CTE/NCDOT
Joint Environmental Research Program

Final Report

Vegetation Management Under Guardrails for North Carolina Roadsides

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March 19, 2004

Technical Report Documentation Page

1. Report No. **FHWA/NC/2004-02**	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle **Vegetation Management under Guardrails for North Carolina Roadsides**		5. Report Date **11-20-2003** 6. Performing Organization Code
7. Author(s) **Dr. Fred Yelverton and Mr. Travis Gannon**		8. Performing Organization Report No.
8. Performing Organization Name and Address **North Carolina State University** **Department of Crop Science** **NCSU Campus Box 7620** **Raleigh, NC 27695**		10. Work Unit No. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address **U.S. Department of Transportation** **Research and Special Programs Administration** **400 7th Street, SW** **Washington, DC 20590-0001**		13. Type of Report and Period Covered **Final Report** **July 1, 2000 – June 30, 2003** 14. Sponsoring Agency Code **2001-06**

Supplementary Notes:

Supported by a grant from the U.S. Department of Transportation and the North Carolina Department of Transportation, through the Center for Transportation and the Environment, NC State University.

16. Abstract

During the spring of 1998 the North Carolina Department of Transportation (NCDOT) began a guardrail installation initiative which required over 1000 miles of newly installed median guardrail on North Carolina's major thoroughfares. The implementation of this program increased workloads and maintenance costs for the NCDOT. Turfgrasses currently used under and adjacent to guardrails include primarily 'Kentucky-31' tall fescue (*Festuca arundinacea* Schreb.) and bahiagrass (*Paspalum notatum* L.). Unfortunately, these species possess high maintenance requirements. Alternative species such as centipedegrass (*Eremochloa ophiuriodes*) or zoysiagrass (*Zoysia japonica*) would reduce maintenance costs on these thoroughfares due to lower maintenance requirements. Centipedegrass is a minimal input turf species requiring no more than 44 lb N/a/yr and infrequent mowing. It is adapted to a wide range of soil conditions, but grows best in sandy, acidic soils which make it ideal for increased use along roadsides. Further, these species improve motorist's visibility due to inconspicuous seedheads resulting in safer, more economical, and aesthetically pleasing roadsides. In a majority of these situations, centipedegrass was sodded into existing roadside vegetation which included turf species such as bahiagrass or tall fescue.

The purpose of this research was to determine management plans for these areas where centipedegrass or zoysiagrass was sodded into existing vegetation. Management plans included herbicide and plant growth regulator tolerance as well as practices to transition the roadside to centipedegrass or zoysiagrass in an effort to achieve a monoculture turfgrass stand. Experiments included centipedegrass tolerance to herbicides and plant growth regulators applied at seeding and soon thereafter, centipedegrass survival when subjected to various fertility regimes, zoysiagrass versus centipedegrass establishment from sod under roadside conditions, among others.

17. Key Words Centipedegrass, herbicide, plant growth regulator (PGR), vegetation management, weed control	18. Distribution Statement		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 20	22. Price

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

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ACKNOWLEDGEMENTS

Support for this research was provided by the North Carolina Department of Transportation. The authors would like to thank personnel within the NC DOT-Roadside Environmental Unit for their cooperation during the grant period.

SUMMARY

Research experiments were designed and initiated to determine the influence of herbicide and plant growth regulators on centipedegrass establishment, evaluate treatments for vegetation management under guardrails, and determine if nitrogen fertility levels affect centipedegrass sod establishment. Experiments were also conducted to attempt to correlate centipedegrass and zoysiagrass problem areas with geographical areas or soil parameters as well as compare common centipedegrass and ‘El Toro’ zoysiagrass establishment from sod simulating vegetation under a guardrail.

Much important data was collected and will aid in devising a more complete vegetation management program for North Carolina Roadsides. Through this research, programs have evolved to convert existing tall fescue or bahiagrass roadsides to centipedegrass increasing motorist safety.

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INTRODUCTION

In spring of 1998, the North Carolina Department of Transportation (NC DOT) began a guardrail installation initiative which required over 1000 miles of newly installed median guardrail on some of North Carolina's major thoroughfares. The implementation of this program increased workloads and maintenance costs for the NC DOT. Turfgrasses currently used under and adjacent to guardrails include primarily 'Kentucky-31' tall fescue (*Festuca arundinacea* Schreb.) and bahiagrass (*Paspalum notatum* L.). Unfortunately, these species possess high maintenance requirements. Alternative species such as centipedegrass (*Eremochloa ophiuriodes*) or zoysiagrass (*Zoysia japonica*) would reduce maintenance costs on these thoroughfares due to lower maintenance requirements. Centipedegrass is a minimal input turf species requiring no more than 44 lb N/a/yr and infrequent mowing. It is adapted to a wide range of soil conditions, but grows best in sandy, acidic soils with optimum pH ranging from 4.0 to 6.1 (Waddington 1992) which makes it ideal for increased use along roadsides. Further, centipedegrass and zoysiagrass improve motorist's visibility due to inconspicuous seedheads resulting in safer, more economical, and aesthetically pleasing roadsides. In a majority of these situations, centipedegrass was sodded into existing roadside vegetation which included turf species such as bahiagrass or tall fescue.

Established centipedegrass is tolerant of sethoxydim and clethodim which provide control of select annual and perennial grasses (Cox et al. 1999; Johnson 1987; McCarty et al. 1986) while broadleaf weeds can be controlled with common broadleaf herbicides not containing 2,4-D (McCarty et al. 2001). Further, research has identified the safety of herbicides applied to recently sprigged centipedegrass. Applied immediately after sprigging, single applications of atrazine or simazine at 1 lb ai/a controlled large crabgrass (*Digitaria sanguinalis*) and goosegrass (*Eleusine indica*) and increased percent ground cover of centipedegrass (Johnson 1973). However, Coats (1975) reported 2 lb ai/a atrazine or simazine applied at sprigging reduced survival and growth of centipedegrass. Although herbicide weed control options exist in established centipedegrass, no herbicide is registered for application during establishment of centipedegrass from seed (Porter 1996).

The purpose of this research was to determine management plans for these areas where centipedegrass or zoysiagrass was sodded into existing vegetation. Management plans included herbicide and plant growth regulator tolerance as well as practices to transition the roadside to centipedegrass or zoysiagrass in an effort to achieve a monoculture turfgrass stand.

MATERIALS AND METHODS

Influence of Herbicide and Plant Growth Regulator Applications at Seeding on Centipedegrass Establishment. Experiments were conducted to determine effects of plant growth regulators (PGR) or herbicides applied at seeding on the establishment of seeded centipedegrass. Field experiments were initiated near Greensboro, NC on 02 June 2000 and 09 May 2001 in areas previously maintained as tall fescue. Six weeks prior to trial initiation, areas were treated with Roundup Pro (2 qt/a). At trial initiation, areas were mown to remove debris and rotary tilled to a 6 inch depth. Soil was a Mecklenburg clay loam (fine, mixed, active, thermic Hapludalfs) with 1.3% organic matter and pH 5.8.

Diammonium phosphate (18-46-0) was applied at 300 lb/a and incorporated to 6 inches with a rotary tiller prior to leveling the seed bed. Treatments were applied and allowed to air-dry before broadcast seeding centipedegrass at a rate of 26 lb/a. Immediately after seeding, a cultipacker was utilized in two directions to ensure optimum soil to seed contact and 0.25 inch irrigation was applied. At 8 and 12 weeks after seeding (WAS), 250 lb/a of a complete fertilizer (10-10-10) was applied.

Treatments applied at seeding included Telar + Embark, at 0.125 oz + 0.5 pt/a, respectively, Plateau at 1, 2, 4, or 6 oz/a, Oust at 0.5 or 1 oz/a, Escort at 0.5 or 1 oz/a, atrazine at 1 or 2 lb ai/a, and simazine at 1 or 2 lb ai/a. Plateau treatments included a methylated seed oil (Dyne-Amic) at 1 qt/a while Oust, Escort, atrazine, and simazine treatments included a non-ionic surfactant (X-77) at 0.25% v/v. Treatments were applied with a CO_2 pressurized hand-held spray boom equipped with four VS8003XR flat fan nozzles on 15 inch spacings calibrated to deliver 32 gallons per acre.

Visual estimates of centipedegrass ground cover were recorded at 12 and 16 WAS in 2000 and 12, 16, and 20 WAS in 2001, utilizing a 0 (no ground cover) to 100% (complete ground cover) scale. Four replicates were included in both experiments and plots (6 by 15 ft) were arranged in a randomized complete block design. A treatment by year interaction prevented pooling data across years; thus data are presented separately.

Centipedegrass Tolerance to Herbicides and Plant Growth Regulators Applied Early POST Emergent. Greenhouse experiments were conducted to determine the effect of PGR and herbicide applications to newly seeded centipedegrass. Centipedegrass was surface seeded (26 lb/a) in 600 ml pots containing a 1:1 (v/v) ratio of sand plus Norfolk loamy fine sand (thermic Typic Kandiudults, pH of 6.1 and 0.3% humic matter). Plants were grown with 30/15 C day/night temperatures and lightly irrigated three times daily with overhead irrigation. Natural lighting was supplemented with metal halide lamps with a photon flux density of 300 Φmol/m^2/s set on a 12-h photoperiod. Plants were fertilized with 22 lb N/a from a commercial greenhouse fertilizer solution 28 days after seeding. Treatments were applied 6 weeks after seeding at which time the centipedegrass was in the one-leaf to one-tiller growth stage.

PGR and herbicide treatments included Telar + Embark, at 0.125 oz + 0.5 pt/a, respectively, Plateau at 1, 2, 4, or 6 oz/a, Oust at 0.5 or 1 oz/a, Escort at 0.5 or 1 oz/a, atrazine at 1 or 2 lb ai/a, and simazine at 1 or 2 lb ai/a. Plateau treatments included a methylated seed oil (Dyne-Amic) at 1 qt/a while Oust, Escort, atrazine, and simazine treatments included a non-ionic surfactant (X-77) at 0.25% v/v. Treatments were applied with a CO_2 pressurized spray chamber equipped with one VS8001E flat fan nozzle calibrated to deliver 32 gallons per acre. Visual estimates of centipedegrass phytotoxicity utilizing a 0 (no injury) to 100% (complete death) scale were recorded at 28 and 56 DAT.

Experiments were conducted twice, each containing four replicates. Treatments were arranged in a completely randomized design. A non-significant ($P>0.05$) treatment by experimental run interaction permitted pooling of data across experimental runs.

Bareground Under Guardrails. Experiments were conducted to determine optimum treatments for bareground under guardrails. Research trials were initiated on US 220 in Montgomery County and were monitored for tall fescue (*Festuca arundinacea*) control and bareground. Treatments included NC DOT's standard treatment as well as other experimental treatments.

Centipedegrass Survival when Subjected to Various Fertility Regimes Prior to Harvesting for Sod. Experiments were initiated to determine if nitrogen fertility levels prior to harvesting centipedegrass for sod had detrimental effects on centipedegrass survival. Split plot experiments were initiated at the Sandhills Research Station during 2000 growing season which included fertility, harvest date, and mowing variables. Fertility variables were as follows: No nitrogen applied or control, 44 lb N/a applied every 4 weeks totaling 132 lb N/a, *or* 44 lb N/a applied every 2 weeks totaling 264 lb N/a. Harvest dates included February, April, *or* June in which the centipedegrass sod was harvested and installed. Mowing variables included mowing (3 inch height) after installation and no mowing after installation. Experiment was conducted twice, each containing four replicates. Plots were evaluated for centipedegrass survival.

Guardrail Sod Survey. Roadsides where centipedegrass or zoysiagrass had been installed under guardrails were visited across the entire state to determine if and where problem areas existed. At each site, areas were split into one mile subsamples, the percent of live turf cover was visually estimated, soil samples were taken, and GPS coordinates were recorded for each location. Soil samples were then analyzed by North Carolina Department of Agriculture. The survey was conducted in 2000 as well as 2001. Collected data were subjected to linear correlation analysis to determine if a correlation among soil properties (CEC, % BS, pH, P, K, Na, etc), location, or sod survival were present.

Zoysiagrass versus Centipedegrass Sod Establishment under Roadside Conditions. Research experiments were designed and initiated (July 2002) at the Sandhills Research Station, Jackson Springs, NC to evaluate common centipedegrass and 'El Toro' zoysiagrass establishment from sod when placed under a guardrail on NC roadsides. Prior to laying sod, the area was tilled with a rotary tiller and rolled after the sod was installed, similar to current NC DOT installation techniques. After installation, the trial was maintained to simulate under a guardrail with no mowing and no irrigation. Plots were evaluated for centipedegrass and zoysiagrass establishment.

Effect of Varying Seeding Rates when Sod Seeding Centipedegrass. Experiments were initiated (July 2002) to determine if centipedegrass seeding rates and the use of Plateau (imazapic) effected centipedegrass establishment when sod seeded into an existing bahiagrass roadside. Three common centipedegrass seeding rates and one Plateau treatment were included. Historically, NC DOT has used 3 – 5 pounds centipedegrass seed per acre but NCSU research has demonstrated with increased seeding rate and weed control during establishment, it is possible to hasten centiepedegrass establishment. Further, centipedegrass has shown a high level of tolerance to Plateau which can be effectively used to regulate bahiagrass growth. Therefore, the experiment was designed to incorporate centipedegrass seeding rates of 5, 10, or 25 pounds of seed per acre as well as Plateau (0 *or* 3 oz/a) to determine if the Plateau application could regulate bahiagrass growth and allow centipedegrass to establish. However, due to droughty conditions, no centipedegrass emergence occurred and the trial was aborted; therefore, there will be no further discussion of this experiment.

FINDINGS AND CONCLUSIONS

Influence of Herbicide and Plant Growth Regulator Applications at Seeding on Centipedegrass Establishment. The treatment by year interaction was likely due to reduced rainfall in 2001 as compared to 2000. Cumulative rainfall in 2000 and 2001 for the 16 WAS was 18 and 11.8 inch, respectively. Rainfall differences reduced the growth of centipedegrass as noted in the control. In 2000, 66% centipedegrass ground cover was observed in the control 12 WAS, while in 2001, only 31% centipedegrass ground cover was observed (Table 1). At 16 WAS, 87% centipedegrass ground cover was observed in 2000 while in 2001, only 68% centipedegrass ground cover was present in the control. Although the plots were irrigated immediately after seeding, the rainfall deficit in 2001 likely had a significant effect reducing centipedegrass ground cover.

Plateau (1 or 2 oz/a), atrazine (1 or 2 lb ai/a), or simazine (1 or 2 lb ai/a) applied at seeding had no effect on centipedegrass ground cover at any observation date in 2000 or 2001 compared to the control. However, Plateau applied at 6 oz/a reduced centipedegrass ground cover compared to the control at all observation dates. Additionally, Plateau applied at 4 oz/a reduced centipedegrass ground cover at 12 WAS in 2000 and 16 WAS in 2001. These data indicate centipedegrass is tolerant to atrazine, simazine, or lower rates of Plateau applied at seeding. Further, these data indicate Plateau rates at seeding should not exceed 2 oz/a unless the possibility of grow-in delay is acceptable. Turner et al. (1990) reported that centipedegrass was tolerant of atrazine and simazine (2 and 3 lb ai/a) while Adcock et al. (1998) reported only slight centipedegrass injury with Plateau (2 to 8 oz/a); however, each were applied to established centipedegrass.

Oust at 1 oz/a and Escort at 0.5 or 1 oz/a reduced centipedegrass ground cover compared to the control at each rating date in 2000 and 2001. Telar + Embark reduced centipedegrass ground cover at 12 and 16 WAS in 2000, but no reduction was observed in 2001. Also in 2000, Oust at 0.5 oz/a did not reduce centipedegrass ground cover compared to the control; however, centipedegrass ground cover was reduced at 12, 16, and 20 WAS in 2001. It is likely that Oust was more persistent and caused additional grow-in delay in 2001 due to less rainfall as compared to 2000.

Oust applications at seeding caused less injury than Escort, likely due to a difference in metabolism of Oust and Escort by centipedegrass (Baird et al. 1989). Label recommendations for Oust permit its application up to 2 oz/a for centipedegrass release in industrial areas; however, these data suggest Oust is injurious at seeding. Further, these data do not suggest the use of Escort on immature centipedegrass which is consistent with label recommendations for Escort that allow the application of 0.25 to 0.5 oz/a on centipedegrass greater than one year old.

Centipedegrass Tolerance to Herbicides and Plant Growth Regulators Applied Early POST Emergent. Plateau at 1, 2, 4, or 6 oz/a, Oust at 0.5 or 1 oz/a, atrazine at 1 or 2 lb ai/a, or simazine at 1 or 2 lb ai/a applied to centipedegrass 6 WAS (one-leaf to one-tiller growth stage) caused $< 15\%$ phytotoxicity at 28 and 56 DAT (Table 2). These data demonstrate the safety of these compounds applied to centipedegrass that has emerged and is actively growing, compared to applications at seeding. Similarly, established or newly sprigged centipedegrass has exhibited tolerance to atrazine, Plateau, or simazine applications (Johnson

1973 and 1976; Adcock et al. 1998). Further, Plateau applications are effective for bahiagrass (Yelverton et al. 1997) and tall fescue growth regulation (Yelverton et al. unpublished data). However, because immature centipedegrass is tolerant to low rates of Plateau, it is possible that Plateau could aid in converting existing bahiagrass and tall fescue roadsides to centipedegrass.

At 28 and 56 DAT, Telar + Embark, or Escort at 0.5 oz/a applied 6 WAS caused 16 to 27% centipedegrass phytotoxicity. Escort at 1 oz/a was detrimental to centipedegrass resulting in 88 and 83% phytotoxicity at 28 and 56 DAT, respectively. With the compounds evaluated, PGR and herbicide tolerance in seedling centipedegrass appears to be similar to established centipedegrass. Newly seeded centipedegrass tolerance to Oust is likely due to centipedegrass readily metabolizing Oust (Baird et al. 1989). From this research, Oust can be applied after centipedegrass has emerged and is actively growing; however, applications at seeding should be avoided.

Bareground under Guardrails. Currently, NC DOT uses a standard treatment of 2 qt Roundup Pro + 2 qt simazine + 1.25 lb ai/a Endurance *or* 2.5 qt Surflan for bareground treatment under guardrails along roadsides. In these experiments, additional treatments were evaluated and compared to NC DOT's standard treatment. Upon completion of the trials, it was determined Plateau + Roundup Pro (12 oz + 2 qt) as well as Sahara + Oust (5 lb + 2 oz) increased tall fescue control and percent bareground at four months after treatment; however, increased control did not persist through one year after treatment as all evaluated treatments were similar at 14 months after treatment (Table 3).

Centipedegrass Survival when Subjected to Various Fertility Regimes Prior to Harvesting for Sod. These data indicate increased nitrogen fertility prior to harvesting centipedegrass for sod during the transition period from dormancy to actively growing (April) decreases centipedegrass survival (Table 4). Further, it appears this trend is exacerbated under non-mowed circumstances similar to that under a guardrail. This is possibly due to centipedegrass crowns becoming elevated above the soil surface under non-mowed conditions making it more prone to cold injury. It is therefore suggested if centipedegrass sod which has been subject to additional nitrogen fertilization is to be utilized, it should be harvested and installed during the active growing season to avoid survival issues.

Guardrail Sod Survey. In 2001 and 2002, problem areas were noted throughout much of North Carolina. In 2001, divisions 4 and 6 were the most problematic areas with respect to centipedegrass or zoysiagrass sod survival. Further, in 2002 divisions 4, 6, 10, 11, 12, and 14 demonstrated decreased sod survival with less than 50% of the sod installed remaining actively growing (Table 5). Although problem areas existed in 2001 and 2002 throughout North Carolina, no correlation between soil properties (CEC, %BS, pH, P, K, Na, etc.) and sod survival were evident.

Zoysiagrass versus Centipedegrass Sod Establishment under Roadside Conditions. Through one year after establishment, there are no differences among common centipedegrass and 'El Toro' zoysiagrass establishment or survival. Each species has survived and continues to perform well ($\geq$90% alive) (Table 6).

RECOMMENDATIONS AND TECHNOLOGY IMPLEMENTATION

NCDOT roadside environmental personnel should integrate these data into existing vegetation management plans for roadsides. Further, these findings should be implemented in various divisions to demonstrate the effectiveness of these programs to convey the results to division personnel.

Influence of Herbicide and Plant Growth Regulator Applications at Seeding on Centipedegrass Establishment. It is suggested when seeding centipedegrass along roadsides, to incorporate an herbicide weed control option to provide weed control allowing optimum centipedegrass establishment. According to these data, applied at seeding, centipedegrass exhibited no harmful effects from the following applied at seeding: Plateau (1 or 2 oz/a), atrazine (1 lb ai/a), or simazine (1 lb ai/a). Further, these data indicate Plateau rates at seeding should not exceed 2 oz/a unless the possibility of establishment delay is acceptable. Additionally, it is suggested Oust or Escort not be utilized at seeding due to hindering centipedegrass establishment.

Centipedegrass Tolerance to Herbicides and Plant Growth Regulators Applied Early POST Emergent. Once centipedegrass has emerged and is actively growing, centipedegrass is much more tolerant of herbicide or plant growth regulator applications compared to applied at seeding. Our data indicate, centipedegrass is highly tolerant of the following herbicide or plant growth regulator applications: Plateau (1, 2, 4, or 6 oz/a), Oust (0.5 or 1 oz/a), atrazine (1 or 2 lb ai/a), or simazine (1 or 2 lb ai/a). Applied to greenhouse-grown centipedegrass 6 WAS (one-leaf to one-tiller growth stage), previously mentioned treatments caused $< 15\%$ phytotoxicity at 28 and 56 DAT. It is therefore suggested these treatments be implemented into vegetation management programs along roadsides to enhance weed control along roadsides which contain immature centipedegrass. Further, Plateau applications are effective for bahiagrass (Yelverton et al. 1997) and tall fescue growth regulation (Yelverton et al. unpublished data). Since immature centipedegrass is tolerant to low rates of Plateau, Plateau could aid in converting existing bahiagrass and tall fescue roadsides to centipedegrass.

Bareground under Guardrails. Currently, NC DOT uses a standard treatment of 2 qt Roundup Pro + 2 qt simazine + 1.25 lb ai/a Endurance *or* 2.5 qt Surflan for bareground treatment under guardrails along roadsides. Upon completion of the trials, it was determined Plateau + Roundup Pro (12 oz + 2 qt) as well as Sahara + Oust (5 lb + 2 oz) increased tall fescue control and percent bareground at four months after treatment; however, increased control did not persist through one year after treatment as all evaluated treatments were similar at 14 months after treatment. It is therefore suggested NC DOT continue to use 2 qt Roundup Pro + 2 qt simazine + 1.25 lb ai/a Endurance *or* 2.5 qt Surflan for bareground treatment under guardrails along roadsides.

Centipedegrass Survival when Subjected to Various Fertility Regimes Prior to Harvesting for Sod. These data indicate increased nitrogen fertility prior to harvesting centipedegrass for sod during the transition period from dormancy to actively growing (April) decreases centipedegrass survival. Further, it appears this trend is exacerbated under non-mowed circumstances similar to that under a guardrail. This is possibly due to centipedegrass crowns becoming elevated above the soil surface under non-mowed conditions making it more prone to cold injury. It is therefore suggested if centipedegrass sod which has been subject to additional nitrogen fertilization is to be utilized, it should be harvested and installed during the active growing season to avoid survival issues. Additionally, it should be mown for one year after installation.

Guardrail Sod Survey. In 2001, divisions 4 and 6 were the most problematic areas with respect to centipedegrass or zoysiagrass sod survival. Further, in 2002 divisions 4, 6, 10, 11, 12, and 14 demonstrated decreased sod survival with less than 50% of the sod installed remaining actively growing. Although problem areas existed in 2001 and 2002 throughout North Carolina, no correlation between soil properties (CEC, %BS, pH, P, K, Na, etc.) and sod survival were evident. It is thought that much of the problems encountered with the installed centipedegrass sod are due to the excessive fertility prior to centipedegrass being harvested for sod.

Zoysiagrass versus Centipedegrass Sod Establishment under Roadside Conditions. Through one year after establishment, there are no differences among common centipedegrass and 'El Toro' zoysiagrass establishment or survival. Each species has survived and continues to perform well ($\geq$90% alive). These data indicate there are no differences through one year after installation.

REFERENCES

Adcock, T. E., K. E. Kalmowitz, R. F. Walls, and J. H. Birk. 1998. Use of imazapic for centipedegrass management. Proc. South. Weed Sci. Soc. 51:79.

Baird, J. H., J. W. Wilcut, G. R. Wehtje, R. Dickens, and S. Sharpe. 1989. Absorption, translocation, and metabolism of sulfometuron in centipedegrass (*Eremochloa ophiuroides*) and bahiagrass (*Paspalum notatum*). Weed Sci. 37:42-46.

Coats, G. E. 1975. Effect of preemergence herbicides on centipedegrass establishment. Proc. South. Weed Sci. Soc. 28:81.

Cox, C. J., L. B. McCarty, and J.K. Higingbottom. 1999. Envoy (clethodim) for bermudagrass control and centipedegrass tolerance. Proc. South. Weed Sci. Soc. 52:68.

Johnson, B. J. 1973. Establishment of centipedegrass and St. Augustine grass with the aid of chemicals. Agron. J. 65:959-962.

Johnson, B. J. 1976. Effects of herbicides on establishment of centipedegrass. Agron. J. 68:852-855.

Johnson, B. J. 1987. Turfgrass species response to herbicides applied postemergence. Weed Technol. 1:305-311.

McCarty, L. B., J. M. Higgins, L. C. Miller, and T. Whitwell. 1986. Centipedegrass tolerance to postemergence grass herbicides. Hort Sci. 21:1405-1407.

McCarty, L. B., J. W. Everest, D. W. Hall, T. R. Murphy, and F. Yelverton. 2001. Color Atlas of Turfgrass Weeds. Ann Arbor Press, Michigan. pp. 233-243.

Porter, W. C. 1996. Evaluation of postemergence herbicides for use in seeded centipedegrass. Proc. South. Weed Sci. Soc. 49:69.

Turner, D. L., S. S. Sharpe, and R. Dickens. 1990. Herbicide effects on tensile strength and rooting of centipedegrass sod. Hort Sci. 25:541-544.

Waddington, D. V. 1992. Soils, Soil Mixtures, and Soil Amendments *in* Mickelson, S.H., ed. Turfgrass. Madison, WI: Agron. pp. 331-383.

Yelverton, F. H., L. B. McCarty, and T. R. Murphy. 1997. Effects of imazameth on the growth of *Paspalum notatum* Fluegge. International Turfgrass Society. 8:1085-1094.

Table 1. Effect of PGR and herbicide applications at seeding on centipedegrass ground cover.

		Centipedegrass ground cover				
		12 WAS		16 WAS		20 WAS
Treatment	Rate	2000	2001	2000	2001	2001
	— per acre—	%				
Telar + Embark	0.125 oz + 0.5 pt	24 ef	44 abc	54 de	71 ab	86 a
Plateau	1 oz	68 ab	56 a	88 ab	78 a	88 a
Plateau	2 oz	68 ab	20 cde	84 ab	59 abc	68 abc
Plateau	4 oz	49 cd	13 def	74 bc	29 cde	50 bcd
Plateau	6 oz	36 de	5 efg	61 cd	9 ef	20 def
Oust	0.5 oz	51 bcd	14 efg	76 abc	28 de	36 cde
Oust	1 oz	24 ef	0 g	46 de	0 f	5 f
Escort	0.5 oz	15 f	0 g	35 ef	8 ef	6 ef
Escort	1 oz	11 f	0 g	21 f	0 f	0 f
Atrazine	1 lb ai	60 abc	48 ab	89 ab	84 a	88 a
Atrazine	2 lb ai	55 abc	24 b-e	83 ab	43 bcd	60 abc
Simazine	1 lb ai	65 ab	31 a-d	86 ab	69 ab	85 a
Simazine	2 lb ai	70 a	16 cde	90 a	48 bcd	45 bcd
Control	-	66 ab	31 a-d	87 ab	68 ab	74 ab

Means within a column followed by the same letters are not significantly different according to Fisher's Protected LSD test at P = 0.05. PGR, plant growth regulator. WAS, weeks after seeding. Treatment by year interaction (P<0.05) prevented pooling data across years. Percent cover based on visual estimates of centipedegrass ground cover utilizing a 0 (no ground cover) to 100% (complete ground cover) scale.

Table 2. Effect of PGR and herbicide applications applied 6 WAS to centipedegrass.

Treatment	Rate	Centipedegrass phytotoxicity	
		28 DAT	56 DAT
	—— per acre ——	—— % ——	
Telar + Embark	0.125 oz + 0.5 pt	22 bc	20 b
Plateau	1 oz	0 d	0 d
Plateau	2 oz	0 d	0 d
Plateau	4 oz	0 d	0 d
Plateau	6 oz	0 d	3 d
Oust	0.5 oz	11 bcd	7 cd
Oust	1 oz	9 cd	11 bcd
Escort	0.5 oz	27 b	16 bc
Escort	1 oz	88 a	83 a
Atrazine	1 lb ai	3 d	0 d
Atrazine	2 lb ai	4 d	5 cd
Simazine	1 lb ai	3 d	3 d
Simazine	2 lb ai	3 d	3 d
Control	-	0 d	0 d

Means within a column followed by the same letters are not significantly different according to Fisher's Protected LSD test at P =0.05, centipedegrass was one-leaf to one-tiller development stage at application. DAT, days after treatment. PGR, plant growth regulator. WAS, weeks after seeding. Phytotoxicity was based on visual estimates utilizing a 0% (no injury) to 100% (complete death) scale.

Table 3. Bareground under guardrails.

		Tall fescue control		Bareground	
Treatment	Rate	4 MAT	14 MAT	4 MAT	14 MAT
	— per acre —	—	— % —	—	—
Plateau	12 oz	26 d	0 a	36 de	10 ab
Plateau + Roundup Pro	12 oz + 2 qt	71 a	0 a	65 ab	10 ab
Roundup Pro + Simazine + Endurance	2 qt + 2 qt + 1.25 lb ai	40 bcd	0 a	53 bcd	11 ab
Roundup Pro + Simazine + Pendimethalin	2 qt + 2 qt + 3 qt	31 cd	0 a	35 de	9 b
Roundup Pro + Simazine + Surflan	2 qt + 2 qt + 2.5 qt	51 a-d	0 a	44 cd	11 ab
Sahara + Oust	5 lb + 2 oz	75 a	0 a	75 a	14 ab
Control	-	0 e	0 a	9 f	10 ab

Means within a column followed by the same letters are not significantly different according to Fisher's Protected LSD test at P =0.05. % tall fescue control was visually estimated on 0 (no control) to 100% (complete control) scale while bareground was visually estimated on 0 to 100% scale. MAT, months after treatment.

Table 4. Centipedegrass Survival when Subjected to Various Fertility Regimes Prior to Harvesting for Sod.

		Centipedegrass survival	
Fertility	Sodding date	Mowed	Non-mowed
lbs N/a (season total)		%	
0 / control	February	78 ab	73 bcd
44 lb n/a every 4 wks (132)	February	84 a	78 abc
44 lb n/a every 2 wks (264)	February	65 bcd	68 cd
0 / control	April	79 ab	61 d
44 lb n/a every 4 wks (132)	April	48 d	20 e
44 lb n/a every 2 wks (264)	April	56 cd	21 e
0 / control	June	85 a	86 a
44 lb n/a every 4 wks (132)	June	83 ab	81 ab
44 lb n/a every 2 wks (264)	June	73 abc	69 bcd

Means within a column followed by the same letters are not significantly different according to Fisher's Protected LSD test at P =0.05, mowed treatments were mown at 3 inches with a rotary mower. % Survival was visually estimated utilizing a 0% (no ground cover) to 100% (complete ground cover) scale.

Table 5. Centipedegrass or zoysiagrass survival after sod installation.

	Sod survival	
Division	2001	2002
	%	
1	94	63
3	89	77
4	40	46
5	78	51
6	41	23
7	92	67
8	82	55
9	84	72
10	79	41
11	62	48
12	75	35
13	67	60
14	75	38
Grand Mean	74	52

Centipedegrass survival was based on visual estimates utilizing a 0% (complete death) to 100% (actively growing) scale.

Table 6. Zoysiagrass versus centipedegrass sod establishment under roadside conditions.

Turfgrass species	Survival
	—— % ——
Common centipedegrass	100 a
'El Toro' zoysiagrass	100 a

Means within a column followed by the same letters are not significantly different according to Fisher's Protected LSD test at P =0.05. Turfgrass survival was based on visual estimates utilizing a 0% (complete death) to 100% (actively growing) scale.