
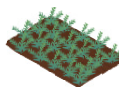



Blue grama

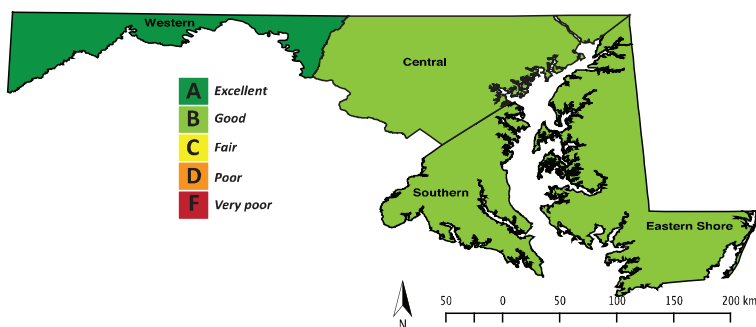
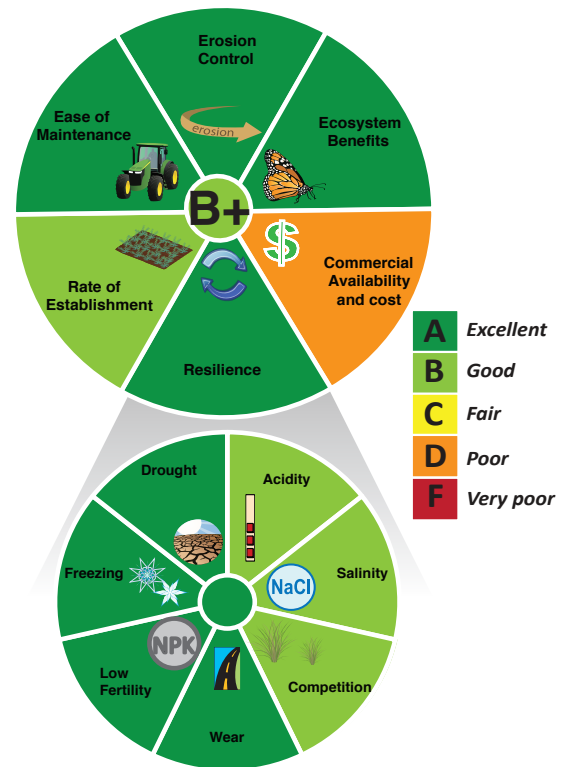
Bouteloua gracilis

Blue grama is native to the short-grass prairies of North America and is therefore well adapted to drought. It is used extensively in low-maintenance and low-input environments, such as roadsides and mine reclamations, owing to its excellent ecosystem benefits, ability to stabilize soil to reduce erosion, and short growth habit that reduces the need for mowing. Blue grama has excellent resilience to most roadside conditions such as drought, freezing, traffic, and low soil fertility. Rated as Good to Excellent (grade = B+), blue grama may be a suitable species for Maryland roadsides with a few challenges:

 Blue grama is commercially available but seed costs are high.

 Blue grama germinates rapidly but establishes slowly, requiring herbicide use within the first 1-2 years to suppress weeds.

 Competitive ability may be reduced in humid environments such as the mid-Atlantic region, which may decrease long-term persistence without management intervention.



Humidity tolerance may be low. Thus, blue grama is best suited for the drier climates of Western Maryland near Green Ridge but may perform adequately throughout the state.



Cultivar Bad River is adapted to cooler climates and therefore suitable for planting in Maryland.

Biology: Blue grama is a perennial warm season grass species that is native to the Great Plains region of North America and adapted to transitional, warm subhumid, warm semiarid, and warm portions of the cool subhumid regions (Beard 1973). It is a dominant species of the short grass steppe, comprising >60% of basal cover (Lowe et al. 2003) and often associated with buffalograss (Johnson 2008). Blue grama is rare outside of the Great Plains region. Owing to its drought tolerance and fast recovery rate after drought, blue grama was an important species for conservation and agriculture after the 1930's drought (Savage and Jacobson 1935, Albertson 1937, Albertson and Weaver 1944). In cooler environments or where grazing pressure is intense, blue grama will form a dense sod, whereas in warmer climates it occurs predominantly as a bunch grass (USDA Plant Guide). Blue grama is used mostly in non-use and low-maintenance environments such as roadsides and similar non-irrigated areas where culture intensity is low and turfgrass quality is less important (Beard 1973, Sedivec et al. 2001). It is also used in surface mine reclamation (USDA Plant Guide).

Seeds per pound: 700,000 to 800,000 seeds per pound (USDA Plant Guide)

Cost per pound: \$15 per pound from Chesapeake Valley Seed

Cost per acre: \$525.00 per acre

Suggested sowing rate: 35 pounds per acre (Chesapeake Valley Seed)

Sowing depth: 0.25 to 0.5 inches (Sedivec et al. 2001)

Germination time: 3-6 days (Biesboer and Jacobson 1994, Biesboer et al. 1995)

Seeding timing: April to mid-May (USDA Plant Guide)

Length of growing season: late May, becomes dormant in the summer and grows again in the fall (Leithead et al. 1971)

Leaf height: 9-18 cm (Lowe et al. 2003)

Height at seed head stage: 12-16 inches (Leithead et al. 1971), 10-24 inches (Simmons et al. 2011), 6-25 inches (USDA Plant Guide)

Shade tolerance: Low


Suggested mowing height: Mowing may be needed to control weeds. Blue grama will tolerate a variety of mowing heights that are similar to those of buffalograss.


Tolerance of wet conditions: Hard fescue needs well-drained soil but can tolerate higher soil moisture than sheep fescue.

Humidity tolerance: Low

Disease resistance: Grasshoppers and white grub larvae will feed on leaves and roots, respectively (USDA Plant Guide). Blue grama is susceptible to leaf and tar spot and rust diseases in South Dakota (USDA Plant Guide).

Services:

 **Commercial availability and cost:** Blue grama is commercially available but, has a high cost per pound of seed. Even with a lower sowing rate, planting this species over a large area can be moderately expensive.

 **Rate of establishment:** Beard (1973) considers establishment of blue grama to be rapid and easy; however, survival of seedlings depends on adequate moisture while seedlings are growing adventitious roots (USDA Plant Guide). In a germination study (Biesboer and Jacobson

1994, Biesboer et al. 1995), blue grama started germinating within 3 days of planting and reached 40-50% germination after 6 days. In contrast, buffalograss started germinating after 6 days and reached 75-80% after 10 days. However, in a salinity experiment, emergence of blue grama was 44% in a control (no salinity) treatment whereas it was 81% in alkaligrass and 85% in Kentucky bluegrass (Neid and Biesboer 2004). In a Virginia roadside trial (Doak et al. 2004), blue grama averaged 94% cover at a study location in the Piedmont region suggesting that blue grama may be better adapted to Piedmont areas where competition from other more aggressive warm season grasses is reduced. However, in Minnesota native plant trials (Meyer and Pederson (1999), blue grama planted as plugs did not provide acceptable cover, color, or overall quality ratings and had major winter injury after the first year. Blue grama was slow to establish and had poor turf quality across 2 years at almost all 8 locations in the North Central Region of the United States (Watkins et al. 2011). Native grass mixtures containing 10-17% blue grama by weight were slow to establish in Minnesota low-input trials (Miller et al. 2013). Blue grama did not survive past the establishment year on reclaimed mine soil in southeast Ohio (Thorne and Cardina 2011) whereas eastern gamagrass and western wheatgrass established well. Blue grama established well when plots were sprayed with herbicide prior to seeding and when the establishment year was suitably wet (MacDougall et al. 2008). Once established, the native community dominated by blue grama was able to resist invasion by exotic species.



Ease of maintenance: Blue grama has a short growth habit (Beard 1973) and therefore requires less mowing (McKernan et al. 2001). Under no-mow conditions, two native grass mixtures containing blue grama produced the best quality and had low weed cover compared to 6 other turfgrass mixtures (Miller et al. 2013).



Erosion control: Blue grama produces short, stout rhizomes that result in high shoot densities and a dense sod (Beard 1973). The root system is fibrous, dense and extensive (Beard 1973) such that blue grama is used with other grasses for erosion control. Beard (1973) rated the roots system as shallow, but the depth of rooting may have been underestimated.



Ecosystem benefits: With buffalograss, blue grama is one of the most important forage plants of the short-grass prairie (USDA Plant Guide). Blue grama is a choice forage for livestock and wildlife and may be harvested for hay (Leithead et al. 1971).





Resilience:





Drought: Blue grama has excellent drought and heat tolerance (Beard 1973, Mintenko et al. 2002, Zhang et al. 2012) owing to a medium low evapotranspiration rate (Kim 1983, Kim and Beard 1988). Motivated by the severe drought of the 1930's, Mueller and Weaver (1942) experimented with the drought tolerance of 14 species and observed blue grama seedlings to be the most resistant to drought compared to buffalograss > dropseed > side-oats grama > prairie junegrass. Blue grama had intermediate evapotranspiration rates when compared to 11 other turfgrass species and cultivars (Kim 1983), higher than buffalograss, zoysia, bahiagrass, centipedegrass, and common and 'Tifgreen' bermudagrass but lower than 'Tifway' bermudagrass, St. Augustinegrass, sand knotgrass, and tall fescue. However, blue grama had significantly higher leaf extension rates (6.31 mm/day) under water stress compared to all other species and cultivars (Kim 1983). Blue grama used in a Virginia roadside trial was able to maintain 60-77% cover across 5 years and was only marginally impacted by a severe drought (Doak et al. 2004). Blue grama, hard fescue, and sheep fescue had superior long-term area coverage at two sites in Alberta that were


impacted by drought (McKernan et al. 2001). Additionally, blue grama was one of the most drought tolerant species at both Alberta sites (McKernan et al. 2001), similar to wheatgrasses, Canada bluegrass and 'Washington' Kentucky bluegrass and higher than fine fescues, tall fescue, and junegrass. Blue grama and buffalograss 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). Cultivar 'Bad River' showed the most promise as a drought resistant blue grama cultivar compared to cultivars 'Alma' and 'Hachita' (Islam et al. 2013).

 **Low fertility:** Blue grama grows best on loams and sandy loams and does not grow well on sand, gravel, or clay (Leithead et al. 1971). It responds well to nitrogen fertilization of 0.1 to 0.3 pounds per 1000 sq. ft. (Beard 1973). In low-input trials in Minnesota (Miller et al. 2013), two native grass mixtures containing 10-17% blue grama by weight performed well after the initial establishment year.

 **Freezing:** Blue grama has excellent low-temperature tolerance (Beard 1973, Mintenko et al. 2002, Stier and Fei 2008), grows at elevations between 3,500 to 7,000 ft in New Mexico, and has been reported to grow up to 10,000 ft (USDA Plant Guide).

 **Salinity:** Blue grama is ranked as moderately tolerant to salinity (Leithead et al. 1971, Harivandi et al. 1992, Uddin 2013) to salt sensitive (Marcum 2008a). In a salinity experiment, Biesboer and Jacobson (1994) observed blue grama to be the most salt tolerant of all species planted, including buffalograss > side oats grama > little bluestem > prairie dropseed > sand dropseed. In contrast, Roberts and Zybura (1967) rank blue grama as lower in salinity tolerance to buffalograss < side-oats grama < sand lovegrass < fescue. Blue grama and buffalograss were the most capable of germinating under high salt concentrations (Biesboer and Jacobson 1994) but higher salt concentrations reduced germination success, seedling survival, and seedling root and shoot biomass (Biesboer et al. 1995). Blue grama attained high germination under moderate to high deicer concentrations similar to buffalograss, little bluestem, mountain brome, and slender wheatgrass (Dudley et al. 2014). In a salinity experiment, blue grama emergence decreased by 12% in a salt solution compared to a no-salt control with higher levels of fertilizer decreasing emergence. In comparison alkaligrass decreased 8% and Kentucky bluegrass 37% in salt solution (Neid and Biesboer 2004). Cultivars 'Lovington' and 'Bad River' had the best germination rates (80-95%) of 8 blue grama and buffalograss cultivars tested under four salinity treatments suggesting blue grama cultivars, on average, have higher salinity tolerance than buffalograss (Zhang et al. 2012). Germination declined to below 40% when salinity was increased from 5 to 10 g NaCl per liter and to less than 5% at higher salt concentrations. Although blue grama had higher salinity tolerance during germination, blue grama showed a greater reduction in vegetative growth than buffalograss when treated with saline water (Zhang et al. 2012) with cultivars 'Lovington' and 'Bad River' performing better than cultivar 'Hachita' under salinity stress.

 **Acidity:** Blue grama tolerates alkaline soils (Beard 1973) and grows on soils ranging in pH from 6.6 to 8.4 (Thorne and Cardina 2011).

 **Wear tolerance:** Blue grama requires a low intensity culture with infrequent mowing at a height of at least 2-3 inches (Beard 1973). Growing points are close to the ground such that plants can withstand close grazing or mowing (Leithead et al. 1971). In a northern

Great Plains study that compared the performance of 25 native species and cultivars (Mintenko et al. 2002), two blue grama varieties ('Bad River' and a Minnesota ecotype) and 'Barkoel' prairie junegrass had the highest turf quality at all mowing heights, across three years, and across both study locations.



Competition: Blue grama is a competitive species at low nitrogen levels. However, at higher nitrogen levels its growth is affected by competition from exotic invaders (Lowe et al. 2003). Blue grama has good seedling vigor and will dominate stands when seeded together with buffalograss (Johnson 2008). Similarly, blue grama was able to coexist well in polyculture with buffalograss and resist invasion by weeds (Simmons et al. 2011). In restoration plantings, blue grama dominated restored plots in the first couple of years after planting but was subsequently replaced by *Elymus lanceolatus* (Bakker and Wilson 2004). Weeds within blue grama turf may be controlled by mowing, grazing or herbicide applications (USDA Plant Guide).

Mixes: Blue grama is rarely planted alone and is often mixed with buffalograss (Johnson 2000). Blue grama frequently occurs in native communities with buffalograss and side-oats grama (Beard 1973). In a Minnesota low-input study of 8 seed mixtures, Miller et al. (2013) included blue grama at 10-17% by weight in two native seed mixtures. Both mixtures were the slowest to establish and had low quality and high weed cover in the establishment year. However in the second and third year of the study, turfgrass quality ratings were second and third only 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 blue grama alone and in mixtures with little bluestem and buffalograss. Blue grama alone and the mixture with buffalograss maintained >70% cover in most years after the first establishment year and despite a severe drought. The mixture with buffalograss performed better than blue grama by itself.

Cultivars: Blue grama is mostly available as ecotypes but none have been selected for turfgrass applications (Johnson 2008). Cultivar 'Lovington' from New Mexico was released in 1963 (USDA Plant Guide). Cultivar 'Hatchita' from New Mexico was released in 1980 and is the most drought tolerant blue grama cultivar; cultivar 'Alma' from New Mexico was released in 1992 for rangeland improvement; and cultivar 'Bad River' from South Dakota establishes rapidly and was released in 1996 to be used in cooler regions (Johnson 2008, USDA Plant Guide). Plugs and sod are also available from a variety of commercial sources.