

Regional Roadside Turfgrass Testing Program

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August 2019

Research Project
Final Report 2019-38

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Technical Report Documentation Page

| | | | | | |
|--|---|--|---|---|--|
| 1. Report No. MN/RC 2019-38 | 2. | 3. Recipients Accession No. | | | |
| 4. Title and Subtitle Regional Roadside Turfgrass Testing Program | | 5. Report Date August 2019 | | | |
| | | 6. | | | |
| 7. Author(s) Eric Watkins, Jon Trappe, Kristine Moncada (UMN) / Mark Renz, Doug Soldat (UW) / William Kreuser (UNL) James Murphy (RU) and Kevin Frank (MSU) | | 8. Performing Organization Report No. | | | |
| 9. Performing Organization Name and Address <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none;"> Department of Horticultural Science University of Minnesota 1970 Folwell Ave. St. Paul, MN 55108 </td> <td style="width: 50%; border: none;"> Department of Horticulture University of Wisconsin-Madison 1575 Linden Drive Madison, WI 53706 </td> </tr> </table> | | Department of Horticultural Science University of Minnesota 1970 Folwell Ave. St. Paul, MN 55108 | Department of Horticulture University of Wisconsin-Madison 1575 Linden Drive Madison, WI 53706 | 10. Project/Task/Work Unit No. CTS Project #2017040 | |
| | | Department of Horticultural Science University of Minnesota 1970 Folwell Ave. St. Paul, MN 55108 | Department of Horticulture University of Wisconsin-Madison 1575 Linden Drive Madison, WI 53706 | | |
| 11. Contract (C) or Grant (G) No. (c) 1003325 (wo) 4 | | | | | |
| 12. Sponsoring Organization Name and Address Minnesota Department of Transportation Office of Research & Innovation 395 John Ireland Boulevard, MS 330 St. Paul, Minnesota 55155-1899 | | 13. Type of Report and Period Covered Final Report | | | |
| | | 14. Sponsoring Agency Code | | | |
| 15. Supplementary Notes http:// mndot.gov/research/reports/2019/201938.pdf | | | | | |
| 16. Abstract (Limit: 250 words) <p>Roadsides are a challenging environment for successfully establishing turfgrass. Site-specific stresses demand multi-site testing of grasses and grass mixtures. This study evaluated 60 entries that varied by cultivar, species, or mixture by establishing on-site trials in MI, MN, NE, NJ, and WI. The entries tested included 50 individual cultivars and 10 standard mixtures, two from each participating state based on their current specifications. One location in each state was along an urban or suburban street with a curb, while the second location was along a rural highway without a curb having a ditch that slopes away from the road with a daily traffic volume of at least 30,000 vehicles. Plots were seeded at most sites in late summer 2016, and data were collected through spring 2018. Turfgrass performance was assessed by counting living turf cover, weed cover, and bare soil using the grid intersect method in the spring and fall of each year. Species and cultivar performance varied among locations. Several species showed potential for inclusion in effective mixtures. Other species performed well at some locations and poorly at others. Performance of standard mixtures was also inconsistent across locations. This research demonstrates the need for locally generated data on roadside turfgrass performance.</p> | | | | | |
| 17. Document Analysis/Descriptors Turf, Grasses, Roadside flora, Seeds | | 18. Availability Statement No restrictions. Document available from: National Technical Information Services, Alexandria, Virginia 22312 | | | |
| 19. Security Class (this report) Unclassified | 20. Security Class (this page) Unclassified | 21. No. of Pages 58 | 22. Price | | |

Regional Roadside Turfgrass Testing Program

FINAL REPORT

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August 2019

Published by:

Minnesota Department of Transportation
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ACKNOWLEDGMENTS

The authors would like to thank the Minnesota Department of Transportation (MnDOT) and the Local Road Research Board (LRRB) for funding this research. We would like to thank the other transportation agencies that funded this project including Michigan Department of Transportation (MDOT), Nebraska Department of Transportation, New Jersey Department of Transportation (NJDOT) and Wisconsin Department of Transportation (WIDOT). Additionally, we thank the University of Wisconsin, the University of Nebraska, Rutgers University, and Michigan State University for partnering in this research. We would also like to thank Dwayne Stenlund (MnDOT), Darwyn Heme (MDOT), Paul Pospiech (NJDOT), and Leif Hubbard (WIDOT) for technical assistance. Finally, we would like to thank the National Cooperative Highway Research Program for coordinating multi-state agency participation as part of the Transportation Pooled Fund Program.

TABLE OF CONTENTS

| | |
|---|-----------|
| CHAPTER 1: Multi-state roadside testing..... | 1 |
| 1.1 Introduction..... | 1 |
| CHAPTER 2: Methods | 3 |
| 2.1 Plant Material | 3 |
| 2.2 Trial Locations..... | 3 |
| 2.3 Trial Establishment | 3 |
| CHAPTER 3: Analysis and Results | 11 |
| 3.1 Analysis | 11 |
| 3.2 Results..... | 11 |
| CHAPTER 4: Discussion | 45 |
| CHAPTER 5: Website development | 46 |
| CHAPTER 6: Conclusions and Recommendations | 47 |
| 6.1 Conclusions..... | 47 |
| REFERENCES | 48 |

LIST OF FIGURES

| | |
|---|----|
| Figure 2.1 Locations of research sites in Michigan, Minnesota, Nebraska, New Jersey, and Wisconsin. | 4 |
| Figure 2.2 Plots at urban site in Michigan. | 5 |
| Figure 3.1 Grid overlaid on a plot in New Jersey. Each grid intersection was logged as being on top of the turfgrass that was originally seeded, a weed, or bare soil. | 12 |

LIST OF TABLES

Table 2.1 Mixture compositions for commonly used DOT mixtures from each testing state that were included at all 10 testing locations. 6

Table 2.2 Site information for location, seeding, and rating dates for each of the 10 testing sites..... 8

Table 2.3 Site-specific soil information for each testing location..... 9

Table 2.4 Site-specific weather information for each testing location..... 10

Table 3.1 Analysis of variance for the effect of seeding mixture treatment, state, and site on mean turf coverage..... 13

Table 3.2 Analysis of variance for the effect of turfgrass species, state, and site on mean turf coverage.14

Table 3.3 Michigan Rural – Total living turf cover [Total Cover (TC)] for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change)..... 15

Table 3.4 Michigan Urban – Total living turf cover [Total Cover (TC)] for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change)..... 17

Table 3.5 Minnesota Rural – Total living turf cover [Total Cover (TC)] for Fall 2017 and Spring 2018; and percent total cover change from 2017 to 2018 (2017-2018 % TC Change)..... 19

Table 3.6 Minnesota Urban – Total living turf cover [Total Cover (TC)] for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change)..... 21

Table 3.7 Nebraska Rural – Total living turf cover [Total Cover (TC)] for Fall 2017 and Spring 2018; and percent total cover change from 2017 to 2018 (2017-2018 % TC Change)..... 23

Table 3.8 Nebraska Urban – Total living turf cover [Total Cover (TC)] for Fall 2017 and Spring 2018; and percent total cover change from 2017 to 2018 (2017-2018 % TC Change)..... 25

Table 3.9 New Jersey Rural – Total living turf cover [Total Cover (TC)] for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change)..... 27

Table 3.10 New Jersey Urban – Total living turf cover [Total Cover (TC)] for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change)..... 29

| | |
|---|----|
| Table 3.11 Wisconsin Rural – Total living turf cover [Total Cover (TC)] for Fall 2016, Spring 2017, and Fall 2017; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change). | 31 |
| Table 3.12 Wisconsin Urban – Total living turf cover [Total Cover (TC)] for Fall 2017 and Spring 2018; and percent total cover change from 2017 to 2018 (2017-2018 % TC Change)..... | 33 |
| Table 3.13 Michigan rural – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change). | 35 |
| Table 3.14 Michigan Urban – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change). | 36 |
| Table 3.15 Minnesota Rural – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2017 and Spring 2018; percent total cover change from 2017 to 2018 (2017-2018 % TC Change). | 37 |
| Table 3.16 Minnesota Urban – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change). | 38 |
| Table 3.17 Nebraska Rural – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2017 and Spring 2018; percent total cover change from 2017 to 2018 (2017-2018 % TC Change). | 39 |
| Table 3.18 Nebraska Urban – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2017 and Spring 2018; percent total cover change from 2017 to 2018 (2017-2018 % TC Change). | 40 |
| Table 3.19 New Jersey Rural – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change). | 41 |
| Table 3.20 New Jersey Urban – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change). | 42 |
| Table 3.21 Wisconsin Rural – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2016, Spring 2017, and Fall 2017; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change). | 43 |
| Table 3.22 Wisconsin Urban - Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2017 and Spring 2018; percent total cover change from 2017 to 2018 (2017-2018 % TC Change). | 44 |

LIST OF ABBREVIATIONS

AL – alkaligrass (*Puccinellia distans*)
AM – seaside alkaligrass (*Puccinellia maritima*)
CH – Chewings fescue (*Festuca rubra* ssp. *fallax*)
DOT – Department of Transportation
HD – hard fescue (*Festuca brevipila*)
KB – Kentucky bluegrass (*Poa pratensis*)
MnDOT – Minnesota Department of Transportation
MX – DOT-specified mixtures
PR – perennial ryegrass (*Lolium perenne*)
SB – smooth bromegrass (*Bromus inermis*)
SL – slender creeping red fescue (*Festuca rubra* ssp. *littoralis*)
ST – strong creeping red fescue (*Festuca rubra* ssp. *rubra*)
TF – tall fescue (*Schedonorus arundinaceus*)
VNS – Variety Not Stated

EXECUTIVE SUMMARY

Survival of turf along roadsides is a significant challenge, particularly in cold climates where salt is applied to roads in the winter. Over the past decade, the University of Minnesota has led a series of projects to address this problem. These projects have included the identification of best management practices for roadside establishment along with new species and cultivar recommendations. One of the challenges of this type of work is year-to-year variability in winter conditions, which reduces the usefulness of single-site testing of turfgrass performance. One approach to this problem is a coordinated, multi-state, multi-location cultivar testing effort that would allow for simultaneous evaluation of various stresses common to roadsides. In this project, we developed a five-state roadside turfgrass cultivar trial and seeded it at two locations within each state (10 total). Turfgrass performance was assessed by counting living turf cover, weed cover, and bare soil, which allowed for the determination of percent living cover calculations for each rating date. Species and cultivar performance for change in living cover from season to season varied among locations. Several species showed potential for inclusion in effective mixtures. Other species performed well at some locations and poorly at others. Performance of standard mixtures was also inconsistent across locations. This research demonstrates the need for locally generated data on roadside turfgrass performance.

CHAPTER 1: MULTI-STATE ROADSIDE TESTING

1.1 INTRODUCTION

Survival of turf along roadsides is a challenge in many states in the central and northern U.S. Grasses growing along roadsides experience a number of stresses including high levels of salt from deicing operations, drought stress from lack of irrigation, and heat stress. State departments of transportation recommend mixtures for various roadside environments; however, many of these mixture recommendations are either outdated or developed without supporting research data collected by an unbiased source. Failed grass installation projects have both economic (labor and materials) and environmental (soil erosion, invasive weed establishment, etc.) impacts.

Failed installations can happen for a number of reasons, and it is our contention based on observation and previous research, that failures often are due to using the wrong species for a given site. These failed installations most often result in needing to reseed or even re-sod. The most basic method for reestablishment of a failed site would be to kill the existing vegetation and reseed, which will still have a cost of \$150 to \$530 per acre when using the most popular roadside seed mixtures plus the added cost of labor and resources needed to rectify a failed installation. Sod can cost nearly \$20,000 per acre. The additional cost of re-grading, installation, and water can also be significant. Using the right turfgrass species for a specific area will provide the best option for a successful establishment.

The primary stress of roadside turfgrass areas in the northern U.S. is often salt stress. There have been only a few recent examples of grasses being tested for salt-tolerance in a roadside environment in the northern states (Biesboer et al., 1998; Brown and Gorres, 2011; Friell et al., 2012). Turfgrass breeders, both public and private, have increasingly focused on research and development of salt-tolerant and low-input turfgrasses (Friell et al., 2012; Koch and Bonos, 2011; Koch and Bonos, 2011; Rose-Fricker and Wipff, 2001; Watkins et al., 2011). New cultivars of numerous species possessing better heat, drought, and salt tolerance are being released that likely are better adapted to the harsh roadside conditions found in the northern U.S. As these cultivars have become available, many states have not updated seed mixes with these new cultivars. This indicates that the current system is not nimble enough to utilize the newest genetic resources for these environmentally sensitive areas along roadsides.

The University of Minnesota previously identified species and cultivars that can be utilized on roadsides in Minnesota. However, today there is a need for additional testing on roadsides so that more recently-developed cultivars and previously unexplored grass species can be identified for inclusion in DOT-recommended mixtures in the northern U.S. In previous studies, multiple sites in a single state (Minnesota) were utilized for this type of research; however, year-to-year variability in weather does not allow for sites in a single state to provide information on the tolerances of these grasses to the many stresses found on roadsides. A multi-state approach, whereby roadside turfgrass trials are planted throughout the northern U.S., would greatly improve the chance that during any given year we will be collecting data on important stress tolerances. Results from a multi-state, multi-site study would

improve our knowledge on roadside turfgrass stress tolerances resulting in better recommendations for state DOTs and ultimately financial benefit to public agencies.

The objective of this study is to assess potential roadside turfgrasses across multiple states in the northern U.S. to generate unbiased data for use by public agencies.

CHAPTER 2: METHODS

2.1 PLANT MATERIAL

A total of 60 entries were included in this trial; this includes 50 individual cultivars and 10 standard mixtures (Table 2.1), two from each participating state based on current specifications for that state. Individually-tested cultivars were chosen based on recommendations from turfgrass breeders along with publicly-available data suggesting that the cultivar had some potential as a roadside turfgrass.

2.2 TRIAL LOCATIONS

Trials were seeded at two locations in each of five states – Michigan, Minnesota, Nebraska, New Jersey, and Wisconsin (Figure 2.1; Table 2.2). One of the two locations was along an urban or suburban street with a curb, having a daily traffic volume of between 10,000 and 15,000 vehicles, while the second location was along a rural highway without a curb having a ditch that sloped away from the road with a daily traffic volume of at least 30,000 vehicles. The curbed locations were those that would be maintained regularly (mowed as needed to maintain turfgrass aesthetics) while the rural sites would typically be mowed between 1-3 times per year. Soil tests were taken at each site prior to seeding (Table 2.3). Precipitation was measured at each site and local temperature data was collected by a nearby weather station (Table 2.4).

2.3 TRIAL ESTABLISHMENT

Each trial was planted as a randomized complete block design with 3 replications. Individual plots were 5 feet long (parallel to the road) and 3 feet wide (perpendicular to the road; Figure 2.2). Seeding rate was 2.0 pure live seeds cm^{-2} . At seeding, a granular starter fertilizer was applied providing approximately 1 lb. P_2O_5 per 1000 ft^2 . Plots were covered with a germination blanket (Futerra Environet [Profile] blankets) after seeding. Plots at the urban site in MN were irrigated using a drip irrigation system supplied by a fire hydrant during establishment at a rate of 0.14 in of water per day and both the rural MN and urban WI sites were watered with a water truck during establishment. All other sites were established with natural precipitation. All plots were mowed as needed to a height appropriate for the site, generally between 3 and 4 inches. The rural site in MN was damaged due to a construction crane and had to be re-seeded in fall 2017. The urban WI site was also seeded in fall 2017. Neither site in NE established in 2016 due to lack of rainfall after seeding. Soil samples were collected and homogenized to form a composite sample for each replication at each site after soil preparation but before seeding (Table 2.3). Soil samples were analyzed by a soil testing laboratory for soil cation exchange capacity, electrical conductivity, pH, and concentrations of soil phosphorus and soil organic matter. Similarly, intact cores were collected to obtain bulk density samples for each location.

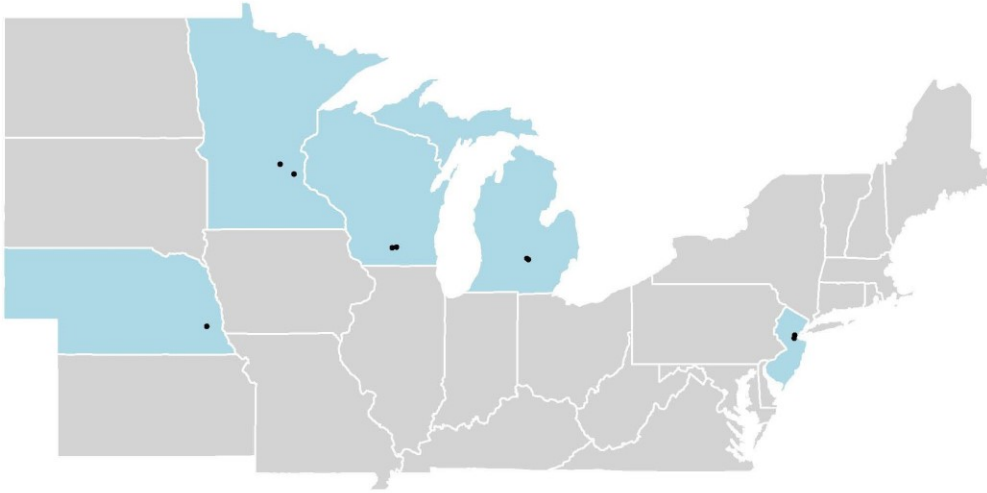


Figure 2.1 Locations of research sites in Michigan, Minnesota, Nebraska, New Jersey, and Wisconsin.



Figure 2.2 Plots at urban site in Michigan.

Table 2.1 Mixture compositions for commonly used DOT mixtures from each testing state that were included at all 10 testing locations.

| Mixture name | Cultivar ¹ | Species | Percent |
|--------------------------------|-----------------------|-----------------------------|---------|
| MI DOT THV Mixture | Pennlawn | Creeping red fescue | 44 |
| | Pennant | Perennial ryegrass | 29 |
| | Baron | Kentucky bluegrass | 15 |
| | Fults | Salt grass | 10 |
| MI DOT TUF Mixture | Dawson | Creeping red fescue | 40 |
| | Pennant III | Perennial ryegrass | 19 |
| | Reliant IV | Hard fescue | 20 |
| | Baron | Kentucky bluegrass | 10 |
| | Fults | Salt grass | 10 |
| MN 25-131 Low Maintenance Turf | Park | Kentucky bluegrass | 16 |
| | VNS | Sheep fescue | 11 |
| | Boreal | Creeping red fescue | 29 |
| | Radar | Chewings fescue | 20 |
| | Chariot | Hard fescue | 14 |
| | VNS | Perennial ryegrass | 9 |
| Salt Tolerant Sod (MNST-12) | Seabreeze GT | Slender creeping red fescue | 20 |
| | Celestial | Strong creeping red fescue | 20 |
| | Moonlight SLT | Kentucky bluegrass | 20 |
| | Bighorn GT | Hard Fescue | 10 |
| | Radar | Chewings fescue | 30 |
| NE Rural MX-5077 | Overland | Winter wheat | 31 |
| | Linn | Perennial ryegrass | 16 |
| | Barton | Western wheatgrass | 13 |
| | Texoka | Buffalograss | 11 |
| | First Strike | Slender wheatgrass | 11 |
| | Butte | Sideoats grama | 9 |
| | KY-31 | Tall fescue | 7 |
| | VNS | Sand dropseed | 1 |
| NE Urban Roadside and Lawns | Titanium | Tall fescue | 88 |
| | Park | Kentucky bluegrass | 7 |
| | Evening Shade | Perennial ryegrass | 5 |
| NJ DOT A-4 Mixture | VNS | Creeping red fescue | 29 |
| | VNS | Chewings fescue | 29 |
| | VNS | Kentucky bluegrass | 29 |
| | VNS | Perennial ryegrass | 10 |
| NJ Type B Mixture | VNS | Creeping red fescue | 44 |
| | KY-31 | Tall Fescue | 15 |
| | Blackwell | Switchgrass | 15 |
| | VNS | Weeping lovegrass | 10 |
| | VNS | Redtop | 9 |

| | | | |
|------------|----------------|---------------------|----|
| | VNS | Perennial ryegrass | 5 |
| WI DOT #20 | 3rd Millennium | Tall fescue | 40 |
| | VNS | Perennial ryegrass | 29 |
| | VNS | Chewings fescue | 24 |
| | VNS | Kentucky bluegrass | 6 |
| WI DOT #40 | Park | Kentucky bluegrass | 34 |
| | VNS | Perennial ryegrass | 25 |
| | VNS | Creeping red fescue | 19 |
| | VNS | Hard fescue | 19 |

¹ VNS = Variety not stated

Table 2.2 Site information for location, seeding, and rating dates for each of the 10 testing sites.

| <i>State</i> | <i>Type</i> | <i>Location description</i> | <i>Latitude, Longitude</i> | <i>Seeding date</i> | <i>Fall '16 rating date</i> | <i>Spring '17 rating date</i> | <i>Fall '17 rating date</i> | <i>Spring '18 rating date</i> |
|--------------|-------------|--|----------------------------|---------------------|-----------------------------|-------------------------------|-----------------------------|-------------------------------|
| MI | Rural | Interstate 96 (I96) - westbound adjacent to the Williamston rest-stop | 42.677271, -84.410884 | 9/21/2016 | 12/1/2016 | 4/26/2017 | 10/9/2017 | 5/23/2018 |
| | Urban | Hagadorn road in East Lansing | 42.716271, -84.462398 | 9/16/2016 | 11/18/2016 | 4/25/2017 | 9/15/2017 | 5/22/2018 |
| MN | Rural | MnROAD research facility, Albertville, MN | 45.258063, -93.702909 | 8/24/2017 | NA | NA | 11/6/2017 | 5/21/2018 |
| | Urban | East side of Cleveland Ave, Falcon Heights, MN | 44.994210, -93.187045 | 8/26/2016 | 12/7/2016 | 5/8/2017 | 11/3/2017 | 5/22/2018 |
| NE | Rural | HWY 34 East of Lincoln, 200' West of 202nd St. to 100' East of 202nd Street | 40.813014, -96.446318 | 10/15/2016 | NA | 5/15/2017 | 10/21/2017 | 4/21/2018 |
| | Urban | Lincoln, south side of Normal BLVD, 0-300 feet west of 70th Street | 40.782382, -96.627521 | 10/15/2016 | NA | 5/15/2017 | 10/21/2017 | 4/21/2018 |
| NJ | Rural | I-287 North; near exits 4 and 5, South Plainfield, NJ | 40.557921, -74.425622 | 10/4/2016 | 12/13/2016 | 5/10/2017 | 10/3/2017 | 6/1/2018 |
| | Urban | US Rt. 1 South; Between Technology Way and Milltown Road Interchanges; North Brunswick, NJ | 40.465826, -74.444616 | 10/5/2016 | 12/1/2016 | 4/27/2017 | 10/18/2017 | 6/1/2018 |
| WI | Rural | Wisconsin State Highway 151 in Madison, WI, approximately 1 km northeast of Exit 81 | 42.999603, -89.495880 | 10/6/2016 | 11/22/2016 | 4/17/2017 | 10/17/2017 | NA |
| | Urban | Median on McCoy Rd, in Fitchburg WI between Wisconsin State Highway 14 and Herman Road | 43.022149, -89.384437 | 9/8/2017 | NA | NA | 10/17/2017 | 4/28/2018 |

Table 2.3 Site-specific soil information for each testing location.

| Location | Site | Soil CEC | Soil pH | Soil P mg kg ⁻¹ | Soil EC Mmhos cm ⁻¹ | Soil B.D. g cm ³ | Soil O.M. (%) | Soil Texture |
|------------|-------|----------|---------|-------------------------------|-----------------------------------|--------------------------------|------------------|---------------------------|
| Michigan | Rural | - | 7.9 | 4.0 | 0.14 | 1.25 | 1.9 | Gilford sandy loam |
| | Urban | - | 8.1 | 7.3 | 0.29 | 1.49 | 3.5 | Metea loamy sand |
| Minnesota | Rural | 32.67 | 7.7 | 14.3 | 0.61 | 1.58 | 3.5 | Cordova loam |
| | Urban | 17.33 | 7.6 | 5.7 | 0.56 | 1.44 | 4.4 | Kingsley sandy loam |
| Nebraska | Rural | 28.60 | 8.1 | 41.0 | - | - | 2.4 | Wymore silty clay loam |
| | Urban | 22.70 | 8.2 | 20.0 | - | - | 2.8 | Aksarben silty clay loam |
| New Jersey | Rural | - | 8.0 | 7.3 | 8.7 | 1.54 | 3.7 | Klinesville channery loam |
| | Urban | - | 6.8 | 36.3 | 1.8 | 1.48 | 3.8 | Matapeake silt loam |
| Wisconsin | Rural | 21.69 | 7.6 | 11.1 | 0.58 | - | 4.1 | Orion silt loam |
| | Urban | 30.32 | 7.3 | 31.0 | 0.63 | 1.33 | 3.9 | McHenry silt loam |

Table 2.4 Site-specific weather information for each testing location.

| Location | Site | Duration of experiment ¹ | Average monthly maximum air temperature | Average monthly minimum air temperature | Total Precipitation | Total snowfall | Total accumulated growing degree days ² | Relative accumulated growing degree days ³ |
|------------|-------|-------------------------------------|---|---|---------------------|----------------|--|---|
| | | Days | °F | °F | in | in | GDDs | GDDs |
| Michigan | Rural | 392 | 54.0 | 36.5 | 44.3 | 47.2 | 3764.4 | 9.6 |
| | Urban | 392 | 54.0 | 36.5 | 46.7 | 56.8 | 3829.7 | 9.8 |
| Minnesota | Rural | 267 | 53.2 | 35.2 | 37.8 | 80.6 | 1053.0 | 3.9 |
| | Urban | 379 | 51.3 | 34.3 | 51.2 | 72.7 | 3525.7 | 9.3 |
| Nebraska | Rural | 355 | 62.8 | 38.3 | 36.8 | 26.6 | 3669.3 | 10.3 |
| | Urban | 355 | 63.5 | 39.6 | 14.7 | 21.4 | 3849.0 | 10.8 |
| New Jersey | Rural | 219 | 60.1 | 40.7 | 43.1 | 24.9 | 4911.5 | 22.4 |
| | Urban | 205 | 59.7 | 40.3 | 45.8 | 33.1 | 4479.2 | 21.9 |
| Wisconsin | Rural | 375 | 50.4 | 32.0 | 30.1 | 36.3 | 2943.2 | 7.9 |
| | Urban | 233 | 44.4 | 26.6 | 12.8 | 37.3 | 646.7 | 2.8 |

¹ Duration of experiment = number of days between planting date and final collection date.

² Total accumulated growing degree days = total summation of daily average temperature (°F) - 40°F for the duration of the experiment.

³ Relative accumulated growing degree days = total accumulated growing degree days divided by the number of days for the experiment.

CHAPTER 3: ANALYSIS AND RESULTS

3.1 ANALYSIS

Turfgrass performance was assessed using the grid-intersect method whereby a 3 x 5 ft. grid of 60 intersections overlaid each plot (Figure 3.3). An observation was made at each intersection as either living turf, weed, or bare soil/germination blanket. Observations were recorded such that the location of each data point within the grid was known. Most plots were assessed four times: late fall 2016, spring 2017 (after snowmelt and prior to turf green-up), fall 2017, and spring 2018 (Tables 3.1 and 3.2).

Mean analyses for turf, weed, or bare soil coverage were analyzed in SAS (SAS Institute Inc., 2014, ver. 9.4, Cary, NC, USA) using PROC GLM. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test ($\alpha = 0.05$) was used to separate means. Negative values for change in turf coverage indicate a reduction in turf coverage of desired species, whereas a positive value means the turf coverage of the plot increased.

3.2 RESULTS

Turfgrass coverage varied greatly by entry, species, state, and whether the site was urban or rural (Tables 3.1 and 3.2). Several seed treatment or turfgrass species by state by location interactions existed, so data are presented within location and state for both cultivar (Tables 3.3 to 3.12) and species (Tables 3.13 to 3.22).

Perennial ryegrass entries were often initially in the top statistical grouping at sites in MI, WI, and NJ (urban only) but did poorly in both locations in MN after a harsh winter in 2016-2017. Alkaligrasses were top performers at rural sites in MN and NJ, but did not do well in MI, primarily due to poor establishment. At the rural site in NJ (Tables 3.9 and 3.19), only alkaligrasses survived through two winters, along with the two state DOT-specified mixtures that contained alkaligrass (Table 2.1). Strong creeping red fescue and slender creeping red fescue performed better than other species at urban sites in MN and WI (Tables 3.6, 3.12, 3.16, and 3.22). The smooth brome grass entry consistently had the lowest turf coverage at the final rating date across all locations.

At several sites, turfgrass entry differences were not significant for turf cover or change in turf cover (Tables 3.4, 3.7, 3.8, 3.10, 3.11, 3.14, 3.17, and 3.21). Urban sites generally had higher turf coverage across all seed mixture treatments compared to rural sites within a state (Tables 3.1 and 3.2).



Figure 3.1 Grid overlaid on a plot in New Jersey. Each grid intersection was logged as being on top of the turfgrass that was originally seeded, a weed, or bare soil.

Table 3.1 Analysis of variance for the effect of seeding mixture treatment, state, and site on mean turf coverage.

| Source | Fall turf cover | | Spring turf cover | | Change turf cover | |
|-----------------|-----------------|---------|-------------------|---------|-------------------|---------|
| | F-value | P-value | F-value | P-value | F-value | P-value |
| Rep | 20.71 | <0.0001 | 2.84 | 0.0589 | 7.85 | 0.0004 |
| Treatment (TRT) | 11.10 | <0.0001 | 6.46 | <0.0001 | 3.96 | <0.0001 |
| State (ST) | 577.46 | <0.0001 | 633.23 | <0.0001 | 566.23 | <0.0001 |
| Site (SI) | 214.24 | <0.0001 | 907.25 | <0.0001 | 178.73 | <0.0001 |
| TRT*ST | 1.08 | 0.3224 | 2.95 | <0.0001 | 1.30 | 0.0640 |
| TRT*SI | 1.88 | <0.0001 | 3.37 | <0.0001 | 1.57 | <0.0001 |
| TRT*ST*SI | 1.95 | <0.0001 | 3.41 | <0.0001 | 2.11 | <0.0001 |

Table 3.2 Analysis of variance for the effect of turfgrass species, state, and site on mean turf coverage.

| Source | Fall turf cover | | Spring turf cover | | Change turf cover | |
|--------------|-----------------|---------|-------------------|---------|-------------------|---------|
| | F-value | P-value | F-value | P-value | F-value | P-value |
| Rep | 21.14 | <0.0001 | 2.75 | 0.0641 | 8.40 | 0.0002 |
| Species (SP) | 47.57 | <0.0001 | 20.22 | <0.0001 | 0.23 | 0.6280 |
| State (ST) | 341.62 | <0.0001 | 408.22 | <0.0001 | 330.91 | <0.0001 |
| Site (SI) | 111.93 | <0.0001 | 475.92 | <0.0001 | 109.46 | <0.0001 |
| SP*ST | 2.44 | <0.0001 | 10.99 | <0.0001 | 4.49 | <0.0001 |
| SP*SI | 5.80 | <0.0001 | 11.87 | <0.0001 | 5.77 | <0.0001 |
| SP*ST*SI | 7.30 | <0.0001 | 12.81 | <0.0001 | 8.27 | <0.0001 |

Table 3.3 Michigan Rural – Total living turf cover [Total Cover (TC)] for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Entry | Species ² | Fall 2016 ¹ | Spring 2017 | 2016-2017 | Fall 2017 | Spring 2018 | 2017-2018 |
|-------------------------|----------------------|------------------------|------------------|-------------|------------------|------------------|-------------|
| | | Total Cover (TC) | Total Cover (TC) | % TC Change | Total Cover (TC) | Total Cover (TC) | % TC Change |
| BAR PD06N17 | AL | 42.8 | 42.8 | 0.0 | 1.7 | 7.8 | 6.1 |
| BAR PD9032 | AL | 15.0 | 15.6 | 0.6 | 27.2 | 22.8 | -4.4 |
| Fults | AL | 73.3 | 70.5 | -2.8 | 2.8 | 12.2 | 9.4 |
| Salton Sea | AL | 36.1 | 38.3 | 2.2 | 20.6 | 15.0 | -5.6 |
| SeaSalt | AL | 25.6 | 33.3 | 7.8 | 3.3 | 7.2 | 3.9 |
| Oceania Maritima | AM | 59.5 | 53.9 | -5.6 | 2.2 | 7.8 | 5.6 |
| Castle | CH | 95.0 | 83.9 | -11.1 | 43.3 | 63.9 | 20.6 |
| Compass II | CH | 90.0 | 84.4 | -5.6 | 46.1 | 66.7 | 20.6 |
| FRC 43 M2 | CH | 96.1 | 89.4 | -6.7 | 52.8 | 74.4 | 21.7 |
| Heathland | CH | 95.0 | 88.4 | -6.6 | 57.8 | 70.6 | 12.8 |
| Beacon | HD | 92.8 | 85.6 | -7.2 | 71.1 | 91.7 | 20.6 |
| Gladiator | HD | 90.0 | 87.8 | -2.2 | 72.8 | 88.3 | 15.6 |
| Nanook | HD | 88.3 | 92.8 | 4.5 | 71.7 | 85.6 | 13.9 |
| Soil Guard | HD | 91.1 | 89.4 | -1.7 | 68.9 | 85.0 | 16.1 |
| Sword | HD | 86.1 | 91.1 | 5.0 | 75.0 | 92.2 | 17.2 |
| Barduke | KB | 60.6 | 51.7 | -8.9 | 41.1 | 43.3 | 2.2 |
| J-525 | KB | 68.9 | 70.5 | 1.6 | 47.8 | 72.2 | 24.4 |
| J-793 | KB | 75.6 | 77.2 | 1.7 | 65.6 | 76.7 | 11.1 |
| J-920 | KB | 64.5 | 62.8 | -1.7 | 46.7 | 70.0 | 23.3 |
| Milagro | KB | 56.7 | 56.1 | -0.6 | 68.3 | 65.0 | -3.3 |
| Morocco | KB | 62.8 | 68.3 | 5.6 | 81.1 | 82.2 | 1.1 |
| Tirem | KB | 59.4 | 65.0 | 5.6 | 37.8 | 58.9 | 21.1 |
| Volt | KB | 63.9 | 67.8 | 3.9 | 56.7 | 58.3 | 1.7 |
| 16-14-Lp 145 | PR | 96.1 | 90.5 | -5.6 | 82.2 | 76.1 | -6.1 |
| BAR Lp 10970 | PR | 97.8 | 91.7 | -6.1 | 63.9 | 66.1 | 2.2 |
| Gray Fox | PR | 97.8 | 93.9 | -3.9 | 75.0 | 78.9 | 3.9 |
| Premium | PR | 97.8 | 97.2 | -0.5 | 75.6 | 76.1 | 0.6 |
| Replicator ³ | PR | 95.0 | 91.1 | -3.9 | 65.0 | 77.2 | 12.2 |
| Stellar | PR | 96.7 | 93.9 | -2.8 | 74.4 | 75.6 | 1.1 |
| BAR BIF 1GRL | SB | 85.6 | 84.4 | -1.1 | 97.8 | 90.6 | -7.2 |
| Blue Mesa | SH | 90.0 | 90.6 | 0.6 | 68.9 | 84.4 | 15.6 |
| J-248 | SH | 91.1 | 86.1 | -5.0 | 67.2 | 82.2 | 15.0 |
| Quatro | SH | 93.3 | 90.6 | -2.8 | 70.0 | 85.0 | 15.0 |
| 10RT DE | SL | 96.7 | 90.0 | -6.7 | 57.2 | 71.7 | 14.4 |
| Sea Mist | SL | 92.2 | 90.6 | -1.7 | 65.0 | 71.7 | 6.7 |
| Seabreeze GT | SL | 93.9 | 86.1 | -7.7 | 62.2 | 70.6 | 8.3 |
| Shoreline | SL | 91.1 | 91.1 | 0.0 | 50.0 | 76.1 | 26.1 |
| FRR 72 M2 | ST | 92.2 | 91.1 | -1.1 | 55.0 | 69.4 | 14.4 |
| Kent | ST | 92.8 | 82.2 | -10.6 | 77.2 | 87.2 | 10.0 |
| Navigator II | ST | 88.3 | 87.2 | -1.1 | 65.6 | 82.8 | 17.2 |

| | | | | | | | |
|-----------------------|----|------|------|-------|------|------|------|
| Ruddy | ST | 91.6 | 91.7 | 0.0 | 62.2 | 77.2 | 15.0 |
| Xeric | ST | 92.8 | 88.3 | -4.4 | 52.2 | 72.2 | 20.0 |
| Avenger II | TF | 98.9 | 92.2 | -6.6 | 90.6 | 90.6 | 0.0 |
| Birmingham | TF | 95.0 | 88.9 | -6.1 | 94.4 | 97.8 | 3.3 |
| Black Tail | TF | 98.3 | 93.3 | -5.0 | 92.2 | 95.6 | 3.3 |
| Fayette | TF | 95.0 | 90.6 | -4.5 | 86.7 | 93.3 | 6.7 |
| JT-621 | TF | 93.3 | 87.2 | -6.1 | 88.9 | 97.2 | 8.3 |
| MNKY | TF | 89.5 | 79.4 | -10.0 | 58.3 | 56.7 | -1.7 |
| Saltillo | TF | 95.0 | 87.2 | -7.8 | 85.0 | 88.9 | 3.9 |
| Thunderstruck | TF | 93.9 | 93.3 | -0.6 | 71.1 | 77.8 | 6.7 |
| MI DOT THV | MX | 93.9 | 88.9 | -5.0 | 63.9 | 75.6 | 11.7 |
| MI DOT TUF | MX | 91.1 | 81.7 | -9.5 | 75.0 | 78.9 | 3.9 |
| MN DOT 25-131 | MX | 93.9 | 84.4 | -9.5 | 61.1 | 84.4 | 23.3 |
| MN DOT MNST-12 | MX | 89.5 | 90.6 | 1.1 | 67.2 | 87.2 | 20.0 |
| NE DOT Rural Region 2 | MX | 38.3 | 46.7 | 8.4 | 62.2 | 61.7 | -0.6 |
| NE DOT Urban and Turf | MX | 97.2 | 91.1 | -6.1 | 85.0 | 90.0 | 5.0 |
| NJ DOT A-4 | MX | 83.3 | 82.2 | -1.1 | 62.2 | 70.6 | 8.3 |
| NJ DOT Type B | MX | 80.0 | 81.7 | 1.7 | 82.2 | 95.6 | 13.3 |
| WI DOT #20 | MX | 90.0 | 83.9 | -6.1 | 77.8 | 87.8 | 10.0 |
| WI DOT #40 | MX | 78.9 | 73.9 | -5.0 | 39.4 | 57.8 | 18.3 |
| LSD (0.05) | | 11.9 | 12.9 | 10.8 | 30.5 | 25.8 | 20.9 |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant. For % TC Change (when significant), the most positive value within a column is shaded blue, while the most negative value within a column is shaded red. Remaining cells are shaded in a blue-purple-red gradient with zero shaded purple. Negative values indicate a reduction in turf coverage of desired species, whereas a positive value means the turf coverage of the plot increased.

2. Species tested include: AL = alkaligrass (*Puccinellia distans*); AM = seaside alkaligrass (*Puccinellia maritima*); CH = Chewings fescue (*Festuca rubra* ssp. *fallax*); HD = hard fescue (*Festuca brevipila*); KB = Kentucky bluegrass (*Poa pratensis*); PR = perennial ryegrass (*Lolium perenne*); SB = smooth bromegrass (*Bromus inermis*); SL = slender creeping red fescue (*Festuca rubra* ssp. *littoralis*); ST = strong creeping red fescue (*Festuca rubra* ssp. *rubra*); TF = tall fescue (*Schedonorus arundinaceus*); MX = DOT-specified mixtures.

3. Tetraploid perennial ryegrass

Table 3.4 Michigan Urban – Total living turf cover [Total Cover (TC)] for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Entry | Species ² | Fall 2016 ¹ | Spring 2017 | 2016-2017 | Fall 2017 | Spring 2018 | 2017-2018 |
|-------------------------|----------------------|------------------------|-------------|-------------|------------------|-------------|-------------|
| | | Total Cover (TC) | | % TC Change | Total Cover (TC) | | % TC Change |
| BAR PD06N17 | AL | 63.9 | 42.2 | -21.7 | 56.1 | 66.1 | 10.0 |
| BAR PD9032 | AL | 33.9 | 15.0 | -18.9 | 58.3 | 67.2 | 8.9 |
| Fults | AL | 77.8 | 46.7 | -31.1 | 57.8 | 70.6 | 12.8 |
| Salton Sea | AL | 56.7 | 35.0 | -21.7 | 56.7 | 67.8 | 11.1 |
| SeaSalt | AL | 31.1 | 20.6 | -10.5 | 52.2 | 66.1 | 13.9 |
| Oceania Maritima | AM | 78.4 | 55.0 | -23.4 | 57.2 | 71.1 | 13.9 |
| Castle | CH | 86.1 | 82.2 | -3.9 | 50.6 | 66.7 | 16.1 |
| Compass II | CH | 91.1 | 85.0 | -6.1 | 56.1 | 67.8 | 11.7 |
| FRC 43 M2 | CH | 96.7 | 81.6 | -15.0 | 56.7 | 68.3 | 11.7 |
| Heathland | CH | 90.0 | 81.1 | -8.9 | 57.8 | 66.7 | 8.9 |
| Beacon | HD | 92.8 | 85.0 | -7.8 | 50.6 | 68.9 | 18.3 |
| Gladiator | HD | 94.4 | 88.3 | -6.1 | 52.2 | 60.6 | 8.3 |
| Nanook | HD | 92.8 | 90.5 | -2.7 | 59.4 | 71.7 | 12.2 |
| Soil Guard | HD | 90.6 | 85.5 | -5.0 | 58.3 | 70.6 | 12.2 |
| Sword | HD | 93.9 | 86.1 | -7.8 | 48.3 | 66.7 | 18.3 |
| Barduke | KB | 60.6 | 13.9 | -46.7 | 50.6 | 61.7 | 11.1 |
| J-525 | KB | 56.1 | 26.1 | -30.0 | 54.4 | 66.7 | 12.2 |
| J-793 | KB | 72.2 | 32.2 | -40.0 | 58.9 | 73.3 | 14.4 |
| J-920 | KB | 57.2 | 28.3 | -28.9 | 53.3 | 62.2 | 8.9 |
| Milagro | KB | 47.8 | 8.3 | -39.4 | 51.7 | 67.8 | 16.1 |
| Morocco | KB | 57.2 | 28.3 | -28.9 | 57.2 | 68.9 | 11.7 |
| Tirem | KB | 57.2 | 29.5 | -27.8 | 56.7 | 67.8 | 11.1 |
| Volt | KB | 65.0 | 29.4 | -35.6 | 58.3 | 72.8 | 14.4 |
| 16-14-Lp 145 | PR | 98.9 | 94.4 | -4.5 | 56.7 | 67.8 | 11.1 |
| BAR Lp 10970 | PR | 98.3 | 95.0 | -3.3 | 59.4 | 71.7 | 12.2 |
| Gray Fox | PR | 99.4 | 98.3 | -1.1 | 57.2 | 63.9 | 6.7 |
| Premium | PR | 100.0 | 97.8 | -2.2 | 55.0 | 67.8 | 12.8 |
| Replicator ³ | PR | 100.0 | 97.8 | -2.2 | 61.1 | 70.0 | 8.9 |
| Stellar | PR | 98.9 | 96.7 | -2.2 | 52.2 | 68.3 | 16.1 |
| BAR BIF 1GRL | SB | 97.8 | 92.8 | -5.0 | 53.9 | 68.3 | 14.4 |
| Blue Mesa | SH | 87.2 | 92.2 | 5.0 | 50.0 | 64.4 | 14.4 |
| J-248 | SH | 95.5 | 90.0 | -5.5 | 54.4 | 68.3 | 13.9 |
| Quatro | SH | 90.0 | 85.0 | -5.0 | 52.8 | 67.8 | 15.0 |
| 10RT DE | SL | 93.9 | 89.5 | -4.4 | 55.6 | 60.0 | 4.4 |
| Sea Mist | SL | 96.1 | 87.8 | -8.3 | 56.1 | 65.0 | 8.9 |
| Seabreeze GT | SL | 97.8 | 87.2 | -10.5 | 58.9 | 70.6 | 11.7 |
| Shoreline | SL | 96.7 | 92.8 | -3.9 | 56.7 | 71.7 | 15.0 |
| FRR 72 M2 | ST | 95.0 | 79.4 | -15.6 | 56.1 | 68.9 | 12.8 |
| Kent | ST | 90.0 | 86.1 | -3.9 | 57.8 | 70.6 | 12.8 |
| Navigator II | ST | 93.3 | 84.4 | -8.9 | 52.8 | 62.8 | 10.0 |

| | | | | | | | |
|-----------------------|----|-------|------|-------|------|------|------|
| Ruddy | ST | 88.9 | 83.3 | -5.5 | 50.6 | 69.4 | 18.9 |
| Xeric | ST | 92.2 | 85.5 | -6.7 | 52.8 | 62.2 | 9.4 |
| Avenger II | TF | 98.3 | 96.7 | -1.7 | 55.6 | 62.2 | 6.7 |
| Birmingham | TF | 100.0 | 91.1 | -8.9 | 52.8 | 62.8 | 10.0 |
| Black Tail | TF | 97.8 | 92.8 | -5.0 | 55.6 | 61.7 | 6.1 |
| Fayette | TF | 96.7 | 88.9 | -7.8 | 57.2 | 66.7 | 9.4 |
| JT-621 | TF | 96.1 | 93.3 | -2.8 | 56.7 | 63.9 | 7.2 |
| MNKY | TF | 93.9 | 85.6 | -8.3 | 53.3 | 62.8 | 9.4 |
| Saltillo | TF | 96.7 | 93.9 | -2.8 | 53.9 | 68.9 | 15.0 |
| Thunderstruck | TF | 97.8 | 88.9 | -8.9 | 55.0 | 70.0 | 15.0 |
| MI DOT THV | MX | 96.1 | 90.6 | -5.5 | 48.9 | 65.6 | 16.7 |
| MI DOT TUF | MX | 97.8 | 93.3 | -4.4 | 48.3 | 65.0 | 16.7 |
| MN DOT 25-131 | MX | 97.2 | 88.9 | -8.3 | 50.0 | 62.8 | 12.8 |
| MN DOT MNST-12 | MX | 96.1 | 86.1 | -10.0 | 57.8 | 68.9 | 11.1 |
| NE DOT Rural Region 2 | MX | 90.0 | 80.0 | -10.0 | 56.7 | 66.1 | 9.4 |
| NE DOT Urban and Turf | MX | 98.9 | 97.8 | -1.1 | 59.4 | 68.9 | 9.4 |
| NJ DOT A-4 | MX | 83.9 | 75.0 | -8.9 | 57.8 | 70.6 | 12.8 |
| NJ DOT Type B | MX | 92.8 | 97.2 | 4.4 | 55.6 | 63.9 | 8.3 |
| WI DOT #20 | MX | 96.1 | 85.0 | -11.1 | 53.9 | 62.2 | 8.3 |
| WI DOT #40 | MX | 86.7 | 75.5 | -11.2 | 56.7 | 67.2 | 10.6 |
| LSD (0.05) | | 12.4 | 13.5 | 11.5 | NS | NS | NS |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant. For % TC Change (when significant), the most positive value within a column is shaded blue, while the most negative value within a column is shaded red. Remaining cells are shaded in a blue-purple-red gradient with zero shaded purple. Negative values indicate a reduction in turf coverage of desired species, whereas a positive value means the turf coverage of the plot increased.

2. Species tested include: AL = alkaligrass (*Puccinellia distans*); AM = seaside alkaligrass (*Puccinellia maritima*); CH = Chewings fescue (*Festuca rubra* ssp. *fallax*); HD = hard fescue (*Festuca brevipila*); KB = Kentucky bluegrass (*Poa pratensis*); PR = perennial ryegrass (*Lolium perenne*); SB = smooth bromegrass (*Bromus inermis*); SL = slender creeping red fescue (*Festuca rubra* ssp. *littoralis*); ST = strong creeping red fescue (*Festuca rubra* ssp. *rubra*); TF = tall fescue (*Schedonorus arundinaceus*); MX = DOT-specified mixtures.

3. Tetraploid perennial ryegrass

Table 3.5 Minnesota Rural – Total living turf cover [Total Cover (TC)] for Fall 2017 and Spring 2018; and percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Entry | Species ² | Fall 2017 ¹ | Spring 2018 | 2017-2018 |
|-------------------------|----------------------|------------------------|-------------|-------------|
| | | Total Cover (TC) | | % TC Change |
| BAR PD06N17 | AL | 76.1 | 46.7 | -29.4 |
| BAR PD9032 | AL | 65.0 | 25.6 | -39.4 |
| Fults | AL | 30.6 | 20.0 | -10.6 |
| Salton Sea | AL | 61.7 | 11.7 | -50.0 |
| SeaSalt | AL | 26.7 | 12.2 | -14.4 |
| Oceania Maritima | AM | 63.9 | 41.1 | -22.8 |
| Castle | CH | 78.9 | 8.9 | -70.0 |
| Compass II | CH | 67.2 | 13.9 | -53.3 |
| FRC 43 M2 | CH | 81.1 | 8.3 | -72.8 |
| Heathland | CH | 70.0 | 13.9 | -56.1 |
| Beacon | HD | 92.2 | 28.9 | -63.3 |
| Gladiator | HD | 84.4 | 25.6 | -58.9 |
| Nanook | HD | 51.1 | 17.2 | -33.9 |
| Soil Guard | HD | 71.7 | 7.2 | -64.4 |
| Sword | HD | 77.2 | 12.2 | -65.0 |
| Barduke | KB | 56.7 | 7.8 | -48.9 |
| J-525 | KB | 52.8 | 4.4 | -48.3 |
| J-793 | KB | 37.8 | 2.2 | -35.6 |
| J-920 | KB | 27.2 | 2.2 | -25.0 |
| Milagro | KB | 57.2 | 1.1 | -56.1 |
| Morocco | KB | 69.4 | 8.3 | -61.1 |
| Tirem | KB | 56.1 | 11.7 | -44.4 |
| Volt | KB | 72.8 | 0.6 | -72.2 |
| 16-14-Lp 145 | PR | 90.6 | 1.1 | -89.4 |
| BAR Lp 10970 | PR | 77.8 | 2.8 | -75.0 |
| Gray Fox | PR | 83.9 | 0.6 | -83.3 |
| Premium | PR | 88.3 | 0.6 | -87.8 |
| Replicator ³ | PR | 90.6 | 1.7 | -88.9 |
| Stellar | PR | 93.9 | 0.6 | -93.3 |
| BAR BIF 1GRL | SB | 40.6 | 1.1 | -39.4 |
| Blue Mesa | SH | 82.2 | 35.6 | -46.7 |
| J-248 | SH | 68.9 | 18.9 | -50.0 |
| Quatro | SH | 81.7 | 23.9 | -57.8 |
| 10RT DE | SL | 90.0 | 29.4 | -60.6 |
| Sea Mist | SL | 91.1 | 25.6 | -65.6 |
| Seabreeze GT | SL | 84.4 | 12.8 | -71.7 |
| Shoreline | SL | 87.8 | 37.2 | -50.6 |
| FRR 72 M2 | ST | 70.0 | 13.9 | -56.1 |
| Kent | ST | 85.0 | 21.1 | -63.9 |
| Navigator II | ST | 70.0 | 23.9 | -46.1 |
| Ruddy | ST | 64.4 | 18.9 | -45.6 |
| Xeric | ST | 81.1 | 18.9 | -62.2 |

| | | | | |
|-----------------------|----|------|------|-------|
| Avenger II | TF | 87.2 | 3.9 | -83.3 |
| Birmingham | TF | 86.1 | 10.6 | -75.6 |
| Black Tail | TF | 68.9 | 5.0 | -63.9 |
| Fayette | TF | 80.6 | 3.3 | -77.2 |
| JT-621 | TF | 73.9 | 1.1 | -72.8 |
| MNKY | TF | 88.9 | 11.7 | -77.2 |
| Saltillo | TF | 79.4 | 7.8 | -71.7 |
| Thunderstruck | TF | 78.9 | 1.7 | -77.2 |
| MI DOT THV | MX | 73.3 | 21.7 | -51.7 |
| MI DOT TUF | MX | 71.1 | 34.4 | -36.7 |
| MN DOT 25-131 | MX | 83.9 | 31.7 | -52.2 |
| MN DOT MNST-12 | MX | 92.8 | 17.8 | -75.0 |
| NE DOT Rural Region 2 | MX | 81.7 | 9.4 | -72.2 |
| NE DOT Urban and Turf | MX | 98.3 | 11.1 | -87.2 |
| NJ DOT A-4 | MX | 84.4 | 18.9 | -65.6 |
| NJ DOT Type B | MX | 80.6 | 11.7 | -68.9 |
| WI DOT #20 | MX | 78.3 | 6.7 | -71.7 |
| WI DOT #40 | MX | 43.9 | 4.4 | -39.4 |
| LSD (0.05) | | 30.8 | 18.6 | 27.4 |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant. For % TC Change (when significant), the most positive value within a column is shaded blue, while the most negative value within a column is shaded red. Remaining cells are shaded in a blue-purple-red gradient with zero shaded purple. Negative values indicate a reduction in turf coverage of desired species, whereas a positive value means the turf coverage of the plot increased.

2. Species tested include: AL = alkaligrass (*Puccinellia distans*); AM = seaside alkaligrass (*Puccinellia maritima*); CH = Chewings fescue (*Festuca rubra* ssp. *fallax*); HD = hard fescue (*Festuca brevipila*); KB = Kentucky bluegrass (*Poa pratensis*); PR = perennial ryegrass (*Lolium perenne*); SB = smooth brome grass (*Bromus inermis*); SL = slender creeping red fescue (*Festuca rubra* ssp. *littoralis*); ST = strong creeping red fescue (*Festuca rubra* ssp. *rubra*); TF = tall fescue (*Schedonorus arundinaceus*); MX = DOT-specified mixtures.

3. Tetraploid perennial ryegrass

Table 3.6 Minnesota Urban – Total living turf cover [Total Cover (TC)] for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Entry | Species ² | Fall 2016 | Spring 2017 | 2016-2017 ¹ | Fall 2017 | Spring 2018 | 2017-2018 |
|-------------------------|----------------------|------------------|------------------|------------------------|------------------|------------------|-------------|
| | | Total Cover (TC) | Total Cover (TC) | % TC Change | Total Cover (TC) | Total Cover (TC) | % TC Change |
| BAR PD06N17 | AL | 98.3 | 85.6 | -12.8 | 7.8 | 1.1 | -6.7 |
| BAR PD9032 | AL | 89.5 | 83.9 | -5.6 | 7.8 | 12.2 | 4.4 |
| Fults | AL | 97.8 | 85.0 | -12.8 | 33.3 | 7.2 | -26.1 |
| Salton Sea | AL | 89.4 | 71.7 | -17.8 | 19.4 | 5.6 | -13.9 |
| SeaSalt | AL | 86.7 | 90.0 | 3.3 | 12.8 | 5.0 | -7.8 |
| Oceania Maritima | AM | 91.6 | 76.1 | -15.5 | 23.3 | 11.7 | -11.7 |
| Castle | CH | 98.9 | 82.2 | -16.7 | 96.1 | 1.1 | -95.0 |
| Compass II | CH | 96.1 | 91.1 | -5.0 | 84.4 | 3.3 | -81.1 |
| FRC 43 M2 | CH | 97.2 | 95.0 | -2.2 | 92.2 | 6.7 | -85.6 |
| Heathland | CH | 99.4 | 90.0 | -9.5 | 86.1 | 29.4 | -56.7 |
| Beacon | HD | 98.9 | 95.0 | -3.9 | 96.7 | 5.0 | -91.7 |
| Gladiator | HD | 97.8 | 92.2 | -5.6 | 63.9 | 8.3 | -55.6 |
| Nanook | HD | 97.2 | 94.5 | -2.8 | 75.0 | 13.9 | -61.1 |
| Soil Guard | HD | 93.3 | 90.6 | -2.8 | 92.8 | 9.4 | -83.3 |
| Sword | HD | 96.7 | 94.5 | -2.2 | 85.0 | 26.1 | -58.9 |
| Barduke | KB | 93.9 | 18.9 | -75.0 | 65.6 | 2.8 | -62.8 |
| J-525 | KB | 98.3 | 47.8 | -50.6 | 65.0 | 7.8 | -57.2 |
| J-793 | KB | 98.3 | 82.8 | -15.5 | 80.6 | 28.9 | -51.7 |
| J-920 | KB | 97.8 | 32.2 | -65.6 | 80.6 | 5.6 | -75.0 |
| Milagro | KB | 96.7 | 36.7 | -60.0 | 58.9 | 0.6 | -58.3 |
| Morocco | KB | 100.0 | 56.1 | -43.9 | 90.0 | 21.1 | -68.9 |
| Tirem | KB | 90.6 | 46.1 | -44.4 | 70.0 | 0.0 | -70.0 |
| Volt | KB | 97.2 | 11.7 | -85.6 | 50.6 | 6.7 | -43.9 |
| 16-14-Lp 145 | PR | 96.7 | 21.1 | -75.5 | 66.7 | 0.0 | -66.7 |
| BAR Lp 10970 | PR | 100.0 | 25.6 | -74.4 | 57.8 | 0.6 | -57.2 |
| Gray Fox | PR | 100.0 | 20.0 | -80.0 | 40.0 | 0.0 | -40.0 |
| Premium | PR | 91.1 | 47.8 | -43.3 | 89.4 | 0.6 | -88.9 |
| Replicator ³ | PR | 98.3 | 1.1 | -97.2 | 25.0 | 0.6 | -24.4 |
| Stellar | PR | 100.0 | 22.8 | -77.2 | 59.4 | 0.0 | -59.4 |
| BAR BIF 1GRL | SB | 100.0 | 94.4 | -5.6 | 37.2 | 0.0 | -37.2 |
| Blue Mesa | SH | 98.3 | 93.3 | -5.0 | 83.3 | 1.1 | -82.2 |
| J-248 | SH | 97.2 | 96.1 | -1.1 | 91.7 | 22.8 | -68.9 |
| Quatro | SH | 96.1 | 88.9 | -7.2 | 73.9 | 7.8 | -66.1 |
| 10RT DE | SL | 100.0 | 96.1 | -3.9 | 86.7 | 30.0 | -56.7 |
| Sea Mist | SL | 98.9 | 97.2 | -1.7 | 91.1 | 21.1 | -70.0 |
| Seabreeze GT | SL | 98.9 | 96.1 | -2.8 | 89.4 | 40.6 | -48.9 |
| Shoreline | SL | 99.4 | 92.2 | -7.2 | 92.2 | 46.7 | -45.6 |
| FRR 72 M2 | ST | 95.6 | 97.2 | 1.6 | 95.0 | 28.9 | -66.1 |
| Kent | ST | 98.9 | 97.2 | -1.6 | 96.1 | 52.8 | -43.3 |
| Navigator II | ST | 96.7 | 95.6 | -1.1 | 86.7 | 46.1 | -40.6 |

| | | | | | | | |
|-----------------------|----|-------|------|-------|------|------|-------|
| Ruddy | ST | 96.7 | 97.8 | 1.1 | 97.8 | 35.0 | -62.8 |
| Xeric | ST | 98.3 | 93.4 | -5.0 | 94.4 | 30.0 | -64.4 |
| Avenger II | TF | 100.0 | 89.4 | -10.6 | 80.0 | 1.1 | -78.9 |
| Birmingham | TF | 99.4 | 91.1 | -8.3 | 88.3 | 2.2 | -86.1 |
| Black Tail | TF | 99.4 | 82.8 | -16.7 | 94.4 | 0.6 | -93.9 |
| Fayette | TF | 90.5 | 86.7 | -3.9 | 78.9 | 0.0 | -78.9 |
| JT-621 | TF | 99.4 | 93.9 | -5.5 | 85.6 | 0.0 | -85.6 |
| MNKY | TF | 97.8 | 82.2 | -15.5 | 77.8 | 0.0 | -77.8 |
| Saltillo | TF | 100.0 | 93.9 | -6.1 | 93.3 | 0.0 | -93.3 |
| Thunderstruck | TF | 98.3 | 80.5 | -17.8 | 89.4 | 0.0 | -89.4 |
| MI DOT THV | MX | 99.4 | 97.8 | -1.7 | 95.0 | 35.0 | -60.0 |
| MI DOT TUF | MX | 100.0 | 98.3 | -1.7 | 88.9 | 35.6 | -53.3 |
| MN DOT 25-131 | MX | 99.4 | 96.7 | -2.8 | 92.8 | 34.4 | -58.3 |
| MN DOT MNST-12 | MX | 89.4 | 96.7 | 7.2 | 93.3 | 27.8 | -65.6 |
| NE DOT Rural Region 2 | MX | 98.9 | 33.9 | -65.0 | 55.0 | 0.0 | -55.0 |
| NE DOT Urban and Turf | MX | 97.8 | 83.3 | -14.4 | 99.4 | 5.6 | -93.9 |
| NJ DOT A-4 | MX | 98.9 | 91.7 | -7.2 | 95.6 | 41.7 | -53.9 |
| NJ DOT Type B | MX | 100.0 | 89.5 | -10.5 | 97.8 | 11.1 | -86.7 |
| WI DOT #20 | MX | 100.0 | 86.7 | -13.3 | 96.1 | 2.8 | -93.3 |
| WI DOT #40 | MX | 97.2 | 86.1 | -11.1 | 97.2 | 47.8 | -49.4 |
| LSD (0.05) | | 7.2 | 21.3 | 22.5 | 30.8 | 14.4 | 32.2 |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant. For % TC Change (when significant), the most positive value within a column is shaded blue, while the most negative value within a column is shaded red. Remaining cells are shaded in a blue-purple-red gradient with zero shaded purple. Negative values indicate a reduction in turf coverage of desired species, whereas a positive value means the turf coverage of the plot increased.

2. Species tested include: AL = alkaligrass (*Puccinellia distans*); AM = seaside alkaligrass (*Puccinellia maritima*); CH = Chewings fescue (*Festuca rubra* ssp. *fallax*); HD = hard fescue (*Festuca brevipila*); KB = Kentucky bluegrass (*Poa pratensis*); PR = perennial ryegrass (*Lolium perenne*); SB = smooth bromegrass (*Bromus inermis*); SL = slender creeping red fescue (*Festuca rubra* ssp. *littoralis*); ST = strong creeping red fescue (*Festuca rubra* ssp. *rubra*); TF = tall fescue (*Schedonorus arundinaceus*); MX = DOT-specified mixtures.

3. Tetraploid perennial ryegrass

Table 3.7 Nebraska Rural – Total living turf cover [Total Cover (TC)] for Fall 2017 and Spring 2018; and percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Entry | Species ² | Fall 2017 | Spring 2018 ¹ | 2017-2018 |
|-------------------------|----------------------|------------------|--------------------------|-------------|
| | | Total Cover (TC) | | % TC Change |
| BAR PD06N17 | AL | 0.0 | 16.7 | 16.7 |
| BAR PD9032 | AL | 0.0 | 32.8 | 32.8 |
| Fults | AL | 0.0 | 12.8 | 12.8 |
| Salton Sea | AL | 0.0 | 17.8 | 17.8 |
| SeaSalt | AL | 0.0 | 27.2 | 27.2 |
| Oceania Maritima | AM | 0.0 | 12.2 | 12.2 |
| Castle | CH | 0.0 | 26.1 | 26.1 |
| Compass II | CH | 0.0 | 7.8 | 7.8 |
| FRC 43 M2 | CH | 0.0 | 0.0 | 0.0 |
| Heathland | CH | 0.0 | 15.0 | 15.0 |
| Beacon | HD | 0.0 | 4.4 | 4.4 |
| Gladiator | HD | 0.0 | 5.6 | 5.6 |
| Nanook | HD | 0.0 | 40.6 | 40.6 |
| Soil Guard | HD | 0.0 | 16.7 | 16.7 |
| Sword | HD | 0.0 | 39.4 | 39.4 |
| Barduke | KB | 0.0 | 16.1 | 16.1 |
| J-525 | KB | 0.0 | 9.4 | 9.4 |
| J-793 | KB | 0.0 | 30.0 | 30.0 |
| J-920 | KB | 0.0 | 25.6 | 25.6 |
| Milagro | KB | 0.0 | 6.1 | 6.1 |
| Morocco | KB | 0.0 | 5.6 | 5.6 |
| Tirem | KB | 0.0 | 5.6 | 5.6 |
| Volt | KB | 0.0 | 12.2 | 12.2 |
| 16-14-Lp 145 | PR | 0.0 | 13.9 | 13.9 |
| BAR Lp 10970 | PR | 0.0 | 32.2 | 32.2 |
| Gray Fox | PR | 0.0 | 16.7 | 16.7 |
| Premium | PR | 0.0 | 15.0 | 15.0 |
| Replicator ³ | PR | 0.0 | 15.6 | 15.6 |
| Stellar | PR | 0.0 | 5.6 | 5.6 |
| BAR BIF 1GRL | SB | 0.0 | 0.0 | 0.0 |
| Blue Mesa | SH | 0.0 | 27.8 | 27.8 |
| J-248 | SH | 0.0 | 49.4 | 49.4 |
| Quatro | SH | 0.0 | 6.1 | 6.1 |
| 10RT DE | SL | 0.0 | 34.4 | 34.4 |
| Sea Mist | SL | 0.0 | 24.4 | 24.4 |
| Seabreeze GT | SL | 1.1 | 20.0 | 18.9 |
| Shoreline | SL | 0.0 | 22.8 | 22.8 |
| FRR 72 M2 | ST | 0.0 | 28.9 | 28.9 |
| Kent | ST | 0.0 | 29.4 | 29.4 |
| Navigator II | ST | 0.0 | 4.4 | 4.4 |
| Ruddy | ST | 0.0 | 13.3 | 13.3 |
| Xeric | ST | 0.0 | 0.0 | 0.0 |
| Avenger II | TF | 0.0 | 18.9 | 18.9 |
| Birmingham | TF | 0.0 | 4.4 | 4.4 |
| Black Tail | TF | 0.0 | 26.1 | 26.1 |
| Fayette | TF | 0.0 | 8.9 | 8.9 |

| | | | | |
|-----------------------|----|-----|------|------|
| JT-621 | TF | 0.0 | 26.7 | 26.7 |
| MNKY | TF | 0.0 | 7.2 | 7.2 |
| Saltillo | TF | 0.0 | 0.0 | 0.0 |
| Thunderstruck | TF | 0.0 | 14.4 | 14.4 |
| MI DOT THV | MX | 0.0 | 2.2 | 2.2 |
| MI DOT TUF | MX | 0.0 | 4.4 | 4.4 |
| MN DOT 25-131 | MX | 0.0 | 20.0 | 20.0 |
| MN DOT MNST-12 | MX | 0.0 | 39.4 | 39.4 |
| NE DOT Rural Region 2 | MX | 0.0 | 42.2 | 42.2 |
| NE DOT Urban and Turf | MX | 0.0 | 8.3 | 8.3 |
| NJ DOT A-4 | MX | 0.0 | 26.1 | 26.1 |
| NJ DOT Type B | MX | 0.0 | 21.1 | 21.1 |
| WI DOT #20 | MX | 0.0 | 8.3 | 8.3 |
| WI DOT #40 | MX | 0.0 | 2.2 | 2.2 |
| LSD (0.05) | | NS | 44.2 | NS |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant.

2. Species tested include: AL = alkaligrass (*Puccinellia distans*); AM = seaside alkaligrass (*Puccinellia maritima*); CH = Chewings fescue (*Festuca rubra* ssp. *fallax*); HD = hard fescue (*Festuca brevipila*); KB = Kentucky bluegrass (*Poa pratensis*); PR = perennial ryegrass (*Lolium perenne*); SB = smooth brome grass (*Bromus inermis*); SL = slender creeping red fescue (*Festuca rubra* ssp. *littoralis*); ST = strong creeping red fescue (*Festuca rubra* ssp. *rubra*); TF = tall fescue (*Schedonorus arundinaceus*); MX = DOT-specified mixtures.

3. Tetraploid perennial ryegrass

Table 3.8 Nebraska Urban – Total living turf cover [Total Cover (TC)] for Fall 2017 and Spring 2018; and percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Entry | Species ² | Fall 2017 ¹ | Spring 2018 | 2017-2018 |
|-------------------------|----------------------|------------------------|-------------|-------------|
| | | Total Cover (TC) | | % TC Change |
| BAR PD06N17 | AL | 10.0 | 3.3 | -6.7 |
| BAR PD9032 | AL | 9.1 | 16.7 | 7.6 |
| Fults | AL | 13.3 | 36.1 | 22.8 |
| Salton Sea | AL | 5.0 | 7.2 | 2.2 |
| SeaSalt | AL | 4.8 | 7.8 | 3.0 |
| Oceania Maritima | AM | 9.8 | 21.1 | 11.3 |
| Castle | CH | 3.9 | 0.0 | -3.9 |
| Compass II | CH | 18.0 | 25.6 | 7.6 |
| FRC 43 M2 | CH | 24.1 | 18.3 | -5.7 |
| Heathland | CH | 23.3 | 25.0 | 1.7 |
| Beacon | HD | 16.9 | 44.4 | 27.6 |
| Gladiator | HD | 52.0 | 47.2 | -4.8 |
| Nanook | HD | 19.6 | 29.4 | 9.8 |
| Soil Guard | HD | 4.4 | 12.8 | 8.3 |
| Sword | HD | 12.2 | 20.6 | 8.3 |
| Barduke | KB | 19.1 | 51.1 | 32.0 |
| J-525 | KB | 25.9 | 28.3 | 2.4 |
| J-793 | KB | 68.5 | 70.6 | 2.0 |
| J-920 | KB | 25.4 | 36.7 | 11.3 |
| Milagro | KB | 37.8 | 28.9 | -8.9 |
| Morocco | KB | 23.0 | 29.4 | 6.5 |
| Tirem | KB | 47.8 | 29.4 | -18.3 |
| Volt | KB | 16.9 | 7.2 | -9.6 |
| 16-14-Lp 145 | PR | 71.5 | 79.4 | 8.0 |
| BAR Lp 10970 | PR | 78.0 | 69.4 | -8.5 |
| Gray Fox | PR | 57.0 | 85.0 | 28.0 |
| Premium | PR | 65.7 | 77.2 | 11.5 |
| Replicator ³ | PR | 45.7 | 68.3 | 22.6 |
| Stellar | PR | 68.5 | 80.6 | 12.0 |
| BAR BIF 1GRL | SB | 49.6 | 1.1 | -48.5 |
| Blue Mesa | SH | 9.6 | 26.7 | 17.0 |
| J-248 | SH | 24.6 | 38.9 | 14.3 |
| Quatro | SH | 6.5 | 21.7 | 15.2 |
| 10RT DE | SL | 11.9 | 25.0 | 13.2 |
| Sea Mist | SL | 35.4 | 49.4 | 14.1 |
| Seabreeze GT | SL | 17.0 | 16.7 | -0.4 |
| Shoreline | SL | 26.9 | 50.0 | 23.2 |
| FRR 72 M2 | ST | 30.2 | 33.9 | 3.7 |
| Kent | ST | 30.2 | 25.0 | -5.2 |
| Navigator II | ST | 25.9 | 33.3 | 7.4 |
| Ruddy | ST | 33.7 | 33.3 | -0.4 |
| Xeric | ST | 10.6 | 15.0 | 4.4 |
| Avenger II | TF | 79.3 | 85.6 | 6.3 |
| Birmingham | TF | 65.4 | 83.3 | 18.0 |
| Black Tail | TF | 65.0 | 55.6 | -9.4 |
| Fayette | TF | 65.6 | 81.7 | 16.1 |

| | | | | |
|-----------------------|----|------|------|------|
| JT-621 | TF | 66.3 | 74.4 | 8.2 |
| MNKY | TF | 58.5 | 61.7 | 3.2 |
| Saltillo | TF | 63.2 | 84.4 | 21.3 |
| Thunderstruck | TF | 81.3 | 87.2 | 5.9 |
| MI DOT THV | MX | 30.4 | 58.9 | 28.5 |
| MI DOT TUF | MX | 15.6 | 58.9 | 43.3 |
| MN DOT 25-131 | MX | 47.4 | 42.2 | -5.2 |
| MN DOT MNST-12 | MX | 17.8 | 17.8 | 0.0 |
| NE DOT Rural Region 2 | MX | 47.6 | 48.3 | 0.7 |
| NE DOT Urban and Turf | MX | 80.0 | 81.1 | 1.1 |
| NJ DOT A-4 | MX | 35.9 | 42.2 | 6.3 |
| NJ DOT Type B | MX | 51.1 | 60.6 | 9.4 |
| WI DOT #20 | MX | 55.0 | 46.1 | -8.9 |
| WI DOT #40 | MX | 52.8 | 65.6 | 12.8 |
| LSD (0.05) | | 36.7 | 37.9 | NS |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant.

2. Species tested include: AL = alkaligrass (*Puccinellia distans*); AM = seaside alkaligrass (*Puccinellia maritima*); CH = Chewings fescue (*Festuca rubra* ssp. *fallax*); HD = hard fescue (*Festuca brevipila*); KB = Kentucky bluegrass (*Poa pratensis*); PR = perennial ryegrass (*Lolium perenne*); SB = smooth brome grass (*Bromus inermis*); SL = slender creeping red fescue (*Festuca rubra* ssp. *littoralis*); ST = strong creeping red fescue (*Festuca rubra* ssp. *rubra*); TF = tall fescue (*Schedonorus arundinaceus*); MX = DOT-specified mixtures.

3. Tetraploid perennial ryegrass

Table 3.9 New Jersey Rural – Total living turf cover [Total Cover (TC)] for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Entry | Species ² | Fall 2016 ¹ | Spring 2017 | 2016-2017 | Fall 2017 | Spring 2018 | 2017-2018 |
|-------------------------|----------------------|------------------------|------------------|-------------|------------------|------------------|-------------|
| | | Total Cover (TC) | Total Cover (TC) | % TC Change | Total Cover (TC) | Total Cover (TC) | % TC Change |
| BAR PD06N17 | AL | 81.7 | 73.9 | -7.8 | 16.7 | 41.7 | 25.0 |
| BAR PD9032 | AL | 36.6 | 22.8 | -13.9 | 35.0 | 34.4 | -0.6 |
| Fulfs | AL | 87.8 | 80.0 | -7.8 | 63.9 | 75.6 | 11.7 |
| Salton Sea | AL | 55.0 | 56.7 | 1.7 | 30.0 | 38.9 | 8.9 |
| SeaSalt | AL | 49.4 | 79.5 | 30.0 | 10.6 | 35.0 | 24.4 |
| Oceania Maritima | AM | 67.2 | 70.5 | 3.3 | 31.1 | 46.7 | 15.6 |
| Castle | CH | 46.7 | 0.0 | -46.7 | 0.0 | 0.0 | 0.0 |
| Compass II | CH | 46.7 | 0.0 | -46.7 | 0.0 | 0.0 | 0.0 |
| FRC 43 M2 | CH | 49.4 | 0.0 | -49.4 | 0.0 | 0.0 | 0.0 |
| Heathland | CH | 39.4 | 0.0 | -39.4 | 0.6 | 0.0 | -0.6 |
| Beacon | HD | 49.5 | 0.0 | -49.5 | 2.8 | 0.0 | -2.8 |
| Gladiator | HD | 43.9 | 0.0 | -43.9 | 0.0 | 0.0 | 0.0 |
| Nanook | HD | 59.4 | 0.0 | -59.4 | 0.0 | 0.0 | 0.0 |
| Soil Guard | HD | 36.7 | 0.0 | -36.7 | 0.0 | 0.0 | 0.0 |
| Sword | HD | 67.2 | 0.0 | -67.2 | 0.6 | 0.0 | -0.6 |
| Barduke | KB | 28.3 | 0.0 | -28.3 | 0.0 | 0.0 | 0.0 |
| J-525 | KB | 21.1 | 0.0 | -21.1 | 0.6 | 0.0 | -0.6 |
| J-793 | KB | 43.4 | 0.0 | -43.4 | 0.0 | 0.0 | 0.0 |
| J-920 | KB | 22.2 | 0.0 | -22.2 | 0.0 | 0.0 | 0.0 |
| Milagro | KB | 20.5 | 0.0 | -20.5 | 1.1 | 0.0 | -1.1 |
| Morocco | KB | 25.6 | 0.0 | -25.6 | 0.0 | 0.0 | 0.0 |
| Tirem | KB | 28.3 | 0.0 | -28.3 | 0.0 | 0.0 | 0.0 |
| Volt | KB | 10.6 | 0.0 | -10.6 | 0.0 | 0.0 | 0.0 |
| 16-14-Lp 145 | PR | 70.5 | 0.0 | -70.5 | 0.0 | 0.0 | 0.0 |
| BAR Lp 10970 | PR | 89.4 | 0.0 | -89.4 | 1.7 | 0.0 | -1.7 |
| Gray Fox | PR | 84.5 | 3.3 | -81.1 | 0.0 | 0.0 | 0.0 |
| Premium | PR | 86.7 | 0.6 | -86.1 | 0.6 | 0.0 | -0.6 |
| Replicator ³ | PR | 66.7 | 0.0 | -66.7 | 0.0 | 0.0 | 0.0 |
| Stellar | PR | 89.4 | 0.6 | -88.9 | 1.7 | 0.0 | -1.7 |
| BAR BIF 1GRL | SB | 55.6 | 4.4 | -51.1 | 0.0 | 0.0 | 0.0 |
| Blue Mesa | SH | 63.3 | 0.0 | -63.3 | 0.0 | 0.0 | 0.0 |
| J-248 | SH | 52.2 | 0.0 | -52.2 | 0.0 | 0.0 | 0.0 |
| Quatro | SH | 40.0 | 2.8 | -37.2 | 0.0 | 0.0 | 0.0 |
| 10RT DE | SL | 83.9 | 15.0 | -68.9 | 0.0 | 0.0 | 0.0 |
| Sea Mist | SL | 68.3 | 0.0 | -68.3 | 0.0 | 0.0 | 0.0 |
| Seabreeze GT | SL | 79.5 | 9.4 | -70.0 | 1.7 | 0.0 | -1.7 |
| Shoreline | SL | 73.3 | 1.1 | -72.2 | 0.6 | 0.0 | -0.6 |
| FRR 72 M2 | ST | 64.5 | 0.0 | -64.5 | 0.0 | 0.0 | 0.0 |
| Kent | ST | 57.8 | 0.6 | -57.2 | 0.6 | 0.0 | -0.6 |
| Navigator II | ST | 52.2 | 0.0 | -52.2 | 0.0 | 0.0 | 0.0 |

| | | | | | | | |
|-----------------------|----|------|------|-------|------|------|------|
| Ruddy | ST | 60.0 | 0.0 | -60.0 | 0.6 | 0.0 | -0.6 |
| Xeric | ST | 51.1 | 0.0 | -51.1 | 0.0 | 0.0 | 0.0 |
| Avenger II | TF | 69.4 | 0.0 | -69.4 | 3.3 | 0.0 | -3.3 |
| Birmingham | TF | 68.9 | 1.7 | -67.2 | 2.2 | 0.0 | -2.2 |
| Black Tail | TF | 61.7 | 2.8 | -58.9 | 4.4 | 0.0 | -4.4 |
| Fayette | TF | 73.9 | 1.7 | -72.2 | 0.6 | 0.0 | -0.6 |
| JT-621 | TF | 63.9 | 4.4 | -59.5 | 3.3 | 0.0 | -3.3 |
| MNKY | TF | 68.9 | 0.6 | -68.3 | 0.0 | 0.0 | 0.0 |
| Saltillo | TF | 77.2 | 6.7 | -70.6 | 4.4 | 0.0 | -4.4 |
| Thunderstruck | TF | 66.6 | 12.8 | -53.9 | 1.1 | 0.0 | -1.1 |
| MI DOT THV | MX | 83.9 | 66.1 | -17.8 | 51.7 | 53.3 | 1.7 |
| MI DOT TUF | MX | 85.0 | 73.9 | -11.1 | 59.4 | 61.1 | 1.7 |
| MN DOT 25-131 | MX | 63.9 | 0.0 | -63.9 | 0.0 | 0.0 | 0.0 |
| MN DOT MNST-12 | MX | 58.3 | 1.1 | -57.2 | 0.6 | 0.0 | -0.6 |
| NE DOT Rural Region 2 | MX | 18.3 | 0.0 | -18.3 | 0.0 | 0.0 | 0.0 |
| NE DOT Urban and Turf | MX | 90.0 | 21.7 | -68.4 | 7.2 | 0.0 | -7.2 |
| NJ DOT A-4 | MX | 46.1 | 0.6 | -45.5 | 0.0 | 0.0 | 0.0 |
| NJ DOT Type B | MX | 45.5 | 0.0 | -45.5 | 1.1 | 0.0 | -1.1 |
| WI DOT #20 | MX | 43.9 | 0.0 | -43.9 | 0.6 | 0.0 | -0.6 |
| WI DOT #40 | MX | 31.1 | 0.0 | -31.1 | 0.0 | 0.0 | 0.0 |
| LSD (0.05) | | 32.7 | 17.9 | 34.0 | 10.4 | 17.9 | 15.0 |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant. For % TC Change (when significant), the most positive value within a column is shaded blue, while the most negative value within a column is shaded red. Remaining cells are shaded in a blue-purple-red gradient with zero shaded purple. Negative values indicate a reduction in turf coverage of desired species, whereas a positive value means the turf coverage of the plot increased.

2. Species tested include: AL = alkaligrass (*Puccinellia distans*); AM = seaside alkaligrass (*Puccinellia maritima*); CH = Chewings fescue (*Festuca rubra* ssp. *fallax*); HD = hard fescue (*Festuca brevipila*); KB = Kentucky bluegrass (*Poa pratensis*); PR = perennial ryegrass (*Lolium perenne*); SB = smooth bromegrass (*Bromus inermis*); SL = slender creeping red fescue (*Festuca rubra* ssp. *littoralis*); ST = strong creeping red fescue (*Festuca rubra* ssp. *rubra*); TF = tall fescue (*Schedonorus arundinaceus*); MX = DOT-specified mixtures.

3. Tetraploid perennial ryegrass

Table 3.10 New Jersey Urban – Total living turf cover [Total Cover (TC)] for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Entry | Species ² | Fall 2016 ¹ | Spring 2017 | 2016-2017 | Fall 2017 | Spring 2018 | 2017-2018 |
|-------------------------|----------------------|------------------------|------------------|-------------|------------------|------------------|-------------|
| | | Total Cover (TC) | Total Cover (TC) | % TC Change | Total Cover (TC) | Total Cover (TC) | % TC Change |
| BAR PD06N17 | AL | 98.3 | 85.6 | -12.8 | 7.8 | 1.1 | -6.7 |
| BAR PD9032 | AL | 59.4 | 38.9 | -20.6 | 32.2 | 55.0 | 22.8 |
| Fults | AL | 75.6 | 57.8 | -17.8 | 55.6 | 74.4 | 18.9 |
| Salton Sea | AL | 23.9 | 23.9 | 0.0 | 14.4 | 53.9 | 39.4 |
| SeaSalt | AL | 25.6 | 28.9 | 3.3 | 28.3 | 60.6 | 32.2 |
| Oceania Maritima | AM | 63.4 | 62.2 | -1.2 | 36.1 | 62.2 | 26.1 |
| Castle | CH | 69.4 | 30.6 | -38.9 | 17.2 | 20.0 | 2.8 |
| Compass II | CH | 72.2 | 18.9 | -53.3 | 22.8 | 30.0 | 7.2 |
| FRC 43 M2 | CH | 67.8 | 20.6 | -47.2 | 14.4 | 22.2 | 7.8 |
| Heathland | CH | 72.8 | 17.2 | -55.6 | 19.4 | 17.8 | -1.7 |
| Beacon | HD | 75.6 | 40.5 | -35.0 | 22.2 | 32.8 | 10.6 |
| Gladiator | HD | 55.6 | 8.9 | -46.7 | 13.3 | 20.0 | 6.7 |
| Nanook | HD | 69.4 | 20.6 | -48.9 | 13.9 | 26.1 | 12.2 |
| Soil Guard | HD | 47.2 | 16.7 | -30.5 | 12.8 | 20.0 | 7.2 |
| Sword | HD | 57.2 | 16.7 | -40.5 | 15.6 | 37.2 | 21.7 |
| Barduke | KB | 31.1 | 4.4 | -26.7 | 4.4 | 15.0 | 10.6 |
| J-525 | KB | 19.4 | 0.0 | -19.4 | 1.1 | 5.6 | 4.4 |
| J-793 | KB | 30.5 | 0.0 | -30.5 | 8.9 | 20.6 | 11.7 |
| J-920 | KB | 28.9 | 5.6 | -23.3 | 7.2 | 18.3 | 11.1 |
| Milagro | KB | 16.6 | 1.1 | -15.5 | 0.6 | 3.3 | 2.8 |
| Morocco | KB | 31.1 | 2.8 | -28.3 | 16.7 | 33.9 | 17.2 |
| Tirem | KB | 33.9 | 6.7 | -27.2 | 24.4 | 40.6 | 16.1 |
| Volt | KB | 27.8 | 2.8 | -25.0 | 2.8 | 16.7 | 13.9 |
| 16-14-Lp 145 | PR | 96.1 | 72.8 | -23.4 | 28.3 | 43.9 | 15.6 |
| BAR Lp 10970 | PR | 90.6 | 68.3 | -22.2 | 41.7 | 50.0 | 8.3 |
| Gray Fox | PR | 88.4 | 83.3 | -5.0 | 25.6 | 45.0 | 19.4 |
| Premium | PR | 93.9 | 77.2 | -16.7 | 30.0 | 42.2 | 12.2 |
| Replicator ³ | PR | 80.0 | 47.8 | -32.2 | 32.2 | 29.4 | -2.8 |
| Stellar | PR | 95.0 | 72.8 | -22.2 | 26.7 | 36.1 | 9.4 |
| BAR BIF 1GRL | SB | 87.2 | 62.8 | -24.5 | 31.7 | 41.7 | 8.3 |
| Blue Mesa | SH | 73.9 | 20.6 | -53.3 | 10.0 | 18.3 | 8.3 |
| J-248 | SH | 73.3 | 27.8 | -45.6 | 22.8 | 31.1 | 8.3 |
| Quatro | SH | 55.5 | 15.5 | -40.0 | 13.3 | 21.7 | 12.2 |
| 10RT DE | SL | 84.4 | 41.7 | -42.8 | 38.3 | 50.6 | 1.1 |
| Sea Mist | SL | 77.2 | 42.2 | -35.0 | 31.1 | 32.2 | 17.8 |
| Seabreeze GT | SL | 83.9 | 60.0 | -23.9 | 45.0 | 62.8 | 13.9 |
| Shoreline | SL | 71.1 | 47.8 | -23.3 | 61.7 | 75.6 | 10.0 |
| FRR 72 M2 | ST | 68.3 | 26.1 | -42.2 | 8.9 | 24.4 | 15.6 |
| Kent | ST | 61.1 | 32.2 | -28.9 | 27.8 | 38.3 | 10.6 |
| Navigator II | ST | 67.2 | 27.2 | -40.0 | 27.8 | 38.3 | 10.6 |

| | | | | | | | |
|-----------------------|----|------|------|-------|------|------|------|
| Ruddy | ST | 70.0 | 25.0 | -45.0 | 8.9 | 22.2 | 13.3 |
| Xeric | ST | 75.0 | 31.1 | -43.9 | 23.9 | 39.4 | 15.6 |
| Avenger II | TF | 57.8 | 47.8 | -10.0 | 43.3 | 59.4 | 16.1 |
| Birmingham | TF | 78.9 | 57.8 | -21.1 | 38.3 | 52.8 | 14.4 |
| Black Tail | TF | 73.9 | 60.0 | -13.9 | 74.4 | 66.7 | -7.8 |
| Fayette | TF | 58.3 | 46.6 | -11.7 | 37.8 | 56.7 | 18.9 |
| JT-621 | TF | 77.8 | 33.3 | -44.4 | 47.8 | 61.1 | 13.3 |
| MNKY | TF | 55.6 | 31.7 | -23.9 | 40.6 | 61.1 | 20.6 |
| Saltillo | TF | 75.5 | 71.1 | -4.4 | 37.2 | 60.0 | 22.8 |
| Thunderstruck | TF | 80.6 | 63.9 | -16.7 | 60.0 | 69.4 | 9.4 |
| MI DOT THV | MX | 81.6 | 70.5 | -11.1 | 71.7 | 88.3 | 16.7 |
| MI DOT TUF | MX | 86.1 | 66.7 | -19.4 | 62.8 | 93.9 | 31.1 |
| MN DOT 25-131 | MX | 81.1 | 66.7 | -14.4 | 46.1 | 58.9 | 12.8 |
| MN DOT MNST-12 | MX | 67.8 | 37.2 | -30.6 | 49.4 | 61.1 | 11.7 |
| NE DOT Rural Region 2 | MX | 29.4 | 10.6 | -18.9 | 17.8 | 27.8 | 10.0 |
| NE DOT Urban and Turf | MX | 94.4 | 83.9 | -10.6 | 44.4 | 73.9 | 29.4 |
| NJ DOT A-4 | MX | 47.8 | 24.4 | -23.4 | 21.7 | 40.0 | 18.3 |
| NJ DOT Type B | MX | 56.1 | 18.4 | -37.7 | 29.4 | 43.9 | 14.4 |
| WI DOT #20 | MX | 59.4 | 34.4 | -25.0 | 46.7 | 64.4 | 17.8 |
| WI DOT #40 | MX | 55.6 | 37.8 | -17.8 | 27.2 | 50.0 | 22.8 |
| LSD (0.05) | | 22.3 | 33.0 | NS | NS | NS | NS |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant.

2. Species tested include: AL = alkaligrass (*Puccinellia distans*); AM = seaside alkaligrass (*Puccinellia maritima*); CH = Chewings fescue (*Festuca rubra* ssp. *fallax*); HD = hard fescue (*Festuca brevipila*); KB = Kentucky bluegrass (*Poa pratensis*); PR = perennial ryegrass (*Lolium perenne*); SB = smooth bromegrass (*Bromus inermis*); SL = slender creeping red fescue (*Festuca rubra* ssp. *littoralis*); ST = strong creeping red fescue (*Festuca rubra* ssp. *rubra*); TF = tall fescue (*Schedonorus arundinaceus*); MX = DOT-specified mixtures.

3. Tetraploid perennial ryegrass

Table 3.11 Wisconsin Rural – Total living turf cover [Total Cover (TC)] for Fall 2016, Spring 2017, and Fall 2017; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change).

| Turfgrass Entry | Species ² | Fall 2016 ¹ | Spring 2017 | 2016-2017 | Fall 2018 |
|-------------------------|----------------------|------------------------|-------------|-------------|------------------|
| | | Total Cover (TC) | | % TC Change | Total Cover (TC) |
| BAR PD06N17 | AL | 24.4 | 45.6 | 21.1 | 10.6 |
| BAR PD9032 | AL | 4.4 | 23.3 | 18.9 | 12.2 |
| Fults | AL | 26.7 | 51.1 | 24.4 | 23.9 |
| Salton Sea | AL | 6.1 | 13.9 | 7.8 | 6.7 |
| SeaSalt | AL | 2.2 | 38.3 | 36.1 | 0.6 |
| Oceania Maritima | AM | 15.6 | 47.8 | 32.2 | 16.7 |
| Castle | CH | 61.1 | 30.0 | -31.1 | 5.6 |
| Compass II | CH | 64.4 | 41.1 | -23.3 | 10.0 |
| FRC 43 M2 | CH | 50.0 | 36.7 | -13.3 | 15.0 |
| Heathland | CH | 56.7 | 49.4 | -7.2 | 9.4 |
| Beacon | HD | 36.1 | 59.4 | 23.3 | 12.8 |
| Gladiator | HD | 35.0 | 50.5 | 15.5 | 18.9 |
| Nanook | HD | 40.6 | 56.7 | 16.1 | 19.4 |
| Soil Guard | HD | 40.0 | 45.0 | 5.0 | 7.8 |
| Sword | HD | 62.8 | 45.6 | -17.2 | 6.7 |
| Barduke | KB | 31.1 | 18.9 | -12.3 | 20.0 |
| J-525 | KB | 27.8 | 25.0 | -2.8 | 11.1 |
| J-793 | KB | 13.3 | 19.4 | 6.1 | 3.3 |
| J-920 | KB | 18.9 | 13.3 | -5.6 | 8.3 |
| Milagro | KB | 15.0 | 13.9 | -1.1 | 21.7 |
| Morocco | KB | 13.9 | 23.9 | 10.0 | 12.8 |
| Tirem | KB | 12.8 | 27.8 | 15.0 | 10.6 |
| Volt | KB | 21.1 | 20.6 | -0.5 | 1.7 |
| 16-14-Lp 145 | PR | 63.3 | 25.0 | -38.3 | 12.8 |
| BAR Lp 10970 | PR | 73.3 | 46.1 | -27.2 | 3.9 |
| Gray Fox | PR | 66.1 | 46.7 | -19.4 | 5.6 |
| Premium | PR | 68.9 | 43.9 | -25.0 | 7.8 |
| Replicator ³ | PR | 73.9 | 50.0 | -23.9 | 12.2 |
| Stellar | PR | 76.1 | 40.5 | -35.6 | 10.0 |
| BAR BIF 1GRL | SB | 35.6 | 21.1 | -14.5 | 0.6 |
| Blue Mesa | SH | 50.0 | 47.2 | -2.8 | 23.9 |
| J-248 | SH | 40.0 | 41.7 | 1.7 | 4.4 |
| Quatro | SH | 35.0 | 35.6 | 0.6 | 13.3 |
| 10RT DE | SL | 81.1 | 60.0 | -21.1 | 29.4 |
| Sea Mist | SL | 53.9 | 51.1 | -2.8 | 20.0 |
| Seabreeze GT | SL | 64.4 | 42.2 | -22.2 | 10.0 |
| Shoreline | SL | 51.1 | 52.2 | 1.1 | 15.6 |
| FRR 72 M2 | ST | 57.2 | 41.7 | -15.6 | 11.7 |
| Kent | ST | 44.4 | 42.8 | -1.7 | 32.2 |
| Navigator II | ST | 62.2 | 55.6 | -6.7 | 25.0 |
| Ruddy | ST | 68.3 | 44.4 | -23.9 | 28.9 |
| Xeric | ST | 59.4 | 35.0 | -24.4 | 19.4 |
| Avenger II | TF | 47.2 | 32.2 | -15.0 | 9.4 |

| | | | | | |
|-----------------------|----|------|------|-------|------|
| Birmingham | TF | 53.3 | 27.8 | -25.5 | 15.6 |
| Black Tail | TF | 76.1 | 35.0 | -41.1 | 11.1 |
| Fayette | TF | 67.8 | 32.2 | -35.6 | 8.3 |
| JT-621 | TF | 43.3 | 25.6 | -17.8 | 2.2 |
| MNKY | TF | 36.1 | 17.2 | -18.9 | 0.0 |
| Saltillo | TF | 72.8 | 22.2 | -50.5 | 22.8 |
| Thunderstruck | TF | 47.2 | 20.6 | -26.7 | 6.1 |
| MI DOT THV | MX | 69.5 | 52.2 | -17.2 | 33.9 |
| MI DOT TUF | MX | 67.8 | 63.9 | -3.9 | 47.2 |
| MN DOT 25-131 | MX | 38.9 | 30.0 | -8.9 | 13.3 |
| MN DOT MNST-12 | MX | 47.2 | 42.2 | -5.0 | 16.7 |
| NE DOT Rural Region 2 | MX | 32.8 | 11.7 | -21.1 | 2.8 |
| NE DOT Urban and Turf | MX | 49.4 | 31.7 | -17.8 | 23.9 |
| NJ DOT A-4 | MX | 46.7 | 34.4 | -12.2 | 11.7 |
| NJ DOT Type B | MX | 39.5 | 47.2 | 7.8 | 22.2 |
| WI DOT #20 | MX | 52.2 | 25.5 | -26.7 | 3.9 |
| WI DOT #40 | MX | 29.5 | 23.9 | -5.6 | 0.0 |
| LSD (0.05) | | 30.0 | 33.3 | 29.6 | NS |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant. For % TC Change (when significant), the most positive value within a column is shaded blue, while the most negative value within a column is shaded red. Remaining cells are shaded in a blue-purple-red gradient with zero shaded purple. Negative values indicate a reduction in turf coverage of desired species, whereas a positive value means the turf coverage of the plot increased.

2. Species tested include: AL = alkaligrass (*Puccinellia distans*); AM = seaside alkaligrass (*Puccinellia maritima*); CH = Chewings fescue (*Festuca rubra* ssp. *fallax*); HD = hard fescue (*Festuca brevipila*); KB = Kentucky bluegrass (*Poa pratensis*); PR = perennial ryegrass (*Lolium perenne*); SB = smooth brome grass (*Bromus inermis*); SL = slender creeping red fescue (*Festuca rubra* ssp. *littoralis*); ST = strong creeping red fescue (*Festuca rubra* ssp. *rubra*); TF = tall fescue (*Schedonorus arundinaceus*); MX = DOT-specified mixtures.

3. Tetraploid perennial ryegrass

Table 3.12 Wisconsin Urban – Total living turf cover [Total Cover (TC)] for Fall 2017 and Spring 2018; and percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Entry | Species ² | Fall 2017 ¹ | Spring 2018 | 2017-2018 |
|-------------------------|----------------------|------------------------|-------------|-------------|
| | | Total Cover (TC) | | % TC Change |
| BAR PD06N17 | AL | 55.6 | 68.9 | 13.3 |
| BAR PD9032 | AL | 8.9 | 71.1 | 62.2 |
| Fults | AL | 30.6 | 76.1 | 45.6 |
| Salton Sea | AL | 1.7 | 45.6 | 43.9 |
| SeaSalt | AL | 8.9 | 69.4 | 60.6 |
| Oceania Maritima | AM | 31.7 | 72.2 | 40.6 |
| Castle | CH | 35.6 | 81.1 | 45.6 |
| Compass II | CH | 58.3 | 81.7 | 23.3 |
| FRC 43 M2 | CH | 37.8 | 85.0 | 47.2 |
| Heathland | CH | 54.4 | 79.4 | 25.0 |
| Beacon | HD | 43.3 | 81.7 | 38.3 |
| Gladiator | HD | 46.1 | 90.6 | 44.4 |
| Nanook | HD | 32.2 | 86.1 | 53.9 |
| Soil Guard | HD | 36.1 | 85.0 | 48.9 |
| Sword | HD | 38.3 | 78.9 | 40.6 |
| Barduke | KB | 33.3 | 62.8 | 29.4 |
| J-525 | KB | 14.4 | 53.3 | 38.9 |
| J-793 | KB | 24.4 | 66.7 | 42.2 |
| J-920 | KB | 13.3 | 54.4 | 41.1 |
| Milagro | KB | 15.6 | 63.3 | 47.8 |
| Morocco | KB | 10.6 | 56.7 | 46.1 |
| Tirem | KB | 12.8 | 55.6 | 42.8 |
| Volt | KB | 13.3 | 47.8 | 34.4 |
| 16-14-Lp 145 | PR | 84.4 | 93.9 | 9.4 |
| BAR Lp 10970 | PR | 83.9 | 96.7 | 12.8 |
| Gray Fox | PR | 86.7 | 96.1 | 9.4 |
| Premium | PR | 89.4 | 96.7 | 7.2 |
| Replicator ³ | PR | 87.2 | 97.8 | 10.6 |
| Stellar | PR | 79.4 | 91.1 | 11.7 |
| BAR BIF 1GRL | SB | 64.4 | 88.9 | 24.4 |
| Blue Mesa | SH | 53.9 | 87.2 | 33.3 |
| J-248 | SH | 35.6 | 79.4 | 43.9 |
| Quatro | SH | 33.3 | 83.3 | 50.0 |
| 10RT DE | SL | 42.2 | 91.1 | 48.9 |
| Sea Mist | SL | 51.7 | 82.8 | 31.1 |
| Seabreeze GT | SL | 55.6 | 88.3 | 32.8 |
| Shoreline | SL | 52.8 | 83.9 | 31.1 |
| FRR 72 M2 | ST | 56.7 | 86.7 | 30.0 |
| Kent | ST | 42.8 | 83.3 | 40.6 |
| Navigator II | ST | 53.3 | 78.3 | 25.0 |
| Ruddy | ST | 61.7 | 90.6 | 28.9 |
| Xeric | ST | 46.1 | 83.9 | 37.8 |

| | | | | |
|-----------------------|----|------|------|------|
| Avenger II | TF | 73.9 | 96.7 | 22.8 |
| Birmingham | TF | 71.1 | 91.1 | 20.0 |
| Black Tail | TF | 55.6 | 87.8 | 32.2 |
| Fayette | TF | 61.1 | 89.4 | 28.3 |
| JT-621 | TF | 67.8 | 90.0 | 22.2 |
| MNKY | TF | 58.3 | 81.1 | 22.8 |
| Saltillo | TF | 78.3 | 93.9 | 15.6 |
| Thunderstruck | TF | 65.0 | 92.8 | 27.8 |
| MI DOT THV | MX | 73.9 | 93.9 | 20.0 |
| MI DOT TUF | MX | 64.4 | 87.8 | 23.3 |
| MN DOT 25-131 | MX | 59.4 | 86.1 | 26.7 |
| MN DOT MNST-12 | MX | 43.9 | 87.2 | 43.3 |
| NE DOT Rural Region 2 | MX | 23.3 | 63.9 | 40.6 |
| NE DOT Urban and Turf | MX | 86.1 | 98.9 | 12.8 |
| NJ DOT A-4 | MX | 33.3 | 73.9 | 40.6 |
| NJ DOT Type B | MX | 51.7 | 88.3 | 36.7 |
| WI DOT #20 | MX | 62.8 | 89.4 | 26.7 |
| WI DOT #40 | MX | 40.0 | 78.9 | 38.9 |
| LSD (0.05) | | 22.4 | 25.3 | 29.6 |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant. For % TC Change (when significant), the most positive value within a column is shaded blue, while the most negative value within a column is shaded red. Remaining cells are shaded in a blue-purple-red gradient with zero shaded purple. Negative values indicate a reduction in turf coverage of desired species, whereas a positive value means the turf coverage of the plot increased.

2. Species tested include: AL = alkaligrass (*Puccinellia distans*); AM = seaside alkaligrass (*Puccinellia maritima*); CH = Chewings fescue (*Festuca rubra* ssp. *fallax*); HD = hard fescue (*Festuca brevipila*); KB = Kentucky bluegrass (*Poa pratensis*); PR = perennial ryegrass (*Lolium perenne*); SB = smooth bromegrass (*Bromus inermis*); SL = slender creeping red fescue (*Festuca rubra* ssp. *littoralis*); ST = strong creeping red fescue (*Festuca rubra* ssp. *rubra*); TF = tall fescue (*Schedonorus arundinaceus*); MX = DOT-specified mixtures.

3. Tetraploid perennial ryegrass

Table 3.13 Michigan rural – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Species | Fall 2016 | Spring 2017 | 2016-2017 | Fall 2017 | Spring 2018 | 2017-2018 |
|-------------------------------|-------------------------------|-------------|-------------|------------------|-------------|-------------|
| | Total Cover (TC) ¹ | | % TC Change | Total Cover (TC) | | % TC Change |
| Alkaligrass | 41.9 | 42.3 | 0.4 | 9.6 | 12.1 | 2.5 |
| Chewings fescue | 94.0 | 86.5 | -7.5 | 50.0 | 68.8 | 18.8 |
| Hard fescue | 89.7 | 89.3 | -0.3 | 71.8 | 88.5 | 16.6 |
| Kentucky bluegrass | 61.7 | 62.5 | 0.8 | 55.6 | 65.8 | 10.2 |
| Mixture | 83.6 | 80.5 | -3.1 | 67.6 | 78.9 | 11.3 |
| Perennial ryegrass | 97.2 | 93.4 | -3.8 | 74.2 | 74.5 | 0.3 |
| Sheep fescue | 91.5 | 89.1 | -2.4 | 68.7 | 83.8 | 15.1 |
| Slender creeping red fescue | 93.5 | 89.5 | -4.0 | 58.6 | 72.5 | 13.8 |
| Smooth brome | 85.6 | 84.4 | -1.1 | 97.7 | 90.5 | -7.2 |
| Strong creeping red fescue | 91.6 | 88.1 | -3.4 | 62.4 | 77.7 | 15.3 |
| Tall fescue | 94.9 | 89.0 | -5.8 | 83.4 | 87.2 | 3.8 |
| Tetraploid perennial ryegrass | 95.0 | 91.1 | -3.9 | 65.0 | 77.2 | 12.2 |
| LSD (0.05) | 9.8 | 9.3 | 7.8 | 15.8 | 13.4 | 12.0 |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant. For % TC Change (when significant), the most positive value within a column is shaded blue, while the most negative value within a column is shaded red. Remaining cells are shaded in a blue-purple-red gradient with zero shaded purple. Negative values indicate a reduction in turf coverage of desired species, whereas a positive value means the turf coverage of the plot increased.

Table 3.14 Michigan Urban – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Species | Fall 2016 | Spring 2017 | 2016-2017 | Fall 2017 | Spring 2018 | 2017-2018 |
|-------------------------------|-------------------------------|-------------|-------------|------------------|-------------|-------------|
| | Total Cover (TC) ¹ | | % TC Change | Total Cover (TC) | | % TC Change |
| Alkaligrass | 55.6 | 34.4 | -21.1 | 56.2 | 66.0 | 9.8 |
| Chewings fescue | 90.9 | 82.4 | -8.4 | 53.0 | 65.1 | 12.0 |
| Hard fescue | 92.9 | 87.1 | -5.7 | 53.8 | 65.4 | 11.5 |
| Kentucky bluegrass | 59.6 | 26.4 | -33.2 | 55.8 | 66.7 | 10.0 |
| Mixture | 93.6 | 86.9 | -6.6 | 53.6 | 66.2 | 12.6 |
| Perennial ryegrass | 99.1 | 96.4 | -2.6 | 57.1 | 67.6 | 10.5 |
| Sheep fescue | 90.9 | 89.0 | -1.8 | 55.9 | 67.5 | 11.6 |
| Slender creeping red fescue | 96.1 | 89.0 | -6.8 | 54.5 | 69.0 | 14.4 |
| Smooth brome | 97.7 | 92.7 | -5.0 | 57.7 | 70.5 | 12.7 |
| Strong creeping red fescue | 91.9 | 83.7 | -8.1 | 56.1 | 68.2 | 12.1 |
| Tall fescue | 97.2 | 91.3 | -5.7 | 54.9 | 68.1 | 13.2 |
| Tetraploid perennial ryegrass | 100.0 | 97.8 | -2.2 | 52.7 | 62.2 | 9.4 |
| LSD (0.05) | 8.0 | 8.1 | 6.4 | NS | NS | NS |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant. For % TC Change (when significant), the most positive value within a column is shaded blue, while the most negative value within a column is shaded red. Remaining cells are shaded in a blue-purple-red gradient with zero shaded purple. Negative values indicate a reduction in turf coverage of desired species, whereas a positive value means the turf coverage of the plot increased.

Table 3.15 Minnesota Rural – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2017 and Spring 2018; percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Species | Fall 2017 | Spring 2018 | 2017-2018 |
|-------------------------------|-------------------------------|-------------|-------------|
| | Total Cover (TC) ¹ | | % TC Change |
| Alkaligrass | 54.0 | 26.2 | -27.8 |
| Chewings fescue | 74.3 | 11.3 | -63.1 |
| Hard fescue | 75.3 | 18.2 | -57.1 |
| Kentucky bluegrass | 53.8 | 4.8 | -49.0 |
| Mixture | 78.8 | 16.8 | -62.1 |
| Perennial ryegrass | 86.9 | 1.1 | -85.8 |
| Sheep fescue | 77.6 | 26.1 | -51.5 |
| Slender creeping red fescue | 88.3 | 26.3 | -62.1 |
| Smooth brome | 40.6 | 1.1 | -39.4 |
| Strong creeping red fescue | 74.1 | 19.3 | -54.8 |
| Tall fescue | 80.5 | 5.6 | -74.9 |
| Tetraploid perennial ryegrass | 90.6 | 1.7 | -88.9 |
| LSD (0.05) | 17.5 | 10.6 | 15.5 |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher’s Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant. For % TC Change (when significant), the most positive value within a column is shaded blue, while the most negative value within a column is shaded red. Remaining cells are shaded in a blue-purple-red gradient with zero shaded purple. Negative values indicate a reduction in turf coverage of desired species, whereas a positive value means the turf coverage of the plot increased.

Table 3.16 Minnesota Urban – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Species | Fall 2016 | Spring 2017 | 2016-2017 | Fall 2017 | Spring 2018 | 2017-2018 |
|-------------------------------|-------------------------------|-------------|-------------|------------------|-------------|-------------|
| | Total Cover (TC) ¹ | | % TC Change | Total Cover (TC) | | % TC Change |
| Alkaligrass | 91.0 | 81.3 | -9.7 | 17.4 | 7.1 | -10.3 |
| Chewings fescue | 97.9 | 89.6 | -8.3 | 89.7 | 10.1 | -79.6 |
| Hard fescue | 96.8 | 93.3 | -3.4 | 82.7 | 12.6 | -70.1 |
| Kentucky bluegrass | 96.8 | 46.4 | -50.4 | 70.1 | 9.2 | -61.0 |
| Mixture | 98.1 | 86.1 | -12.1 | 91.1 | 24.2 | -67.0 |
| Perennial ryegrass | 97.6 | 27.5 | -70.1 | 62.7 | 0.2 | -62.4 |
| Sheep fescue | 97.2 | 92.8 | -4.4 | 83.0 | 10.6 | -72.4 |
| Slender creeping red fescue | 99.3 | 95.4 | -3.9 | 89.9 | 34.6 | -55.3 |
| Smooth brome | 100.0 | 94.4 | -5.6 | 37.2 | 0.0 | -37.2 |
| Strong creeping red fescue | 97.2 | 96.2 | -1.0 | 94.0 | 38.6 | -55.4 |
| Tall fescue | 98.1 | 87.6 | -10.6 | 86.0 | 0.5 | -85.5 |
| Tetraploid perennial ryegrass | 98.3 | 1.1 | -97.2 | 25.0 | 0.6 | -24.4 |
| LSD (0.05) | 4.6 | 14.2 | 14.8 | 15.9 | 10.5 | 17.5 |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant. For % TC Change (when significant), the most positive value within a column is shaded blue, while the most negative value within a column is shaded red. Remaining cells are shaded in a blue-purple-red gradient with zero shaded purple. Negative values indicate a reduction in turf coverage of desired species, whereas a positive value means the turf coverage of the plot increased.

Table 3.17 Nebraska Rural – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2017 and Spring 2018; percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Species | Fall 2017 | Spring 2018 | 2017-2018 |
|-------------------------------|-------------------------------------|--------------------|--------------------|
| | Total Cover (TC)¹ | | % TC Change |
| Alkaligrass | 0.0 | 19.9 | 19.9 |
| Chewings fescue | 0.0 | 12.2 | 12.2 |
| Hard fescue | 0.0 | 21.3 | 21.3 |
| Kentucky bluegrass | 0.0 | 13.8 | 13.8 |
| Mixture | 0.0 | 17.4 | 17.4 |
| Perennial ryegrass | 0.0 | 16.7 | 16.7 |
| Sheep fescue | 0.0 | 27.8 | 27.8 |
| Slender creeping red fescue | 0.3 | 25.4 | 25.1 |
| Smooth brome grass | 0.0 | 0.0 | 0.0 |
| Strong creeping red fescue | 0.0 | 15.2 | 15.2 |
| Tall fescue | 0.0 | 13.3 | 13.3 |
| Tetraploid perennial ryegrass | 0.0 | 15.6 | 15.6 |
| LSD (0.05) | NS | NS | NS |

1. There were no significant differences among species treatments.

Table 3.18 Nebraska Urban – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2017 and Spring 2018; percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Species | Fall 2017 | Spring 2018 | 2017-2018 |
|-------------------------------|-------------------------------|-------------|-------------|
| | Total Cover (TC) ¹ | | % TC Change |
| Alkaligrass | 8.7 | 15.4 | 6.7 |
| Chewings fescue | 17.3 | 17.2 | -0.1 |
| Hard fescue | 21.0 | 30.9 | 9.9 |
| Kentucky bluegrass | 33.0 | 35.2 | 2.2 |
| Mixture | 43.4 | 52.2 | 8.8 |
| Perennial ryegrass | 68.2 | 78.3 | 10.2 |
| Sheep fescue | 13.6 | 29.1 | 15.5 |
| Slender | 22.8 | 35.3 | 12.5 |
| Smooth bromegrass | 49.6 | 1.1 | -48.5 |
| Strong creeping red fescue | 26.1 | 28.1 | 2.0 |
| Tall fescue | 68.1 | 76.7 | 8.7 |
| Tetraploid perennial ryegrass | 45.7 | 68.3 | 22.6 |
| LSD (0.05) | 19.4 | 20.0 | 20.8 |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant. For % TC Change (when significant), the most positive value within a column is shaded blue, while the most negative value within a column is shaded red. Remaining cells are shaded in a blue-purple-red gradient with zero shaded purple. Negative values indicate a reduction in turf coverage of desired species, whereas a positive value means the turf coverage of the plot increased.

Table 3.19 New Jersey Rural – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Species | Fall 2016 | Spring 2017 | 2016-2017 | Fall 2017 | Spring 2018 | 2017-2018 |
|-------------------------------|-------------------------------|-------------|-------------|------------------|-------------|-------------|
| | Total Cover (TC) ¹ | | % TC Change | Total Cover (TC) | | % TC Change |
| Alkaligrass | 59.2 | 61.9 | 2.7 | 31.2 | 45.4 | 14.2 |
| Chewings fescue | 45.6 | 0.0 | -45.6 | 0.1 | 0.0 | -0.1 |
| Hard fescue | 51.3 | 0.0 | -51.3 | 0.7 | 0.0 | -0.7 |
| Kentucky bluegrass | 31.3 | 8.2 | -23.1 | 0.2 | 0.0 | -0.2 |
| Mixture | 56.6 | 16.3 | -40.3 | 12.1 | 11.4 | -0.6 |
| Perennial ryegrass | 84.1 | 0.9 | -83.2 | 0.8 | 0.0 | -0.8 |
| Sheep fescue | 51.8 | 0.9 | -50.9 | 0.0 | 0.0 | 0.0 |
| Slender creeping red fescue | 76.3 | 6.4 | -69.9 | 0.6 | 0.0 | -0.6 |
| Smooth brome | 55.6 | 4.4 | -51.1 | 0.0 | 0.0 | 0.0 |
| Strong creeping red fescue | 57.1 | 0.1 | -57.0 | 0.2 | 0.0 | -0.2 |
| Tall fescue | 68.8 | 3.8 | -65.0 | 2.4 | 0.0 | -2.4 |
| Tetraploid perennial ryegrass | 66.7 | 0.0 | -66.7 | 0.0 | 0.0 | 0.0 |
| LSD (0.05) | 19.8 | 16.1 | 17.7 | 10.4 | 12.0 | 7.8 |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant. For % TC Change (when significant), the most positive value within a column is shaded blue, while the most negative value within a column is shaded red. Remaining cells are shaded in a blue-purple-red gradient with zero shaded purple. Negative values indicate a reduction in turf coverage of desired species, whereas a positive value means the turf coverage of the plot increased.

Table 3.20 New Jersey Urban – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2016, Spring 2017, Fall 2017 and Spring 2018; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change) and percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Species | Fall 2016 | Spring 2017 | 2016-2017 % TC Change | Fall 2017 | Spring 2018 | 2017-2018 % TC Change |
|-------------------------------|-------------------------------|------------------|-----------------------|------------------|------------------|-----------------------|
| | Total Cover (TC) ¹ | Total Cover (TC) | % TC Change | Total Cover (TC) | Total Cover (TC) | % TC Change |
| Alkaligrass | 49.6 | 42.3 | -7.2 | 30.0 | 55.7 | 25.7 |
| Chewings fescue | 70.6 | 21.8 | -48.8 | 18.5 | 22.5 | 4.0 |
| Hard fescue | 61.0 | 20.7 | -40.3 | 15.6 | 27.2 | 11.7 |
| Kentucky bluegrass | 31.2 | 9.1 | -22.2 | 8.3 | 19.2 | 11.0 |
| Mixture | 65.9 | 45.1 | -20.9 | 41.7 | 60.2 | 18.5 |
| Perennial ryegrass | 92.8 | 74.9 | -17.9 | 30.4 | 43.5 | 13.0 |
| Sheep fescue | 67.6 | 21.3 | -46.3 | 15.4 | 23.7 | 8.3 |
| Slender creeping red fescue | 79.2 | 47.9 | -31.3 | 44.0 | 55.3 | 11.3 |
| Smooth brome grass | 87.2 | 62.8 | -24.5 | 31.7 | 41.7 | 10.0 |
| Strong creeping red fescue | 68.3 | 28.3 | -40.0 | 19.4 | 32.6 | 13.1 |
| Tall fescue | 69.8 | 51.5 | -18.3 | 47.4 | 60.9 | 13.5 |
| Tetraploid perennial ryegrass | 80.0 | 47.8 | -32.2 | 32.2 | 29.5 | -2.8 |
| LSD (0.05) | 14.5 | 19.4 | 17.8 | 23.8 | 27.0 | 15.5 |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant. For % TC Change (when significant), the most positive value within a column is shaded blue, while the most negative value within a column is shaded red. Remaining cells are shaded in a blue-purple-red gradient with zero shaded purple. Negative values indicate a reduction in turf coverage of desired species, whereas a positive value means the turf coverage of the plot increased.

Table 3.21 Wisconsin Rural – Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2016, Spring 2017, and Fall 2017; and percent total cover change from 2016 to 2017 (2016-2017 % TC Change).

| Turfgrass Species | Fall 2016 | Spring 2017 | 2016-2017 | Fall 2017 |
|-------------------------------|------------------|-------------|-----------|------------------|
| | Total Cover (TC) | % TC Change | | Total Cover (TC) |
| Alkaligrass | 11.0 | 34.9 | 23.9 | 11.8 |
| Chewings fescue | 58.1 | 39.3 | -18.8 | 10.0 |
| Hard fescue | 42.9 | 51.4 | 8.6 | 13.1 |
| Kentucky bluegrass | 19.8 | 23.2 | 3.3 | 11.2 |
| Mixture | 47.3 | 36.3 | -11.1 | 17.6 |
| Perennial ryegrass | 69.6 | 40.4 | -29.1 | 8.0 |
| Sheep fescue | 41.7 | 41.5 | -0.2 | 13.9 |
| Slender creeping red fescue | 62.6 | 51.4 | -11.3 | 18.8 |
| Smooth brome grass | 35.6 | 21.1 | -14.4 | 0.6 |
| Strong creeping red fescue | 58.3 | 43.9 | -14.5 | 23.4 |
| Tall fescue | 55.5 | 26.6 | -28.9 | 9.4 |
| Tetraploid perennial ryegrass | 73.9 | 50.0 | -23.9 | 12.2 |
| LSD (0.05) | 15.7 | 14.9 | 15.8 | NS |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant. For % TC Change (when significant), the most positive value within a column is shaded blue, while the most negative value within a column is shaded red. Remaining cells are shaded in a blue-purple-red gradient with zero shaded purple. Negative values indicate a reduction in turf coverage of desired species, whereas a positive value means the turf coverage of the plot increased.

Table 3.22 Wisconsin Urban - Total living turf cover [Total Cover (TC)] by turfgrass species for Fall 2017 and Spring 2018; percent total cover change from 2017 to 2018 (2017-2018 % TC Change).

| Turfgrass Species | Fall 2017 | Spring 2018 | 2017-2018 |
|-------------------------------|-------------------------------|-------------|-------------|
| | Total Cover (TC) ¹ | | % TC Change |
| Alkaligrass | 22.9 | 67.2 | 44.4 |
| Chewings fescue | 46.5 | 81.8 | 35.3 |
| Hard fescue | 39.2 | 84.4 | 45.2 |
| Kentucky bluegrass | 17.2 | 57.6 | 40.4 |
| Mixture | 53.9 | 84.8 | 30.9 |
| Perennial ryegrass | 84.8 | 94.9 | 10.1 |
| Sheep fescue | 40.9 | 83.3 | 42.4 |
| Slender creeping red fescue | 50.6 | 86.5 | 36.0 |
| Smooth brome | 64.4 | 88.9 | 24.5 |
| Strong creeping red fescue | 52.1 | 84.6 | 32.4 |
| Tall fescue | 66.4 | 90.4 | 24.0 |
| Tetraploid perennial ryegrass | 87.2 | 97.8 | 10.6 |
| LSD (0.05) | 13.6 | 8.9 | 12.1 |

1. When treatment F tests were significant ($p \leq 0.05$), the Fisher's Protected Least Significant Difference Test (LSD) ($\alpha = 0.05$) was used to separate means. NS = not significant. For % TC Change (when significant), the most positive value within a column is shaded blue, while the most negative value within a column is shaded red. Remaining cells are shaded in a blue-purple-red gradient with zero shaded purple. Negative values indicate a reduction in turf coverage of desired species, whereas a positive value means the turf coverage of the plot increased.

CHAPTER 4: DISCUSSION

This experiment highlights the importance of multi-location testing and demonstrates the difficulty of roadside turf establishments, as only 6 of the 10 planned sites provided first year data. Delayed establishment due to weather or human interference ultimately affected total accumulated growing degree days (Table 2.4) for these sites, which is an important parameter for turf establishment (Frank et al., 1998). Accumulated growing degree days has been used to predict plant growth and development (Frank et al., 1998) as well as predicting emergence of annual weed populations (Fidanza et al., 1996). Even when adjusting for potential accumulation days (Table 2.4), growing degree days did not adequately explain differences in turf establishment across locations.

Weather may have been a determining factor for cultivar or species mixture composition success at a particular site. In cases where fine fescue entries had higher spring-rated turf coverage over Kentucky bluegrass (MI, MN, NJ Urban, and WI), higher snowfall amounts were more prevalent at these sites. Increased snowfall may have resulted in increased salt usage, a condition under which the fine fescues have been shown to be more tolerant (Friel et al., 2012). Accumulated salts from high road salt use was apparent at the rural site in New Jersey; this site had the highest electrical conductivity of any of the sites (Table 2.3). Our results suggest that high salt sites would benefit from mixtures with high proportions of alkaligrass; for example, the top performing mixtures at the rural site in New Jersey were the two mixtures from Michigan (THV and TUV) both of which contained alkaligrass (Table 2.1). No other mixtures in our study contained alkaligrass.

In several cases, no significant differences for turfgrass entry were detected suggesting that factors other than genetics must be considered. However, several turfgrasses performed well at multiple sites; this was especially the case for the alkaligrass entries. Mixtures that performed well at urban sites often included high percentages of fine fescues, especially *Festuca rubra* ssp.

Because practitioners always plant mixtures of species along roadsides, future studies should test a range of mixtures across the northern U.S. More precise site-specific ancillary data, such as controlled environment screening for salt stress, may prove useful for better understanding why particular entries or species perform better at particular locations.

CHAPTER 5: WEBSITE DEVELOPMENT

We created a website to increase availability of our research results for stakeholders in our partner states, as well as for department of transportation professionals in other northern states. These results can be found at <http://roadsideturf.umn.edu/research/regional-roadside-testing-project>. The website topics pertaining to the project are:

1. Introduction - <http://roadsideturf.umn.edu/research/regional-roadside-testing-project>
2. Materials and methods - <http://roadsideturf.umn.edu/regional-roadside-testing-materials-and-methods>
3. Results - <http://roadsideturf.umn.edu/regional-roadside-testing-results>
4. Project partners - <http://roadsideturf.umn.edu/regional-roadside-testing-partners-and-collaborators>
5. Acknowledgements – <http://roadsideturf.umn.edu/regional-roadside-mixtures/funding>

We will add research results from other roadside projects as they are completed. We will monitor the number of website visits via Google Analytics.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

Establishment of turfgrass entry was highly variable by state or site. Alkaligrasses tended to perform well at most testing locations; however, previous studies have suggested that this grass does not improve mixture performance (Friell et al., 2015) and in non-roadside turf situations has poor persistence (Watkins et al, 2011). Roadsides that are to be established in the northern U.S. in urban environments should be established with a higher percentage of fine fescues, especially either slender or strong creeping red fescues. Future research projects evaluating optimum cultivars, species, or mixtures for roadsides should include multi-site testing. These future studies could be coordinated with the same group of researchers and even expanded to include other interested states. One approach to regular multi-state cultivar testing would be to partner with the National Turfgrass Evaluation Program (n tep.org) to utilize its existing national turfgrass cultivar testing infrastructure. The methods and results described earlier in this report will be useful to any future national testing program.

This multi-state research project is the first to provide participating departments of transportation with unbiased, up-to-date information about the performance of turfgrass cultivars and mixtures used on roadsides in the northern U.S. Based on our results, we recommend the following:

1. Regular, ongoing roadside cultivar evaluation trials should be funded by state departments of transportation. This could be accomplished through a mechanism similar to the funding of this project, or through the National Turfgrass Evaluation Program (NTEP). The NTEP program is funded by fees paid by entry sponsors; since seed companies would stand to gain significant sales if a cultivar performed well in this type of trial, a fee-based system would likely work well. Based on the frequency of new cultivars being brought to the market, a new trial could be established approximately every 5 years.
2. Future studies should include a greater number of species mixtures.
3. On high-traffic roadways where salt loads are high, newer cultivars of alkaligrass should be included in mixtures.
4. In areas where traffic is lower, and aesthetics are important, mixtures with high percentages of fine fescues will generally be the best choice.
5. Perennial ryegrass should be avoided in areas where winter injury is likely due to harsh winters. If the fast germination rate of perennial ryegrass is desired, it should constitute a low (less than 20%) proportion of the mixture.
6. State departments of transportation should continue to investigate best management practices for turf establishment and maintenance to make sure the genetic potential of adapted cultivars is fulfilled.

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