BENTGRASS (*AGROSTIS*) CULTIVAR BOTANICAL CHARACTERISTICS AND CULTURE

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The golfer movement to more fast putting green surfaces has changed the cultural practices on greens, including very close mowing of 5/32 to 1/8 inch (4.0-3.2 mm). These very close mowing heights tend to cause a reduced shoot density in many turfgrass cultivars, and a resultant decline in surface turf quality and increased annual bluegrass (*Poa annua*), moss, and algae problems. The very close mowing also has emphasized:

1. The need for turfgrass cultivars that sustain shoot density and rooting at a 1/8 inch (3.2 mm) cutting height.
2. Changes in turfgrass cultural practices, such as canopy biomass management.
3. The potential for proper turf rolling on high-sand greens.
4. The problem of spike marks caused by traditional metal spikes.

Creeping bentgrass (*Agrostis stolonifera* L.) is widely used as the preferred turfgrass species on putting greens in cool climates. It is uniquely adapted morphologically for use on putting greens (Beard, 1982). Extensive, prostrate lateral stem development and a dense shoot-leaf canopy have been sustained under frequent, close mowing of 3/16 to 1/4 inch (4.8-6.4 mm). The lateral stem growth speeds turf recovery from ball marks and other damages to the turf surface. Creeping bentgrass is a cool-season, C_3, perennial turfgrass that has an optimum growing temperature of 55 to 75°F (16-24°C). It responds to nitrogen fertilization and irrigation, especially under intense traffic stress. Penncross has been the creeping bentgrass cultivar most widely accepted and used throughout the world for the past 35 years. A number of new creeping bentgrass cultivars have been released in recent years. There is a need to assess their potential for use under golf course putting green conditions, and especially at cutting heights of 1/8 to 5/32 inch (3.2-4.0 mm).

BOTANICAL CHARACTERISTICS

There are two key botanical characteristics in turfgrass cultivar performance for which there needs to be a clear documentation as to the effects of close mowing heights of 1/8 to 5/32 inch (3.2-4.0 mm). These specific responses will be documented in this paper via research conducted at two sites.

One study site involves a 5-year cultivar characterization study conducted at a golf course near Torino, Italy, on a USGA Method high-sand root zone construction. The climatic conditions at this Mediterranean site at the foot of the Alps are reasonably similar to those found in Michigan, except that the extent of snow fall is less in most years. This results in a substantial reduction in snow mold disease problems. The main diseases on the site were sclerotinia dollar spot, fairy ring, and a infrequent occurrence of rhizoctonia brown patch. The main insect problem has been leatherjackets (*Tipula* spp.).

The second study site was located in Rolesville, North Carolina, involving a 3-year study conducted on a 100% sand root zone. The botanical characterizations were conducted at this site in mid-May of 2-years following relatively mild winter conditions, with several months of optimum growing conditions prior to the assessments. The second series of assessments was conducted in mid-October for two years, each following extraordinarily severe heat stress during the summer. This heat stress level would be much more severe than that experienced in Michigan. However, there are occasional periods of heat stress in some locations in southern Michigan that are of concern and thus these data may be of value.

The research methods and materials and results for these two investigations are presented in the two attached papers. The general results will be summarized in the following section.

SHOOT DENSITY

The turfs of many creeping bentgrass cultivars tend to thin as the cutting height is reduced below 3/16 inch (4.8 mm). High shoot densities provide better overall turf cover, which restricts light penetration to the soil surface, and therefore results in reduced annual bluegrass, moss, and algae problems. Also, high shoot densities tend to increase surface uniformity and smoothness, which are important components of putting quality. A higher shoot density and

higher biomass also provide improved wear stress tolerance as well. Finally, there is visual appearance, which is important, but does not necessarily relate to the putting quality of the surface. It is possible that the higher shoot densities of certain cultivars could result in a slower green speed, depending on the relative stiffness of the leaf, especially as related to the lignin content of the scarified leaf tissues.

Among creeping bentgrass cultivars maintained under close mowing at the two sites., the shoot densities ranged from 755 to 3,547 shoots per square decimeter. Because shoot density on putting greens can be affected significantly by the nitrogen nutrition level, the shoot counts at the Torino site generally were lower than at the site in North Carolina. The slightly higher mowing at Torino also may have contributed to the lower shoot density compared with the North Carolina site. Exhibiting the highest shoot densities in autumn under the lower nitrogen fertility levels and cooler conditions at the Torino site were Penn G-1, Seaside II, Penn G-2, and Penn A-1; followed by Penn G-6 Southshore, Providence, SR 1020, and Penn Links. After the cutting height was lowered from 4.8 to 4.0 mm and the nitrogen nutritional level raised at the end of the 1994 season, there was a general increase in shoot density. Cultivars with the greatest shoot densities under higher nitrogen levels and lower cutting heights at the North Carolina site were Penn G-2, Penn G-6, and Penn A-1, followed by Southshore and SR 1020.

Moss and Annual Bluegrass Invasion. The cultivars Penn G-1, A-1, G-6, and G-2 had a higher shoot density and turfgrass quality, and a lower degree of annual bluegrass and moss invasion after 5+ years of assessments in the Torino study. Four cultivars, National, Emerald, Seaside and Astoria, provided unacceptable shoot density and turfgrass quality for putting greens. Generally, those cultivars with higher shoot densities exhibited the least proneness to annual bluegrass and moss invasion. In the case of annual bluegrass, there tended to be a general increase over the years 1995 through 1997, particularly in the case of the cultivars with a lower shoot density. In contrast, the moss invasion did not exhibit an increasing tend over time, but rather varied from year-to-year and from cultivar-to-cultivar, which suggests that the variations were more a response to climatic conditions. There also was a intra-seasonal variation in the extent of moss coverage, with the peak occurring in June.

Cultivars with very high or very low shoot densities do not necessarily have a corresponding high or low shoot/mat/thatch dry weight, in the case of these 12 creeping bentgrass cultivars in the North Carolina study. Also, cultivars possessing the highest or lowest shoot densities do not necessarily have the corresponding highest and lowest visual turfgrass quality. Generally a high above-ground biomass contributes to better wear stress tolerance to traffic stresses.

CANOPY BIOMASS

Cultivars with a high shoot biomass would most probably be more wear stress tolerant, although this association should be confirmed through actual wear simulation stress treatment comparisons. Shoot canopy biomass dry weight values ranged from 22 to 63 grams per square decimeter in the North Carolina Study. Penn G-2, Penneagle, PennLinks, and Cobra had the highest shoot biomass in October following an extremely hot, humid summer.

LEAF BLADE WIDTH

Typically, greater shoot density in a cultivar corresponds with narrower leaves, and this was generally true at the two research sites. A narrow leaf blade purportedly allows faster putts, although this is not necessarily the case. The fine-leaf fescues have very narrow leaves, but their putting-green ball roll speed is much slower than for creeping bentgrasses which may have leaves twice a wide. The stiff, highly scarified tissue found in the fine-leaf fescues inhibits ball roll.

Among the 16 creeping bentgrass cultivars in the Torino study, the leaf blade widths after 4 full growing seasons ranged from 0.62 to 0.96 mm. Seaside II, Penn G-6, Penn G-2, Penn A-1 and Penn G-1 had the narrowest leaves in the 0.62 to 0.69 mm range, followed by SR 1020, Southshore, Providence and Putter in the 0.73 to 0.82 mm range.

ROOT BIOMASS

Turfgrass cultivars capable of producing deep, extensive root systems will take up water from a greater portion of the soil profile than the shallow rooted cultivars. This reduces the cultivar's sensitivity to heat and drought stresses. Vigorous roots also typically allow less frequent irrigation. Overall, a large root biomass contributes to a healthy turf, which is characterized by a reduced susceptibility to many stresses. Under favorable growing conditions at the North Carolina site the root biomass ranged from a high of 101 grams for Penncross, with Penn G-2 at 94 grams and Penn G-6 at 80 grams to a low of 14 grams for Crenshaw.

HEAT STRESS TOLERANCE

One of the first negative plant responses observed on turfgrasses following the onset of heat stress is a dieback of the root system and a cessation of new root initiation when soil temperatures exceed 80°F (27°C). Lately this condition has been loosely described as "bentgrass decline" and blamed in part on various pathogens. Extensive investigations in the late 1950s revealed that the annual cyclic nature of "bentgrass decline" was closely correlated and caused by supraoptimal chronic temperature stress. In many bentgrass cultivars this is a normal occurrence associated with hot summers. While diseases or other stress factors may contribute to the problem, the correction of these secondary problems will not negate the typical midsummer decline in the bentgrass root system associated with heat stress.

The summers of 1995 and 1996 offered an ideal opportunity to assess heat stress-dominated effects on the rooting and shoot density of creeping bentgrass cultivars under a very close mowing height at the experimental site in North Carolina. Among 12 creeping bentgrass cultivars the root biomass levels ranged from 3 to 51 grams per surface square decimeter following the summer heat-stress. The extent of root losses during the summer were in the general range-between 35 and 80%. The best summer-heat-stressed root biomass levels were found for Penn G-2 and Penncross, with PennLinks having a relatively high root biomass. A majority of the bentgrass cultivars had root biomass levels in the 23 to 24 grams per square decimeter range, while Crenshaw and Cato were deficient in root biomass following summer stress under the very close mowing.

Decreases in most botanical parameters were observed in October following the hot-humid stress period at the North Carolina site, with the shoot densities ranging from a high of 3,313/sq. dm for Penn G-2 to 1,533/sq. dm for PennLinks. There was a general decline in shoot density for most cultivars, except for 3 where the density actually increased. They were Seaside II, Penncross, and PennLinks, which suggests that they have better adaptation to summer heat stress conditions.

While a few cultivars showed an increase in shoot density during the summer heat stress, none of the cultivars had an increase in root biomass. Two cultivars which had relatively low shoot densities exhibited quite high root biomass levels, specifically Penncross and PennLinks. These data would suggest that the creeping bentgrass cultivars with better rooting and root survival capabilities under hot summer stress conditions contribute significantly to an overall better turf performance during summer stress conditions.

The substantial decrease in shoot/mat/thatch dry weight from May to October tends to reflect the growth environment during the humid-hot season, with shoot senescence and decomposition exceeding new shoot initiation and growth.

PUTTING GREENS CULTURAL CONSIDERATIONS

The substantial variations in both shoot density and root biomass among the creeping bentgrass cultivars may require adjustments in the cultural practices selected, depending on the specific characteristics of each individual creeping bentgrass cultivar. For example, a very high shoot density and canopy biomass may require a closer height of cut and more timely vertical cutting, grooming and topdressing practices, while low root biomass levels may dictate higher irrigation and fertilization frequencies. Furthermore, the higher shoot density types will be more competitive against the invasion of weeds, including annual bluegrass (*Poa annua*), moss and algae, thereby decreasing the amount of pesticides required. While cultivars with high shoot densities may require closer mowing and increased biomass management, they also may offer the benefit of improved putting surface quality, including uniformity and erect leaf orientation.

A suggested cultural system for creeping bentgrass follows. Key adjustments for the high-density cultivars noted include: (a) a very close cutting height of less than 5/32 inch (4.0 mm) and down to 1/8 inch (3.2 mm), (b) canopy biomass management consisting of timely vertical cutting as needed, and (c) opening the canopy prior to granular fertilization and topdressing by high-density, 0.25 inch (13 mm) mini-tine punch cultivation. Some may comment that the high density cultivars require increased cost and time in terms of these additional cultural practices, but one should recognize the trade-offs in terms of reduced nitrogen fertilization and less need for algae, moss, and annual bluegrass control.