Selecting The Right Grass

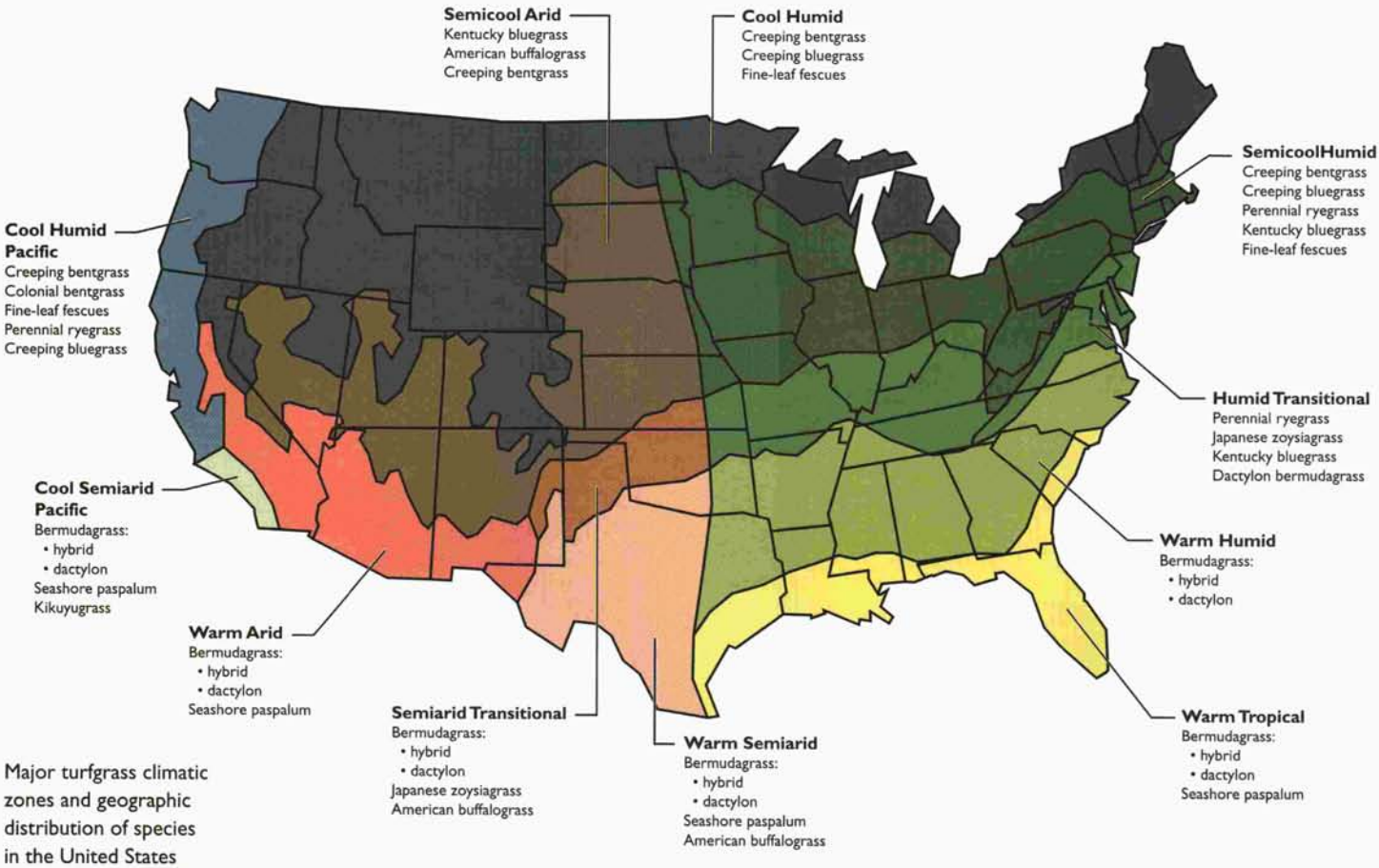
With many warm-season turfgrass options available, determining the most appropriate is a daunting task.

BY JOHN FOY

Ten years ago, if you were building or renovating a golf course in the southern portion of the United States where warm-season turfgrasses have traditionally been used, grass selection was a simple proposition. Bermudagrass, and primarily the hybrid cultivar Tifway (419), was the standard and was considered to have very good overall adaptation for tee, fairway, and rough areas. Similarly, Tifdwarf bermuda was the standard for putting greens. However, golfer demands and expectations for fast putting speeds have also resulted in efforts to push bentgrass further south. In less than a decade, the turfgrass selection equation has become much more complicated.

Introduction of the ultradwarf bermudagrasses — Champion, Floradwarf, TifEagle, and MiniVerde — started the revolution and raised the bar for quality and conditioning of warm-season putting greens. The increase in the number of entries in the National Turfgrass Evaluation Program (NTEP) from a total of 26 (16 seeded, 10 vegetative) in 1992 to 42 (29 seeded, 13 vegetative) in 2002 clearly illustrates that a lot of work has been put forth to develop additional bermudagrass options for fairways and roughs. Furthermore, while bermudagrass has long been the king of warm-season grasses, an increasing number of seashore paspalum and zoysiagrass cultivars or varieties are available today.

There has been a big slowdown in new course construction in the United States; however, there has also been a surge in course renovation projects. In Florida alone, there were more than 50 renovation projects slated for 2006, and it is estimated that a similar amount of work will be undertaken annually for the next several years.



Major turfgrass climatic zones and geographic distribution of species in the United States (adapted from Beard 2002).

Resurfacing of putting greens and conversion to an ultradwarf cultivar are the driving forces behind much of the project work being undertaken. Yet, there are also complete course renovation and replanting projects being performed, and there are more than 100 courses being built across the country annually. To assist in selecting the best suited and appropriate warm-season golf course turfgrass options, the following is a review of their general characteristics along with guidelines to use in the decision-making process.

RANGE OF ADAPTATION

Turgrasses have long been separated into two basic groups based on their climatic adaptation and specifically the temperature range required for optimum growth. The warm-season turfgrasses grow best in the temperature range of 80 to 95 degrees F, whereas the cool-season turfgrasses exhibit optimum growth when temperatures are in the 60 to 75 degrees F range. In general, warm-season turfgrasses have better drought, heat, and wear tolerance compared to cool-season species, but they enter into a dormant stage and go off-color (brown) when temperatures in the 50-degree F range or colder occur. Poor tolerance to cold winter temperatures and winter kill are limiting factors in the distribution and use of warm-season species through the upper transition zone and northern portion of the United States. Geographic distribution of the warm-season turfgrasses in relation to the major climatic zones of the U.S. is depicted in Figure 1.

There are approximately 14 warm-season species utilized for turfgrass purposes around the world.[2] However, for the remainder of this article, discussions will focus on bermudagrass (*Cynodon* species), seashore paspalum (*Paspalum vaginatum*), and zoysiagrass (*Zoysia* species) because they are currently the main species used on primary playing surfaces in North America. Buffalograss (*Buchloe dactyloides*) is a native species of the Great Plains of North America and is extremely well adapted to semi-arid regions. Although improved cultivars have been developed over the past few years, it is definitely under utilized.

SPECIES/CULTIVAR ADAPTATION

For selecting the best-suited warm-season species and cultivar, a number of factors need to be taken into consideration. Across the country, irrigation water availability and quality are major concerns for golf courses. This brings to the forefront water usage rates, salinity tolerance, and drought resistance as factors to consider. Also, it is essential that every effort be made to minimize potential

negative environmental impacts and conserve resources. Thus, pest problems and management inputs such as fertilizer requirements need to be components in the selection equation.

WATER USAGE, SALINITY TOLERANCE, AND DROUGHT RESISTANCE

As a group, warm-season grasses have lower water use rates (based on mean summertime evapotranspiration rates) compared to cool-season species. Buffalograss is at the head of the pack and has a relative ranking of very low water usage. It is followed by bermudagrass and then zoysiagrass, with low to medium rankings. Based on previous research, seashore paspalum is also ranked as having a medium water usage rate relative to these other species.

New bermudagrass, zoysia, and paspalum cultivars have become available since these water use rate studies were conducted, and variability among cultivars does occur. This is especially true with seashore paspalum. There have been advertising and marketing claims that seashore paspalum needs only 50% of the irrigation of bermudagrass, but research conducted by Dr. Bob Carrow at the University of Georgia determined that water requirements of SeaIsle I, which was the most drought-tolerant paspalum, are similar to Tifway bermuda.[3] With proper nitrogen fertilization and irrigation management to maintain maximum root system development, an additional reduction in water usage of SeaIsle I is possible. In another study conducted at Clemson University, it was found that improvements in water use rates and drought tolerance have been achieved with some of the newer bermudagrasses that are now available.[1] Additional unbiased cultivar and species evaluation of this very important performance character is needed.

In the past, salinity and water quality problems were, for the most part, only an issue in arid to semi-arid regions. Degradation of ground and surface water supplies along with increased use of effluent and non-potable water sources, however, has resulted in salinity tolerance becoming a concern in humid regions as well. Bermudagrass, and in particular the hybrid cultivars, are ranked as having very good salinity tolerance along with zoysiagrass. Seashore paspalum is considered the most salt tolerant of all warm-season species, and several cultivars are available today that also have improved turfgrass quality characteristics. Once again, there is variability in salinity tolerance of the paspalums, and some selections can survive irrigation with brackish or even ocean water. However, additional management inputs are required when irrigation water contains moderate to high salt levels. In particular, larger quantities of irrigation water must be available for periodic leaching of salt accumulations out of the root-zone. Buffalograss is ranked as having fair salinity tolerance.

With irrigation restrictions becoming a fact of life in more areas of the country, the ability to survive drought conditions has become an even more important factor in turfgrass selection. Bermudagrass, buffalograss, seashore paspalum, and zoysia get relative rankings of superior, excellent, to good as far as their drought resistance. Avoidance, tolerance, and/or escape are the mechanisms by which turfgrasses achieve drought resistance. Bermudagrass enters into a dormant stage and thus uses an avoidance mechanism with the onset of drought stress. The brown, off-color character that results is not aesthetically attractive, but as long as excessive wear or damage does not occur, a turf cover will persist. Also, with reestablishment of adequate soil moisture by rainfall or irrigation, a rapid recovery and green-up response will occur. Furthermore, it has been observed in the field that the green-up and recovery response of some of the new fine-leaf zoysiagrasses is faster than bermuda.

Even when maintained at very low heights of cut, seashore paspalum can produce an extensive root system.

With the ability to produce an extensive and deep root system, seashore paspalum is able to utilize moisure from lower depths in the soil and is an example of drought tolerance. However, with the onset of drought stress, shoot die-back occurs and turf coverage and surface quality deteriorate to an unacceptable condition. Excellent root and rhizome survival does allow full recovery, but redevelopment of a good quality turf cover can take significantly longer when compared to bermuda and zoysiagrass.

Not forgetting about buffalograss, it can persist on as little as two inches of rainfall or irrigation annually. However, attempts to utilize it in the humid eastern part of the country have met with limited success because of too much rain.

PEST PROBLEMS

To produce and maintain top-quality playing surfaces in keeping with current golfer expectations, controlling insect, disease, and weed problems is necessary. Yet, pesticide usage on golf courses has and will continue to be a major concern because of perceived and potential impacts on the environment. Treatments can also add significantly to annual course operating costs. Clearly, selecting species and cultivars that have pest resistance or tolerance is advisable.

In humid and tropical regions, insect and disease pressure can be very high. Mole crickets have long been the number-one pest problem of bermudagrass-based golf courses in the lower Southeast and Florida. Without annual insecticide treatments, significant turf damage and loss will occur. At the long-running bermudagrass breeding program at the Coastal Plains Experiment Station in Tifton, Georgia, Dr. Wayne Hanna found that there was a consistent pattern of lower mole cricket numbers and reduced damage in TifSport plots compared to the other cultivars being evaluated. This is considered a "non preference" characteristic as opposed to resistance. However, on golf courses where TifSport has been used, insecticide treatments for mole cricket control have still been required.

Fall, early winter, and spring preventive fungicide treatments on fairways can be required for control of zoysia patch and large patch disease on zoysiagrass. Large patch disease has also been experienced on seashore paspalum, and while extensive turf loss has not occurred, preventive fungicide treatments are being made. Pest tolerance/resistance is one of several important selection criteria.

Foliage-feeding caterpillars (army worms and sod webworms), grubs, billbugs, and chinch bugs are some of the other common insect pests encountered on warm-season golf courses. With increased use of seashore paspalum on courses in Florida, it has been found that insect pests similar to those that plague bermudagrass are being experienced. This is especially true as far as sod webworms and army worms. More attention is being given to screening for and identification of insect resistance mechanisms with all of the warm-season turfgrasses, and with luck this will pay dividends in the near future.

Plant parasitic nematodes are replacing mole crickets as the number-one pest problem of Florida courses. With limitations on nematicide treatments today and into the future, dealing with this pest problem is naturally a major concern. Turf resistance to nematodes would be a highly desirable trait, but it is not an option at this time. Thus, an alternative strategy would be to select turfgrasses that are able to produce extensive, deep root systems and also have an aggressive growth habit that provides increased tolerance to nematodes. Seashore paspalum and some of the new bermudagrass cultivars have exhibited improved tolerance to nematodes because of these growth characteristics.

Compared to cool-season turfgrasses, the warm-season species have significantly fewer disease problems. The aggressive growth habit of bermudagrass provides tolerance to most diseases, even though fungal pathogens are always present. Very rarely do disease activity and turf damage reach the point that fungicide treatments can be justified on bermudagrass tees and fairways. Spring Dead Spot (SDS) disease is the exception and is considered a major problem on courses in the transition zone. Identification of tolerant or resistant cultivars is desperately needed.

In the fall, as the growth rate of both zoysia and seashore paspalum naturally begin to slow down, outbreaks of patch diseases have been experienced on numerous courses. Large patch (*Rhizoctonia solani*) and yellow patch (*R. cerealis*) are the main problems for zoysia fairways, while large patch has been identified on paspalum. Also, dollar spot (*Sclerotinia homeocarpa*) outbreaks have been experienced on paspalum. Preventative fungicide treatments in the fall are being recommended for control of patch disease problems through the winter and spring and until sustained growth resumes. With seashore paspalum, improper nitrogen fertilization and irrigation can contribute to increased patch disease incidence, but it should be pointed out that no cases of devastating turf damage and loss have been

A classic case of bermudagrass winterkill. Replanting with a more cold-tolerant cultivar could help minimize recurrence of this problem.

reported. Nevertheless, the disease problems that have been experienced to date and increased fungicide usage are concerns.

A very dense turf is a key component minimizing weed invasion, and this is a common characteristic of zoysiagrass, seashore paspalum, and bermudagrass. There are, however, several opportunistic and highly invasive annual and perennial weeds that can become established in all warm-season turfgrasses. Thus, herbicide treatments are needed to maintain acceptable levels of weed control, and with both zoysia and bermuda, an adequate arsenal of pre- and post-emergent materials is available. The list of options for seashore paspalum is also growing.

The superior salinity tolerance of seashore paspalum also makes topical applications of salt a weed control option. Directly applying rock salt or spraying ocean water on weeds can provide acceptable control of a number of problem species. However, this strategy has not worked satisfactorily for controlling bermudagrass infestations in paspalum. Nor are there any selective herbicides currently available that provide good control/suppression of bermudagrass without also causing unacceptable damage to the paspalum. Most golfers do not recognize this weed problem, and thus it can be debated as to whether or not it is a truly significant problem. However, at least in Florida, a lot of time and effort are being devoted to bermudagrass control.

FERTILITY REQUIREMENTS

Fertilization is a basic and necessary turfgrass and golf course management practice. However, as with pesticides, potential negative impacts on groundwater and/or surface water supplies are major concerns with fertilizer usage. Fertilizer can also be one of the bigger line items in the annual operating budget for a course. Thus, a low fertilizer requirement is a highly desirable characteristic. Bermudagrass has a relatively high fertilizer requirement, and in the past excessive nitrogen applications were unfortunately all too common in an effort to produce a darker green

color. Bermuda cultivars are now available that perform satisfactorily with lower fertilizer inputs and also have a more aesthetically pleasing color character.

Seashore paspalum is extremely efficient as far as nitrogen utilization is concerned, even on infertile, sandy soils; fertilization requirements can be less than half of what is required for bermudagrass. Zoysiagrass also requires less fertilization compared to bermuda, but it has been found that the new, finer-leaf cultivars require more nitrogen than older cultivars.

COLD TOLERANCE

Throughout the transition zone of the United States, cold tolerance is a critically important selection factor with warm-season turfgrasses. Even in the mid to lower South, where the ground does not freeze for extended periods of time, periodic winter kill of bermudagrass can occur. This and its brown color when it is dormant have been limiting factors in its use. Excellent strides have been made in the development of more cold-tolerant bermudagrasses, increasing its range further north in the transition zone.

The cold tolerance of seashore paspalum is similar to that of bermudagrass, but further evaluation of this characteristic is also needed. In areas such as Central to South Florida, where bermudagrass does not go fully dormant and brown, paspalum maintains a greener color, very similar to a winter overseeding cover. Yet, cart traffic and wear damage problems similar to what is experienced with bermuda can occur when moderate to heavy play is hosted. It has also been found that seashore paspalum transitions out of overseeding smoothly and better than bermudagrass.

Zoysiagrass has better cold tolerance relative to bermudagrass. This and its ability to maintain a greener color character longer into the fall are factors in its increased use. Yet, once again, variability in cold tolerance occurs among the zoysias, and some of the new fine-leaf types have significantly reduced tolerance compared to Meyer and Emerald.[4] Furthermore, good drainage, minimal shade, and proper management play a role in minimizing the potential for winter kill with all warm-season turfgrasses.

SUNLIGHT REQUIREMENTS

All plants require sunlight for photosynthesis and growth, and as a group the warm-season turfgrasses have a high light requirement. Lack of shade tolerance has long been recognized as a major limiting factor with bermudagrass, and eight hours of direct sunlight is considered the minimum requirement for sustained healthy growth. Seashore paspalum was initially thought to be very similar to bermuda as far as its tolerance to tree shade. It has been found, however, that paspalum is persisting and performing satis-

Lack of a selective herbicide to control bermudagrass infestation in seashore paspalum is a problem, especially when converting from one species to another.

factorily in shaded locations where bermuda failed. Paspalum is also more tolerant to periods of reduced sunlight intensity due to heavy, persistent cloud cover.

Zoysiagrass has moderate shade tolerance, and in the past it has been used as an alternative to bermuda. Development of more bermudagrasses with shade tolerance has been a goal of some breeding programs, and there are commercially available cultivars now available that have performed as well as, if not better than, zoysia in shaded locations.

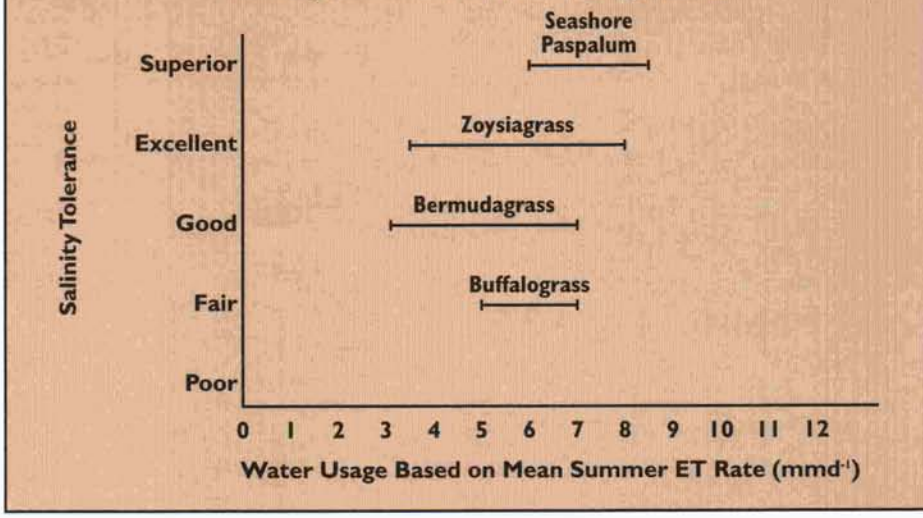
OTHER CONSIDERATIONS

Going beyond the basic factors that affect warm-season turfgrass growth, establishment rate, wear tolerance, and recuperative ability are characteristics that need to be considered in the selection process. Until recently, the best quality cultivars were vegetatively propagated, and thus sprigs or sod has been used for establishment. When environmental conditions are favorable to sustain active growth in the summertime, both bermudagrass and seashore paspalum have a very rapid establishment rate. A full turf cover and appropriate conditions can be developed in as little as 8-12 weeks after sprigging. If poor quality irrigation water must be used during the grow-in process, however, the rate of paspalum establishment will be significantly slower. A number of seeded bermudagrasses are now available that have comparable quality to the vegetative hybrids and, in general, their establishment rate is similar. Zoysia establishment from sprigs is slow, and thus strip or solid sodding has typically been employed despite the additional cost.

As a group, bermudagrass, seashore paspalum, and zoysiagrass have very good wear tolerance. The aggressive growth habit of bermuda also provides it with good recovery from damage. Paspalum has good recuperative ability as well, but its recovery from mechanical damage such as mower scalping and drought stress can be quite slow. The inherently slow growth rate of zoysiagrass is a problem as far as recovery from damage is concerned.

Aesthetics and play characteristics are two other factors that must be considered. From the purely agronomic standpoint, color is a minor consideration, but American golfers expect and demand lush green playing surfaces. Both seashore paspalum and zoysiagrass have a "greener" color compared to bermuda, and this color is very appealing to most golfers. Furthermore, mower striping patterns are more pronounced with both paspalum and zoysia compared to bermuda. The combination of these characteristics results in an aesthetic "WOW factor" that is being heavily weighted in the selection process.

Table 1
Summary and Comparison of Relative Salinity Tolerance to Water Usage Rates



Hybrid bermudagrasses, seashore paspalum, and the fine-leaf zoysias all have a very dense and upright shoot growth character, providing an excellent tee and fairway surface condition. The "stiffer" leaf of paspalum and zoysia also provides greater ball support so that it sits right on top of the turf surface. Some, but not all, golfers like the very tight and firm fairways that can be produced. There are also distinct differences in the play character of the putting green surrounds and roughs of the warm-season grasses, but that's a topic for another time.

With regard to warm-season putting surfaces, the old standard of Tifdwarf is not a bad grass; with the tools available today, appropriate and good quality conditioning for daily play can be provided. However, the ultradwarf cultivars have raised the bar as far as the level of conditioning and quality that can be provided. As a result, there is no longer the push to try to maintain bentgrass putting greens in hot and humid regions where it is not adapted to survive on a year-round basis. The ultradwarfs are certainly not bullet proof, but along with being better adapted for meeting current golfer demands, they have exhibited a more stable performance character compared to Tifdwarf. There is a consensus opinion that the ultradwarfs have replaced Tifdwarf as the standard.

Table 2
Summary of Mean Rates of Turfgrass Evapotranspiration

Turfgrass Species[1]			
Cool Season	**Warm Season**	**Mean Summer ET Rate (mmd^{-1})[2]**	**Relative Ranking**
	Buffalograss	5-7	Very low
	Bermudagrass hybrids	3.1-7	Low
	Centipedegrass	3.8-9	
	Bermudagrass	3-9	
	Zoysiagrass	3.5-8	
Hard fescue		7-8.5	Medium
Chewings fescue		7-8.5	
Red fescue		7-8.5	
	Bahiagrass	6-8.5	
	Seashore paspalum	6-8.5	
	St. Augustinegrass	3.3-6.9	
Perennial ryegrass		6.6-11.2	High
	Carpetgrass	8.8-10	
	Kikuyugrass	8.5-10	
Tall fescue		3.6-12.6	
Creeping bentgrass		5-10	
Annual bluegrass		>10	
Kentucky bluegrass		4->10	
Italian ryegrass		>10	

[1]Based on the most widely used cultivars of each species

[2]Mean rates of water use based on research by Aronson et al. 1987a; Aronson et al. 1987b; Beard 1985; Biran et al. 1981; Carrow 1991; Gibeault et al. 1985; Johns, Beard, and van Bavel 1983; Kim and Beard 1988; Kneebone and Pepper 1982; Kneebone and Pepper 1984; Kopec et al. 1988; Krans and Johnson 1974; Meyer, Gibeault, and Younger 1985; O'Neil and Carrow 1983; Pruitt 1964; Shearman and Beard 1973; Sifers et al. 1987; Tovey, Spencer and Muckell 1969; van Bavel 1966; and Younger et al. 1981.

Table 3
Relative Salt Resistance of Several Turfgrass Species Used in the United States

Turfgrass Species*		
Cool Season	**Warm Season**	**Ranking**
Alkaligrass	Seashore paspalum	Excellent
Creeping bentgrass Tall fescue	Zoysiagrass St. Augustinegrass Bermudagrass hybrids Bermudagrass Bahiagrass Centipedegrass Carpetgrass	Good
Perennial ryegrass Fine fescues	Buffalograss	Fair
Kentucky bluegrass		Poor

*Based on the most used cultivars of each species

Similar to Tifdwarf, appropriate and good quality conditioning can be produced with seashore paspalum putting greens. However, maintaining a consistent putting speed through the day and keeping speeds comparable to the ultradwarfs have become concerns at some facilities. Growth regulator treatment programs can help, but at this time, mowing and rolling inputs are much higher relative to what is conducted with bermuda greens.

Finally, with comparison of a number of the selection factors discussed in this article, seashore paspalum and zoysiagrass have advantages over bermudagrass. Absolutely, if a poor quality saline irrigation water source is a factor, paspalum is a logical choice. Also, the cold tolerance of zoysiagrass favors its use in the most northern portion of the transition zone. However, in regions where bermudagrass is well adapted and has performed satisfactorily for many years, it would be urged not to put too much emphasis on the aesthetic "WOW" factor. With both paspalum and zoysia, mowing and cultural management requirements, increased equipment maintenance costs, and having to conduct large-acreage preventive fungicide treatments can negate cost savings achieved in other areas.

For assistance in selecting the right grass, the logical starting points are the National Turfgrass Evaluation Program (NTEP) and state university trials in a similar climatic zone. The Green Section regional agronomists are also an excellent source of unbiased information on species and cultivar performance on area courses. While not always an option, on-site evaluation is strongly encouraged, and at least two to five years needs to be allowed to gain a good understanding of performance and management requirements.

REFERENCES

1. Baldwin, C. M.; Liu, H.; McCarty, L. B.; Bauerle, W. L.; Toler, J. E. 2006. Response of six bermudagrass cultivars to different irrigation intervals. *HortTechnology*. July-September. 16(3):466-470.
2. Beard, James. 1973. Turfgrass Science and Culture. p. 132. Prentice-Hall, Inc., Englewood Cliffs, N.J.
   Beard, James B. 2002. Turf Management for Golf Courses. p. 27. Wiley & Sons, Inc., Hoboken, N.J.
3. Carrow, Robert. Seashore Paspalum Ecotype Responses to Drought and Root Limiting Stresses. USGA Turfgrass and Environmental Research Online 4(13):1-9. TGIF Record Number: 105521.
4. Carrow, Robert. What We Know About The New Zoysiagrasses. North Carolina Turfgrass. Summer, 1995.

JOHN FOY *has spent more than 20 years helping golf courses select the right warm-season turfgrasses.*