Buffalograss

Buchloe dactyloides

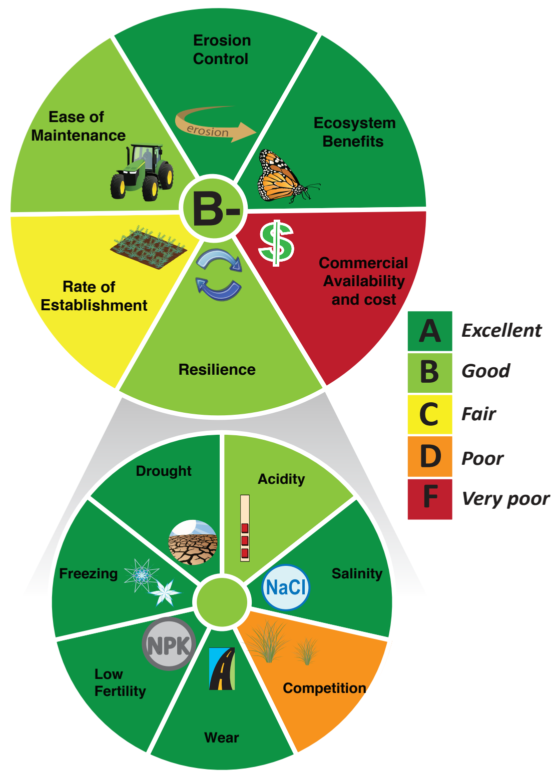
Buffalograss is native to the short-grass prairies of North America and therefore has excellent tolerance to drought, cold climates, and frequent traffic. Its low stature reduces the need for mowing, ecosystem benefits are excellent, and a dense sod stabilizes soil for erosion control. Buffalograss is therefore rated as Good to Fair (grade = B-) for use along Maryland roadsides; however several major management concerns may limit wide-spread use:

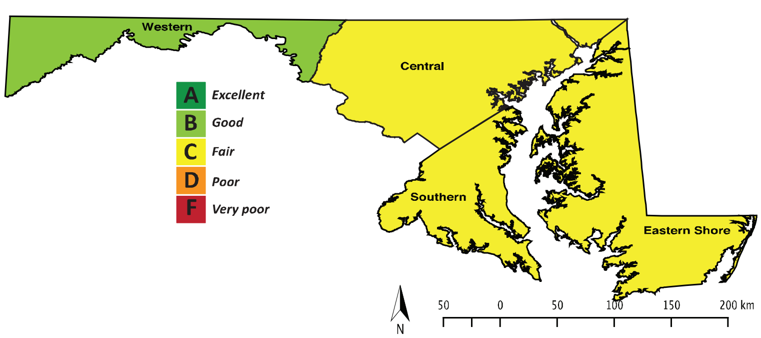
Buffalograss is commercially available but seed costs may prohibit use in larger areas.

Buffalograss often germinates poorly and requires 2 or more years for adequate establishment.

Buffalograss is a poor competitor in humid environments, such as the mid-Atlantic region.

Slow establishment and inferior competitive ability in humid environments require sustained herbicide use to suppress weeds, which increases maintenance costs.





Buffalograss may not be a high performer in Maryland owing to its low tolerance for humidity. Drier areas of Western Maryland may be suitable but other areas of Maryland may only be marginal for low-maintenance management.

Cultivars for use in Maryland will need to have northern origins. Vegetative cultivars from the northern Great Plains include Legacy, Prestige and Turffalo, and for seeded cultivars include Cody, Bowie, and Sharp's Improved.

Biology: Buffalograss is a warm-season dioecious grass that is native to the short-grass prairies of North America (Leithead et al. 1971, Beard 1973, Wu et al. 1989, Riordan et al. 1993, Johnson 2000, 2008, Johnson et al. 2001, Riordan and Browning 2003, Duble 2012, Zhang et al. 2012) and has sometimes been called the bermudagrass of the north (Beetle 1950). The species was important in the recovery of the short-grass prairie after the 1930's drought (Albertson 1937, Albertson and Weaver 1944, Beetle 1950) and provided important forage for bison and sod for the houses of early settlers (Beard 1973, Duble 2012). Predominantly restricted to the short-grass prairie, it was introduced to Virginia in 1856 and was successfully introduced to New York (Riordan and Browning 2003). Owing to its low stature, adaptation to drought and good recuperative ability, tolerance to different mowing heights, and relatively quick establishment, it is the most commonly used native grass species in turfgrass applications (Riordan and Browning 2003, Johnson 2008). Buffalograss is now used in low maintenance conditions such as airfields, highway right-of-ways, cemeteries, parks and sports fields (Beetle 1950, Riordan et al. 1993, Johnson 2000, Sedivec et al. 2001, Riordan and Browning 2003, Duble 2012).

Seeds per pound: 335,000 seeds per pound (Ernst Conservation Seed)
Cost per pound: $16 per pound from Chesapeake Valley Seed and Ernst Conservation Seed
Cost per acre: $2,000.00 per acre
Suggested sowing rate: 125 pounds per acre (Chesapeake Valley Seed)
Sowing depth: 0.5 inches (Heckman et al. 2002, Riordan and Browning 2003), < ½ inch (Beetle 1950, Koski 2012)
Germination time: 7-10 days of treated seed with adequate moisture (Duble 2012), 7-21 days with warm soil and consistent irrigation (Koski 2012)
Seeding timing: late April or May, or fall with germination in the spring (Duble 2012). Mid to late May (Koski 2012). Optimum moisture is important (Riordan and Browning 2003). Seeding in July, August and September do not produce successful stands (Frank et al. 1998, Koski 2012)
Length of growing season: Late May through early September (Leithead et al. 1971, Koski 2012)
Leaf height: 3-6 inches (Leithead et al. 1971), 8-10 inches (Duble 2012), 4-6 inches (Riordan and Browning 2003)
Height at seed head stage: 4-6 inches (Leithead et al. 1971), 8-10 inches (Duble 2012), 8 inches (Simmons et al. 2011).
Shade tolerance: Not shade tolerant (Beetle 1950)
Suggested mowing height: does not need to be mowed to remain attractive (Koski 2012), 2-3 inches in lawns (Duble 2012), 2-3 inches (Frank et al. 2004), most commonly mowed at 3 inches (Johnson 2008), no mowing will result in a turf that is 6-8 inches tall (Johnson 2008). Mowing however may be needed to control weeds.
Humidity tolerance: Not adapted to humid climates. Higher rainfall will allow taller growing species to outcompete buffalograss (Duble 2012).
Disease resistance: Buffalograss is highly susceptible to western chinch bug (Blissus occiduus) in Nebraska (Riordan and Browning 2003, Carstens et al. 2007), and can be damaged by white grubs, grasshoppers, leafhoppers, prairie ants, buffalograss webworm, rhodesgrass mealybug and others (Riordan and Browning 2003). False smut caused by *Cercospora seminalis* affects burs in areas with higher rainfall (Riordan and Browning 2003). Leaf blotch caused by the fungus *Helminthosporium inconseicuum* causes plants to look brown (Riordan and Browning 2003). Infections, however are seldom severe (Riordan and Browning 2003).

Services:

Commercial availability and cost: Buffalograss is commercially available from a variety of vendors. However, seed is relatively expensive compared to fescues, Kentucky bluegrass, and perennial ryegrass. High seed cost and sowing rate make buffalograss an undesirable species to plant in large areas.

Rate of establishment: Buffalograss has a stoloniferous growth habit (Riordan and Browning 2003), which results in a uniform and complete turf in a short time (Johnson 2008). Planted plugs provided complete cover within 8-12 weeks (Koski 2012) with hexaploid cultivar 'Legacy' establishing faster from sprigs than tetrapoid cultivar 'Prestige' (Peterson et al. 2010).

Buffalograss seed germination can be poor owing to seed dormancy (Beetle 1950, Riordan and Browning 2003) and inhibitor substances in the glumes that delay germination (Wu et al. 1989, Riordan and Browning 2003, Duble 2012). Only 40% of new seed germinated the first year after planting and thus stratification, chemical treatment, and/or dehulling is necessary to increase germination rate (Beetle 1950, Beard 1973, Riordan and Browning 2003). Seed chilled at 5-10^{o}C for 6-8 weeks or treated chemically have 80-90% germination as opposed to 20% germination of untreated seed (Duble 2012). Harrington and Meikle (1992) reported 80% germination for buffalograss. Likewise, Tinsley et al. (2006) reported a germination rate of 93% for buffalograss, 73% for side-oats grama, and 66% for little bluestem. In germination experiments (Biesboer and Jacobson 1994, Biesboer et al. 1995), buffalograss reached 75-80% maximum germination after 9-10 days but germination was delayed by 5-10 days and reduced to 30-50% when treated with salinity. In contrast, blue grama maximum germination was 40-50% and was reached after 5 days, and little bluestem germination never exceeded 10% germination (Biesboer and Jacobson 1994). Thus, buffalograss germination is excellent when seeds are dehulled, soaked, stratified, and/or chemically treated (Riordan and Browning 2003).

Rate of establishment (reaching 70-100% cover), however, is slow (Johnson 2000, Simmons et al. 2011). In a Virginia roadside trial, buffalograss cover in the second year of growth never exceeded 60% cover and most plots covered less than 40% at a sowing density of 40 pounds PLS per acre (Doak et al. 2004). In the third year, however, four buffalograss cultivars had an average ground cover above 70% despite a severe summer drought. In Minnesota native plant trials by Meyer and Pederson (1999), buffalograss planted as plugs did not provide acceptable cover, color, or overall quality ratings and did not compete well with weeds. By the end of the first full year of growth, buffalograss covered only 10%. Cultivar 'Bowie' developed acceptable quality and cover ratings at slightly over 1 month after seeding at bur seeding rates of 20-40 g/m^2 (Shearman et al. 2005). At lower seeding rates, however, adequate establishment required two years. Weed interference is a major limiting factor for establishment such that seeding in April and May is recommended (Frank et al. 1998) and results in complete coverage within 7 to 13 weeks (Fry et al. 1993). Soaking burrs prior to seeding resulted in complete coverage one week sooner than unsoaked seeds (Fry et al. 1998). Seeding in July, August, and September leads to unsuccessful establishment (Fry et al. 1993, Frank et al. 1998). Buffalograss was slower to establish 95% cover than bermudagrass, bahiagrass and seashore paspalum, equal in establishment rate to centipedegrass and faster than zoysia (Severmutlu et al. 2011). Native grass mixtures containing 39% buffalograss by weight were slow to establish in Minnesota low-input trials (Miller et al. 2013). Establishment rate can be improved by nitrogen fertilization of up to 147 kg/ha (Frank et al. 2002) and irrigation (Beard 1973, Duble 2012). In a low input turfgrass trial of 12 species across seven states in the Upper Midwest of the United States, buffalograss establishment was excellent in Ohio and southern

Illinois, similar or higher than the best performing tall fescue and sheep fescue cultivars (Diesburg et al. 1997). However, buffalograss establishment was poor in Iowa, Michigan, Indiana, central Illinois, Missouri and Wisconsin.

Ease of maintenance: Buffalograss, as a low-stature species, has a low requirement for mowing (Riordan et al. 1989 but see Brede 2002) and will not persist under intensive management (Duble 2012). In high rainfall areas, buffalograss is competitively inferior such that weed control may need to be used to maintain buffalograss presence (McCarty and Colvin 1992, Riordan et al. 1993). Under no-mow conditions, one native grass mixture containing buffalograss produced the best quality and had no weed cover compared to 6 other turfgrass mixtures, which contained up to 47% weed cover (Miller et al. 2013).

Erosion control: Buffalograss produces a dense sod (Beard 1973, Johnson 2000) that is effective in binding soil to prevent wind and water erosion (Riordan et al. 1993, Riordan and Browning 2003). It rapidly spreads vegetatively through extensive stolons (Riordan and Browning 2003) but does not possess rhizomes (Duble 2012). Beard (1973) considered the root system of buffalograss to be shallow although Riordan and Browning (2003) summarize several studies that observed the root system of buffalograss to be 60-120 cm long with some roots excavated at depths of up to 3 m. Similarly, Huang (1998) observed 18 to 31% of buffalograss total root dry weight to occur in the 40-80 cm soil layer in well-watered and drought conditions, respectively, whereas zoysia distributed 8-13% of its roots within that same soil layers and conditions. In a study of four turfgrasses (Qian et al. 1997), buffalograss roots reached 67 cm soil depth, which was less than tall fescue, equal to bermudagrass, and deeper than zoysia. Almost 50% of buffalograss roots were located below 30 cm soil depth as opposed to 43% in bermudagrass and 30% in zoysia. In addition to binding soil, buffalograss sod has high water-holding capacity that is between 57 to 60% field capacity (Beetle 1950, Riordan and Browning 2003).

Ecosystem benefits: Buffalograss is native to the central United States. Owing to its dense sod and tolerance to grazing, buffalograss was able to sustain vast herds of bison before the turn of the century and is still highly regarded as a good forage grass (Riordan and Browning 2003). Buffalograss sod provided building material for early settlers (Riordan and Browning 2003). It is used for seeding grass waterways on farms, lawns and recreational areas (Leithead et al. 1971) and is associated with numerous beneficial arthropods including spiders, predatory ants, ground beetles, rove beetles, big eyed bugs, and several species of hymenopterous parasitoids (Riordan and Browning 2003, Carstens et al. 2007).

<u>Resilience</u>:

Drought: Buffalograss has excellent drought (Beetle 1950, Leithead et al. 1971, Beard 1973, Wallner et al. 1982, Riordan et al. 1989, Riordan and Browning 2003) and heat tolerance (Beard 1973, Zhang et al. 2012). Drought tolerance is conferred through high water holding capacity (Riordan et al. 1993, Huang 1998, Riordan and Browning 2003), low evapotranspiration rate (Feldhake et al. 1984, Kim 1983, Kim and Beard 1988, Beard and Kim 1989, Riordan and Browning 2003), leaf rolling during drought stress (Savage and Jacobson 1935, Riordan et al. 1993, Riordan and Browning 2003), and deep roots (Qian et al. 1997, Johnson 2008) or plasticity in root distribution (Huang 1998). Buffalograss can go dormant quickly with drought stress and also revive quickly when the drought is alleviated (Beard 1973, Riordan et al. 1993, Riordan and Browning 2003, Johnson 2008). Its reestablishment after the 1930's drought was important for conservation and agriculture

(Savage and Jacobson 1935, Albertson and Weaver 1944, Beetle 1950, Riordan et al. 1993, Riordan and Browning 2003). Motivated by the 1930's drought, Mueller and Weaver (1942) experimented with the drought tolerance of 14 species and observed buffalograss seedlings to be less drought tolerant than blue grama but more drought tolerant than dropseed > side-oats grama > prairie junegrass. Buffalograss had the lowest evapotranspiration rate of 12 turfgrass species and cultivars under water limiting conditions (Kim 1983). Buffalograss and blue grama had superior plant vigor and color than tall fescue and Kentucky bluegrass under rain-fed conditions whereas the reverse was observed under irrigated conditions (Islam et al. 2013). In a field experiment (Qian and Engelke 1999), buffalograss maintained acceptable turf quality at 26% pan evaporation, which was lower than tall fescue (67%), Zoysia (68%), and St. Augustinegrass (44%) and bermudagrass (35%). Osmotic adjustments of buffalograss (0.84 MPa) were the highest during dry down in a controlled greenhouse experiment (Qian and Fry 1997), compared to zoysia (0.77 MPa), bermudagrass (0.60 MPa) and especially tall fescue (0.34 MPa). In a Virginia roadside trial, four buffalograss cultivars were able to maintain cover above 70% despite a severe drought (Doak et al. 2004). Cultivar 'Cody' showed the most promise as a drought resistant buffalograss cultivar compared to cultivars 'Bison' and 'Bowie' (Islam et al. 2013).

NPK Low fertility: Buffalograss is adapted to heavy loamy clay soils (Riordan and Browning 2003) that are intermittently wet and dry (Leithead et al. 1971). Buffalograss is adapted to low input conditions (Riordan et al. 1989) and is reported to require very little fertilization in rangeland applications (Johnson 2008). However fertilizer application of 98 kg N/ha sustained quality, color and density of buffalograss whereas lower fertilizer applications decreased performance (Frank et al. 2004). In low-input trials in Minnesota (Miller et al. 2013), one native grass mixtures containing 39% buffalograss by weight performed well after the initial establishment year.

Freezing*:* Buffalograss is adapted to altitudes up to 2000 m (Beetle 1950) and can grow well in northern latitudes (Riordan et al. 1993, Bhowmik et al. 2008). It is therefore well adapted to cold temperatures (Beetle 1950, Beard 1973) and has excellent low-temperature tolerance (Stier and Fei 2008). Following freezing treatments, 'Tatanka' and 'NE91-118' maintained higher relative shoot and root regrowth than four other cultivars (Qian et al. 2001). Maximum freezing tolerance also differed among cultivars with cultivars 'Tatanka' (LT50 = -18 to -21^{o}C) and 'Texoca' (LT50 = -17 to -22^{o}C) being the most tolerant (Qian et al. 2001). Higher glucose, fructose, and raffinose endogenous soluble carbohydrates were higher in cultivar 'NE91-118' than in cultivar '609' and may be responsible for why 'NE91-118' was able to survive 4.5 to 4.9 ^{o}C colder temperatures (Ball et al. 2002).

NaCl Salinity: Buffalograss has some capacity to preferentially exclude sodium from its leaves (Wu and Lin 1994, Marcum 2002, 2008b) but is not adapted to highly saline soils (Johnson 2008) and is therefore ranked as moderately salt sensitive (Wu and Lin 1994, Marcum 2002, 2008a, b) or moderately tolerant (Harivandi et al. 1992, Uddin 2013). However, substantial variation in salt tolerance has been observed (Wu and Lin 1994, Zhang et al. 2012). Among seven species, buffalograss was less tolerant to salt than salt grass, dropseed, bermudagrass and zoysia but more tolerant than side-oats grama (Marcum 1999). Among eight species tested, buffalograss demonstrated the greatest tolerance to salt compared with side-oats grama, little bluestem and others (Harrington and Meikle 1992). In a salinity experiment, Biesboer and Jacobson (1994) observed buffalograss to be more salt sensitive than blue grama but more salt tolerant than side-oats grama, little bluestem, prairie dropseed, and sand dropseed. In contrast, Roberts and

Zybura (1967) rank buffalograss as less sensitive to salt than blue grama but more sensitive than side-oats grama, sand lovegrass, and tall fescue. In greenhouse experiments, buffalograss was less tolerant to salinity than alkaligrass and tall fescue but more tolerant than blue grama (Marcum 2008a). Of six native species, buffalograss and blue grama were the most capable of germinating under high salt concentrations (Biesboer and Jacobson 1994) but germination was delayed by 5 to 10 days, survival reduced by 50%, and shoot and root biomass reduced by 75% when plants were treated with 5,000 ppm NaCl (Biesboer et al. 1995). Out of 5 buffalograss and 3 blue grama cultivars tested under four salinity treatments (Zhang et al. 2012), buffalograss on average was more salt sensitive than blue grama. The germination rate of buffalograss cultivar 'Texoka' at 5 g NaCl per liter was 63 - 66% and for the other buffalograss cultivars was <30%. Germination decreased rapidly to below 10% at 10 g NaCl per liter and was entirely inhibited at higher concentrations. In contrast, although germination was greatly reduced, blue grama cultivars were able to maintain limited germination at higher salinity levels (Zhang et al. 2012). At the vegetative stage, however, blue grama showed higher sensitivity to salt than buffalograss (Zhang et al. 2012). Seedlings are less tolerant of salt than young shoots from established clones (Wu and Lin 1994). Buffalograss attained high germination under moderate to high deicer concentrations similar to blue grama, little bluestem, mountain brome, and slender wheatgrass (Dudley et al. 2014).

Acidity: Buffalograss is adapted to neutral soils ranging in pH from 6.5 to 8.0 (Thorne and Cardina 2011) and has medium aluminum tolerance (Liu et al. 2008). Buffalograss consistently performed poorly, showing a 55% decrease in relative root mass and 72% decrease in phosphorus root recovery at high aluminum concentrations in the soil (Baldwin et al. 2005).

Wear tolerance: Growing points are close to the ground such that buffalograss can withstand close grazing and mowing (Leithead et al. 1971). Buffalograss can withstand moderate to heavy grazing (Riordan et al. 1993), which removes species that might otherwise be superior competitors (Riordan and Browning 2003). Thus, mowing can increase performance of buffalograss (Savage and Jacobson 1935, Riordan and Browning 2003). However, overgrazing and excessive traffic and mowing can weaken plants and lead to the deterioration of a stand of buffalograss (Beetle 1950, Leithead et al. 1971, Duble 2012, Koski 2012). Mowing can lead to scalping of buffalograss (Simmons et al. 2011), which exposes the lower, non-photosynthetic portion of tillers and weakens plants. A study that compared the performance of 24 native species and cultivars under different mowing heights (Mintenko et al. 2002) found that buffalograss did not perform as well as blue grama and prairie junegrass but better than most other native grasses including side-oats grama and alkaligrass. Fertilizer application of 98 kg nitrogen per hectare can improve traffic tolerance (Johnson 2008).

Competition: Weed management is very important in buffalograss turf (Koski 2012), especially when buffalograss is establishing (Meyer and Pederson 1999, Johnson 2008) or grown in suboptimal conditions such as higher rainfall. Nurse grasses are not recommended when planting buffalograss (Riordan and Browning 2003). Buffalograss cannot compete with taller species that grow where greater rainfall favors their growth (Riordan et al. 1993, Duble 2012). Thus, in high rainfall areas such as the eastern United States, buffalograss is not a superior competitor and will therefore not resist weed invasion (McCarty and Colvin 1992). Similarly, buffalograss will be an inferior competitor under disturbed conditions (overgrazing, heavy traffic, intensive management) when weeds may invade and outcompete buffalograss (Beetle 1950, Duble 2012). However, once established, buffalograss monocultures and polycultures with blue grama and other native species were able to suppress weeds better than a monoculture of bermudagrass (Simmons et al. 2011). Overseeding red fescue, blue fescue, and chewings fescue on buffalograss resulted in dominance of fine fescues (Johnson 2003, 2008, Severmutlu et al. 2005). Buffalograss is also an inferior competitor in southern locations when mixed with bermudagrass (Beetle 1950). Once fully established and in good condition, buffalograss competes well with weeds (Johnson 2008).

<u>Mixes</u>: Buffalograss frequently co-dominates native communities with blue grama and side-oats grama (Savage and Jacobson 1935, Beard 1973, Riordan and Browning 2003). Buffalograss and blue grama comprise 90% of vegetation on non-sandy soils of the short-grass prairie (Riordan and Browning 2003). On rocky calcareous slopes, buffalograss can grow naturally with blue grama, side-oats grama, hairy grama, sand dropseed, and little bluestem (Riordan and Browning 2003). Fine fescues are overseeded on buffalograss to enhance visual quality in the winter (Severmutlu et al. 2005, Abeyo et al. 2009). 'Legacy' buffalograss and 'DR-3200' blue fescue performed the best in terms of visual compatibility (Abeyo et al. 2009). However, fine fescues tend to dominate the mixture. In a Minnesota low-input study of 8 seed mixtures, Miller et al. (2013) included buffalograss at 39% by weight in one of two native seed mixtures. Both native grass mixtures were slow to establish and had low quality and high weed cover in the establishment year. However, the mixture containing buffalograss established faster with 63% cover 56 days after seeding than the other native grass mixture with 47% cover. In the third year of the study, turfgrass quality ratings were excellent and equal to a tall fescue blend. Weed cover sowed in native grass mixtures was higher or equal to plots seeded with tall fescue and fine fescues but lower than plots containing Kentucky bluegrass. Virginia roadside trials (Doak et al. 2004) used buffalograss alone and in mixtures with little bluestem, or blue grama, or side-oats grama, or with little bluestem and either blue grama or side-oats grama. Buffalograss alone and the mixture with blue grama performed the best with >70% cover in most years after the first establishment year and despite a severe drought. Texas DOT uses buffalograss in mixtures with side-oats grama, bermudagrass, indiangrass and green sprangletop (Tinsley et al. 2006) and observe good establishment of buffalograss and side-oats grama.

<u>Cultivars</u>: Improvement of buffalograss began in 1936 (Riordan and Browning 2003). Collections from northern and southern location showed differences in morphology and management requirements (Riordan and Browning 2003) with northern accessions being shorter and requiring less mowing. Southern accessions were vigorous growers with better disease resistance. Early cultivars 'Prairie' and '609' showed the best performance (Riordan et al. 1993) and were released as cultivars in 1990 (Duble 2012). Both are female plant selections and need to be established as sod or plugs (Duble 2012). Accessions of buffalograss differ greatly in root distribution (Klingenberg 1992) and response to climate (Peterson et al. 2010). Commercially available vegetative cultivars include 'Prairie', '609', 'Density', 'UC-Verde', and 'Scout' from southern Great Plains, as well as 'Legacy', 'Prestige', 'Turffalo', and '378' from northern Great Plains (Riordan and Browning 2003, Johnson 2008, Koski 2012). Winter hardy cultivars include 'Legacy', 'Prestige', and 'Turffalo'. Seeded cultivars include 'Bison', 'Plains', Topgun', and 'Texoca' from southern Great Plains, as well as 'Bowie' from northern Great Plains. 'Cody' and 'Sharp's Improved' are seeded cultivars from both southern and northern Great Plains. (Johnson 2008, Koski 2012). Cultivars 'Legacy', 'Scout', '609', '378', and 'Cody' showed the best performance according to 1999 NTEP results (Riordan and Browning 2003).

Symbols courtesy of Integration and Application Network, University of Maryland Center for Environmental Science (ian.umces.edu/symbols/).