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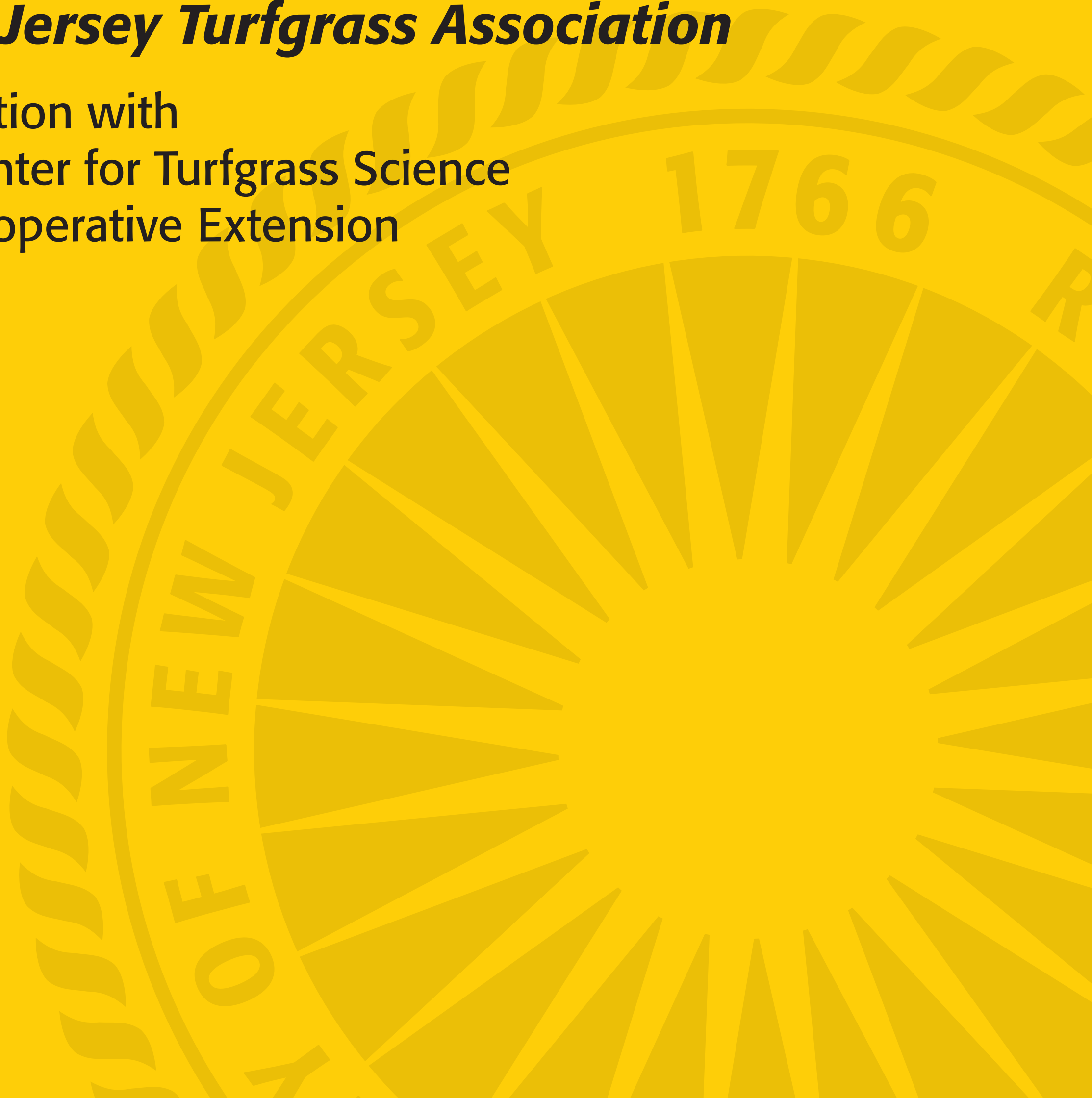

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The Rutgers Turfgrass Proceedings is published yearly by the Rutgers Center for Turfgrass Science, Rutgers Cooperative Extension, and the New Jersey Agricultural Experiment Station, School of Environmental and Biological Sciences, Rutgers, The State University of New Jersey in cooperation with the New Jersey Turfgrass Association. The purpose of this document is to provide a forum for the dissemination of information and the exchange of ideas and knowledge. The proceedings provide turfgrass managers, research scientists, extension specialists, and industry personnel with opportunities to communicate with co-workers. Through this forum, these professionals also reach a more general audience, which includes the public.

This publication includes lecture notes of papers presented at the 2013 GREEN EXPO Turf and Landscape Conference. Publication of these lectures provides a readily available source of information covering a wide range of topics and includes technical and popular presentations of importance to the turfgrass industry.

This proceedings also includes research papers that contain original research findings and reviews of selected subjects in turfgrass science. These papers are presented primarily to facilitate the timely dissemination of original turfgrass research for use by the turfgrass industry.

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Dr. Ann Brooks Gould, Editor
Dr. Bruce B. Clarke, Coordinator

PERFORMANCE OF FINE FESCUES UNDER TWO TYPES OF TRAFFIC DURING 2013

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The fine fescues (*Festuca* spp.) include several different species that have relatively fine leaf texture. As a group, fine fescues are known as low-input turfgrasses since they require less water and fertilizer to maintain a dense turf than many other commonly utilized grasses. Good drought tolerance of most fine fescue species also enable them to survive under chronic drought stress. Another outstanding characteristic of fine fescues is excellent shade tolerance, which makes these species useful in mixtures with other cool-season grasses.

There are many species and subspecies of *Festuca* used as turfgrass. Strong creeping red fescue (*Festuca rubra* L. *rubra*) produces long, abundant rhizomes and exhibits the widest range of color variation, ranging from light to dark green varieties. Slender creeping red fescue (*F. rubra* L. var. *littoralis* Vasey ex Beal) has shorter and weaker rhizomes compared to strong creeping red fescue. Chewings fescue [*F. rubra* L. subsp. *fallax* (Thuill.) Nyman] is a bunch-type aggressive grass and is considered to be more tolerant of lower mowing heights than other fine fescues. Hard fescue (*F. brevilipa* R. Tracey) also has bunch-type growth and it prefers less frequent mowing. It has very dark blue-green color and the greatest drought tolerance and also performs well under heat and low fertility conditions. Sheeps fescue (*F. ovina* L.) has a bunch-type growth habit and stiff leaves and can be used as a low-input turf. Blue fescue (*F. glauca* Vill.) is a bunch type species with bluish color that is normally used as ornamental plant instead of a turfgrass. Blue x hard fescue is a hybrid of blue fescue and hard fescue that exhibits a bluish green color and forms a denser turf canopy compared to blue fescue.

Durability and persistence under traffic stress is an important attribute of widely used turfgrasses. Although fine fescues possess a number of positive attributes, these species are not utilized to the same extent as other cool-season turfgrass species due, in part, to a lower tolerance of traffic and slower recuperative ability after damage (Shearman and Beard, 1975; Cook, 2003; Minner and Valverde, 2005). More extensive and recent studies of fine fescues have reported better tolerance to traffic under reduced maintenance (Stier, 2002; Horgan et al., 2007; Watkins et al., 2010; Cortese et al., 2011) or in mixtures (Newell et al., 1996). Improvement in the traffic tolerance of fine fescues would enable greater use of these species by the turf industry.

Traffic is a general term often used to describe one or more abiotic stresses including wear, compaction of soil, soil displacement, and divot removal (Carrow and Petrovic, 1992). Wear injury results from abrasion, tearing, or shredding of the leaf tissue. Soil compaction decreases soil porosity and increases soil strength which inhibits root growth and water infiltration and drainage. Carrow (1980) indicated that wear can be a greater factor contributing to differences among turfgrass species caused by traffic than compaction alone. A recent study also showed that injury caused by wear is the principal stress under traffic, accounting for 90% of the injury compared to soil compaction (Dest et al., 2009).

Turf response to traffic stress may vary based on the type of traffic is applied. The Rutgers Wear Simulator (RWS) was designed to apply abrasion and tearing of aboveground plant parts such as leaves, stems, and shoots with minimal compaction of the soil (Bonos et al., 2001). The Cady Traffic Simulator (CTS) was developed to impart a trampling effect that crushes aboveground plant parts and compacts the soil surface (Henderson et al., 2005). The objective of this study was to evaluate the performance

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of six fine fescues species under abrasive wear applied by the RWS and trampling applied by the CTS. Results will provide insight into whether abrasive wear or trampling stress is of greater importance among the fine fescues.

MATERIALS AND METHODS

This trial used a 3 x 10 factorial split-plot design with 4 replications. The main plot factor was the type of traffic with three levels: abrasive wear applied with the RWS, trampling applied with the CTS, and an untreated control. The subplot factor consisted of ten fine fescues entries: Aurora Gold and Beacon hard fescue, Culumbra II and Radar Chewings fescue, PPG-FRR-106 and Garnet strong creeping red fescue, Shoreline and Seabreeze GT slender creeping red fescue, Quatro sheeps fescue, and Blueray blue x hard fescue.

The fine fescue entries were seeded in September 2012 on a loam at the Rutgers Horticultural Research Farm II in North Brunswick, NJ. Testing in March 2014 indicated that soil pH was 6.44 and soil phosphorous (P) and potassium (K) were 260 and 269 lb per acre, respectively. The trial was mowed at 2.5 inch (6.4 cm) and irrigated to avoid drought stress. Nitrogen (N) applications in 2012 totaled 1.45 lb per 1000 ft^2 applied as 0.75 and 0.70 lb per 1000 ft^2 on 12 September and 12 October, respectively. In 2013, 1.77 lb per 1000 ft^2 was applied to the trial (0.89, 0.48, and 0.40 lb per 1000 ft^2 on 26 March, 1 May, and 9 September, respectively). Pesticides were applied preventively to control summer patch, brown patch, and dollar spot diseases in 2013.

Eight passes (one pass per week) of each traffic simulator were applied to main plots over 8 weeks from 24 September to 10 November 2013. Paddles on the RWS rotated at 250 rpm while the machine moved at 2.5 miles per hour. These treatments will be conducted in the same manner during the spring and summer of 2014. Traffic will be stopped for four weeks rest between the spring and summer traffic periods to allow recovery.

Turf quality (assessed on a 1 to 9 scale where 9 = ideal turf) was visually evaluated once a month during 2013. Uniformity and density of turf cover (UDC; evaluated on a 1 to 9 scale where 9 = most uniform turf cover), fullness of turf canopy (FTC; 0 to 100% scale where 100% = full canopy), and leaf bruising (1 to 9 scale where 9 = no bruising) were visually assessed before and after each traffic period. Percent green cover was evaluated using digital image analysis after each traffic period.

Analysis of variance was performed on data using a 3 x 10 factorial combination of traffic type and entries arranged in a split-plot design with four replications. Means were separated using Fisher's protected least significant difference (LSD) test at $p \leq 0.05$.

RESULTS AND DISCUSSION

As expected, both types of traffic applied in the autumn of 2013 had detrimental effects on fine fescues by reducing the UDC, FTC, and percent green cover, and increasing leaf bruising (Table 1). The CTS reduced FTC more than the RWS. However, the abrasive wear applied by the RWS resulted in more bruising injury and loss of green cover than the trampling caused by the CTS. The analysis of variance indicated that the fine fescue cultivar response for UDC, FTC, and leaf bruising depended on the type of traffic stress (traffic type by cultivar interactions; Table 1).

Radar and Beacon had the most uniform and dense cover and the greatest FTC while Aurora Gold and Seebreeze GT had the lowest UDC and FTC (Tables 2 and 3). Poor establishment before traffic (Table 6) was initiated was one explanation for the poor UDC and FTC of Aurora Gold and Seebreeze GT.

Beacon and Radar both exhibited a high UDC rating and a high relative UDC (Table 2). Quatro also ranked among the top group of entries for relative UDC but had only a moderate rating for UDC, suggesting that this cultivar has high traffic tolerance even though it is genetically limited in the ability to form a uniform and dense turf. Seabreeze GT and Aurora Gold had the lowest UDC under traffic. However, relative UDC data suggested that Aurora Gold had moderate traffic tolerance and Seabreeze GT had poor traffic tolerance (Table 2).

Similarly, Radar and Beacon maintained the greatest FTC under both types of traffic while Aurora Gold and Seabreeze GT had the lowest FTC under traffic (Table 3). Relative FTC indicated that Quatro and Beacon had the greatest tolerance of trampling traffic and Quatro, Beacon, Radar, Blueray, Shoreline, and PPG-FRR-106 had the greatest tolerance of abrasive traffic.

Bruising injury was not closely associated with UDC or FTC data during the autumn of 2013 (Table 4). Abrasive wear from the RWS caused differences among fine fescues for bruising injury as opposed to trampling from the CTS. Quatro sheeps fescue had the least bruising of all the fine fescues while Radar, Blueray, Shoreline, and Garnet exhibited the greatest bruising damage.

Green cover determined by digital image analysis (Table 5) was influenced more by discoloration (leaf bruising; Table 4) than the UDC or FTC of the plots. Quatro had the least bruising damage after abrasive wear (RWS) and the greatest green cover. Radar maintained a dense cover after wear (Tables 2 and 3) but exhibited severe discoloration from bruising damage and thus lower green cover.

In summary, differences in performance under traffic were observed among fine fescue species and cultivars during 2013 and the responses often depended on the type of traffic. Abrasive wear (RWS) caused more bruising injury than trampling (CTS) while the CTS reduce the density and uniformity of turf cover more than the RWS. Some species-cultivars expressed good tolerance to traffic but were strongly discolored (bruised) by abrasive wear stress. For example, Radar had better UDC and FTC under traffic but suffered severe bruising. Quatro had excellent resistance to bruising and tolerance to traffic but is limited in the ability to form a high quality turf.

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Table 1. Analysis of variance (ANOVA) of the uniformity and density of cover, fullness of turfgrass cover, leaf bruising, and green cover of fine fescues as affected by traffic type on 11 November 2013 in North Brunswick, NJ.

	Uniformity and Density of Cover[1]	Fullness of Turfgrass Cover[2]	Leaf Bruising[3]	Green Cover[4]	
				Before Wear	After Wear
Traffic Type	--1 to 9 scale--	----%----	--1 to 9 scale--	----------------% ----------------	
No Traffic	8.3	84.5	9.0	53.7	72.6
Cady Traffic Simulator[5]	5.8	57.3	6.3	54.2	53.6
Rutgers Wear Simulator[5]	6.5	70.8	4.0	55.5	38.7
LSD at 5% =	0.8	8.0	0.9	NS	4.8
Source of Variation	-------------------------------------Probability of significant F test-------------------------------------				
Traffic Type	***	***	***	NS	***
Cultivar	***	***	***	***	NS
Traffic Type x Cultivar	***	***	***	NS	NS
CV (%)	9.1	8.5	10.4	16.9	12.5

[1] 9 = most dense, uniform canopy
[2] 100% = full canopy
[3] 9 = least bruised
[4] 100% = complete green cover determined by digital image analysis
[5] 1 pass per week from 24 September to 10 November 2013
NS, *, **, ***Not significant, or significant at the 0.05, 0.01, and 0.001 probability level, respectively

Table 2. Uniformity and density of cover of fine fescues as affected by traffic type on 11 November 2013 in North Brunswick, NJ.

		Uniformity and Density of Cover (UDC)[1]			Relative UDC[2]	
Cultivar	Species	No Traffic	Cady Traffic Simulator[3]	Rutgers Wear Simulator[3]	Cady Traffic Simulator	Rutgers Wear Simulator
		------------------1 to 9 scale ------------------			--------------% --------------	
Radar	Chewings fescue	9.0	7.5	8.0	83.4	88.9
Beacon	Hard fescue	8.5	7.5	7.8	88.6	91.3
Blueray	Blue x hard fescue	9.0	6.3	7.5	74.1	85.2
PPG-FRR-106	Strong creeping red fescue	9.0	5.8	7.3	63.9	80.6
Shoreline	Slender fescue	8.5	6.0	6.8	71.2	79.2
Quatro	Sheeps fescue	7.5	6.3	6.5	83.7	87.3
Culumbra II	Chewings fescue	8.5	5.3	6.5	62.2	76.4
Garnet	Strong creeping red fescue	9.0	5.3	6.5	58.4	72.3
Aurora Gold	Hard fescue	6.0	4.0	4.5	72.0	75.4
Seabreeze GT	Slender creeping red fescue	7.5	4.0	4.0	53.1	53.6
	LSD at 5% Row		0.8		10.0	
	LSD at 5% Column		0.7		8.0	

[1] 9 = most dense, uniform canopy

[2] Relative UDC = (UDC for simulator/UDC for no traffic) x 100

[3] 1 pass per week from 24 September to 10 November 2013

Table 3. Fullness of turfgrass canopy of fine fescues as affected by traffic type on 11 November 2013 in North Brunswick, NJ.

		Fullness of Turfgrass Canopy (FTC)[1]			Relative FTC[2]	
Cultivar	Species	No Traffic	Cady Traffic Simulator[3]	Rutgers Wear Simulator[3]	Cady Traffic Simulator	Rutgers Wear Simulator
		------------------------%	------------------------		--------------%	--------------
Radar	Chewings fescue	96.3	76.3	87.5	79.3	91.0
Beacon	Hard fescue	88.8	76.3	81.3	86.0	91.6
PPG-FRR-106	Strong creeping red fescue	91.3	57.5	78.8	62.9	86.5
Blueray	Blue x hard fescue	90.0	65.0	77.5	76.3	90.9
Shoreline	Slender fescue	82.5	57.5	73.8	69.8	89.2
Garnet	Strong creeping red fescue	93.8	48.8	72.5	52.0	77.4
Quatro	Sheeps fescue	73.8	65.0	68.8	88.3	93.2
Culumbra II	Chewings fescue	88.8	51.3	68.8	58.0	77.5
Aurora Gold	Hard fescue	65.0	38.3	50.0	63.5	78.9
Seabreeze GT	Slender creeping red fescue	76.3	35.0	48.8	45.9	64.0
	LSD at 5% Row		8.0		8.8	
	LSD at 5% Column		7.1		7.7	

[1] 100% = fullest canopy

[2] Relative FTC = (FTC for simulator/FTC for no traffic) x 100

[3] 1 pass per week from 24 September to 10 November 2013

Table 4. Leaf bruising of fine fescues as affected by traffic type on 11 November 2013 in North Brunswick, NJ.

		Leaf Bruising[1]		
Cultivar	Species	No Traffic	Cady Traffic Simulator[2]	Rutgers Wear Simulator[2]
		-----------------------	1 to 9 scale	-----------------------
Quatro	Sheeps fescue	9.0	7.0	7.3
Aurora Gold	Hard fescue	9.0	5.3	5.3
Seabreeze GT	Slender creeping red fescue	9.0	6.5	4.3
PPG-FRR-106	Strong creeping red fescue	9.0	6.8	4.0
Beacon	Hard fescue	9.0	6.0	3.8
Culumbra II	Chewings fescue	9.0	5.8	3.5
Garnet	Strong creeping red fescue	9.0	6.0	3.3
Shoreline	Slender fescue	9.0	6.5	3.0
Blueray	Blue x hard fescue	9.0	5.3	3.0
Radar	Chewings fescue	9.0	7.0	2.5
	LSD at 5% Row		0.9	
	LSD at 5% Column		0.8	

[1] 9 = least bruising

[2] 1 pass per week from 24 September to 10 November 2013

Table 5. Green cover of fine fescues as affected by traffic type on 11 November 2013 in North Brunswick, NJ.

Cultivar	Species		Cover Before Traffic[1]	Cover After Traffic[1]
			--------------------%--------------------	
PPG-FRR-106	Strong creeping red fescue		68.7	59.3
Seabreeze GT	Slender creeping red fescue		55.7	57.9
Quatro	Sheeps fescue		57.0	56.8
Radar	Chewings fescue		62.7	56.1
Garnet	Strong creeping red fescue		58.8	56.1
Shoreline	Slender creeping red fescue		60.1	55.3
Blueray	Blue x hard fescue		52.2	53.6
Beacon	Hard fescue		45.4	53.3
Culumbra II	Chewings fescue		51.4	52.2
Aurora Gold	Hard fescue		34.0	50.4
		LSD at 5% =	7.5	NS

[1] 100% = most green cover; 1 pass per week from 24 September to 10 November 2013

Table 6. Turf establishment, spring green-up, turf quality, and susceptibility to summer patch of fine fescues before traffic during 2013 in North Brunswick, NJ.

Cultivar	Species	Turf Establishment[1] 16 April	Spring-Green-up[2] 4 April	Turf Quality[3] 30 April	30 May	26 June	23 July	26 Aug.	24 Sept.	Summer Patch[4] 17 July
		---1 to 9 scale---								
Radar	Chewings fescue	6.0	7.3	6.2	8.3	8.4	8.2	8.4	8.3	9.0
PPG-FRR-106	Strong creeping red fescue	6.9	2.9	5.5	7.7	8.3	8.2	7.9	8.0	9.0
Shoreline	Slender creeping red fescue	6.3	5.9	5.3	7.5	7.8	6.4	6.5	6.8	9.0
Garnet	Strong creeping red fescue	7.8	6.3	5.3	7.6	8.2	7.9	6.8	6.5	9.0
Culumbra II	Chewings fescue	6.8	7.0	6.3	8.3	7.4	6.0	6.2	6.2	9.0
Blueray	Blue x hard fescue	5.1	3.3	4.3	4.9	6.7	5.3	4.8	6.1	6.9
Beacon	Hard fescue	6.5	3.5	5.0	6.5	7.3	5.9	5.3	5.8	7.3
Quatro	Sheeps fescue	7.3	5.8	5.0	4.8	5.3	5.1	5.5	5.1	8.5
Seabreeze GT	Slender creeping red fescue	1.1	2.9	1.0	1.0	2.4	3.3	5.1	4.5	9.0
Aurora Gold	Hard fescue	3.8	2.7	2.4	3.8	4.4	3.1	2.9	3.0	7.7
	LSD at 5% =	0.7	0.5	0.5	0.5	0.5	1.2	1.2	1.0	1.0

[1] 9 = best establishment
[2] 9 = earliest spring green-up
[3] 9 = best turf quality
[4] 9 = least disease