Zoysiagrass: economic and environmental sense in the transition zone

Zoysiagrass fairways require fewer inputs, which add up to fewer dollars and better environmental management.

Editor's note: *GCM has a commitment to publishing research that will benefit superintendents. Although the information presented in this article is not based on a scientific investigation of maintenance expenses, we believe the information will be useful to superintendents and we are publishing the article to generate thought and discussion on the topic. The figures for expenses are estimates obtained through discussions with superintendents and other industry representatives and not actual costs obtained from a survey.*

On occasion, the quest for perfect playing conditions clouds our ability to make good economic and environmental decisions. Such is the case when one considers turf selection for tees and fairways in the transition zone, the region of turf adaptation in the middle of the U.S., with a center running from central Kansas to Washington D.C. Superintendents in this zone experience summer and winter temperature extremes, high relative humidity and the associated problems these conditions create for turfgrass growth.

Creeping bentgrass (*Agrostis stolonifera*) for tees and fairways has increased in popularity in the transition zone, particularly in the mid-Atlantic region. At present, there are 14,332 acres (5,800 hectares) of creeping bentgrass fairways and tees in the transition zone (2). Desirable characteristics of creeping bentgrass on fairways include the high-quality surface it produces when mowed at heights from 0.25 to 0.5 inch (6.4 to 12.7 millimeters); ability to recover rapidly via strong stolon growth; and desirable green color through much of the calendar year. These characteristics alone, however, do not make creeping bentgrass a wise choice for fairways in the transition zone — either economically or environmentally. It's reminiscent of the line from the movie "Jurassic Park" uttered by Dr. Ian Malcolm (played by Jeff Goldblum): "… your scientists were so preoccupied with whether or not they could, they didn't stop to think if they should."

Reduction in pesticide use is an advantage of using zoysiagrass in the transition zone. **Photo by Jack Fry**

Creeping bentgrass fairways have high maintenance requirements, requiring significant water, pesticide and cultivation inputs in order to maintain a high-quality playing surface. Meyer zoysiagrass (*Zoysia japonica* Steud.), the popular cultivar used on transition-zone golf courses since 1952, has relatively low maintenance requirements and a high-quality surface that can be maintained with low inputs of water, fertilizer and pesticides. At present, there are 11,462 acres (4,638.5 hectares) of zoysiagrass (*Zoysia* species) fairways and

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tees in the transition zone (2), 2,870 fewer acres (1,160 fewer hectares) than creeping bentgrass.

In today's economic climate, in which reports of golf course closings are more common than reports of new openings, superintendents are keeping a close eye on expenditures. Furthermore, over the last 25 years, the United States Golf Association has sponsored numerous research projects investigating the effects of turf management practices on the environment. Audubon International has likewise promoted sound management practices for a sustainable environment. All responsible superintendents would agree that a goal of the environmentally conscious manager is to maintain a quality surface with less water and fewer nutrient and pesticide applications.

It makes sense that, as environmental stewards, superintendents select turfgrasses wisely to ensure economic and environmental sustainability. The choice of creeping bentgrass for fairways in the transition zone certainly comes at an economic cost — and with greater potential for a negative impact on the environment — than choosing zoysiagrass. For years, turf researchers, educators and Extension specialists have suggested that zoysiagrass is a wise choice for transition-zone fairways and tees, for many of the reasons mentioned above. However, the potential economic impact has never been described in detail. Here we compare the maintenance costs of 30 acres (12 hectares) of hypothetical high-quality creeping bentgrass and zoysiagrass fairways in Kansas City, the heart of the transition zone. The numbers were determined after consulting with industry representatives listed in our acknowledgments, including several superintendents in the transition zone growing zoysiagrass and several growing bentgrass, equipment salespersons, a water company representative, fertilizer and pesticide salespersons, and a sod producer.

In the transition zone, zoysiagrass fairways are generally thought to be more economical than creeping bentgrass fairways. The zoysiagrass fairways shown are at Colbert Hills GC, Manhattan, Kan. **Photos courtesy of David Gourlay**

Mowing expenses

Species	Total mowings*	Hours†	Labor ($)‡	Fuel ($)§	Total cost ($)
Creeping bentgrass	84	672	6,720	3,712	10,432
Zoysiagrass	60	480	4,800	2,652	7,452

*For creeping bentgrass: two mowings in March; eight in April; 12 for May through September; 10 in October; and four in November. For zoysiagrass: two in April; 10 in May; 12 for June through August; eight in September; and four in October.
†Assumes 8 hours of labor to mow 30 acres.
‡Labor cost of $10/hour.
§Fuel consumption at 1.7 gallons/hour and a fuel cost of $3.25 per gallon: 1,142 gallons for creeping bentgrass; 816 gallons for zoysiagrass.

Table 1. Mowing expenses for creeping bentgrass and zoysiagrass fairways from April 1 to Nov. 30 at a hypothetical golf course in the Kansas City area.

Average daily (ET) rate

Species	March & April	May	June-Sept.	Oct.	Nov.	Total ET (inches)	Total gallons required*	Total cost ($)†
Creeping bentgrass	0.08	0.10	0.20	0.10	0.08	37.9	14,076,781	69,324
Zoysiagrass	0.04	0.08	0.17	0.08	0.04	29.0	8,309,211	40,921

*Assuming irrigation at 80% of ET.
†Cost includes an estimated additional 25% for pump electricity.

Table 2. Average daily evapotranspiration (ET) rate (inches) of creeping bentgrass and zoysiagrass from March 1 to Nov. 30 on a hypothetical golf course in the Kansas City area.

Mowing

Active zoysiagrass growth occurs from mid-April through September; creeping bentgrass requires mowing from March into November. Therefore, during the year, creeping bentgrass requires 24 more mowings — 720 more mowed acres (291 hectares) — than zoysiagrass (Table 1). In addition, mowing creeping bentgrass fairways requires 192 more hours of labor than mowing zoysiagrass, increasing total expenses by $2,980.

Irrigation

Differences in water costs between the two grasses can be calculated by first determining average daily evapotranspiration (ET) rates. The rates in Table 2 were taken from research conducted with these grasses in the Midwest. The total ET for creeping bentgrass from March 1 to Nov. 30 in Kansas City is estimated at 37.9 inches (96.3 centimeters). Assume that half of all rain-

fall can be used by each of the grasses. Precipitation in Kansas City averages 32.5 inches (82.6 centimeters) from March 1 to Nov. 30; assume that 16.3 inches (41.4 centimeters) is available to the turf. So, 37.9 inches (96.3 centimeters) of ET - 16.3 inches (41.4 centimeters) of useable rainfall = 21.6 inches (54.9 centimeters) of irrigation water required. However, the research-based ET values assume that the turf is always growing under conditions where soil water is not limiting, which is not the case. Soil dries down between irrigations, and this reduces ET. For our purposes, assume that actual ET is 80% of ET under well-watered conditions. Therefore, 21.6 inches (54.9 centimeters) × 0.80 = 17.3 inches (43.9 centimeters) of irrigation water needed. Conversion of 17.3 inches (43.9 centimeters) of water over 30 acres (12 hectares) indicates that a total of 14,076,781 gallons (53,286,412.7 liters) at a cost of $69,324 would be needed for the creeping bentgrass.

For zoysiagrass, total ET from March 1 to Nov. 30 is estimated at 29 inches (73.7 centimeters). Subtracting estimated rainfall of 16.3 inches (41.4 centimeters) leaves a water requirement of 12.7 inches (32.3 centimeters). Using the same 80% adjustment factor, 12.7 inches × 0.80 = 10.2 inches. Therefore, a total of 10.2 inches (25.9 centimeters) of water would be required, or 8,309,211 gallons (31,453,785.2 liters) (Table 2). Assuming that city water is used for irrigation, the cost of water in Johnson County, Kansas (a Kansas City suburb), is $3.94 per 1,000 gallons (3,785.4 liters) of water, after the average winter water use amount is taken into account. The annual cost of water for creeping bentgrass, including an estimated 25% additional cost for pump electricity, would be $28,403 more than for zoysiagrass. These numbers assume that the superintendent has the capability to water fairways and tees efficiently, delivering water where desired. A less efficient system could obviously minimize the difference between the two grasses.

Fertilization

For the level of quality desired, we assume that creeping bentgrass receives 4.0 pounds of nitrogen/1,000 square feet/year (19.5 grams/square meter/year), and zoysiagrass receives 2.0 pounds (9.8 grams/square meter), and applications to each grass are made at the rate of 1.0 pound/1,000 square feet (4.9 grams/square meter), four times for creeping bentgrass, twice for zoysiagrass (Table 3). We also assume that a polymer-coated urea is used as the nitrogen source for all applications and that application of other nutrients is the same for each grass. Total fertilization cost would be $4,869 more for creeping bentgrass than for zoysiagrass.

Zoysiagrass fairways require less irrigation than creeping bentgrass fairways in the Kansas City area. The zoysiagrass fairways shown are at Colbert Hills GC, Manhattan, Kan.

Fertilization

Species	Total nitrogen for 30 acres (pounds)*	Fertilizer cost pounds of nitrogen/1,000 square feet ($)†	No. of applications	Fuel + labor ($)‡	Total cost ($)
Creeping bentgrass	5,228	9,515	4	222	9,737
Zoysiagrass	2,614	4,757	2	111	4,868

*Annual application of 4 pounds of nitrogen/1,000 square feet to creeping bentgrass and 2 pounds of nitrogen/1,000 square feet to zoysiagrass.
†Application of a polymer-coated urea product at $1.82/pound of nitrogen.
‡Assumes fairways can be fertilized in four hours at $10/hour for labor; assumes the vehicle uses 1.2 gallons/hour at $3.25/gallon.

Table 3. Nitrogen requirements and fertilization costs for 30 acres of creeping bentgrass or zoysiagrass at a hypothetical golf course in the Kansas City area.

Annual fungicide applications

Species	No. of sprays*	Fungicide ($)	Labor + fuel ($)†	Total cost ($)
Creeping bentgrass	9	42,557	2,385	44,942
Zoysiagrass	1	4,280	133	4,413

*Fungicide applications for creeping bentgrass include Emerald (one application in June and October), Daconil Weatherstick (two applications in July and two in August), Banner MAXX (one application in September), and Subdue MAXX (one application in July and one in August). Zoysiagrass receives one application of Prostar to 50% of the fairways (spot treatment) in late September.
†Assumes 20 hours to treat 30 acres in one application, and a labor cost of $10/hour. Fuel cost assumes that a vehicle carrying a sprayer uses 1.0 gallon/hour at a cost of $3.25/gallon.

Table 4. Annual fungicide applications and associated costs for 30 acres of creeping bentgrass and zoysiagrass fairways at a hypothetical golf course in the Kansas City area.

(Top) Pythium blight is a frequent problem on creeping bentgrass fairways in the transition zone. **Photo by Megan Kennelly**
(Bottom) Large patch damage is the only disease of consequence on zoysiagrass. **Photo by Jack Fry**

Disease control

Creeping bentgrass is particularly susceptible to dollar spot, and we assume that a preventive program begins in June and runs through October (Table 4). Brown patch is also a concern in summer, so a fungicide capable of controlling both brown patch and dollar spot is necessary. A combination of contact and systemic fungicides is used through the growing season. We also assume that fungicide is applied in July and August to prevent pythium blight.

The only disease of consequence in zoysiagrass is rhizoctonia large patch. An effective systemic fungicide would be applied in late September to areas that have a history of large patch (Table 4). Additional localized applications may be applied after green-up in the spring. For the purposes of this article, we assume that half the zoysiagrass fairways and tees are treated at once.

Creeping bentgrass fungicide requirements cost $38,277 more than zoysiagrass applications (Table 4). In addition, eight more applications are required for the creeping bentgrass, which means labor and fuel costs are $2,252 more for creeping bentgrass than for zoysiagrass.

Weed control

Fairways of creeping bentgrass or zoysiagrass receive a pre-emergence herbicide application in the spring (Table 5). Creeping bentgrass also receives two applications of Velocity for annual bluegrass control. Zoysiagrass receives an application of a nonselective herbicide in February, during dormancy, for control of winter annuals. Total cost of weed control in creeping bentgrass is $10,677 more than in zoysiagrass. Additional herbicides, such as post-emergence applications for grassy or broadleaf weeds may be needed, but are not included in this example. Zoysiagrass is so dense that most weed problems are minimized when it is actively growing; creeping bentgrass is more susceptible to weed encroachment. Although growth regulators can be used on either grass to suppress growth or improve quality, for the purposes of this discussion, we assume no growth regulators are used.

Insect control

All 30 acres (12 hectares) of each grass are treated for white grubs; southern masked chafer is common in this part of the country, and creeping bentgrass is also susceptible to an infestation of black turfgrass ataenius (Table 6). In addition, the creeping bentgrass is likely to require a couple of additional insecticide applications to control surface-feeding insects, including cutworms.

Total insecticide costs for creeping bentgrass are $5,991 higher than for zoysiagrass.

Cultivation

Creeping bentgrass and zoysiagrass have a tendency to accumulate organic matter on the soil surface, and managing this is important. Creeping bentgrass is aggressively stoloniferous and can become quite "puffy" if organic accumulation is not managed. Some golf courses have gone to the extreme of topdressing creeping bentgrass fairways with sand in an effort to help minimize organic matter accumulation at the surface; we omit sand topdressing in our example.

Because the growing season for zoysiagrass in the transition zone is relatively short, superintendents prefer not to be too aggressive with thatch management. It is common to core-aerify once and verticut to break up the soil so that it will infiltrate into the canopy.

We assume that once during the season each species is core-aerified and immediately verticut to break up the cores (Table 7). Creeping bentgrass will receive four additional verticutting treatments, and zoysiagrass will receive one, to help minimize thatch accumulation. In this example, annual cultivation expenses for creeping bentgrass are $1,428 more than for zoysiagrass.

Summary

At this hypothetical Kansas City golf course, annual fairway maintenance costs would be $94,877 less if zoysiagrass were used instead of creeping bentgrass (Table 8). Zoysiagrass is less expensive to maintain than creeping bentgrass in all categories evaluated: mowing, irrigation, fertilization, pest control and cultivation. The greatest differences in maintenance costs between the species were in disease control ($40,529) and irrigation ($28,403). Environmental benefits resulting from choosing zoysiagrass over creeping bentgrass are more difficult to put a finger on, but applying less water, fertilizer and pesticides is environmentally positive.

Golfer preferences

Some golfers have strong feelings about which surface they prefer. Creeping bentgrass has good winter color when zoysiagrass is dormant, but midsummer zoysiagrass quality is often superior to that of creeping bentgrass, which can be less playable while suffering from heat stress. The way the golf ball sits on each surface is also quite different — standing higher on the dense stand of zoysiagrass, and sitting lower on the creeping bentgrass. It is sometimes difficult to remove a

Herbicide applications

Species	No. of applications*	Herbicide ($)	Labor + fuel ($)†	Total cost ($)
Creeping bentgrass	3	11,682	790	12,472
Zoysiagrass	2	1,265	530	1,795

*Creeping bentgrass is treated with Barricade in early spring for control of annual grasses and also receives two applications of Velocity for annual bluegrass control. Zoysiagrass receives an application of Roundup Pro in February for winter annual control and an application of Barricade in early spring for control of annual grasses.
†Assumes 20 hours to treat 30 acres in one application, and labor costs of $10/hour. Fuel cost assumes that the vehicle carrying the sprayer uses 1 gallon/hour at $3.25/gallon.

Table 5. Annual herbicide applications and associated costs for 30 acres of creeping bentgrass and zoysiagrass fairways at a hypothetical golf course in the Kansas City area.

Insecticide applications

Species	No. of applications*	Herbicide ($)	Labor + fuel ($)†	Total cost ($)
Creeping bentgrass	3	9,911	334	10,245
Zoysiagrass	1	4,143	111	4,254

*Creeping bentgrass is treated with Merit for white grub control and also receives two applications of Talstar for surface-feeding insects during the year. Zoysiagrass is treated only with Merit.
†Assumes eight hours to apply a granular product to 30 acres in one application, and a labor cost of $10/hour. Fuel cost assumes that the vehicle uses 1.2 gallons/hour at a cost of $3.25/gallon.

Table 6. Annual insecticide applications and associated costs for 30 acres of creeping bentgrass and zoysiagrass fairways at a hypothetical golf course in the Kansas City area.

Cultivation practices

Species	No. of core aerifications	No. of verticuttings	Labor + fuel ($)*
Creeping bentgrass	1	5	2,856
Zoysiagrass	1	2	1,428

*Labor costs assume 16 hours of labor for two employees (at $10/hour each) to core-aerify or verticut (one to operate aerifier or verticutter, the other to blow off debris). Fuel cost assumes that two tractors, each using fuel at 1.5 gallons/hour, are used for each operation and the cost of fuel is $3.25/gallon.

Table 7. Annual cultivation practices and associated costs for 30 acres of creeping bentgrass and zoysiagrass fairways at a hypothetical golf course in the Kansas City area.

Annual expenses

Cultural practice	Creeping bentgrass ($)	Zoysiagrass ($)	Difference (bentgrass – zoysiagrass) ($)
Mowing	10,432	7,452	2,980
Irrigation	69,324	40,921	28,403
Fertilization	9,737	4,868	4,869
Disease control	44,942	4,413	40,529
Weed control	12,477	1,795	10,682
Insect control	10,245	4,254	5,991
Cultivation	2,856	1,428	1,428
Total	**160,013**	**65,131**	**94,882**

Table 8. Comparison of annual expenses for maintaining a hypothetical golf course in the Kansas City area with 30 acres of either creeping bentgrass or zoysiagrass fairways.

The research says

→ The cost of maintaining a hypothetical Kansas City golf course with creeping bentgrass fairways is compared to the cost of maintaining the same course with zoysiagrass fairways.

→ Expenses for labor, fuel, inputs (water, nutrients and pesticides) were calculated for both grass species for a year.

→ In all categories — mowing; fertilization; disease, weed and insect control; and cultivation — zoysiagrass was significantly less expensive to maintain than creeping bentgrass, with an estimated annual savings of $94,877.

divot from zoysiagrass, but toupee-like divots from creeping bentgrass are common. Each grass has positive and negatives in terms of year-round playability and quality.

Zoysiagrass establishment and reestablishment costs

Initial establishment of zoysiagrass can be costly. To solid-sod 30 acres (12 hectares) of Meyer zoysiagrass would cost in the neighborhood of $500,000. Strip-sodding of zoysia (1) can be done for less than half this cost, however, and is particularly helpful when conversion from perennial ryegrass is desired, and there is a desire to continue revenue flow at the golf course. Higher costs associated with zoysiagrass establishment are quickly returned, as indicated by the numbers presented here. Even if zoysiagrass is solid-sodded at $500,000, savings in maintenance costs would be recouped within five years after planting, and savings on zoysiagrass compared to creeping bentgrass would be substantial over an extended period of time. Freezing injury on zoysiagrass fairways occurs about every five to 10 years in the Kansas City area, and resodding damaged areas would be an additional expense that was not accounted for in this example.

We hope this comparison will help those making decisions regarding selection of fairway turfgrasses for use in the transition zone. A little common sense regarding our roles as sound economic and environmental managers can go a long way in sustainable golf course management.

Disclaimer

Pesticide examples used do not imply recommendation or endorsement of those products.

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