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Are Turf-type Tall Fescue Cultivars Useful for Reducing Wildlife Hazards in Airport Environments?

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Abstract: Wildlife-aircraft collisions pose a serious risk to aircraft and cost civil aviation over US$1 billion worldwide annually. Habitat management within airport environments is the most important long-term component of an integrated approach to reduce the use of airfields by hazardous wildlife. Recent research has demonstrated that Canada geese avoid foraging on endophyte-infected tall fescue; consequently, this turfgrass might be useful in airfield revegetation and seeding projects. Although some research evaluating commercially available tall fescue cultivars on airfields has been conducted, additional information is needed to determine if tall fescue cultivars might be viable for airfields in various regions of the U.S. In 2007, a study was initiated to examine the establishment of currently available high-endophyte 'turf-type' tall fescue grasses at 9 airfields. The objectives were to: 1) determine if selected tall fescue cultivars establish on airfields across the U.S. and 2) provide airport-specific recommendations for tall fescue cultivar selection. At each airfield, 12 tall fescue cultivars were seeded into 3 replicate experimental plots in either fall of 2007 or spring of 2008. Although tall fescue cover varied among airports, most cultivars resulted in similar amounts of tall fescue cover after one or two growing seasons. This study demonstrates and identifies tall fescue cultivars that will grow successfully in the environmental conditions found on these airfields while providing airfield vegetation that is minimally attractive to wildlife hazardous to aviation.

Key Words: airports, bird control, birds, birdstrike hazard, grass, habitat management, tall fescue, *Schedonorus phoenix*

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INTRODUCTION

Wildlife-aircraft collisions cause serious safety hazards to aircraft and their occupants. Wildlife strikes cost civil aviation approximately $682 million annually in the United States (Dolbeer et al. 2011). Gulls (*Larus* spp.), waterfowl such as Canada geese (*Branta canadensis*), raptors (hawks and owls), and blackbirds (Icterinae)/starlings (*Sturnus vulgaris*) are the species presently of most concern at airports (Dolbeer et al. 2000, Dolbeer et al. 2011). Most strikes occur under 500 feet altitude (above ground level) in the vicinity of the airport (Dolbeer 2006, Dolbeer et al. 2011). Wildlife management techniques that reduce the number of birds in and around airports are therefore critical for safe airport operations.

Habitat management is a long-term component of an integrated approach for reducing wildlife use of airports. Species composition of plant communities (the types of plants) on airfield areas might also impact the degree of attractiveness of airfields to hazardous birds and other bird attractants (e.g., insects, small mammals) (Dekker and van der Zee 1996, Washburn and Seamans 2004, Washburn et al. 2007a). Ideally, airfield vegetation should possess a variety of desirable qualities. Vegetation used on airfields should be aesthetically pleasing to the public, relatively inflammable, tolerant to vehicle traffic, drought tolerant, and require minimal care and maintenance. In addition, favorable airfield vegetation should provide limited food resources (e.g., seeds, insects) for hazardous birds, provide little cover for small mammals (an attractant to raptors and owls), and resist invasion by other plants that provide food and cover for wildlife (Linnell et al. 2009, Washburn et al. 2011).

Tall fescue (*Schedonorus phoenix* (Scop.) Holub) is a cool-season perennial sod-forming grass that grows well in the U.S. in areas of temperate climate. In recent years, this turfgrass has become very popular and is used widely by the green industry in parks, lawns, golf courses, sports fields, and other areas (Casler 2006). Tall fescue is frequently infested with the fungal endophyte *Neotyphodium coenophialum* that forms a mutualistic symbiotic relationship with the grass. Grasses containing endophytic fungi derive several benefits, such as resistance to both grazing and insect herbivory, increased heat and drought stress tolerance, and increased vigor (Ju et al. 2006). Tall fescue is extremely competitive and develops into solid stands, crowding out other grasses, legumes, and annual weeds (Barnes et al. 1995, Washburn et al. 2000) and consequently tall fescue grasslands might be unattractive to wildlife (Mead and Carter 1973, Barnes et al. 1995, Washburn et al. 2007a).

Alkaloids (i.e., plant defense chemicals) produced by the endophyte-infected tall fescue have been shown to cause weight loss, reproductive problems, and a variety of diseases in livestock and laboratory small mammals (Schmidt and Osborn 1993, Bacon and Hill 1997). Further, research studies suggest wild mammals and birds might be negatively affected by consumption of endophyte-infected tall fescue (Madej and Clay 1991, Conover and Messmer 1996, Washburn 2000). Recent research has shown that grazing Canada geese do not consume endophyte-infected tall fescue (Washburn et al. 2007a, Washburn and Seamans 2012). These findings suggest endophyte-infected tall fescues might be favorable turfgrass cultivars to use in reseeding and vegetation renovation projects on airfields and other areas where Canada geese are unwanted.

Recently, a large number of 'turf-type' tall fescue cultivars have been developed for the turfgrass industry. Turf-type tall fescues are bred to maintain deep green color, drought and disease resistance, and grow to shorter heights at maturity than traditional tall fescues. In addition, many of these new cultivars have high levels of endophyte infection (Mohr et al. 2002). Over 200 varieties of turf-type tall fescue are currently available from the turfgrass industry

Table 1. Nine civil airports and military airfields in the northeastern, southeastern, and central United States where 12 commercially available tall fescue cultivars were seeded and evaluated during 2008-2010.

Airfield	State	Seeding Season	Seeding Date	Mulch applied?
Westover Air Reserve Base	MA	Fall	2 Oct 2007	Yes[a]
Washington Dulles International	VA	Fall	30 Oct 2007	Yes[a]
Capital City Regional	IL	Fall	17 Sept 2007	No
Williamson County Regional	IL	Fall	4 Oct 2007	No
Birmingham-Shuttlesworth International	AL	Spring	9 April 2008	Yes[b]
Cleveland-Hopkins International	OH	Spring	23 April 2008	Yes[c]
Gerald R. Ford International	MI	Spring	29 April 2008	No
Minneapolis-St. Paul International	MN	Spring	30 May 2008	No
St. Paul Downtown	MN	Spring	22 May 2008	No

[a]Mulch applied to study plots consisted of hay straw.
[b]Mulch applied to study plots consisted of pine straw.
[c]Mulch applied to study plots consisted of commercial hydromulch.

Table 2. Average tall fescue cover (%) and vegetation height (cm) during the first and second growing seasons following seeding of tall fescue cultivars at 9 airports during 2008-2010.

Airport	Tall fescue			
	First growing season		Second growing season	
	Cover (%)	Height (cm)	Cover (%)	Height (cm)
Fall Seeded				
Westover ARB	41	22.4	32	1.2
Washington Dulles IA	23	15.7	49	14.5
Capital City RA	65	17.9	71	22.2
Williamson County RA	3	3.6	--- [a]	--- [a]
Spring Seeded				
Minneapolis-St. Paul IA	9	30.2	45	10.8
St. Paul Downtown RA	2	53.5	19	30.2
Cleveland-Hopkins IA	29	8.1	52	--- [b]
Birmingham-Shutt. IA	1	13.6	--- [a]	--- [a]
Gerald R. Ford IA	50	7.6	35	17.3

[a] Essentially no tall fescue plants were found in the study plots during the second growing season.
[b] Airfield maintenance mowed the test plots to approximately 13 cm in height one week before the vegetation measurements were taken.

that could be used in airfield revegetation projects.

Previous research demonstrated that tall fescue cultivars will establish in airport environments, but more information is needed (Washburn et al. 2007b). Soil, climate, and biological (e.g., weed competition) conditions on airfields are typically very harsh for establishing and growing desirable vegetation. An additional series of experiments was conducted at numerous airports across the U.S. to evaluate the establishment of several new cultivars of tall fescue grass, each containing high levels of endophytic fungus. The objectives of the study were to: 1) determine if selected turf-type tall fescue cultivars will establish on various airfields across the U.S. and 2) provide airport-specific recommendations for tall fescue variety selection.

METHODS

This study was conducted at 9 civilian or military airfields in the northeastern, southeastern, and central United States (Table 1). At each airport, 12 tall fescue cultivars were seeded into 3 replicate experimental plots.

On each facility, 1,400 m^2 (15,000 ft^2) section of the airfield was prepared for seeding. All 12 tall fescue cultivars were seeded into 3 separate replicated plots (approximately 467 m^2 each) at each airport. Cultivars were selected based on information gained from seed companies and agronomists. All tall fescue cultivars were high-endophyte turf-type tall fescues, except for the 'Kentucky-31' cultivar (also high-endophyte) which is the original agronomic tall fescue variety found in the U.S. (Mohr et al. 2002). Eleven turf-type tall fescue cultivars were evaluated in this study, including 7 that were evaluated in previous experiments ('2nd Millennium', 'Crossfire II', 'Finesse II', 'Grande II', 'Mustang III', 'SR8600', and 'Titan LTD') and 4 new cultivars ('Inferno', 'Chocise III', 'Justice', and 'Rhambler'). We seeded the experimental plots by hand for increased control of seed application rate; all cultivars were seeded at a rate of 8 lbs./1000 ft^2. Following seeding, test plots were raked, "packed", and fertilizer was applied. Mulch was applied to treatment plots at some airfields at the time of seeding if the location of the plots relative to active aircraft movement areas allowed (Table 1).

Establishment and growth of seeded tall fescue cultivars was quantified by randomly establishing and sampling 5 0.25-m^2 herbaceous sampling plots in each treatment plot during the first and/or second growing season following seeding. Tall fescue cover (%), other grass (i.e., non-fescue) cover (%), forb and legume cover (%), bare ground (%), and height of living vegetation (cm) was visually estimated in each 0.25-m^2 sampling plot (Bonham 1989). Fescue cultivars seeded at 4 airfields in fall of 2007 were evaluated in fall 2008 and spring 2009 or fall 2009. The 5 airfields seeded in spring 2008 were evaluated in fall 2008 and fall 2009.

Airports seeded in the fall and the spring were analysed independently. Analysis of variance (ANOVA) techniques were used to test for differences in tall fescue cover and vegetation height among airports, among tall fescue cultivars, and for interactions between these 2 factors. Fisher's protected LSD tests were used for multiple comparisons when treatment effects (e.g., airports, cultivars) were significant ($P < 0.05$).

RESULTS

Fall Seedings

When averaged across all tall fescue cultivars, tall fescue cover at airports seeded during the fall was 33% (range 3% to 65%) 12 months after seeding and 51% (range 32% to 71%) 24 months after seeding (Table 2). Variation in tall fescue establishment among airports was evident at the end of the first ($F_{3,47}$ = 920.13, $P < 0.0001$) and second ($F_{2,35}$ = 129.74, $P < 0.0001$) growing seasons; tall fescue cover was highest at the Capital City Regional Airport and lowest at the Williamson County Regional Airport.

When averaged across all tall fescue cultivars, tall fescue cover at airports seeded during the fall was 33% (range 31% to 39%) and 51% (range 43% to 60%) 12 and 24 months after seeding, respectively (Table 3). At the end of the first growing season, the average cover of 'Kentucky-31' tall fescue was higher ($F_{3,47}$ = 2.36, P = 0.03) than the cover of the other 11 tall fescue cultivars. Tall fescue cover was not different ($F_{3,47}$ = 1.64, P = 0.16) among the 12 cultivars when assessed 24 months after seeding.

Spring Seedings

When averaged across all tall fescue cultivars, tall fescue cover at airports seeded during the spring was 18% (range 1% to 50%) and 38% (range 19% to 52%) 12 and 24 months after seeding, respectively (Table 2). Variation in tall fescue establishment among airports was evident at the end of the first growing season ($F_{4,59}$ = 99.60, $P < 0.0001$) and second ($F_{3,47}$ = 39.22, $P < 0.0001$) growing seasons; tall fescue cover was highest at the Gerald R. Ford International Airport and lowest at the Birmingham-Shuttlesworth International Airport. Similarly, tall fescue cover varied ($F_{3,47}$ = 39.22, $P < 0.0001$) among the airports after 24 months; the highest tall fescue cover occurred at Cleveland-Hopkins International Airport and the lowest at the St. Paul Downtown Airport.

When averaged across all tall fescue cultivars, tall fescue cover at airports seeded during the spring was 18% (range 12% to 28%) 12 months after seeding and 39% (range 26% to 52%) 24 months after seeding (Table 4). At the end of the first growing season, tall fescue cover was not different ($F_{11,59}$ = 1.85, P = 0.07) among the 12 cultivars. However, after 24 months tall fescue cover varied ($F_{11,47}$ = 2.86, P = 0.01) among the 12 cultivars; the 'Kentucky-31' and 'Rhambler' cultivars had the highest amount of tall fescue cover whereas the 'Chocise III' cultivar had the lowest.

Table 3. Average tall fescue cover (%) and vegetation height (cm) during the first and second growing seasons following fall seeding of 12 tall fescue cultivars at 4 airports during 2008-2010.

Tall fescue cultivar	Tall fescue			
	First growing season		Second growing season	
	Cover (%)	Height (cm)	Cover (%)	Height (cm)
Kentucky-31	39	16.8	60	16.7
2nd Millennium	33	14.5	53	12.2
Crossfire II	31	15.8	46	11.8
Finesse II	31	15.1	50	13.0
Grande II	34	14.6	49	12.2
Mustang III	31	13.5	43	12.0
SR8600	33	13.7	51	12.0
Titan LTD	32	15.3	49	12.1
Inferno	33	14.5	52	12.7
Chocise III	31	14.7	51	12.2
Justice	34	14.0	51	11.3
Rhambler	36	15.6	55	13.4

DISCUSSION

Consistent with previous research efforts, the findings from this study suggest commercially available high-endophyte tall fescue turf-type cultivars might be favorable turfgrass cultivars to use in reseeding and vegetation renovation projects on airfields and other areas. Overall, tall fescue cultivars established and grew on the 9 airfields utilized during this study. These airfields were located in various parts of the eastern and central United States and represent a diversity of soils, climates, and other local conditions. Consequently, they add to the existing knowledge base regarding the use of tall fescue cultivars within actual airport environments. Although all of the tall fescue cultivars seeded at each airport provided at least some tall fescue cover after one or two growing seasons, not unexpectedly, variation in performance among tall fescue cultivars did occur (i.e., some cultivars established and grew better than others). This variation was much more prominent at some airfields (e.g., St. Paul Downtown Airport) than others (e.g., Capital City Regional Airport), which is likely a function of differences in local climate and growing conditions.

Abiotic factors, such as climatic conditions and soil nutrient levels, and biotic factors (e.g., weed competition) have strong influence on the rate of establishment of turfgrasses and other plants seeded as part of an airfield renovation or revegetation project. Further, these abiotic and biotic factors can vary greatly among airports, depending on the geographic location of those airports and the local geology and soil conditions. Some factors, such as weather, cannot be controlled or predicted, and thus these influences are not in the control of airfield managers. In contrast, other factors can be monitored and amended, using methods such as soil testing and fertilization, using good quality turfgrass seed, and applying appropriate chemical control (e.g., herbicides) to reduce weed competition. The very poor quality soils, resulting from previous strip mining operations at the site, resulted in little to no establishment of tall fescue cultivars at the Williamson County Regional Airport. Consequently, soil amendments (e.g., fertilizer, addition of topsoil) would be useful in increasing the establishment of vegetation on this airfield. As another example, at Westover Air Reserve Base high amounts of clovers (*Trifolium* spp. L). were present in the plant community and provided intense competition for the seeded tall fescue cultivars. Selective herbicide appli-

Table 4. Average tall fescue cover (%) and vegetation height (cm) during the first and second growing seasons following spring seeding of 12 tall fescue cultivars at 5 airports during 2008-2010.

Tall fescue cultivar	Tall fescue			
	First growing season		Second growing season	
	Cover (%)	Height (cm)	Cover (%)	Height (cm)
Kentucky-31	28	21.4	52	20.3
2nd Millennium	22	22.5	36	15.0
Crossfire II	20	22.7	34	21.7
Finesse II	16	22.8	37	17.5
Grande II	17	19.2	41	19.6
Mustang III	16	24.7	32	19.6
SR8600	22	22.9	42	18.4
Titan LTD	16	22.1	36	17.8
Inferno	14	25.3	33	20.6
Chocise III	12	21.8	26	21.3
Justice	18	23.8	37	20.4
Rhambler	17	21.8	45	16.6

cations to remove the clovers and ultimately increase the coverage of tall fescue would be useful and effective in this and other situations.

Performance information of high endophyte tall fescue cultivars provided by this study, found within Washburn et al. (2007b) and within Washburn (2011), will be useful for airfield managers, grounds and maintenance personnel, and other individuals that are interested in selecting turfgrass cultivars for seeding or vegetation renovation projects on or near airfields. The experimental trials provide airport-specific recommendations regarding tall fescue cultivars for the 9 airfields where this study was conducted. In addition, this information can be used to make selections of tall fescue cultivars for other airports and facilities. Tall fescue cultivars that established and grew at individual airports is useful at other facilities within the same geographic region with similar soils, climate, and other local conditions.

Other sources of information regarding the utility of different tall fescue cultivars, such as the findings released by the National Turfgrass Evaluation Program (e.g., National Turfgrass Evaluation Program 2006), can be of assistance to airfield managers and other individuals interested in selecting turfgrass cultivars that might successfully establish and grow on airfields. However, caution is warranted when interpreting this information as the standard methods of turfgrass management (e.g., heavy irrigation, fertilization, and mowing) utilized in these studies (e.g., Asay et al. 2001, Asay et al. 2002) are very different than the low to no maintenance vegetation establishment and management methods used on airfields (e.g., seeded and "left alone").

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