cultivar's mean. Statistical differences occur when this value is larger than the corresponding LSD value. If the difference between the mean values for two cultiiars within the same column is not greater than the corresponding LSD, then the two cultivars are statistically the same for that specific quality component.

others (e.g., TGS-W 10, QT 2047, and JZ 1, exhibit a yellow green color). The majority of cultivars, however, are naturally a light green color. They all lost color during winter months and went dormant. Although, as indicated from winter color ratings in Table 1, there was a significant difference in the amount of 'greenness" evident in winter, even the highest rating of any cultivar was not sufficient to categorize it as "green" in winter. As indicated from the dormancy color ratings, most cultivars entered dormancy during the month of October, all were dormant from November through February, and almost all were out of dormancy by March. Thus in Central Coastal California, zoysiagrasses will have a dormancy of 4 to 5 months.

No disease or insect activity was detected/isolated on any of the cultivars during this study. Minor weed invasion occurred in a few of the plots. Although no thatch measurements were taken, it appeared that almost all cultivars have a fast rate of thatch (mat) development, which could be a challenge in their maintenance.

The results of these studies indicate that despite well documented advantages attributed to zoysiagrasses (e.g., drought, heat, salt, and wear tolerance, good competitive ability against weeds, relatively high tolerance of diseases and insect, and low fertility requirements), there are inherent disadvantages which should be considered before choosing zoysiagrass as a general purpose turf in areas with climates similar to Central Coastal California. Among these disadvantages are: long dormancy period in winter, scalping problem if mowed with rotary mower, unavailability of high quality seeded-type cultivars, and slow rate of establishment. Considering stand density and thatch characteristics, it is almost certain that only power mowers would be suitable for proper mowing of zoysiagrasses. Considering the advances in developing desirable zoysiagrasses, however, it is anticipated that in the near future more desirable zoysiagrass cultivars will become available for use as general purpose turf use for areas similar to Central Coastal California.

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Table 2. Average monthly air and soil temperatures in Santa Clara, CA (1991-1994).

Month	Air Temperature °F		Mean	Soil Temperature °F*		Mean
	Ave. Max	Ave. Min.		Ave. Max.	Ave. Min.	
January	**56.9**	40.3	48.6	51	43	47.0
February	62.3	45.6	54.0	55	47	51.0
March	60.3	44.3	52.3	59	51	55.0
April	68.4	45.8	57.2	63	56	59.5
May	73.6	51.3	62.5	68	62	65.0
June	77.1	53.6	70.4	70	65	67.5
July	80.5	56.3	68.4	73	69	71.0
August	80.6	56.7	68.7	74	69	71.5
September	79.0	52.3	65.7	72	68	70.0
October	76.6	51.1	63.8	69	62	65.0
November	64.2	40.4	52.3	62	51	56.5
December	54.8	36.8	45.8	53	46	49.5

*Soil temperature measured 4 inches below surface. Maximum and minimum are highest and lowest for the months.

Evaluation of Grass Species and Cultivars Under Abrasive Wear

J. Michael Henry[1]

While on sabbatical leave in 1993 at the Sports Turf Research Institute (STRI) Bingley, England, I conducted field research on closely mown cool-season turfgrass species to determine relative wear tolerance. Bingley is located 10 miles northwest of Leeds, England in a temperate climate zone. While some of the species and cultivars are not adapted or available here in California, many of the general findings offer new information and perspectives on sports turf species. This summary highlights the findings reported in the Journal *Sports Turf Research Institute,* Vol. 7, 1995; EFFECTS OF ABRASIVE WEAR ON CLOSE MOWN AMENITY GRASS SPECIES AND CULTIVARS by J.M. Henry, A.J. Newell & A.C. Jones.

Natural turf surfaces, especially for sports uses, are often subjected to intensive wear. As a consequence, any meaningful investigation of the performance of different grasses for sports use must include wear. This wear must also be of an intensity and a type which reflects the proposed use. The need to subject grasses to wear as a means of testing the performance of those grasses has been recognized at the STRI for a number of years. Artificial wear was first applied to trials at the STRI in the winter of 1969 (Shildrick, 1970,1971). Other workers have developed and used wear machines prior to this time. The first was designed and used in California. This machine was self powered and moved round a central stake making eight revolutions per minute, it was also able to simulate two types of wear, scuffling and roller-type with golf spikes (Perry, 1958; Youngner, 1961). At the STRI the differential slip wear machine was developed in the mid 1970s (Canaway, 1976a). This machine simulates three types of turfgrass wear; heavy studded wear similar to that caused by soccer or rugby play, spiked wear for golf and abrasive wear to simulate damage caused by rubber soled sports shoes, as would be caused by sports such as tennis. The differential slip wear machine was subsequently evaluated alongside actual soccer fields (Canaway, 1976b, 1981a) and for fine turf golf-type wear (Canaway, 1982). This machine is now used routinely at the STRI as part of the turfgrass evaluation program in which grasses are tested for use in soccer and rugby fields and for finer turf uses such as golf greens. Although the wear machine was initially developed to simulate abrasive-type wear, the effects of this wear on different grass species and cultivars, and indeed grass mixtures, has as yet to be investigated. That said, some limited work with the machine set up for abrasive wear has been reported for tine fescues (Laycock, 198 1).

Large variation in wear tolerance has been found among different grass species and cultivars when soccer-type wear has been applied (Canaway, 198 1 b; Cockerham *et al.,* 1990; Minner *et al.,* 1993). This study tests the assumption that grass species and cultivars vary in their tolerance of abrasive-type wear. To do this, abrasive wear was applied to a range of well-established grass species.

Close mown grass species (dryland bentgrass, *Agrostis castellana* Boiss. and Reuter; colonial bentgrass, *A. tenius* Sibth.; tall fescue, *Festuca arundinacea* Schreb.; red fescue, *F. rubra* L.; timothy, *Phleum pratense L.;* Canada bluegrass, *Poa compressa L.;* wood bluegrass, *P. nemoralis L.;* Kentucky bluegrass, *P. pratensis L.;* and perennial ryegrass, *Lolium perenne L.)* were subjected to abrasive wear in the summer of 1993. Before and after wear was applied, large differences in ground cover and visual appeal were found among species. Prior to wear being applied, the finer turfgrasses *(A. castellana, A. tenius* and *F. rubra)* had the largest live ground cover and the highest visual appeal. Before wear, live ground cover ranged from 87.3% to 49.3% for cultivars of *P. pratensis,* 82.3% to 46.7% for cultivars of *F. arundinacea* and 53.0% to 25.0% for cultivars of *L. perenne.* After wear, there was a four-fold difference between the best cultivar of *P. pratensis* which retained 66.3% ground cover and the worst which retained 18.0% ground cover. At

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this time, the cultivars of *F. arundinacea* varied from 43.0% to 15.0% and those of *L. perenne* from 32.0% to 19.3%. Importantly, this work demonstrates that finer turfgrass species which perform best under persistent close mowing may not perform better than other grasses when they are subjected to close mowing and wear. The work is discussed in relation to choosing grasses for uses which include close mowing and abrasive wear. The work reported here extends the above observations to include the effects of abrasive-type wear. In this trial, distinct differences were found both among species and among cultivars within particular species to abrasive-type wear. Prior to the start of wear, the bentgrasses and the red fescues appeared markedly superior to the other grasses in trial. This no doubt reflects the superior tolerance of close mowing that these finer grasses possess. However, when the same grasses were subjected to additional treatments, in this case abrasive wear, the finer turfgrasses no longer performed better than the other grasses in trial. Under close mowing and abrasive wear the Kentucky bluegrass, in particular, performed better than the other grasses in trial.

These marked differences among species and cultivars within species in relation to their tolerance of abrasive wear begs the question, is abrasive wear important? Abrasive wear would be the predominant type of wear for a number of summer sports such as cricket, lawn bowling & tennis. It would also be the wear which most domestic lawns and indeed many park areas are commonly subjected to. Thus, the wear itself is of some importance and choosing grasses which are most tolerant to this type of wear would also be of some importance in the above situations. As there is no published work prior to this study, many ill-informed decisions regarding the choice of sports turf for these particular uses, may be reconsidered. Perennial ryegrasses which are very tolerant of football-type wear were found to be rather intolerant of this abrasive-type wear. This probably reflected its intolerance of persistent close mowing. It is possible to speculate that tolerance of close mowing would be a larger limiting factor than wear for cultivars of perennial ryegrass in this type of study. In contrast, cultivars of Kentucky bluegrass, which rank fairly high for their tolerance of football-type wear, also performed particularly well under the present regime of close mowing and abrasive wear.

Fine-leaved turfgrasses were inferior to the coarse turfgrasses when wear was applied. However, there were also differences among these grasses themselves. This was most strongly demonstrated by the difference between 'Sefton' Colonial bent and 'Highland' Colonial bent; both grasses ranked high prior to wear being applied. After wear, 'Highland' was markedly inferior to 'Sefton'. Indeed, 'Highland' ranked next to last in the study overall, whereas 'Sefton' probably ranked midway and was still comparable to a number of Kentucky bluegrass and other grasses which performed reasonably well.

The appearance of the grasses prior to wear being applied is also worthy of note. There is little published information on the relative tolerances of the coarse turf&asses to persistent close mowing and, in particular, tall fescue to persistent close mowing. In this respect, it is surprising to find that cultivars of tall fescue are fairly tolerant of persistent close mowing. Indeed, if the cultivars tested are fairly representative then this grass would appear to be more tolerant of persistent close mowing than perennial ryegrass. It is also apparent that Kentucky bluegrass as a species is more tolerant of persistent close mowing than tall fescues and perennial ryegrass.

In sports like tennis and cricket, until recently grasses were chosen on the basis of their ability to withstand close mowing. This study suggests that wear tolerance may be of greater importance than tolerance of close mowing in this choice.

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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.

. PHYTOTOXICITY: Certain Chemicals may cause plant injury if used at the wrong stage of plant development or when temperatures are too high. Injury may also result from excessive amounts of the wrong formulation or from mixing incompatible materials. Inert ingredients, such as wetters, spreaders, emulsifiers, diluents and solvents, can cause plant injury. Since formulations are often changed by manufacturers, it is possible that plant injury may occur, even though no injury was noted in previous seasons.

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