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Foraging preferences of captive Canada geese related to turfgrass mixtures

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Abstract:

Overabundant populations of Canada geese (*Branta canadensis*) cause economic and safety concerns associated with collisions with civil and military aircraft. Habitat management techniques that reduce the use of airfield habitats by geese might reduce these concerns. The objective of this study was to determine if captive Canada geese exhibited a foraging preference between a vegetation mixture consisting mostly of perennial ryegrass (*Lolium perenne*) and white clover (*Trifolium repens*) versus an endophyte-infected tall fescue-(*Festuca arundinacea*) based vegetation mixture. We established 6 paired plots of perennial ryegrass-dominated and tall fescue-dominated mixtures at NASA Plum Brook Station in north-central Ohio during 2000. Behavioral observations of captive Canada geese were conducted during 2001 and 2003. In 2001, ryegrass plots contained 4% perennial ryegrass and 94% white clover. Fescue plots contained 72% tall fescue and 6% clover. The numbers of geese observed in ryegrass plots ($\bar{x}$ = 2.0 geese/plot, SE = 0.35) and tall fescue plots ($\bar{x}$ = 1.9 geese/plot, SE = 0.33) were not different ($F_{1,10}$ = 0.03, P = 0.86). Foraging by captive Canada geese was similar ($F_{1,10}$ = 0.26, P = 0.62) in the perennial ryegrass plots ($\bar{x}$ = 12.8 bill contacts/minute/4 geese, SE = 1.4) and the tall fescue plots ($\bar{x}$ = 11.2 bill contacts/minute/4 geese, SE = 2.9). In 2003, ryegrass plots contained 42% perennial ryegrass and 20% white clover. Fescue plots contained 91% tall fescue. The number of captive geese observed in ryegrass plots ($\bar{x}$ = 3.0 geese/plot, SE = 0.19) was greater ($F_{1,10}$ = 56.9, $P \leq 0.001$) than in the fescue plots ($\bar{x}$ = 1.0 geese/plot, SE = 0.19). Foraging by Canada geese was greater ($F_{1,10}$ = 346.5, $P \leq 0.001$) in the ryegrass plots ($\bar{x}$ = 30.7 bill contacts/minute/4 geese, SE = 1.55) than in the tall fescue plots ($\bar{x}$ = 0.8 bill contacts/minute/4 geese, SE = 0.41). Our findings suggest tall fescue might be a favorable species to be used in reseeding and vegetation renovation projects in areas where Canada geese are a potential problem. We recommend field trials be conducted in various parts of the United States to determine which high-endophyte tall fescue varieties might be useful for goose management in different physiographic regions of North America.

Key words: airports, *Branta canadensis*, Canada geese, captive, endophytic fungus, foraging, human–wildlife conflicts, tall fescue, wildlife strikes

Overabundant populations of Canada geese (*Branta canadensis*) cause damage to agricultural crops (Flegler et al. 1987, Conover 1988, Knittle and Porter 1988), are safety hazards to aircraft (Dolbeer et al. 2000, Cleary et al. 2006), and degrade the aesthetics of parks, golf courses, and other areas (Conover and Chasko 1985, Smith et al. 1999). Human health and safety concerns resulting from overabundant Canada goose populations are issues that must be addressed. Wildlife-aircraft collisions (wildlife strikes) cost the civil aviation industry approximately $500 million annually, with Canada geese causing at least $2.3 million in damage each year (Cleary et al. 2006). Since 1990, Canada geese have been involved in at least 965 strikes with civil aircraft, resulting in 14 injuries to human passengers (Cleary et al. 2006). Since 1973, the U.S. Air Force has reported 74 Canada goose strikes, with an average cost of $1,261,786 per strike event (http://afsafety.af.mil/SEF/Bash/SEFW_stats.shtml, accessed January 1, 2006). In September 1995, 24 people were killed, and a $190 million aircraft was destroyed when a U.S. Air Force Boeing 707 E-38 AWACS aircraft taking off from Elmendorf Air Force Base, Alaska, struck a flock of Canada geese and crashed (Wright 1997).

Most wildlife strikes occur under 305 m above ground level within the vicinity of airports (Cleary et al. 2006). Therefore, wildlife

Experimental pens with 2 types of grasses.

management techniques that reduce bird numbers on and around airfields are critical for safe airport operations. Habitat management is a long-term component of an integrated approach for reducing bird use in areas of conflict. One method suggested to reduce bird numbers is to manage vegetation height. The basis for these recommendations comes from studies done in Great Britain (Brough 1971, Mead and Carter 1973, Brough and Bridgman 1980) in which bird species of concern in the United States were not present. Preliminary studies to determine if tall grass reduces bird activity in the United States have produced conflicting results (Buckley and McCarthy 1994, Blackwell et al. 1999, Seamans et al. 1999, Barras et al. 2000, Seamans et al. 2007).

Species composition of grassland areas can also affect the relative attractiveness of these areas for birds and small mammals (Austin-Smith and Lewis 1969, Brooks et al. 1976, Smith 1976, Dekker and van der Zee 1996). Tall fescue (*Festuca arundinacea*), a sod-forming, cool-season grass of temperate environments, might also be unattractive to wildlife. Tall fescue is also deep-rooted and drought resistant, which might be advantageous for areas with poor soils. Many varieties of tall fescue are infested with the endophytic fungus *Neotyphodium coenophialum* and thus might repel small mammals (Pelton et al. 1991, Coley et al. 1995, Conover 1998) and birds (Conover 1991, Conover and Messmer 1996) following repeated consumption.

Our objective was to determine whether Canada geese exhibit a foraging preference when given a choice between a perennial ryegrass-(*Lolium perenne*) dominated plant mixture and an endophyte-infected tall-fescue-dominated plant mixture. We presented captive Canada geese in north-central Ohio with plots of vegetation resulting from 2 seed mixtures. To determine whether geese demonstrated a preference for either vegetation type, we made one mixture containing primarily perennial ryegrass and white clover (*Trifolium repens*) and the other mixture containing primarily endophyte-infected tall fescue. The National Wildlife Research Center Institutional Animal Care and Use Committee approved procedures involving Canada geese (QA-753).

Study area and methods

Experimental design

The study design followed that of Dolbeer et al. (1998). We established 6 experimental arenas (18.3 X 31.5 m), each delineated with a 1.5-m-tall black plastic fence. Each arena was divided into 2 plots measuring 18.3 x 15.2 m. Prior to plot construction, one of 2 plant mixes (ryegrass or fescue) was randomly assigned to each plot within an arena. The seed mixture planted in ryegrass plots consisted of perennial ryegrass (40%), creeping red fescue (*Festuca rubra*; 40%), white clover (10%), and highland bentgrass (*Agrostis capillaries*; 10%). This seed mixture is the standard mix used for erosion control by the Washington State Department of Transportation. We seeded fescue plots with an experimental mixture dominated by Crossfire II® tall fescue (95%), a high-endophyte, turf-type tall fescue variety, containing subterranean clover (*Trifolium subterraneum*; 5%). Ryegrass and fescue seed mixtures were seeded into the appropriate plots in May of 2000. Vegetation in ryegrass and fescue plots was allowed to establish for a 13-month period prior to the start of experiments with captive Canada geese. We maintained vegetation

Captive geese in study pen.

height by mowing all plots to a height of 15–20 cm prior to the start of experiments.

Study animals

We captured Canada geese of undetermined sex during molt in northern Ohio during June 2001 and June 2003 and transported them to our goose holding facilities at the National Aeronautics and Space Administration's (NASA) Plum Brook Station, Erie County, Ohio (41°37′N, 82°66′W). We cut the primary feathers from 1 wing of each goose prior to releasing the animals into a fenced 2-ha pond. Grass and shade were available along the perimeter of the pond, and we provided whole-kernel corn and poultry pellets as food supplements.

Prior to each experiment, we randomly selected 24 geese and herded them into a 0.4-ha holding area. Each goose was randomly assigned to 1 of 6 arenas (i.e., 4 geese/arena). We placed an arena-specific color-coded neck band on each goose to ensure the same group of 4 geese were placed into the same arena each day. Corn, poultry pellets, shade, grass, and a 20-m^2 area of the pond were available to geese in the holding area.

Each day of the experiments, we placed a 0.5-m diameter pan of water in the center of each ryegrass and fescue plot. We herded 4 geese from the holding area into each of the 6 arenas daily at 0830 hours and allowed them to graze on the ryegrass and fescue plots until 1200 hours, when we returned them to their holding area.

Canada goose behavioral observations

We conducted behavioral observations of captive Canada geese for 18 days during July 11–August 20, 2001, and for 15 days during July 1–August 14, 2003. Three observers stationed on towers 20 m from the arenas monitored goose activity. We made observations for 2 periods of 1-hour each (0.5 and 2.5 hours after geese were herded into arenas) on 3 days per week. Each observer watched 2 arenas, alternating observations of each arena every minute. At the start of each minute, observers recorded the initial number of geese in each plot (ryegrass and fescue) and then for the following 30-seconds counted the number of bill contacts with grass of all geese in each plot.

Plant community composition

In 2001, we monitored plant communities in the ryegrass and fescue plots each week during July 26–August 24, 2001, and during July 17–August 28, 2003. We randomly selected 3 sample points in each ryegrass and fescue plot. At each sample point, we measured the maximum vegetation height by placing 2 vertical 1-m sticks attached with a 1.5 m string. We adjusted the height of the string horizontally to the top of the tallest plant under the string and recorded the distance of the string to the ground. We sampled plant community composition at 6 set points along the string used to measure vegetation height. We identified and recorded the plant species immediately below each sample point.

Statistical analyses

Plots were the experimental unit upon which all statistics were conducted. We conducted separate analyses of Canada goose behavioral data from 2001 and 2003. We compared the number of geese in plots and the number of bill contacts by geese using repeated measures analysis of variance (Crowder and Hand 1990). We compared mean maximum height of vegetation (cm) in the fescue and ryegrass plots using paired *t*-tests (SAS Institute 1990). We compared the coverage of tall fescue, perennial ryegrass, and white clover during 2001 and 2003 using comparison of proportion tests (SAS Institute 1990). We considered differences significant at $P \leq 0.05$ and conducted all analyses using SAS 9.1 (SAS Institute 1990).

Results

Canada goose behavior

During 2001, the numbers of geese we observed in fescue plots ($\bar{x}$ = 1.9 geese/plot, SE = 0.3) did not differ ($F_{1,10}$ = 0.03, P = 0.86) from that of perennial ryegrass plots ($\bar{x}$ = 2.0 geese/plot, SE = 0.4). The number of bill contacts by geese in tall fescue plots ($\bar{x}$ = 11.2 bill contacts/minute/4 geese, SE = 2.9) was similar ($F_{1,10}$ = 0.26, P = 0.62) to the number of bill contacts by geese in the perennial ryegrass plots ($\bar{x}$ = 12.8 bill contacts/minute/4 geese, SE = 1.4) during 2001. Overall, there was no temporal pattern in use of ryegrass or fescue plot vegetation demonstrated by the number of geese observed in plots (Figure 1) or the number of bill contacts by geese (Figure 2).

During 2003, the number of captive geese observed in ryegrass plots ($\bar{x}$ = 3.0 geese/plot, SE = 0.19) was 3 times higher ($F_{1,10}$ = 56.86, $P \leq 0.001$) than those observed in the fescue plots ($\bar{x}$ = 1.0 geese/plot, SE = 0.19). The number of bill contacts by geese in the perennial ryegrass plots ($\bar{x}$ = 30.7 bill contacts per minute/4 geese, SE = 1.55) was 38 times higher ($F_{1,10}$ = 346.54, $P \leq 0.001$) than the number of bill contacts by geese in the tall fescue plots ($\bar{x}$ = 0.8 bill contacts per minute/4 geese, SE = 0.41). In 2003, foraging captive Canada geese exhibited a clear preference for the vegetation in the ryegrass plots as demonstrated by both the number of geese observed in plots (Figure 3) and the number of bill contacts (Figure 4) on all 15 observation days.

Plant community composition

Mean maximum vegetation height in the fescue plots ($\bar{x}$ = 11.0 cm, SE = 0.33) was higher (t_{178}

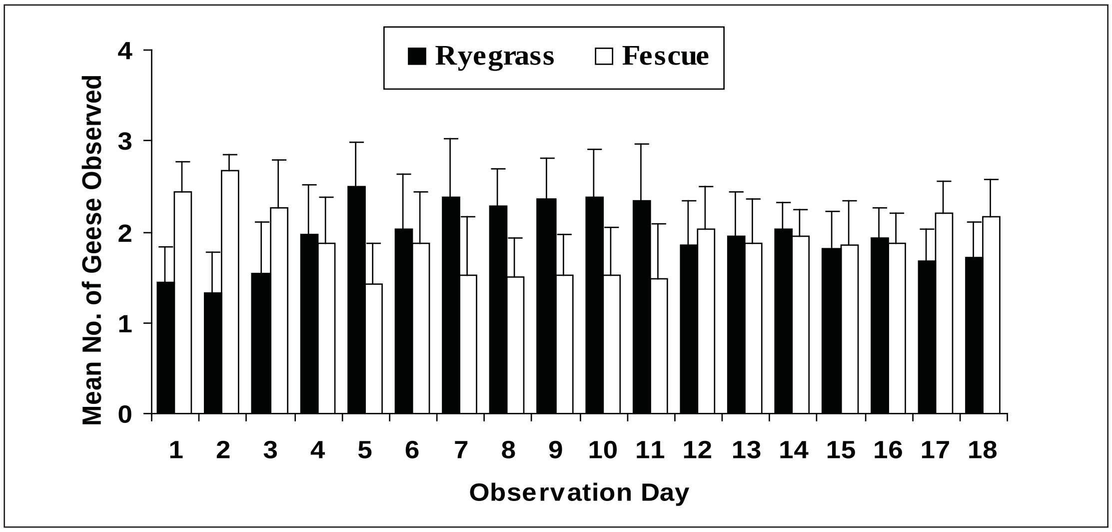

Figure 1. Mean number of captive Canada geese observed in 6 paired plots of vegetation dominated by a perennial ryegrass-based mixture or tall fescue at NASA Plum Brook Station, Ohio, July 11–August 20, 2001. Capped vertical lines represent 1 standard error.

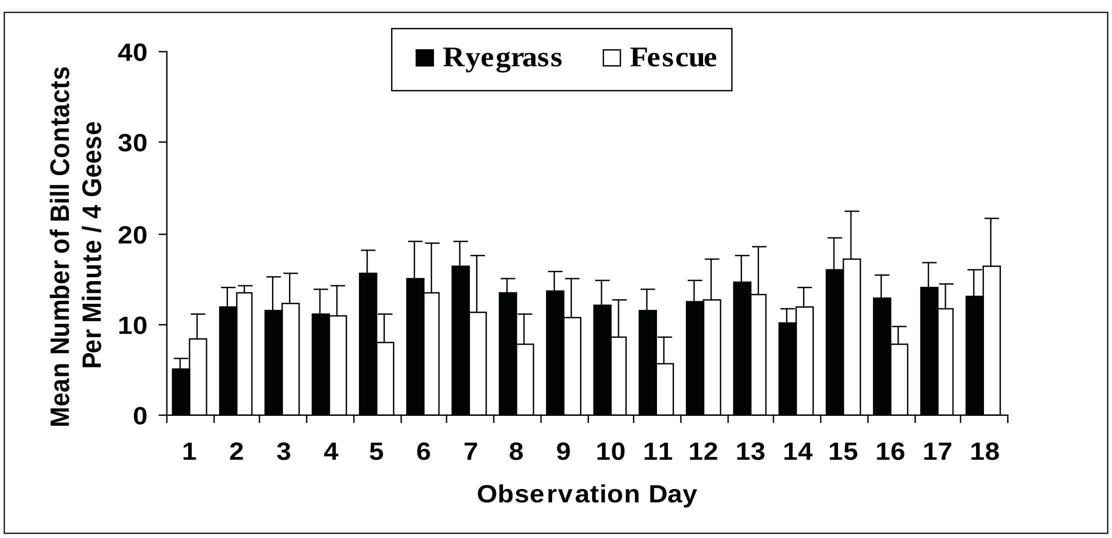

Figure 2. Mean number of bill contacts/minute by captive Canada geese in 6 paired plots of vegetation dominated by a perennial ryegrass-based mixture or tall fescue at NASA Plum Brook Station, Ohio, July 11–August 20, 2001. Capped vertical lines represent 1 standard error.

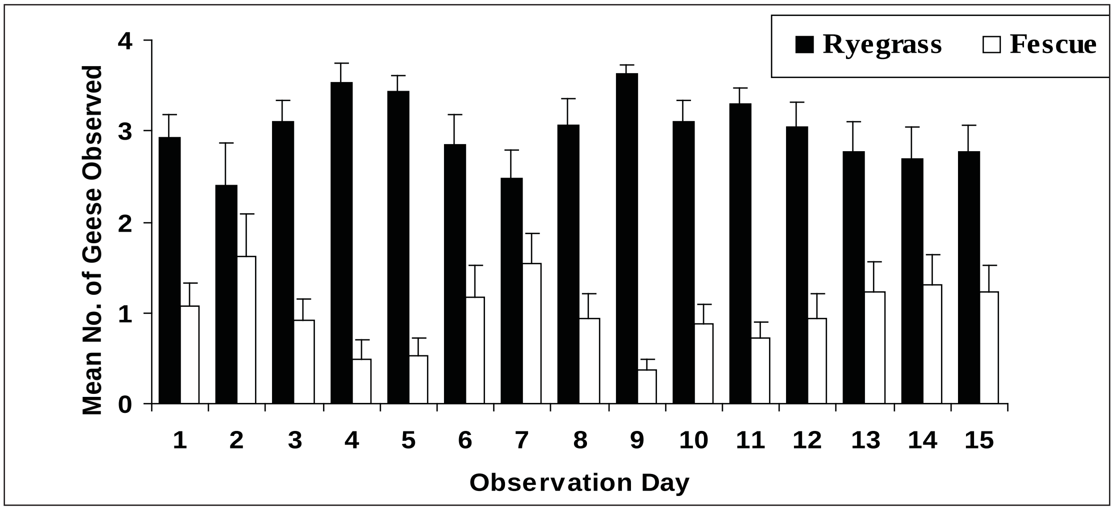

FIGURE 3. Mean number of captive Canada geese observed in 6 paired plots of vegetation dominated by a perennial ryegrass-based mixture or tall fescue at NASA Plum Brook Station, Ohio, July 15–August 14, 2003. Capped vertical lines represent 1 standard error.

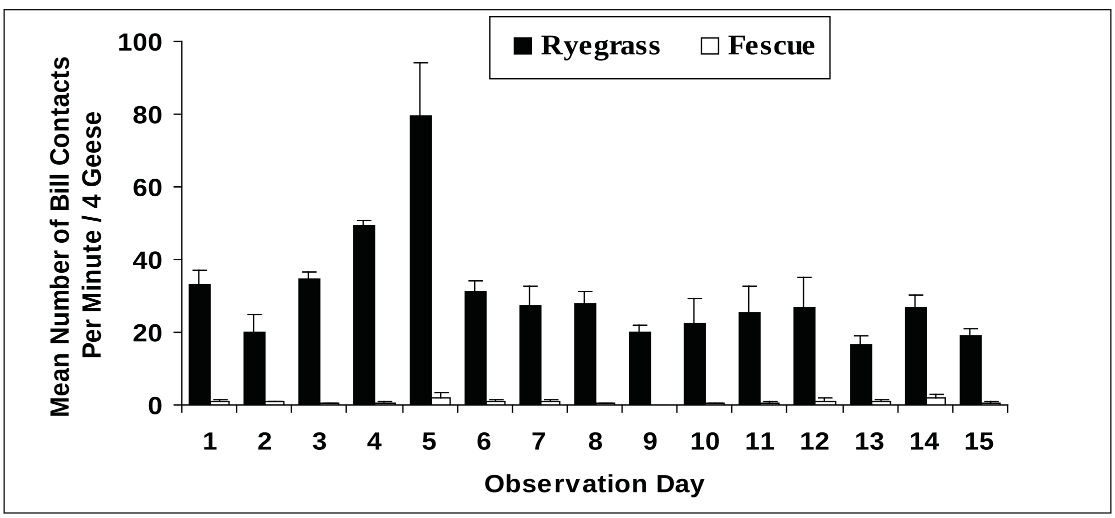

FIGURE 4. Mean number of bill contacts/minute by captive Canada geese in 6 paired plots of vegetation dominated by a perennial ryegrass-based mixture or tall fescue at NASA Plum Brook Station, Ohio, July 15–August 14, 2003. Capped vertical lines represent 1 standard error.

= 2.34, P = 0.02) than in the ryegrass plots ($\bar{x}$ = 9.9 cm, SE = 0.28) during 2001. Plant communities in the ryegrass plots were dominated by white clover (94% coverage), with small amounts of perennial ryegrass and other plants (Figure 5). Plant communities in the fescue plots had large amounts of tall fescue (72% coverage), slight amounts of subterranean clover (6% coverage), and 22% coverage by other plants (e.g., broad-leaved plantain (*Plantago major*), hairy crabgrass (*Digitaria sanguinalis*); Figure 5).

During 2003, mean maximum vegetation height in the fescue plots ($\bar{x}$ = 20.3 cm, SE = 0.53) was higher (t_{214} = 2.34, P = 0.02) than it was in the ryegrass plots ($\bar{x}$ = 18.6 cm, SE = 0.65). Plant communities in the ryegrass plots consisted of 42% more perennial ryegrass and 20% white clover (Figure 5). By 2003, tall fescue dominated (91% coverage) the fescue plots; small amounts of other plants and subterranean clover were present, as well (Figure 5).

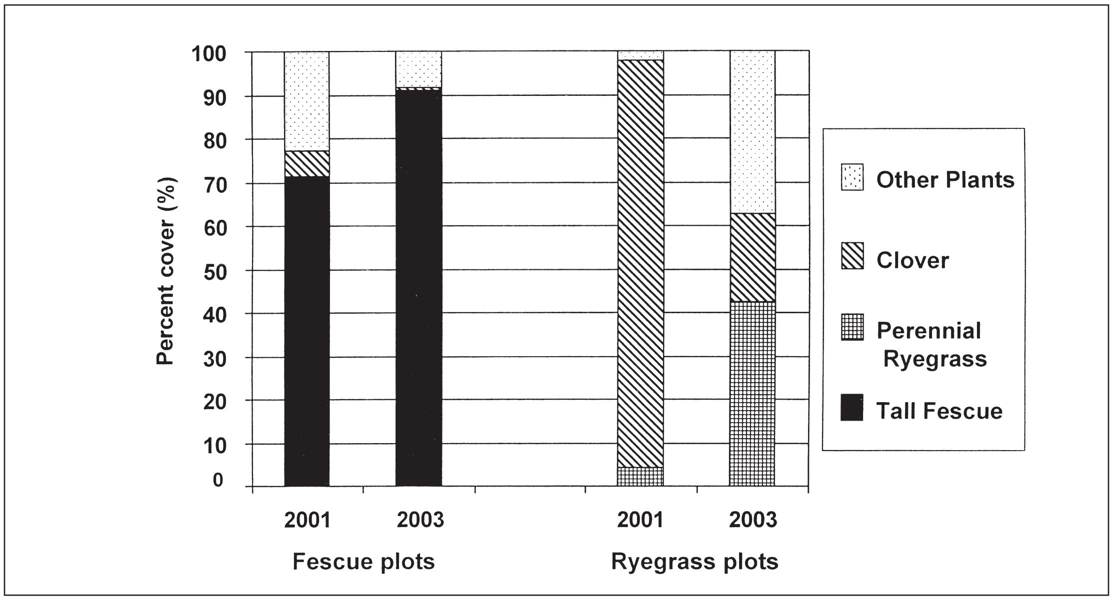

Figure 5. Percentage canopy coverage of tall fescue, perennial ryegrass, clovers, and other plant species in 6 paired plots of vegetation dominated by a perennial ryegrass-based mixture or tall fescue at NASA Plum Brook Station, Ohio, July–August, 2001 and July–August, 2003.

Discussion

During the first growing season after we planted grass, Canada geese spent time and foraged in both the endophyte-infected tall fescue and the perennial ryegrass plots. In addition to foraging, time in each plot was spent loafing or in other nonfeeding behaviors. Given the dominance of white clover in the perennial ryegrass plots, geese were likely foraging on that species when feeding in those plots. White clover is a preferred forage of brent geese (*Branta bernicla*; McKay et al. 2001) and greater snow geese (*Chen caerulescens*; Gauthier and Bedard 1991) and thus might be favored by Canada geese due to its relatively high protein and relatively low fiber content (Ball et al. 1991). Although Canada geese foraging in the tall fescue plots might have been feeding on tall fescue, it is more likely they were selecting for subterranean clover or other nonfescue plants. Washburn (2000) found that wild eastern cottontail rabbits (*Sylvilagus floridanus*) selectively avoided foraging on tall fescue in grasslands that consisted primarily (approximately 95% coverage) of this grass.

Plant community composition changed in both the fescue and ryegrass plots between the end of the first and the start of the third growing season after planting. 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). In this study, tall fescue formed a dense monoculture, increasing to over 90% coverage by the third growing season. In the perennial ryegrass plots, coverage of white clover decreased by approximately 75% from the first to the third growing season, whereas the amount of perennial ryegrass and other plants increased during the same time period.

During the third growing season after planting, Canada geese exhibited a strong feeding preference for the vegetation resulting from the perennial ryegrass and white clover seed mixture compared to the tall fescue-dominated seed mixture. Canada geese spent approximately 75% of their time in the perennial ryegrass and clover plots and foraged almost exclusively in those plots. Conversely, geese rarely foraged in the tall fescue plots.

Several factors might explain the change in feeding behavior by the geese we observed in this study. In the ryegrass plots, geese were likely foraging on perennial ryegrass, white clover, other plants (e.g., crabgrass), or a combination thereof. Perennial ryegrass is a preferred forage of lesser snow geese (*Chen caerulescens caerulescens*; Leslie and Zwank 1985) and thus might have been attractive to the Canada geese in this study.

Observers record goose activity from towers in study area.

In addition, the increase in tall fescue coverage (from 70% to 90%) and simultaneous decrease in subterranean clover and other plants likely reduced foraging opportunities in the fescue plots. Conover (1991) also reported that Canada geese preferred to forage on perennial ryegrass compared to tall fescue.

The difference in vegetation height between the ryegrass and fescue plots is not likely to have caused any change in goose behavior. Blackwell et al. (1999) showed that Canada geese did not select for or against vegetation as tall as 21 cm. Vegetation height differences between plots resulted from growth characteristics of perennial ryegrass and tall fescue, not as a result of more intense feeding by geese in the ryegrass plots.

Canada geese likely avoided foraging on tall fescue grass during this study because of the presence of the tall fescue endophyte, a naturally occurring fungus that forms a symbiotic relationship with the grass. Endophyte-infected tall fescue produces a variety of secondary plant defense compounds (e.g., alkaloids) that 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). Recent studies suggest that wild mammals and birds might be adversely affected by consumption of endophyte-infected tall fescue (Madej and Clay 1991, Pelton et al. 1991, Coley et al. 1995, Lane 1995). Alkaloids produced by endophyte-infected tall fescue act as a feeding deterrent (e.g., taste aversion) and result in post-ingestion distress in animals that consume the plant (Aldrich et al. 1993, Bacon and Hill 1997). Conover and Messmer (1996) reported that captive Canada geese preferred to graze on noninfected tall fescue compared to endophyte-infected tall fescue and that geese foraging on endophyte-infected tall fescue lost body mass.

Recently, a large number of turf-type tall fescue varieties have been developed for lawns, golf courses, parks, and other traditional turfgrass uses. Turf-type tall fescue varieties are bred for horticultural characteristics important to the turfgrass industry (e.g., deep green color, drought and disease resistance, and growth to shorter heights than traditional tall fescues). In addition, many of these new varieties have high levels of *Neotyphonium* endophyte infection (Mohr et al. 2002).

In addition to endophyte-infected tall fescue, other plants have shown promise as desirable airport vegetation that is unattractive to wildlife. On tropical airfields, *Wedelia* sp. was found to be unattractive to birds and small mammals (Linnell et al. 1995). Pochop et al. (1999) found 3 species of native Alaskan plants that were not preferred by Canada geese and could feasibly be planted on airfields. These studies are limited to specific ecotypes but do demonstrate the availability of regionally specific plants that are not desired by geese.

Many questions remain unanswered regarding which specific vegetation types and plant species are most appropriate to minimize the attractiveness of grassland areas to Canada geese in the different geographical regions of the United States. Much future research will be required to find those plants that will meet the needs of turfgrass users (e.g., golf courses, and airports) without attracting Canada geese.

Management implications

Due to the hazards presented by Canada geese at airports, it is critical to reduce the attractiveness of airfields to geese. Our findings suggest endophyte-infected tall fescues might be favorable turfgrass varieties to use in reseeding and vegetation renovation projects on areas where Canada geese are unwanted. We recommend that field trials be conducted in various parts of the United States to determine which high endophyte tall fescue varieties might be useful for goose management in different physiographic regions of North America.

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