Evaluation and Management of Turfgrass on Virginia Roadsides
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ABSTRACT

Turfgrass Cultivar Evaluations

The trial data in this report are reflected in the VDOT Seed Specifications for Grasses and Legumes (Form RD-4) [see appendices]. The drought of 2002 had a major negative impact on the survival of many cultivars. This demonstrates why the protocol for the RD-4 list reflects real roadside conditions and places the plants under conditions that will separate the cultivars that can survive under the harsh parameters from the ones that may do fine under higher maintenance conditions [lawns or athletic fields].

New cultivar trials of Kentucky bluegrass, tall fescue, perennial ryegrass and fine fescue were planted in November 2002. The 2001 Petersburg plantings may be terminated in the fall of 2004 because of the damage [lack of recovery] due to the summer 2002 drought. New plantings in 2003 in Harrisonburg and Blacksburg will provide data on new cultivars for adequate updating of the RD-4 list. Older cool-season grass trials that were installed in the fall of 1999 at Blacksburg and Orange are concluded and the data gathered from 1999 will be used to formulate recommendations for the RD-4 list.

Orange and Petersburg are parallel cool season trials [both have the same species] planted to determine if there is a difference in performance between the northern piedmont and ridge & valley regions. The Orange county location produced nine total cultivars with over 70% ground cover while the Blacksburg site produced 24 cultivars. The difference in site climates may account for the differences in successful cultivars. The drought of 2002 affected both sites, however the lack of shade at the Orange county site resulted in more severe conditions and the lower number of qualifying cultivars.

The differences in successful cultivars at the identical trials in Blacksburg and Orange County show that site and climate factors will impact the ability of individual cultivars to survive. The future cultivar trials will need to account for differences before making recommendations to the RD-4 list.
Warm season turfgrasses [bermudagrass, zoysiagrass, centipedegrass, bahiagrass] as well as low growing warm season native grass [buffalograss, blue grama] trials, were installed at Hampton Roads and Culpeper in the summer of 2001. These locations should provide data for the RD-4 list by the end of 2004. Most species have performed well, but the higher percentage of cultivars with acceptable cover is at the Hampton Roads site. This is expected based on the large climatic and soil differences between the two sites, but there are 9 bermudagrass cultivars at Culpeper with acceptable cover. This indicates that this species may be useful in roadside situations in a wider area of Virginia than previously thought.

Management Studies

New mowing guidelines have been formulated, based on past experiments and agronomic principles. These have been forwarded to VDOT for their inspection [see appendices].

Native Grass Studies

The most successful low growing native grass evaluated to date is blue grama. In cultivar experiments located in four different climatic regions in Virginia, two cultivars have shown the ability to establish quickly and persist.

Establishment of the shorter warm season native grasses [buffalograss, blue grama, and little bluestem] is difficult because these grasses are slow to germinate and/or spread and do not produce much top growth during their first year of development. This makes weed and erosion control paramount in the first three years of establishment. Experiments at Virginia Tech have shown that several annual grassy weed control products enhance the establishment of native grasses. The shorter natives [buffalograss, blue grama and little bluestem] establish better on areas where there was no previous vegetation. These same shorter natives have proved to be very difficult to establish in areas that were vegetated prior to establishment. The overwhelming reason for the difference was competition from annual grassy weeds on the previously vegetated plots and the lack of competition on the roadside cut slope. The use of companion plants and/or weed control is paramount for effective erosion-free establishment of the warm-season species on slopes. Several experiments investigating the use of companion plants or weed control for successful native grass establishment have shown that most adapted cool season grasses that were planted with the native grasses soon overwhelmed the natives. Planting in the correct season and control of annual grassy weeds are keys to successful establishment. The best time to plant natives is in the summer especially if annual grassy weeds can be eliminated prior to planting. The use of pre-emergent herbicides is also beneficial, but only specific herbicides with specific native grasses. Information is contained in the 2001-2002 report. [Use web site to access report].

Web site for Virginia Roadside Vegetation Research

The web site has been established to post annual reports, research updates, photographs, and to be a vehicle for communication between the researchers and the VDOT personnel in the field. The web address is:

http://filebox.vt.edu/cals/cropsci/roadside.vegetation/

This site is under continual development and improvement because it is changed based on the user's needs and comments.

1. INTRODUCTION

The current roadside research program continues to fulfill three missions: (1) to evaluate turfgrass cultivars and other species to ascertain their suitability for use on Virginia roadsides [soil stabilization and persistence] (2) vegetation management studies to determine the optimum methods for successfully establishing and maintaining vegetation for stabilization and aesthetic purposes under variable conditions found on Virginia highway soils and (3) to carry out these missions in an environmentally and financially sound manner based on agronomic and scientific principles.

Cool season, warm season and native cultivars (varieties) are continually evaluated in trials lasting for three or more years after seeding. This process ensures that new cultivars introduced into the market are evaluated in Virginia environments and the ones selected are best suited to our roadside conditions and maintenance protocols. This testing procedure is designed so that the cultivars on the VDOT Seed Specifications for Grasses and Legumes (Form RD-4) document may be periodically updated.

The cultivars that are recommended for inclusion in Form RD-4 have achieved and maintained 70% or greater ground coverage three or more years after being sown. The standard test is for three years but may be extended if the test areas have not been subjected to several stress periods. This determination will be based on weather data collected at the sites and on the overall condition of the test plots. Even though all the recommended cultivars meet the 70% density minimum, some cultivars consistently have a higher percentage of ground cover than others in separate tests, and may be given a “strongly recommended” status. Cultivars that meet a 75% threshold after two years may be designated as “promising”. These "promising" cultivars are for emergency use only and are not be included in the recommended list because they have not been tested for the full three years.

Tall fescue and hard fescues have been the focus of our management research for many years. A strong role on Virginia roadsides exists for this group of adapted grasses because of many years of successful performance. Virginia has several climatic zones and the fescues are used successfully in most areas; however, there are some areas and conditions where certain species and/or combination of species work best. In western regions, [ridge and valley, northern piedmont] with higher elevations and cooler average temperatures, hard fescues consistently dominate mixed stands. Tall fescues establish and persist better in the middle piedmont region to the coastal plain. In these regions the standard mix is 50% tall fescue and 50% hard fescue. This mixture can be used on over 90+ percent of Virginia for successful erosion control and the maintenance of an aesthetically pleasing ground cover. Ongoing experiments indicate that certain seeded bermudagrass varieties may be useful in a wide area of Virginia for roadside vegetation.

Our warm-season native grass research is currently focused on proper establishment methods and variety selection. There are several species of native grasses that could be potentially used successfully on Virginia roadsides. The most promising native species is blue grama because it establishes rapidly and has shown the ability to compete successfully with annual grassy weeds. Several variety trials throughout Virginia are currently underway and should indicate ecotype and variety adaptability to various climatic regions.

2. DATA RECORDING AND MANIPULATION

Data reported here are visual estimates of percent density (% of live ground cover) and overall performance of each experiment and demonstration. The use of the overall performance (OP) rating system reflects the general quality of the stand. Most of the data are shown as percent density of ground cover. Our observation is that plots with a density of 70% generally provide adequate coverage to exclude weeds and control soil erosion. Therefore, plots with 70% or greater density of live ground cover will be considered acceptable for roadside use. The term "70% threshold" will be used to indicate this concept. Data collected are a combination of visual observations by a trained specialist.

The trial and management studies were evaluated in both the fall (late September to November, after the first frost), in late spring (April to May) and in mid summer (late June to late July). These dates allow for observation during a full range of growing conditions.

When statistical analyses were performed, methods from SAS Institute and means separation with Duncan's Multiple Range Test were employed.

3. GENERAL ESTABLISHMENT AND MANAGEMENT INFORMATION

All of the sites are prepared following VDOT guidelines unless specified. The original vegetation is killed with glyphosate, the site is disked or rototilled, and then seeded. The site may be covered with hydro-mulch or straw to control erosion. The cultivars or treatments are arranged in a replicated randomized block design. Plot sizes vary but generally are 1.82 m by 2.4 m (6'x8'). Large sized seed [fescue and ryegrasses, etc] are sown at a rate of 100 lb/A and the smaller sized seed [bluegrass, bentgrass, bermudagrass, zoysiagrass, etc] are sown at 50 lb/A. Lime is applied as dictated by a pre-establishment soil test to bring the soil close to a pH of 6.2. The only fertilizer the plots receive is at the time of seeding at a rate of 300 lb/A of 15-30-15 fertilizer and are mowed one to three times a year depending on location. Herbicides are used only when there is a risk of losing the entire site to weed infestation. All cool-season grass studies are planted in the Fall (September - November) or Spring (Feb -March) unless noted differently. Warm-season grasses are established in late spring (May- June).

4. TURFGRASS CULTIVAR EVALUATIONS - Tall Fescue

Tall fescue has been one of the main turfgrasses of VDOT's plantings. Tall fescue has proven to be a low cost, consistent germinator that persists under difficult conditions and has very good drought survival once fully mature. This combination has proven successful for several decades and the new cultivars are providing improved tolerances to insects and diseases. In the western regions, tall fescue persistence has not been as good as fine fescue persistence.

4.1. 1999 BLACKSBURG TALL FESCUE TRIALS

Procedure: Thirty-nine cultivars were planted on 17 September 1999 at the Turfgrass Research Center in Blacksburg. The standard planting protocol was followed.

Results and Discussion: The mild winter [1999] and the relatively cool and wet summers [2000 - 1] provided a nearly stress free period which resulted in all the tall fescue cultivars averaging between 67 -76% ground cover [Table 1.0]. The summer drought of 2002 reduced the percentage of live ground cover but an entire replication was shaded from late afternoon sun, which skewed the data upward. There were 15 tall fescues that had over 70% ground cover in the spring of 2003 compared to only 4 at the Orange County site.

4.2. 1999 ORANGE TALL FESCUE TRIALS

Procedure: Thirty-nine cultivars were planted on 14 September 1999 at the Orange County Research Center. This experiment is identical to the Blacksburg planting and is designed to determine if cultivar performance would differ between two Virginia climatic regions.

Results and Discussion: The mild winter [1999] and relatively cool and wet summers [2000-1] caused all the tall fescue cultivars to increase from between 77 - 90% to 82 - 100% ground coverage. The summer drought of 2002 reduced the percentage of live ground cover with no varieties above the 70% LIVE cover minimum. There were many plots that had over 70% [brown] cover but it could not be determined if the plants were viable. By the end of spring 2003 there was recovery sufficient for four tall fescue cultivars to have over 70% live ground cover [Table 2.0].

This trial and the Blacksburg trial have produced data for the RD-4 list and will be terminated.

4.3. 2001 PETERSBURG TALL FESCUE TRIALS

Procedure: Thirty-one cultivars were planted on 14 November 2001 at the Petersburg research site located at the intersection of route 460 and interstate 295 [Table 3.0]

Results and Discussion: The mild winter of 2001 allowed high germination and establishment of all species. By June 2002, 27 cultivars had a rating of over 70% ground cover. The severe drought of summer 2002 decimated this non-irrigated, shallow soil site. There were only twelve cultivars with ratings over 35% live cover. By the end of 2003 only 7 tall fescue cultivars had

over 40% ground cover including a single entry that had 50%.It is interesting to note that the best average of any species was the one orchardgrass entry at 68 % cover. The data helps demonstrate that even with good early establishment the grass had not had enough time to create a fully mature root system prior to the extended drought of 2002. In fairness this was a major drought and fully mature plants would have a very difficult time surviving. This site will be monitored until fall 2004 to see if any more recovery will take place; if not, the location will be recycled.

5. TURFGRASS CULTIVAR EVALUATIONS - Fine Fescue

Fine fescues combined with tall fescue have been a standard seeding mixture used by VDOT for many years. The fine fescues tend to work best in the cooler regions of Virginia while the tall fescues perform best in the piedmont and upper coastal plain. The combination of both species provides a wider range of adapted areas [soil, climate and light] than either single component. However, it is recommended that tall fescue not be planted in the region of Virginia west of the blue ridge mountains because the fine fescues will dominate the stand in a short time. The converse is also true. Fine fescue will not persist on the coastal plain in most roadside situations and should not be planted with tall fescue in this region.

Fine fescue is a term which includes four species or subspecies within the genus *Festuca*: hard fescue (HF) (*Festuca longifolia*), Chewings fescue (CF) (*Festuca rubra* ssp. *commutata*), creeping red fescue (CRF) (*Festuca rubra* ssp. *rubra*, also referred to as strong creeping fescue), sheep fescue (SF) (*Festuca ovina*) and slender creeping red fescue (SCRF) (*Festuca rubra* ssp. *trichophylla*). Botanical authorities consider them genetically different, but it is often difficult to tell them apart. However, our studies reveal that the hard fescues generally tend to outperform the other fine fescue species in Virginia.

5.1. 1999 BLACKSBURG FINE FESCUE TRIALS

Procedure: Fifteen fine fescue cultivars were planted at the Turfgrass Research Center in Blacksburg on 17 September 1999. The area received an application of pelletized lime [20 lb per 1000 ft^2] and 300 lbs of 15-30-15 per VDOT standards.

Results and Discussion: The mild weather of the first year of establishment resulted in all but one cultivar being above the 70% threshold. The soil at the Blacksburg site is a loam with good depth, which also contributed to the good establishment. The drought of 2002 reduced the % cover in most plots, however the shading effect of some nearby woods helped mitigate the drought effects. The experiment was concluded in fall of 2003 at which time five hard fescue, one strong creeping red fescue and one chewings fescue had over 70% ground cover and will be included in the next updated RD-4 list [Table 1.0].

5.2. 1999 ORANGE COUNTY FINE FESCUE TRIALS

Procedure: The same fifteen fine fescue cultivars were planted on 14 September 1999 at the Orange Agriculture Research Center as were planted at the Blacksburg fine fescue trial and the combined data will show if the cultivars perform differently in two climatic regions of Virginia. The seed was planted according to the protocol outlined in section 3. No lime was applied to this site with a clay loam soil.

Results and Discussion: The weather after seeding was very favorable for germination and the mild winter [2000] combined with the cool wet summer [2001] provided outstanding growing conditions. By early June 2002 all cultivars were above the 70% threshold. The severe drought of summer 2002 decimated this non-irrigated, shallow soil site. There were no cultivars with ratings over 30% live cover. This result illustrates why trials are also needed on roadside sites. Four hard fescue and one sheep fescue had recovered by the end of 2003 to have an average ground cover of over 70% and will be included in the next updated RD-4 list [Table 2.0]. Blacksburg had a total of seven fine fescue cultivars with 70% + ground cover while Orange had only five successful cultivars. Only three of the five were successful at both locations, which demonstrates that location is a major factor in determining if a cultivar is successful. Future recommendations may have to be adjusted to reflect this factor.

5.3. 2001 PETERSBURG FINE FESCUE TRIALS

Procedure: Nineteen cultivars were planted on 14 November 2001 at the Petersburg research site located at the intersection of route 460 and interstate 295. This experiment is identical to the Roanoke planting [Spring 2002] and is designed to determine if cultivar performance would differ between two Virginia climatic regions.

Results and Discussion: The mild winter of 2001 allowed high germination and establishment of all species. By June 2002, [prior to drought effects] 27 cultivars had a rating of over 70% ground cover. The severe drought of summer 2002 decimated this non-irrigated, shallow soil site. There were only three cultivars with average ratings over 15% live cover and two were hard fescue varieties [Table 3.0]. In 2003 there was little recovery and only one had 20% cover. This shows the devastating effects of a drought on newly established plants [7 months old].

6. TURFGRASS CULTIVAR EVALUATIONS - Kentucky bluegrass

6.1. 1999 BLACKSBURG KENTUCKY BLUEGRASS TRIALS

Procedure: Fifteen Kentucky bluegrass cultivars were planted on 17 September 1999 at the Turfgrass Research Center in Blacksburg.

Results and Discussion: This location yielded results that ranged from 70 - 90 % ground cover in 2001. At the last rating date of 2001 all cultivars were over the 70% threshold. The weather for the first two years after seeding was very favorable for germination and the mild winters combined with the cool wet summers provided outstanding growing conditions. This helps demonstrate that initial growing conditions have a large impact on stand establishment. The summer drought of 2002 reduced the number of Kentucky bluegrass cultivars that had over 70% cover to 5, but by the fall of 2003 there were only two cultivars that were above the minimum threshold [Table 1.0]. These will be added to the RD-4 list at the next update.

6.2. 1999 ORANGE COUNTY KENTUCKY BLUEGRASS TRIALS

Procedure: Fifteen Kentucky bluegrass cultivars were planted on 14 September 1999 at the Orange county AREC using the standard protocol described in section 3 of this report. This experiment is identical to the Blacksburg planting and is designed to determine if the cultivars perform differently between two different Virginia climatic regions.

Results and Discussion: This location yielded second year results that ranged from 55 - 88 % ground cover with 5 cultivars above the 70% threshold. The mild winter of 1999 and the relatively cool and wet summer of 2000 produced nearly stress free conditions. The drought of 2002 reduced live ground cover of all species and in fall 2002 none of the bluegrasses had over 36% cover, with most in the 20% range. There was little recovery by the summer of 2003 and all cultivars were below 53% [Table 2.0]. The Orange county site had no irrigation and was in full sunlight the entire day which is much hotter than the Blacksburg site that was shaded for several hours in the evening. The differences show that site factors influence survival of different cultivars.

6.3. 2001 PETERSBURG KENTUCKY BLUEGRASS TRIALS

Procedure: Eighteen cultivars were planted on 14 November 2001 at the Petersburg research site located at the intersection of route 460 and interstate 295. This trial was established following the standard protocol described in section 3 of this report

Results and Discussion: The mild winter of 2001 allowed high germination and establishment of all species. By June 2002, 27 cultivars had a rating of over 70% ground cover. The severe drought of summer 2002 decimated this non-irrigated, shallow soil site. In November 2002 there were only four cultivars with average ratings over 10% live cover. Kentucky bluegrass has a dormancy mechanism for survival during a drought and by November 2003 some recovery had occurred. There were nine cultivars with ground cover over 20%, but only two cultivars with ground cover between 30 and 36%.

7. PERENNIAL RYEGRASS TRIALS AND MISCELLANEOUS COOL SEASON VARIETY TRIALS

Perennial ryegrass was added in 2001 to the list of species to investigate for potential roadside utility. National breeding programs have developed some varieties that tolerate heat and drought fairly well. The advantage of perennial ryegrass is that it is one of the fastest germinating turfgrass species [3-4 days under good conditions]. Fast germination could result in perennial ryegrass being a useful component to the standard mix of fine and tall fescues.

7.1. 2001 PETERSBURG PERENNIAL RYEGRASS TRIALS

Procedure: Thirteen cultivars were planted on 14 November 2001 at the Petersburg research site located at the intersection of route 460 and interstate 295. This trial was established following the standard protocol described in section 3 of this report. This experiment is identical to the Roanoke planting [Spring 2002] and is designed to determine if cultivar performance would differ in two Virginia climatic regions [Table 3.0].

Results and Discussion: The mild winter of 2001 allowed high germination and establishment of all cultivars. By June 2002, all cultivars had a rating of over 70% ground cover. The severe drought of summer 2002 decimated this non-irrigated, shallow soil site. In fall 2002 there were only four cultivars with average ratings over 20% live cover. Data collected in 2003 indicated there was some recovery with six cultivars rated over 20% and the best rated at 37%. Survival and recovery comparable to Kentucky bluegrass at this site may indicate that perennial ryegrass has a place in roadside vegetation, especially as a quick germinating component in a mix with tall or fine fescues.

7.2. 2001 PETERSBURG - MISC COOL SEASON TRIALS

Procedure: Eleven cultivars of miscellaneous species were planted on 14 November 2001 at the Petersburg research site located at the intersection of route 460 and interstate 295. This trial was established following the standard protocol established by VDOT and designed to evaluate non-standard grasses. This experiment is identical to the Roanoke planting [Spring 2002] and is designed to determine if the cultivar performance would differ between two Virginia climatic regions.

Results and Discussion: The severe drought of summer 2002 decimated this non-irrigated, shallow soil site. There was only one miscellaneous cultivar with a rating of 45% live cover and this was an orchardgrass. In November 2003 the top rated grass was an orchardgrass with 68.3%. All the other miscellaneous grasses did not perform well, with most having zero ground cover.

8. WARM SEASON VARIETY TRIALS

8.1. 2001 Warm season grass trials in Hampton Roads

Warm season grass trials in Hampton Roads and Culpeper used identical seed and setups. The Hampton Roads trials were planted on May 1, 2001 with 15 bermudagrass, 5 zoysiagrass, 7 buffalograss, 1 centipedegrass and 2 bahiagrass cultivars. The buffalograss was planted at 40 lb PLS (pure live seed) per acre and all others were planted at 50 lb (bulk) per acre [Table 4.0]. The grasses established well in the wet mild summer. Two mowing regimes on one half of each plot were started to see if frequency [once every 4-6 weeks vs. once a year] influenced survivability. In the end of 2002 all but one bermudagrass were above the 70% level with most in the 90% range. Two of the zoysiagrasses reached the 70% range with the others less than 63%. None of the buffalograss was above 60% with most below the 40% level. This result was not unexpected because buffalograss is known for its slow germination and spread. A surprise is the outstanding performance of the centipedegrass with a cover of 90%, while both of the bahiagrasses were below 22% cover. Mowing did not affect the survival or percent cover of the grasses. The September 2003 rating showed a general reduction in live cover from 2002 most likely due to the wet, cloudy conditions in 2003 resulting in less heat and more cool-season weed pressure in the plots. There were 9 bermudagrass, 4 buffalograss and 2 zoysiagrass cultivars with average ground cover above 70% with only two bermudagrasses above 80%.

8.2. 2001 Warm season grass trials in Culpeper

The 2001 warm season grass trials in Culpeper were planted on May 1, 2001 with 14 bermudagrass, 5 zoysiagrass, 7 buffalograss, 1 centipedegrass, 2 bahiagrasses and 1 blue grama cultivar. The preliminary results are similar to the Hampton Roads experiment [Table 4.0]. The bermudagrasses were generally in the 80% range except one at the 37% level. Overall, the coverage was less than at Hampton Roads, which is expected in the cooler Culpeper [upper piedmont] region. One zoysiagrass did very well [95%] while the others were less than 15%. The centipede managed a respectable 66% while the blue grama averaged 94% coverage. By the end of 2003 there were only nine bermudagrasses with ground cover percentages greater than 70% and none of the cultivars from the others species had acceptable cover. As stated earlier this raises the possibility that bermudagrass may be able to be used in areas of the piedmont. These results also indicate that blue grama may be more adapted to the Piedmont rather than the Coastal Plain where more aggressive warm-season species such as bermudagrass dominate.

9. NATIVE GRASS RESEARCH

9.1 Demonstration of Native Grasses for Roadside Use at Blacksburg

Procedure: Twenty types of native grasses were sown in 10' X 10' blocks as a demonstration. These grasses were established in the Valley & Ridge (Blacksburg) region (Turfgrass Research Center) in the late spring of 1997. All varieties examined were seeded and established according to information gathered from the literature and seed sources.

Results and Discussion: The Blacksburg demonstration continues to perform well for several species while several species were hard hit by a combination of drought and disease. Switchgrass and Indiangrass maintained their density and even had some plants invade an adjacent plowed area. Gamagrass showed acceptable density for the first time since replanting in 2001. The density of buffalograss and sideoats grama declined to just below acceptable standards [70% ground cover] due to unfavorable conditions and disease in 2002. This non-replicated demonstration shows that during drier years buffalograss will do well but when there are seasons of extended wet weather increased disease pressure will cause a decline in live cover. The stand of Virginia wildrye and Canadian wildrye will be replanted in spring 2004 because of a greatly reduced density.

The plots are mowed to 5" each November. The whole site was fertilized with 2 lb of phosphorus and 1/2 lb nitrogen in early April 2002. [This was the only fertilizer applied since establishment in 1997]. The native cool-season grass, Koleria, responded to the fertilizer with a lush growth in the spring but suffered under the summer 2002 drought. Western wheatgrass did attain sufficient growth early but only produced sparse seedheads. These results indicate that the natives are susceptible to declines in percentage of cover. This may due to the cultivars planted in 1998, prior to the cultivar trials now underway, which may not have been the best available for adaptation to the Mid-Atlantic climate. The demonstration plots have been used by classes at Virginia Tech, local gardener groups and some academic groups as examples of type and size of these native species.

9.2 Persistence of Pure and Mixed Stands of Short and Tall Native Grasses

Continuing at the Smart Road in Blacksburg, VA

Objective: The goal of this study was to determine the adaptation and persistence of selected native grasses to the Valley and Ridge region of Virginia when seeded on a newly constructed slope in Montgomery County, Virginia.

Methods and materials: Pure and mixed stands of short [TABLE 6.0 & 6.1] and tall [TABLE 7.0 & 7.1] warm-season native grasses were sown on April 28, 1998 on a newly cut roadside slope of the Smart Road Project. Located in Montgomery County, just east of Blacksburg, Virginia the rocky north-eastern facing 2:1 slope with an elevation of 638 meters and a soil pH of 8.0 was divided into 10' by 10' plots. The experiment used a randomized block

design with 3 replications. The site was planted with a cover crop of *Coreopsis tinctoria* and 1 lb N/1000 ft^2 from sulfur coated urea, 6.3 lb of P_2O_5 and 2 lb of K_2O was applied at time of seeding. The site was then covered with hydromulch (1500 lb/A). Additional erosion control measures were taken later in 1998 because of the wetter than average spring. In July 1998, 2,000 lbs/A of straw was blown onto the plots and 20 lbs/A of German millet (*Setaria italica*), 300 lbs/A of 15-30-15 and 1000 lbs/A of paper mulch were applied with a hydraulic seeder. Glyphosate has been periodically applied to selectively control the few large broadleaf weeds [mainly vetch]. In July 1999 sulfur coated urea (45 N lb/A) was applied. In 2001 and 2003 a three way broadleaf weed killer was selectively applied to remove common and crown vetch that was encroaching on the experiment site. The vetch species are the biggest weed problem on this site. The source is the stand that the Virginia Tech Transportation Institute planted at the base of the experiment. The invasiveness of the vetch on the rocky slope testify to its greater adaptation to these roadside conditions.

Results of the short native grass: The northeast-facing site that was used for this study was a very rocky 2:1 slope. Additional factors contributed to the difficulty of establishing vegetation on this site. Montgomery County experienced a drought from August to October in 1998 and a severe drought in the summer of 1999. The short native grass percentage ground cover on the slopes was slower to develop than the standard tall/hard fescue plots. [TABLE 7.1]. In June 2000 all of the short-grass entries exceeded 50% cover with 7 of 12 exceeding 70%. The little bluestem and sideoats grama plots only had coverage in the 40% range, significantly less than the other species. The standard mix [hard and tall fescue] was superior to the native species until the second year. Two years after seeding the buffalograss/blue grama mix had the most cover of any short grass species; in fact, any mix that included either buffalo and/or blue grama was statistically and numerically similar to the fescue mix plots with 73.3% ground cover. The third year showed increases in percentage cover in all plantings except the little bluestem/sideoats grama plots. Also, after three years the buffalograss plots average cover [86.7%] was numerically superior to the fescue mix [85.0%]. The sideoats grama, little bluestem and side oats/little bluestem average ground cover were less than 70% and statistically less than the other short grass species tested. The fourth year produced a general decline in coverage, much was due to an invasion of common vetch over a wide area of the test site. A 2-4,D product was applied to control the vetch. Year five [2003] has shown a decrease in cover in all plots with two of the combination plots having the largest reduction. The combinations with buffalograss and little bluestem took the biggest declines, dropping from the low 70's to the upper 50's in percent live ground cover. Even the fescue plot dropped over 15 points to just over 70 percent. This could be due to the weather or disease. This experiment is continuing to gather data on the persistence of the native grasses after they are established. The native plants that have shown promise continue to provide adequate control of erosion on this rocky slope. The blue grama and buffalograss plots were statistically equal to the fescues by the end of the second year and remain equal to the fescue plots. The adapted grasses [fescues] established much faster than the natives. TABLES 6.1 and 7.1 show these trends over the past five years.

Results of the tall native grass species: The first year ended with only the two standards, hard fescue and tall fescue, achieving a ground cover of greater that 70% [TABLE 7.1]. The best tall native species was big bluestem / indiangrass at 50% cover. The density of the tall native grasses improved the second year. As expected, the switchgrass and big bluestem were the best native

species at the end of the second year with averages of 33% and 50%. However, all species did not rival the density of the tall or hard fescue at 60% and 83%. At the end of 2001 only one native, big bluestem, had a close to adequate a ground cover of over 60%. Hard fescue density increased to 90% while the tall fescue decreased to 52%. By the end of 2002 the hard fescue plots were holding at 83% while the tall fescue fell to 43%. Indiangrass plots increased slightly while most other species showed decreases. It should be noted that the tall natives are still stunted [on this rocky, sandy slope] compared to the same cultivars grown at the Turfgrass Research Center.

The tall native species used in this trial have not reached the minimum erosion control standard of 70% cover after four years. Several reasons may account for this: the sandy nature of the slope limits water retention and the early erosion control measures may have thinned the stand. It should be noted that these species performed well in a trial at the Turfgrass Center on a flat site with many annual grassy weeds present. In 2003 there were several changes in population of the tall native species. The ground cover of big bluestem increased while indiangrass and the combination plantings percentages declined. The indiangrass was observed to have almost 100% lodging [dry stalks on the ground] in spring 2003. This is a change from the "usual" 50% + upright stalks in spring. This may have affected the new spring growth of the plant. Deertongue had been declining and was reduced to less than 5 percent. Switchgrass and fine fescue remained basically unchanged.

9.3 Short Native Grasses Planted with Selected Companion Species using Seasonal Planting Times

Objective: The goal of this study was to help determine the "best planting practices" for short native plants by using companion species and by using three different establishment timings.

Methods and Materials: Pure and mixed stands of short warm-season native grasses were sown on 5 July 2001 [summer], 5 December 2001 [winter] and 30 May 2002 [spring] at the Turfgrass Research Center. The experiment used a randomized block design with 3 replications. The seed was mixed and sown by hand. The seeding consisted of a "basic mix" of native grasses and selected companion grasses planted as mixes and planted alone. Table 5.0 lists the mixes and results.

Data collection: The percent ground cover of the natives, the companions in the mixed plots and the percent of ground cover of the single variety plots were recorded.

Results: **The data indicates that the best establishment percentage of the low growing natives was without using any companions** [Table 5.0]. Native grass ground cover was the highest or next to the best percentage across all planting dates when no companions were used. Note, the best overall native ground cover was 50% which will not provide enough erosion control to be acceptable. **The late spring and summer are almost equally good times to plant the natives, with a slight edge going to the summer if no companion plants are used.** The use of most adapted grasses as a companion is not recommended because they tend to overwhelm the

natives. The late May planting allowed the natives to establish the best populations with cool season grass companions. [Note: the best was 33% cover]. This may be due to the weaker stand of cool season turfgrass that the short spring establishment time creates, which allows the natives to grow better throughout the summer. **These data supports our numerous other observations that fine fescues do not establish well when planted in the spring compared to tall fescue.** This site had previous vegetation and the encroachment of annual weeds was a major factor in the low establishment rate of the natives. Compare the cover percentages in section 9.2 and table 6.3 'Persistence of Pure and Mixed Stands of Short and Tall Native Grasses' where the newly constructed slope did not have any previous cover.

The best companions for summer planting are Buckwheat and C. tinctoria because of their tendency to emerge fast in the first year, cover the area, have an open growth habit allowing some light to the soil, and to decline and die in the second and third year after seeding. Buckwheat is best because it usually did not appear in the second year. The native mix that produced the best cover was dominated by blue grama, probably due to its shorter germination time.

10. ACKNOWLEDGMENTS

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11. DISCLAIMER

12. TABLES

TABLE 1.0 1999 BLACKSBURG COOL SEASON TRALS – FINAL RESULTS

Seeded Sept 1999

24-Sep-03 % LIVE COVER	VARIETY	SPECIES
60	SR 7100	BENT
60	INTRIGUE	CHEW
50	SANDPIPER	CHEW
70	BRITTANY	CRF
65	SHADEMARK	CRF
60	SR 5200 E	CRF
60	TRAPEZE	CRF
80	ATTLIA E	HF
90	DEFIANT	HF
90	**MINOTAUR**	**HF**
80	**OSPREY**	**HF**
90	**RESCUE**	**HF**
30	SCALDIS	HF
60	BLUEMOON	KBG
30	BLUESTAR	KBG
75	**CANON**	**KBG**
50	CHICAGO II	KBG
30	CYNTHIA	KBG
40	DELLWOOD	KBG
60	DENIM	KBG
50	DRAGON	KBG
60	FREEDOM II	KBG
60	GINGER	KBG

24-Sep-03 % LIVE COVER	VARIETY	SPECIES
65	ADVENTURE II	TF
85	ANTHEM 11	TF
60	APACHE II	TF
50	ARABIA	TF
60	ARID 3	TF
60	ARID II	TF
70	AVANTI	TF
85	AZTEC II	TF
70	BONANAZA II	TF
60	BRANDY	TF
80	BRAVO	TF
80	CISI - TF23	TF
80	COMSTOCK	TF
60	CORONADO GOLD	TF
85	CREWCUT	TF
60	DL / SP	TF
60	GRANDE	TF
60	HOUNDDOG 5	TF
70	JT -2	TF
60	JT -4	TF
90	JT-1	TF
60	JT-3	TF
70	KITTYHAWK SST	TF

70	LIVINGSTON	KBG
40	MERIT	KBG
65	NOTTINGHAM	KBG
70	SR 2100	KBG
60	VOYAGER	KBG
80	DAWSON	SCRF
60	MX86AE	SHEEP
60	QUATRO	SHEEP

70	LANCER	TF
60	LARAMIE	TF
60	MC2	TF
80	MILLENNIUM	TF
80	PIXIE	TF
80	PRIDE	TF
60	R594E - 97	TF
80	REGIMENT	TF
50	SCORPION	TF
90	SR 8300	TF
65	STETSON	TF
85	TARHILL	TF
50	TOMAHAWK	TF
70	TSD	TF
55	TULSA	TF
50	WOLFPACK	TF

TABLE 2.0 1999 ORANGE AREC COOL SEASON TRIALS – FINAL RESULTS

Seeded Sept 1999

17-Jun-03 **% LIVE COVER**	VARIETY	SPECIES
2	SR 7100	BENT
53	INTRIGUE	CHEW
50	SANDPIPER	CHEW
40	BRITTANY	CRF
40	SHADEMARK	CRF
52	SR 5200 E	CRF
53	TRAPEZE	CRF
52	ATTLIA E	HF
78	DEFIANT	HF
75	MINOTAUR	HF
73	OSPREY	HF
55	RESCUE	HF
80	SCALDIS	HF
45	252591	KBG
33	BLUEMOON	KBG
18	BLUESTAR	KBG
30	CANON	KBG
20	CHICAGO II	KBG
35	CYNTHIA	KBG
28	DELLWOOD	KBG
28	DENIM	KBG
35	FREEDOM II	KBG
53	GINGER	KBG
22	LIVINGSTON	KBG
25	MERIT	KBG
30	NOTTINGHAM	KBG
23	SR 2100	KBG
45	VOYAGER	KBG
15	DAWSON	SCRF

17-jun-03 **% LIVE COVER**	VARIETY	SPECIES
60	ADVENTURE II	TF
73	ANTHEM 11	TF
68	APACHE II	TF
58	ARABIA	TF
53	ARID 3	TF
55	ARID II	TF
65	AVANTI	TF
53	AZTEC II	TF
60	BONANAZA II	TF
62	BRANDY	TF
68	BRAVO	TF
60	CISI - TF23	TF
	COMSTOCK	TF
55	CORONADO GOLD	TF
57	CREWCUT	TF
58	DL / SP	TF
68	GRANDE	TF
68	HOUNDDOG 5	TF
58	JT -2	TF
58	JT -4	TF
62	JT-1	TF
67	JT-3	TF
75	KITTYHAWK SST	TF
55	LANCER	TF
70	LARAMIE	TF
68	MC2	TF
58	MILLENNIUM	TF
50	PIXIE	TF
67	PRIDE	TF

70	MX86AE	SHEEP	63	R594E - 97	TF
65	QUATRO	SHEEP	75	REGIMENT	TF
			53	SCORPION	TF
			60	SR 8300	TF
			60	STETSON	TF
			43	TARHILL	TF
			62	TOMAHAWK	TF
			52	TSD	TF
			53	TULSA	TF
			55	WOLFPACK	TF

TABLE 3.0 2001 PETERSBURG COOL SEASON VARIETY TRIALS – CULTIVAR LISTING

SORTED BY SUPPLIER

planted on 14 November 2001

Seed Name	Variety	Supplier	Seed Name	Variety	Supplier	Seed Name	Variety	Supplier
Voyager	KBG	Turf Seed	Premeir II	PR	Barenbrug USA	Crewcut II	TF	Seed Research
PST-B5-43	KBG	Turf Seed	Barrington	TF	Barenbrug USA	Grande	TF	Seed Research
Denim	KBG	Turf Seed	Pinnacle II	PR	Barenbrug USA	SR 8500	TF	Seed Research
PST-A6-214	KBG	Turf Seed	Barrera	TF	Barenbrug USA	SR 8600	TF	Seed Research
BlueStar	KBG	Turf Seed	Barlennium	PR	Barenbrug USA	SR 8250	TF	Seed Research
Elsie	ORC	Turf Seed	Peak	PR	Barenbrug USA	SR 8210	TF	Seed Research
Discovery	HF	Turf Seed	Hardtop	HF	Barenbrug USA	SR 2100	KBG	Seed Research
Megabite	ORC	Turf Seed	Pirouette	PR	Barenbrug USA	Canon	KBG	Seed Research
Shademaster II	CRF	Turf Seed	TF 66	TF	Barenbrug USA	Osprey	HF	Seed Research
Tiffany	CHF	Turf Seed	Barlexas	TF	Barenbrug USA	Scaldis II	HF	Seed Research
Aurora Gold	TF	Turf Seed	Tracer	TF	Barenbrug USA	Sandpipers	CHF	Seed Research
Pure Gold	TF	Turf Seed	Bridgeport	CHF	Barenbrug USA	SR 5100	CHF	Seed Research
Wolfpack	TF	Turf Seed	BAR CF 8 FUS1	CRF	Barenbrug USA	SR 5210	CRF	Seed Research

Maximize	TF	Turf Seed	Barkoel	KOL	Barenbrug USA	SR 7100	COB	Seed Research
Endeavor	TF	Turf Seed	Barleria	KOL	Barenbrug USA	SR 7200	VB	Seed Research
Tar Heel	TF	Turf Seed	Baron	KBG	Barenbrug USA	SR 3100	HF	Seed Research
Coronado Gold	TF	Turf Seed	Baritone	KBG	Barenbrug USA	Goldstar	IB	Simplot -Jacklin
Olympic Gold	TF	Turf Seed	Barzan	KBG	Barenbrug USA	ASAP	PR	Simplot -Jacklin
PST B5 89	KBG	Turf Seed	Baronie	KBG	Barenbrug USA	Goalkeeper	PR	Simplot - Jacklin
PST B4 246	KBG	Turf Seed	Barpressa	CBG	Barenbrug USA	Arid II	TF	Simplot - Jacklin
PST B9 35	KBG	Turf Seed	Bar WB02	VG	Barenbrug USA	Rescue 911	HF	Simplot - Jacklin
Defiant	HF	Lesco, Inc		THG	Barenbrug USA	Quest	TF	Simplot - Jacklin
Shademark	CRF	Lesco, Inc	Minotaur	HF	TMI, Inc.	Arid 3	TF	Simplot - Jacklin
Brittany	CHF	Lesco, Inc	Millennium	TF	TMI, Inc.	Arabia	TF	Simplot - Jacklin
Shamrock	KBG	Lesco, Inc	Brooklawn	KBG	TMI, Inc.	Langara	KBG	
Pro Am	PT	Lesco, Inc	Intrigue	CHF	TMI, Inc.	Prosport	PR	
Prospect	PR	Lesco, Inc	Focus	TF	TMI, Inc.	Jasper II	CRF	
Legacy II	PR	Lesco, Inc	Pizzazz	PR	TMI, Inc.			
Linedrive	PR	Lesco, Inc	Coyote	TF	Landmark Seed			
Allsport	PR	Lesco, Inc	Southeast	TF	Landmark Seed			
Stetson	TF	Lesco, Inc	Dynasty	TF				
Bravo	TF	Lesco, Inc	Unique	KBG				

TABLE 4.0 2001 HAMPTON ROADS AREC AND CULPEPER WARM SEASON TRIALS - CULTIVAR LISTING

Seeded April and May 2001

Buffalo converted to PLS Seed at 40 pls/A

All Others were seeded at 50 lb bulk per Acre

NAME	COMPANY	TYPE	NAME	COMPANY	TYPE
Sungrazer		Berm.	Mohawk	Seeds West	Berm.
Campanion	SRO	Zoysia	Savannah-c	Turf-Seed	Berm.
Yukon	SRO	Berm.	Barmuda	Barenburg	Berm.
PennBuf	SRO	Buffalo	Sharp's Imp2	Sharp Bros	Buffalo
Cathay	Jacklin	Zoysia	Cody-pb-c	Pawnee-Buttes	Buffalo
Jackpot	Jacklin	Berm.	Sharp Shooter	Sharp Bros	Buffalo
Sun Devil 2	Jacklin	Berm.	AU Sand Mtn	SRO	Bahia
SR9554	SRO	Berm.	990210H	SRO	Berm.
Southern Star	Jacklin	Berm.	Del Sol	TMI	
Bison	Stock Seed	Buffalo	Zen 300	TMI	Zoysia
Texoka	Stock Seed	Buffalo	Sydney	Seeds West	Berm.
Cody-st-c	Stock Seed	Buffalo	Riba	SRO	Bahia
Sunstar	Lesco	Berm.	Centipede	Patten Seed	Centipede
U-3	Bermuda Ind.	Berm.			
Zenith	Patten Seed	Zoysia			
Majestic-c	Bermuda Ind.	Berm.			
Sahara	Barenburg	Berm.			

TABLE 5.0 2001 NATIVE MIX AND COMPANION PLANTS WITH SEASONAL PLANTING TIMES - RESULTS

Basic mix of natives is 25 pls /A Buffalograss, 10 pls / A little bluestem and 10pls /A blue grama
Companions were added to the basic mix or planted alone

SUMMER PLANTING Planted 5 July 2001	WINTER PLANTING Planted 5 Dec 01	SPRING PLANTING Planted 30 MAY 2002	
2002-3 AVERAGE Native comp or Mix	2002-3 AVERAGE Native comp or Mix	2002-3 AVERAGE Native comp or Mix	Companions:
30	16.7	36.7	G. Millet @ 15 Lb / A
0	0	33.3	Creeping Red Fescue @ 15 Lb / A "Shademaster II
36.7	0	13.3	C. Tinctoria @ 2.25 lb / A
33.3	21.7	20	Buckwheat @ 20 PLS / A
1.7	1.7	10	Birdsfoot trefoil @ 5 lb / A
21.7	20	26.7	Crimson Clover @ 8 PLS/ A
33.3	11.7	25	Prairie Clover @ 8 PLS / A
6.7	5	40	Hard Fescue @ 15 lb / A "Discovery"
0	0	20	Tall Fescue @ 15 lb / A "Coyote"
46.7	23.3	50	Basic mix alone
33.3	36.7	33.3	Blue Grama and Buffalograss -only
36.7	8.3	10	Blue grama @ 15 PLS lb /A - only
26.7	10	35	Buffalograss @ 30 PLS lb / A -only
0	0	13.3	Hard Fescue @ 15 lb / A "Discovery" -only
0	5	16.7	Tall Fescue @ 15 lb / A "Coyote" -only
3.3	10	13.3	Creeping Red Fescue @ 15 Lb / A "Shademaster II - only
13.3	6.7	21.7	Little Bluestem @ 10 PLS lb / A "Camper" - only
0	0	0	Basic mix with Intermed. P. Rye @ 15 lb /A "Transist" planted 6 July

TABLE 6.0_ NATIVE WARM SEASON GRASS SCREENING TRIAL IN BLACKSBURG, VA. THE SHORT NATIVE GRASSES SEEDING RATES. PLS MEANS THE SEEDING RATE IS BASED ON PURE LIVE SEED AND BULK MEANS SEEDING RATE IS BASED ON BULK RATE.

	Bulk Lbs Per Acre	Lbs PLS Per Acre
Buffalograss 'Cody'		44.00
Blue grama		11.00
Sideoats grama		23.00
Little bluestem 'Little Camper'		17.00
Hard and Tall Fescue (1:1)	100.00	
Buffalograss 'Cody' + little bluestem 'Little Camper'		44.00 8.00
Buffalograss 'Cody' + blue grama		44.00 5.00
Buffalograss 'Cody' +sideoats grama		44.00 11.00
Little bluestem 'Little Camper' + blue grama		17.00 5.00
Little bluestem 'Little Camper' +sideoats grama		17.00 11.00
Buffalograss 'Cody' + little bluestem 'Little Camper' + blue grama		44.00 8.00 3.00
Buffalograss 'Cody' + little bluestem 'Little Camper' +sideoats grama		44.00 8.00 11.00

TABLE 6.1 SCREENING OF WARM SEASON SHORT NATIVE GRASSES IN BLACKSBURG, VA. – RESULTS . SEEDED 28 APRIL 1998 ON A NW FACING CUT SLOPE. THE DATA PRESENTED ARE THE PERCENTAGE OF GROUND COVER, THE AVERAGE OF THREE REPLICATIONS.

Percent of Ground Cover

Plants	Nov-98	Dec-99	Jun-00	Jul-01	Jul-02	Jul-03
Buffalograss 'Cody'	48.3BD	66.7A	73.3A	86.7A	80.3AB	70.0 A
Blue grama	56.7AB	66.7A	73.3A	76.7AB	72.6B	60.0 B
Sideoats grama	35.0D	50.0AC	41.7C	53.3B	40.4C	33.0 C
Little bluestem 'Little Camper'	38.3CD	33.3C	46.7BC	66.7AB	60.4B	52.6 B
Hard and Tall Fescue (1:1)	68.3A	70.0A	73.3A	85.0AB	87.0A*	73.0 A
Buffalograss /L bluestem	51.7BC	60.0AB	66.7A	70.0AB	60.1AB	47.0 BC
Buffalograss /blue grama	55.0AB	60.0AB	73.3A	80.0AB	76.2B	72.8 A
Buffalograss/sideoats	53.3AC	53.3AB	73.3A	71.7AB	72.7B	49.4 BC
Little bluestem/blue grama	58.3AB	63.3AB	73.3A	75.0AB	70.0B	63 .0 B
Little bluestem /sideoats	35.0D	43.3BC	53.3AC	53.3B	45.0B	40.3 C
Buffalograss/L bluestem/blue grama	58.3AB	63.3AB	63.3A	73.3AB	70.8B	49.6 BC
Buffalograss/L Bluestem/sideoats	48.3BD	63.3AB	56.7AC	70.0AB	66.7B	62.7 B

Within each column the values followed by the same letter do not significantly differ at the 5% level of probability using the Duncan's Multiple Range Test.

Means are the average of 3 replications in a randomized block design.

*** The plots are now dominated by hard fescue - over 80 %. This shows that hard fescue will dominate grass areas in the western part of Virginia. [higher elevation and cool temperatures than coastal area of Virginia]**

TABLE 7.0 NATIVE WARM SEASON GRASS SCREENING TRIAL IN BLACKSBURG, VA. <u>THE TALL NATIVE GRASSES SEEDING RATES</u>. PLS means the seeding rate is based on pure live seed and BULK means seeding rate is based on a bulk rate.

Plants	Bulk Lbs per Acre	Lbs PLS seeds per Acre	
Big bluestem 'Niagara'		13.20	
Indiangrass		12.40	
Switchgrass 'Blackwell'		5.60	
Deertongue 'Tioga'		5.60	
Big bluestem 'Niagara'		6.60	
+ Indiangrass		6.20	
Switchgrass 'Blackwell'		2.80	
+ deertongue 'Tioga'		2.80	
Hard fescue 'Nordic'	100.00		
Tall fescue 'Eldorado'	100.00		

TABLE 7.1 SCREENING OF WARM SEASON TALL NATIVE GRASSES IN BLACKSBURG, VA. - RESULTS

Seeded 28 April 1998 on a NW facing road cut slope. The data presented are the percentage of ground cover, average of three replications**.**

Percent of Ground Cover

Plants	Aug-98	May-99	Dec-99	Jun-00	July-01	July-02	July-03
Big bluestem 'Niagara'	36.7BC	55.0B	36.7B	50.0BC	61.7AB	58.8AB	67.0 AB
Indiangrass	35.0BC	45.0B	23.3B	16.7E	25.0B	30.6B	10.0 C
Switchgrass 'Blackwell'	43.3BC	48.3B	36.7B	33.3CE	46.7B	47.2B	45.0 AB
Deertongue 'Tioga'	30.0C	50.0B	23.3B	16.7E	28.4B	10.5C	0.0 D
Big bluestem/indiangrass	51.7B	45.0B	36.7B	43.3BD	56.7AB	57.7AB	47.0 AB
Switchgrass 'Blackwell'/deertongue	26.7C	56.7B	30.0B	26.7DE	43.3B	40.5B	22.0 C
Hard fescue 'Nordic'	71.7A	78.3A	80.0A	83.3A	90.0A	83.2A	82.0 A
Tall fescue 'Eldorado'	75.0A	83.3A	63.3A	60.0B	51.7B	42.4B	8.0 C

Within each column the values followed by the same letter do not significantly differ at the 5% level of probability using the Duncan's Multiple Range Test.

Means are the average of 3 replications in a randomized block design.

13. APPENDICES:

Proposed Mowing Guidelines and Rationale for Virginia Roadsides

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Mowing cool season turfgrasses [fescues, bluegrasses]

Mowing highway corridors is an expensive operation requiring special mechanical equipment, labor, and fuel. Mowing along highways subjects personnel and motorists to higher risks of accidents. Thus, a minimum mowing schedule will reduce traffic hazards, labor, repairs, equipment, and fuel costs. Vegetation that obstructs views for the safety of motorists, as along certain medians and interchanges, must be mowed; however, it should not be necessary to mow more often than one to three times yearly by following the guidelines and principles outlined below.

The primary grasses used in medians and shoulders by VDOT are cool-season grasses such as tall fescue and the fine-leaf fescues (Hard, Chewings, and Creeping Red), with Kentucky bluegrass being a very minor component. These grasses thrive during cooler periods and develop seedheads only once yearly during the spring season. Once-a-year seedhead development occurs because there are two distinct requirements: 1) short days with cold temperatures during the fall-winter season induct special buds capable of forming stems with seedheads, and 2) the inducted buds develop into seedheads the next spring in response to warming temperatures and longer days. All tillers (or shoots) with inducted buds die after seedhead maturity; they also die when mowed below the inducted seedhead. This is not bad; it is a natural process that should be allowed to run its course.

Mowing just below these developed (or developing) seedheads is the primary goal of the first spring mowing. Why? The plant is genetically programmed to develop seedheads each spring and so it is directing much of its energy towards this and not to vegetative shoot production. If mowing occurs too early and only removes half or less of the developing seedhead, then the plant keeps directing its energy to re-grow the seedhead. Waiting to mow until just after the boot stage (when the seedhead is still enclosed in the stem) as the seedhead begins to emerge, should effectively remove the whole seedhead. At this point, these reproductive tillers die and stored energy is then released and directed towards production of vegetative (leafy) tillers. The resulting re-growth consists almost entirely of “leafy” plants that increase in density and provide a shorter, more groomed, appearance. Proper spring mowing results in turf density that suppresses weeds.

Research has shown that the ideal mowing height for roadside cool season grasses is 4 to 6 inches. Lower mowing heights remove too much of the leaf area and reduces the plant’s ability to photosynthesize, maintain density, and provide adequate energy for a robust root system. Severe

mowing events that scalp the turf (going from 10 or 12 inches to 2 inches, rather than 4-6) shock the plants, often leading to root death and stand thinning.
Bottom line: Do not mow cool season grasses lower that 4 inches on the roadside and avoid summer mowings to already heat or drought-stressed plants.

Additional mowings may be needed to control and prevent the spread of tall, unsightly weeds along the roadsides or because of line-of sight issues.

VDOT-sponsored mowing research at the Turfgrass Research Center in Blacksburg conducted over a five-year period indicated no significant difference in tall fescue or fine fescue percent ground cover between mowing at a 4-inch height once in the spring, mowing spring + fall, or mowing spring + summer + fall. The plots that were never mowed showed a much higher weed infestation than those that were mowed.
Bottom line: Mowing at least once a year following seedhead emergence increases turf density and lowers weed infestation.

Setting Spring Mowing Schedules for Cool Season Grasses Based on Growing Degree Days

For many cool-season plants temperature and light signals the timing of reproductive growth; a common measure agronomists use to predict growth stages are growing degree days [GDD]. GDD are the accumulation of average daily temperatures above a certain baseline temperature. **The chart uses 50 ^{o}F as a baseline and 30 to 50 year average weather data to determine the dates when enough GDD have been accumulated for the boot stage to be occurring (= 400 GDD) and total seedhead emergence to have occurred (= 600 GDD).** Our estimate is that tall fescue will have reached the boot stage by 400 GDD and completely headed-out (flowered) by the time 600 GDD have been reached in each District. **Mowing should not begin until fescue has reached the boot stage, but should be completed in each District by the time complete flowering [seedhead emergence] has occurred.** This is the basis for the suggested beginning and ending mowing dates listed in the table above. Our GDD ranges are based on 30 to 50 year averages from weather stations located near each District Office. These data can be accessed at:
http://www.dnr.state.sc.us/climate/sercc/climateinfo/historical/historical_va.html

Boot stage is when the reproductive tillers can be cut open and the immature seedhead can be found. The next stage [emergence] is the seedhead starting to come out of the tiller and the final stage is the seedhead fully emerged.

Mowing warm season turfgrasses [bermudagrass, zoysiagrass]

Warm-season grasses have more prostrate (or horizontal) growth habits and can be safely mowed at a height of 2 to 3 inches, if the terrain is smooth enough to prevent scalping. On the Coastal Plain they will green-up in April, but will not put on enough vertical growth to require mowing until late May or June. Mowing prior to this may mostly be for cutting down unsightly cool-season weeds. Bermudagrass will produce seedheads throughout the summer growing season, but they do not often extend much above the turf canopy, nor are they a large energy-drain concern as with the fescues. Mowing once or twice per summer season may be all that is required for weed control and aesthetics.

VDOT Roadside Turf Mowing Schedule by District – Cool Season Grasses

This chart lists the approximate dates for mowing of cool season grasses. The timing of the first mowing is the key to the mowing maintenance program. The subsequent mowings control herbaceous and woody growth or are needed for line-of-sight issues.

District	Office	Mowing Height Range	GDD range*	First Mowing [control grass growth]		Second Mowing [control herbaceous weeds]	Third Mowing [control woody growth]
				begin	end		
1	Bristol	4" to 6"	400-600	May 10	June 10	late July to late Aug	mid Sept to late Oct
2	Salem	4" to 6"	400-600	May 5	June 5	late July to late Aug	mid Sept to late Oct
3	Lynchburg	4" to 6"	400-600	May 5	June 5	late July to late Aug	mid Sept to late Oct
4	Richmond	4" to 6"	400-600	May 1	June 1	late July to early Aug	mid Sept to late Oct
5	Hampton Roads	4" to 6"	400-600	April 20	May 20	early July to early Aug	late Sept to late Oct
6	Fredericksburg	4" to 6"	400-600	May 5	June 5	late July to late Aug	mid Sept to late Oct
7	Culpeper	4" to 6"	400-600	May 5	June 5	late July to late Aug	mid Sept to late Oct
8	Staunton	4" to 6"	400-600	May 10	June 10	late July to late Aug	mid Sept to late Oct
9	N. Virginia	4" to 6"	400-600	May 5	June 5	late July to late Aug	mid Sept to late Oct

*****GDD = Growing Degree Days with a base temperature of 50 ^{o}F.

GDD = Average daily temperature minus 50 ^{o}F beginning Jan 1. If the GDD total for a certain day is not > 0 it is not counted towards the cumulative sum of GDD.

VDOT Roadside Turf Mowing Schedule by District – Warm Season Grasses

This chart lists the approximate dates for mowing of <u>Warm Season</u> grasses. Mowing will continue throughout the growing season at approximately every 3-4 weeks. Some areas may require more frequent mowings to control herbaceous and woody growth or are needed for line-of-sight issues.

District	Office	Mowing Height Range	Mowing Dates [Approx.]		
			first	last	
4	Richmond	2” to 4”	May25	Aug 30	Bermudagrass, Zoysiagrass, Centipedegrass will continue to grow steadily throughout the warm months of summer and go dormant [requires no mowing] from late Sept until May
5	Hampton Roads	2” to 4”	May 10	Sept 20	
6	Fredericksburg	2” to 4”	June 5	Aug 30	
9	N. Virginia	2” to 4”	June 5	Aug 30	

VDOT Roadside Turf Mowing Schedule – Legumes, Wildflowers and Native Grasses

This chart lists the approximate dates for mowing of wildflower and native grasses. Subsequent mowings to control herbaceous and woody growth or for line-of-sight issues may be needed.

		Mowing Height Range	Mowing Dates [Approx.]		
Legumes	**Lespedeza, crown vetch, flat pea**	**> 8”**	**Mid July**	**Mid Sept**	**Legumes are generally planted in areas where no mowing occurs. Mowing more than twice per year without a 60 day rest period between will greatly reduce or destroy the legumes.**
Wildflowers	**Many species**	**4” to 6”**		**Oct 15**	**Mow only after blooms have dried and to clean up area in late fall**
Tall Native grasses	**Switchgrass, Indiangrass, Big Bluestem**	**6” to 12”**	**Mid April**	**Or Oct 15**	**Theses species should NEVER be planted where line of sight is an important factor. The best time to mow these species is in early spring and the second best time is in late fall**
Short Native grasses	**Blue grama buffalograss**	**6” to 8”**	**Mid April**	**Or Oct 15**	**These plants will not exceed 15 inches in height and may not need to be mowed. They could be mowed in the late fall to reduce the amount of dry top growth.**

Mowing prior to prescribed times may be used to cut down unsightly cool-season weeds. The weed control mowing may take place in early June with a minimum cutting height of 8 inches.

The native grasses are warm season species that grow during the summer and are dormant from fall until mid spring. When dormant, the above ground portion of these plants will dry and the potential fire hazard should be monitored.

VDOT Roadside Turf Mowing Schedule –Ditch lines or steep slope areas

This chart lists the options for low maintenance

		Mowing Height Range	Mowing Dates [Approx.]		
Ditchlines	**Generally cool season grasses**	**4” to 6”**	**Mid May**	**To Mid June**	**If cool season grasses dominate, then only a single mowing may be needed. [see the mowing schedule for cool season grass for the timing of this cutting]**
Areas adjacent to ditchlines	**Generally cool season grasses**	**4” to 6”**			**These areas may not need to be mowed unless there is a weed or water flow concern. See the notes for ditchline mowing.**
Steep slopes	**Grasses and legume mixes**	**6” to 8”**			**These areas should be planted with “no mow” species and weed control may be best handled by chemical means, if height control is required.**

The subsequent mowings may be needed to control herbaceous and woody growth or if water flow issues require. Selective chemical control for unwanted vegetation may be an option.

VDOT Roadside Height

	Approximate maximum height in inches that each species may reach
Tall Fescue	**36-48**
Kentucky bluegrass	**24-36**
Fine Fescues [Hard Creeping, Chewings, Sheep]	**8-18**
Bermudagrass	**12-15**
Zoysiagrass	**8-12**
Weeping lovegrass	**10-16**
Orchardgrass	**8-12**
Switchgrass	**84-120**
Indiangrass	**39-120**
Blue grama	**8-20**
Buffalograss	**6-12**

The maximum height will vary by cultivar within each species.

Mowing at the prescribed times listed in these charts should allow most PTO driven rotary mowers to produce a clean and attractive cut.

If the grasses are allowed to reach full height and maturity their physical makeup changes to become stiffer and drier with less soft tissue. This makes it harder for rotary mowers to produce an even cut. The result is usually an unattractive cut with differences in stubble height and clumps of cut grass on the surface. There is an extra energy cost to mow this tougher grass as well as increased wear on the machines. Flail type mowers spin faster than PTO rotary mowers and therefore create more energy to cut the grass. The design of the flail mower allows it to cut the clippings several times before they exit the mower. These elements allow the flail mower to produce a cleaner cut when mowing tall mature grass. The drawbacks of the flail mower are the relatively small width of cut and the extra expense of the machine.

The primary key to a good looking cut is the sharpness of the mower blades.

RD - 4 list - VDOT approved species and cultivars

VIRGINIA DEPARTMENT OF TRANSPORTATION

SPECIFICATIONS FOR STANDARD AND NON-STANDARD SEED ITEMS

I. Specifications for Standard Seed Items
II. Specifications for Non-Standard Seed Items
III. Sampling and Testing Procedures for In State and Out of State Vendors

BOTANICAL NAME	**COMMON NAME**
Coronilla varia	Crownvetch
Cynodon dactylon	Bermudagrass
Dactylis glomerata	Orchardgrass
Eragrostis currula	Weeping Lovegrass
*****Festuca arundinacea	Tall Fescue
*****Festuca longifolia	Fine Hard Fescue
*****Festuca ovina	Fine Sheep Fescue
*****Festuca rubra ssp. commutata	Fine Chewings Fescue
*****Festuca rubra ssp. rubra	Fine Creeping Red Fescue
Hordeum vulgare	Barley
Lathyrus sylvestris	Flat Pea
Lepedeza cuneata	Serecia Lespedeza
Lolium multiflorum	Annual Ryegrass
Lotus corniculatus	Birdsfoot Trefoil
*****Poa pratensis	Kentucky Bluegrass
Secale cereale	Rye (Winter Rye)
Setaria italica	Foxtail Millet (German)
Triticum aestivum	Wheat
Trifolium repens	White Dutch clover

***Certified Seed Required For These**

VIRGINIA DEPARTMENT OF TRANSPORTATION

1. SPECIFICATIONS FOR STANDARD SEED ITEMS

Kind and Cultivars	**Min. PureSeed %**	**Min. Germ. %**	**Min. Germ. Plus Hard Seed %**	**Weed Seed Not to Exceed %**	**LIMITATIONS**
Tall Fescue Cultivars: Apache, Arid, Aztec, Barlexus, Bonzai, Bonzai II, Bonsai 2000, Carefree, Chieftain, Coyote, Crossfire, Falcon II, Finelawn 1, Finelawn Petite, Finelawn 2, Georgia 5, Guardian, Willamette, Hound dog 5, Jaguar 3, Kitty Hawk, Micro, Monarch, Mustang, Mustang II, Pacer, Phoenix, Rebel II, Rebel 3D, Rebel Jr., Scorpion, Shenandoah, Shortstop II, Silverado, Tradition, Vegas, Winchester	98	90	--	0.25	**RES. NOX. WEEDSEEDS** Same As VA Seed Law **PROH. NOX. WEEDSEEDS** Same As VA Seed Law **LAWN & TURF REST. NOX** 10 Per ounce or 160 Per Pound
Kentucky Bluegrass Cultivars: Columbia, Dellwood, Eclipse, Georgetown, Glade, Kenblue, Nustar, Victa	98	85	--	0.25	
Fine Hard Fescue Cultivars: Attila, Spartan, Reliant, Ecostar, Brigade, Vernon, Scaldis, Discovery, Aurora, SR3200, Reliant II, Eureka II, Chariot, Osprey, Defiant, Biljart, Valda, Pamela, Nordic	98	85	--	0.25	

Kind and Cultivars	**Min. Pure Seed %`**	**Min. Germ. %**	**Min. Germ. Plus Hard Seed %**	**Weed Seed Not to Exceed %**	**LIMITATIONS**
Fine Creeping Red Fescue Cultivars: Cindy Navigator Dover Pennlawn Ensylva	98	85	--	0.25	
Fine Chewings Fescue Cultivars: Bridgeport Sandpiper Banner III Shadow II Brittany SR 5100 Culumbra Treazure Jamestown II K-2 Koket	98	85	--	0.25	
Fine Sheep Fescue Cultivars: Azure Blue, Bighorn, Quatro	98	85	--	0.25	
Bermudagrass **(2)**	98	85	--	0.25	
Foxtail Millet (German)	98	85	--	0.25	
Annual Ryegrass	98	90	--	0.25	
Rye (Winter Rye) Cultivars: Abruzzi, Balboa	98	85	--	0.25	
Triticum aestivum Wheat	98	85	--	0.25	
Hordeum vulgare (Barley)	98	85	--	0.25	
Weeping Love Grass	98	85	--	0.25	
Orchardgrass Cultivars: **(1)**, OG1A OG, Potomac, Shilo, Taos	90	85	--	0.50	
Sericea Lespedeza **(2), (3)**	98	40	75	0.50	

Kind and Cultivars	Min. Pure Seed %`	Min. Germ. %	Min. Germ. Plus Hard Seed %	Weed Seed Not to Exceed %	LIMITATIONS
Crownvetch Cultivars: **(3)** Chemung, Emerald, Penngift	98	36	71	0.25	
Flat Pea **(3)**	99	38	75	0.25	
White Dutch Clover **(3)**	99	80	90	0.25	
Birdfoots Trefoil Cultivars: **(3)** AuDewey, Empire, Norcen	98	60	80	0.50	

(1) Virginia origin or approved cultivars.
(2) Spring-Hulled, Fall-Unhulled
(3) Seed must be inoculated with the appropriate strain and rate of bacteria. For hydroseeding, use a minimum of five times the dry seeding rate of inoculant.

Note: The removal of several cultivars from the list this does not invalidate any seed that was inspected by VDOT and GREEN TAGGED prior to the issuance of the updates listings.

III. SAMPLING PROCEDURE

A. Virginia Supplier

1. The supplier, prior to shipment, shall have the Virginia Department of Agricultural and Consumer Services seed inspector for the area draw samples for testing on all seed lots intended for purchase order deliveries to the Virginia Department of Transportation.

2. All seed lots shall be properly labeled and clearly identified by a lot number prior to sampling by the Virginia Department of Agriculture and Consumer Services seed inspector. The purchase order number, if known, shall be given to the inspector and shown on the test reports.

3. Test results on such samples will be reported to the Virginia Department of Transportation and to the supplier by the Virginia Department of Agriculture and Consumer Services.

4. Seed will not be accepted at any VDOT facility for delivery until the test results have been received and the seed is found to conform to the Virginia Seed Law, and the Virginia

Department of Transportation's RD-4 seed specifications and bear a valid green tag. Seed in open bags, seed bags that do not have an attached and valid Green Tag, or bags with expired green tags will not be accepted.

B. Out-Of-State Suppliers

1. Seed will not be accepted for delivery until seed lots have been found to meet the Virginia Department of Transportation's seed specifications and bear the green tag.

2. At the time of shipment, the Virginia Department of Agriculture and Consumer Services, Seed Laboratory, One North 14th Street, Room 238, Telephone – (804) -786-8795, Richmond, Virginia, 23219, shall be notified.
At the point of delivery to a non-VDOT facility, all lots will be subject to sampling and testing by the Virginia Department of Agriculture and Consumer Services. Seed will not be accepted at any VDOT facility for delivery until the test results have been received and the seed is found to conform to the Virginia Seed Law, and the Virginia Department of Transportation's RD-4 seed specifications and bear a valid green tag. Seed in open bags or bags with expired green tags will not be accepted.

3. The results of tests by the Virginia Department of Agriculture and Consumer Services will take precedence over tests performed by others. All seeds are subject to sampling and testing by the Virginia Department of Agriculture and Consumer Services and/or certified VDOT personnel whose decision shall be final. Seed tests shall have been completed within a 9-month period, exclusive of the calendar month in which the test was completed, prior to the delivery date.

4. The labels and seed(s) must conform to these specifications and all Federal and State laws, rules and regulations.
No prohibited noxious-weed seeds, as defined by the rules and regulations adopted for enforcement of the Virginia Seed Laws, will be permitted; i.e., Canada Thistle, Field Bindweed, Quackgrass, Johnsongrass, Plumeless Thistle, etc. Restricted noxious-weed seeds shall not exceed the number per ounce or per pound of such noxious-weed seeds specified in such rules and regulations.

SEED SAMPLE REPORT

FOR SEED SAMPLED OUT OF VIRGINIA FOR USE BY
THE VIRGINIA DEPARTMENT OF TRANSPORTATION

Kind and Variety of Seed: _____

Lot Number: _____

Control Number (supplied by compliance official)_____

Number of Bags Represented by the Sample: _____ Weight per Bag: _____

Number of Bags Sampled: _____ Pounds Represented by the Sample: _____

Shipper=s Name: _____

Complete Mailing Address: _____

_____

Shipper=s Telephone Number: _____

Virginia Receiver=s Name: _____

Complete Mailing Address: _____

_____

I _____, as an employee of the _____,
Compliance Official's Name State Seed Enforcement Agency

certify that I have sampled the above represented seed lot using sampling procedures approved by the Association of Official Seed Analysts or the Seed Control Official of my state and have personally sealed the sample for shipment to the Virginia Department of Agriculture & Consumer Services= Seed Laboratory.

Attach Seed Label Here:

_____
Signature of Compliance Official

_____
Title

IT IS THE POLICY OF THE VDACS SEED LABORATORY TO USE AOSA TESTING PROCEDURES AND NOT TO PROVIDE TEST RESULTS THAT MIGHT VIOLATE THE RIGHTS OF ANY UTILITY PATENT HOLDER OR THE RIGHTS OF ANY CERTIFICATE OWNER PROTECTED UNDER THE U. S. PLANT VARIETY PROTECTION ACT.

I HAVE READ AND UNDERSTAND THE INFORMATION PRESENTED ON THIS SAMPLE REQUEST FORM. I UNDERSTAND THAT I WILL BE RESPONSIBLE FOR ALL CHARGES FOR THE REQUESTED TEST.

_____ _____
SHIPPER'S SIGNATURE DATE