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Texas A&M scientists investigated foraging preference of the red imported fire ant, *Solenopsis invicta*, on cultivars of bermudagrass, zoziagrass, St. Augustinegrass, and buffalograss, and bluegrass hybrids. Fire ants preferred foraging on buffalograss the least and significant differences in foraging activity was observed among genotypes of each species and hybrids.

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PURPOSE

The purpose of *USGA Turfgrass and Environmental Research Online* is to effectively communicate the results of research projects funded under USGA's Turfgrass and Environmental Research Program to all who can benefit from such knowledge. Since 1983, the USGA has funded more than 450 projects at a cost of \$31 million. The private, non-profit research program provides funding opportunities to university faculty interested in working on environmental and turf management problems affecting golf courses. The outstanding playing conditions of today's golf courses are a direct result of ***using science to benefit golf***.

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Red Imported Fire Ants Forage on Turfgrasses

James A. Reinert

SUMMARY

The red imported fire ant, *Solenopsis invicta* Buren (Hymenoptera; Formicidae) is a major pest in urban landscapes including golf courses, sports fields, parks, residential/commercial lawns, and highway right-of-ways and infests over 133.5 million hectares (330 million acres) across the southern U.S. Foraging preference for various turfgrass clippings was investigated under controlled lab conditions.

● Among bermudagrass (*Cynodon spp.*) cultivars, clippings of 'Tifway' and 'Baby' were 7 times more preferred than clippings of 'Tifton 10' and 'GN1'.

● The Texas bluegrass x Kentucky bluegrass hybrid (*Poa pratensis* L. X *P. arachnifera* Torr.), 'TXKY 00-34-2' had 5 times more foraging ants on it than 'TXKY 01-59-9'

● Among the zoysiagrasses (*Zoysia japonica*), 'El Toro' was only 2 times more preferred than 'Crowne'.

● For St. Augustinegrass (*Stenotaphrum secundatum* Walt. Kuntze), 'BitterBlue' was 3.4 times more preferred than 'Floratum'.

● On buffalograss [*Buchloe dactyloides* (Nutt.) Engelm.] cultivars, there were 2 and 4 times more ants foraging 'Texoka' than either 'Prairie' or 'Bison', respectively.

● After foraging for 5 hours on clippings of the five or six cultivars in each replicate, the number of ants on each grass was bermudagrass (169.3) > zoysiagrass (137.5) = bluegrass hybrids (136.8) > St. Augustinegrass (127.1) > buffalograss (34.5).

The red imported fire ant, *Solenopsis invicta* Buren (Hymenoptera: Formicidae), is an invasive and constant pest in urban/suburban landscapes across the southern United States. Their colonies may be present in any areas in which turfgrass is used including golf courses, sports fields, parks, and residential/commercial lawns, (16, 18, 25). They are also a serious problem on roadside right-of-ways and in sod production facilities (23).

Red imported fire ants were accidentally introduced into the southeastern United States in the 1930s from native habitats in South America

(5). They have now spread from coast to coast and infests over 133.5 million hectares (330 million acres) across the southern United States, and they are predicted to spread (11). They have most recently spread into Mexico (2005) and infest portions of Australia (2001), New Zealand (2001), Taiwan (2004), and China (2006). Total annual cost from damages and expenditures for control for red imported fire ants within Texas alone was estimated at over \$1.2 billion for 1998, and the costs continue to rise each year (14, 15).

On a golf course, where these ants often nest near and forage on greens and tees, their presence bring on a major medical concern since the red imported fire ant is an aggressive stinging insects. When a colony is disturbed, thousands of workers swarm the area in search of the intruder. Their stings are extremely painful and the venom causes localized blisters. For a limited percentage (only 6%) of the population who are stung and very sensitive to the venom, it can cause anaphylactic shock and occasionally death, so emergency medical treatment is required (6). More than 80 deaths have been reported due to fire ant stings (4).



Red imported fire ants now spread from coast to coast and infest over 330 million acres across the southern United States and are predicted to spread.

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Red imported fire ant stings are extremely painful and the venom causes localized blisters. For a limited percentage (only 6%) of the population who are stung and very sensitive to the venom, it can cause anaphylactic shock and occasionally death, so emergency medical treatment is required.

Several species of turfgrass are maintained under lawn culture across the southern states where red imported fire ants are well established. These turfgrasses include annual ryegrass (*Lolium multiflorum* Lam.), bahiagrass (*Paspalum notatum* Flugge), bermudagrass [*Cynodon dactylon* (L.) Pers. and *C. transvaalensis* Burtt-Davy], buffalograss [*Buchloe dactyloides* (Nutt.) Engelm.], centipedegrass (*Eremochloa ophiuroides* Munro Hack.), perennial ryegrass (*Lolium perenne* L.), Texas bluegrass (*Poa arachnifera* Torr.), bluegrass hybrids (*P. pratensis* L. × *P. arachnifera* Torr.), seashore paspalum (*P. vaginatum* Swartz), St. Augustinegrass (*Stenotaphrum secundatum* Walt. Kuntze), tall fescue (*Festuca arundinacea* Schreb.) and zoysiagrass (*Zoysia japonica* Steud. and *Z. matrella* L. Willd.) (1, 3, 8). These lawns or landscapes are mowed often and weekly or biweekly in residential/ commercial lawns and usually daily or twice-daily on golf greens and some sports fields.

Leaf exudate contain sugars, mineral salts, amino acids, amides and other organic compounds

(2, 7, 22). Sugars, and some minerals and amino acids are attractive and consumed by the red imported fire ant (20, 24) and are probably gathered as food from exudates of grass clippings by red imported fire ants since they are available during the night time hours when this ant does much of its foraging.

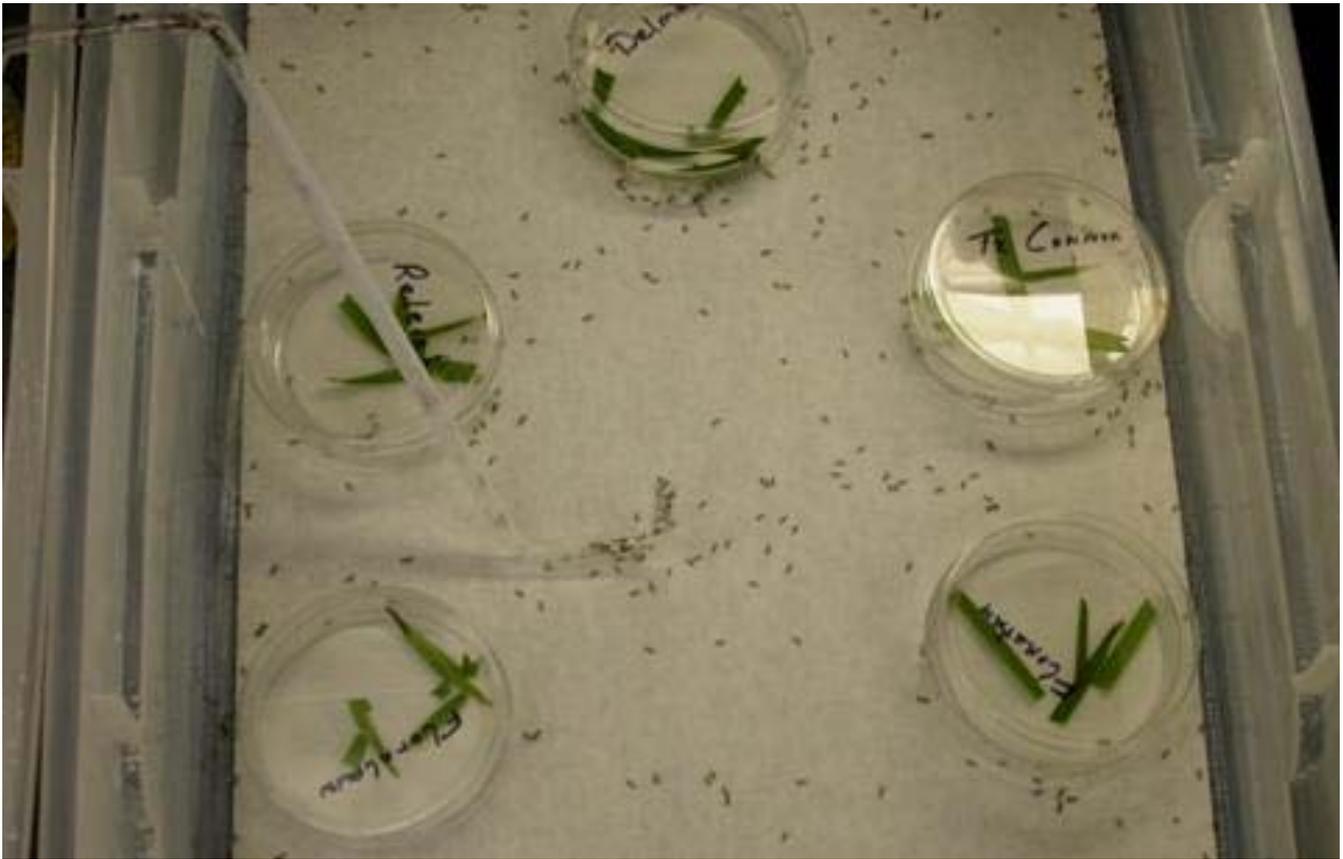
Materials and Methods

Grasses for these evaluations were maintained in the greenhouse in 18-cell trays at the Texas AgriLife Research and Extension Urban Solution Center, Texas A&M System, Dallas, TX. Tray cells measured 7.5 x 7.5 cm and 4 cm deep. Plants were fertilized bi-monthly during the growing season and monthly during winter with Miracle-Gro All Purpose fertilizer [24-8-16 + B (200 ppm), Cu (700 ppm), Fe (1500 ppm), Mn (500 ppm), Mo (5 ppm), Zn (600 ppm)] (Scotts, Marysville, OH). Plants were watered and trimmed as needed throughout the test period to maintain good vegetative growth.

Laboratory studies of red imported fire ant foraging on grass clippings were conducted over a period from September 2004 to December 2005 (17). Cultivars evaluated including: 5 bermudagrasses ('Baby', 'GN1', 'TifSport', 'Tifton 10' and 'Tifway'); 6 Buffalograsses ('609', 'Bison', 'Density', 'Legacy', 'Prairie' and 'Texoka'); 5 Texas × Kentucky bluegrass hybrids ('Reveille',



Red imported fire ant colonies may be present in any areas in which turfgrass is used including golf courses, sports fields, parks, and residential/commercial lawns.



Glass tubes were shaped so that the ants traveling through the tube emerged as close to the center as possible in the test chamber and non-directional from the turned upwards end of the tube. Each Petri dish containing grass clippings was provided with a 5-7 mm opening facing the travel tube to allow ants to freely enter the dish.

TX-KY 00-31-18, TX-KY 00-34-2, TX-KY 01-59-6, TX-KY 01-59-9 and TX-KY 00-64-21); 6 St Augustinegrasses ('BitterBlue', 'Delmar', 'Floralawn', 'Floritam', 'Raleigh' and 'Texas Common') and 6 zoysiagrasses ('Cavalier', 'Crowne', 'DeAnza', 'El Toro', 'Palisades', and 'Zeon'). Grasses were grouped by species (and hybrids) and exposed to foraging by ants from five established red imported fire ant lab colonies.

Red imported fire ant lab colonies were established using large nearly complete field-collected colonies, transferred to the laboratory, and allowed to become acclimated for several weeks. Five colonies used in these studies were maintained in rearing chambers using a modification of the rearing procedures of Khan et al. (10) and Kuriachan and Vinson (2000). Each rearing chamber consisted of a 27-L (59 x 43 x 15 cm) plastic box. Boxes were colonized with a medium-sized polygyne red imported fire ant colony (the queens,

eggs and larvae were contained within a 15 cm covered Petri dishes) and provided with feeding stations consisting of cotton-stoppered test tubes of distilled water and plastic weight boats containing cotton balls saturated with 10% sugar water. Frozen crickets were also provided as needed as food in separate weight boats. A 10-cm band around the upper edge of each chamber was coated with Insect-a-Slip Insect Barrier--Fluon® (BioQuip Products, Rancho Dominguez, CA) to prevent the ants from escaping.

Foragers from the lab-reared red imported fire ant colonies were introduced via glass travel tubes (6.0 mm ID) to a second plastic chamber (59 x 43 x 15 cm) in which the Petri dishes (9-cm diam. x 20 mm deep) containing test grass clippings were randomly arranged in a circle around the turned-up end of the travel tube. Each dish was provided with 2 water-saturated 7.5-cm filter paper discs and contained a 0.25-0.50 g sample of

RIFA Foragers / Grass

Grass	Reps	Mean # / Rep at 5 h
Bermudagrass (5)	16	169.3 a
Zoysiagrass (6)	12	137.5 a
Bluegrass Hybrids (6)	12	136.8 a
St. Augustinegrass (6)	14	127.1 a
Buffalograss (6)	13	34.5 b

Table 1. Mean number of foraging red imported fire ants on five turfgrass species and hybrids.

the test grass that had been clipped from plants in the greenhouse no more than 1 hour earlier.

Dishes were provided with lids to help prevent desiccation of the grass samples. Glass tubes were shaped so that the ants traveling through the tube emerged as close to the center as possible in the test chamber and non-directional from the turned-upwards end of the tube. Each Petri dish containing grass clippings was provided with a 5-7-mm opening facing the travel tube to allow ants to freely enter the dish. The Petri dish lids were opened slightly to allow the foraging ants to more quickly find the grasses.

Red imported fire ant colonies were randomly assigned to replications daily. Grasses were re-randomized for each replicate: 16 reps of bermudagrass, 13 reps of buffalograss, 12 reps of Texas × Kentucky bluegrass hybrids, 14 reps of St Augustinegrass, and 12 reps of zoysiagrass were evaluated. After each of the 5 grass genera was evaluated individually, the most foraged and the least foraged cultivar for each grass were brought together for an evaluation of preference across the 5 genera of grasses in 2 additional tests, each with 18 reps.

Ants were introduced in the morning and allowed to forage for 5 hours. Without disturbing the ants, all foragers on each grass in each of the test dishes were recorded at 1, 1.5, 2, 2.5, 3, and 4 hours. Since there were far more red imported fire

ant foragers at 5 hours, and the experiment was being terminated, each dish was physically removed from the test arena to a holding plastic box where the ants could be more easily counted. Notes were made during each test to record any unusual foraging behavior associated with each cultivar or genera of grass.

Statistical transformations were used on each data set to achieve normality and homogeneity of variance before analysis (12), but untransformed means are presented. Analyses of variance (ANOVA) for randomized complete block design were performed to test the differences between treatments, and means were compared at the 5% level of significance using Fisher's least-significant difference (LSD) multiple range test (21).

Results and Discussion

A comparison of the foraging activity within each test on each grass indicated a high preference for bermudagrass clippings and a least preferred or non-preference for buffalograss clippings. When the final assays were taken at 5 hours, the mean number of red imported fire ant foragers on clippings of the 5 or 6 grasses in the Petri dishes within each replicate was bermudagrass (169.3) > zoysiagrass (137.5) = bluegrass hybrids (136.8) > St. Augustinegrass (127.1) >

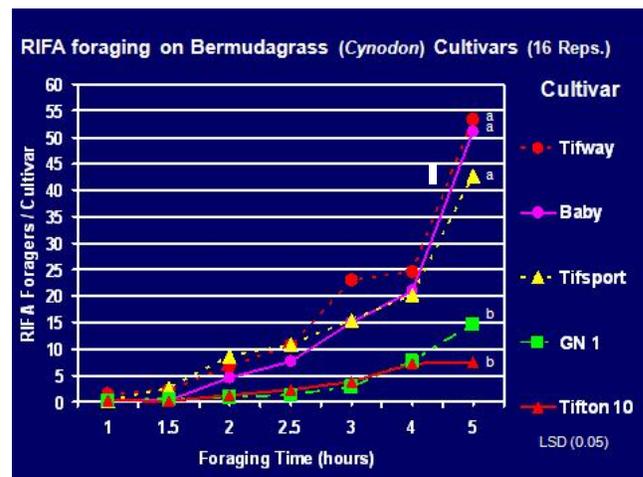


Figure 1. Red imported fire ant foraging behavior on five cultivars of bermudagrass, Dallas, TX. Mean data points at 5 hours followed by the same letter are not significantly different by Fisher's protected LSD ($P \leq 0.05$).

buffalograss (34.5, Table 1). Most ants were observed inside the individual Petri dishes, except in tests with buffalograss. In the buffalograss foraging chambers, with a mean number of 271.7 foragers within the chamber, only 12.7% of the ants were observed foraging within the Petri dishes. With the other more preferred grasses, only a small percentage of ants were not on the grass or forming the trail back to the transport tube to the colony.

For each of the turfgrasses evaluated, a mean of greater than 5 red imported fire ant foragers found the grass selections within 1 hour, and foragers usually did not exceed a mean of 10 until after 2.5 hours of exposure. Only after 3 or 4 hours of foraging did the number of ants on the highly foraged entries begin to exponentially increase to the high number of foragers recorded at 5 hours. This may be a result of the time it takes the initial foraging ants to recruit additional workers in high numbers. Also, throughout these studies, pieces of grass blades were sometimes removed from the Petri dishes and attempts were made to carry them through the travel tubes back to the colony.

Bermudagrass

‘Tifway’ and ‘Baby’ (mean greater than 50 foragers) were the highest foraged cultivars among all 5 genera of grasses and the most pre-

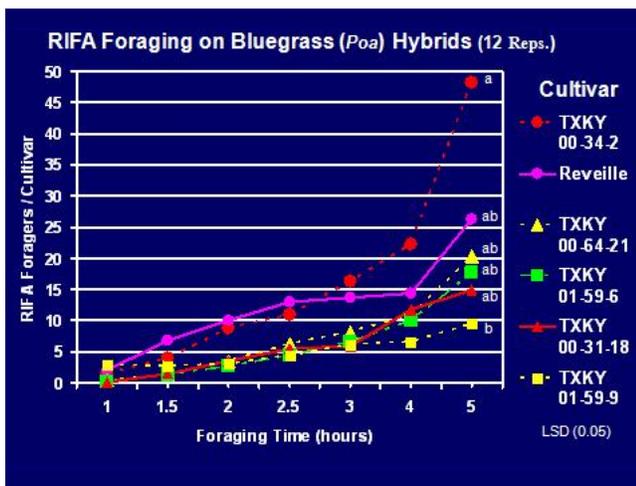


Figure 2. Red imported fire ant foraging behavior on six cultivars of bluegrass hybrids, Dallas, TX. Mean data points at 5 hours followed by the same letter are not significantly different by Fisher’s protected LSD ($P \leq 0.05$).

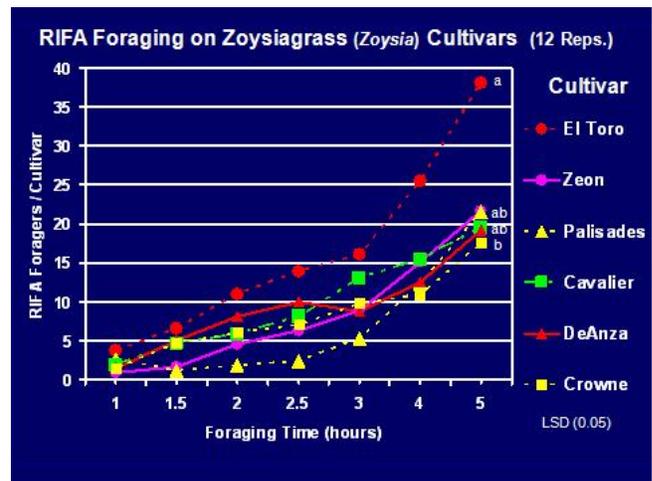


Figure 3. Red imported fire ant foraging behavior on six cultivars of zoysiagrass, Dallas, TX. Mean data points at 5 hours followed by the same letter are not significantly different by Fisher’s protected LSD ($P \leq 0.05$).

ferred among the bermudagrasses, but not statistically different from ‘TifSport’ when foraging counts were made at 5 hours (Figure 1). ‘Tifton 10’ and ‘GN1’ were significantly and 7 times less preferred than ‘Tifway’ and ‘Baby’. Noteworthy, the number of foragers more than doubled from 4 to 5 hours on all three cultivars (‘Tifway’, ‘Baby’ and ‘TifSport’).

Bluegrass

Among the bluegrass hybrids, TXKY 00-34-2 (mean of 48.2 foragers) was significantly more heavily foraged and had 5.1 times as many foraging ants on it as TXKY 01-59-9 (mean of 9.4 foragers) (Figure 2). The number of foragers on TXKY 00-34-2 also doubled during the period from 4 to 5 hours. ‘Reveille’, the commercial hybrid, had an intermediate level of foragers.

Zoysiagrass

‘El Toro’ (mean of 38.1 foragers) was significantly more preferred among the zoysiagrasses, but it was only 2 times more preferred than ‘Crowne’ (mean of 17.5), the least preferred (Figure 3). Foraging increased exponentially from 3 to 5 hours on ‘El Toro’, similarly to the increases observed on the bermudagrasses and bluegrass

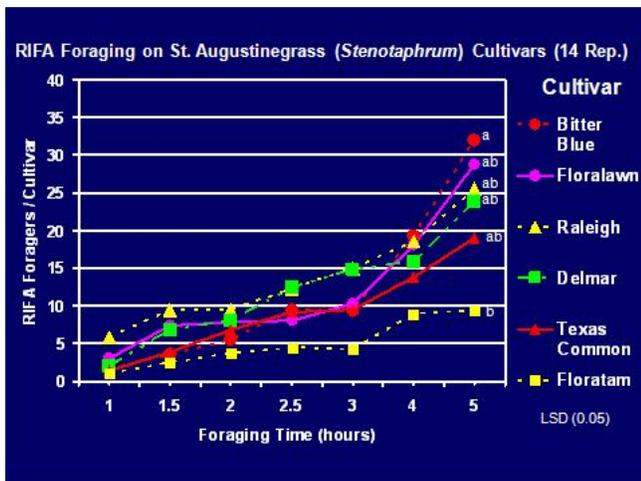


Figure 4. Red imported fire ant foraging behavior on six cultivars of St. Augustinegrass, Dallas, TX. Mean data points at 5 hours followed by the same letter are not significantly different by Fisher's protected LSD ($P \leq 0.05$).

hybrids. Foraging on 'El Tor'o increased 1.6 times from 3 to 4 hours and another 1.5 times from 4 to 5 hours, while foraging on the other 5 cultivars did increase, but not as dramatically.

St. Augustinegrass

Differences in foraging among the cultivars of St. Augustinegrass were not as dramatic as among the cultivars of bermudagrass, bluegrass, or zoysiagrass. 'BitterBlue' (mean of 32.0) was significantly preferred and 3.4 times greater than on 'Floratam' (mean of 9.3), the least preferred (Figure 4). Foraging on 'BitterBlue' increased 2.1 times from 3 to 4 hours but only 1.7 times during the last period from 4 to 5 hours.

Buffalograss

The amount of foraging on the aforementioned turfgrasses was 3.7 to 4.9 times greater than on the buffalograss cultivars. However, among the buffalograss cultivars, 'Texoka' (mean of 25.9 foragers) was significantly preferred over either 'Prairie' or 'Bison' (3.5 and 2.0, respectively) (Figure 5). Like the other grasses tested, there was a dramatic and exponential increase in foraging activity from the 3-hour observation to the 5-hour reading for the 3 most preferred cultivars.

This increase was 4.3, 6.6, and 6.1 fold for 'Density', '609', and 'Texoka', respectively.

Comparison of High and Low Foraged Cultivars among the Tested Grasses

When the cultivars that ranked highest and were most preferred for each genus of grass were compared, there was very little separation in foraging activity until the period from 4 to 5 hours. At the 5-hour reading, 'Texoka' buffalograss (mean of 25.9) was 5.5 times more preferred and significantly different from 'BitterBlue' St. Augustinegrass (mean of 4.7), the least preferred (Figure 6A). The other three test grasses were not significantly different from either 'Texoka' or 'BitterBlue'.

The cultivars that were least preferred for each of the grasses were also compared. TXKY 01-59-9 bluegrass hybrid (mean of 27.7) was most preferred and had 4.3 times more red imported fire ant foragers than 'Floratam' St. Augustinegrass (mean of 6.5) the least preferred, but there were no statistical significances due to excessive variance (Figure 6B). The excessive variation may help to support why each of these grasses was also least-preferred for each genus of grass. The means for these grasses did however begin to separate much

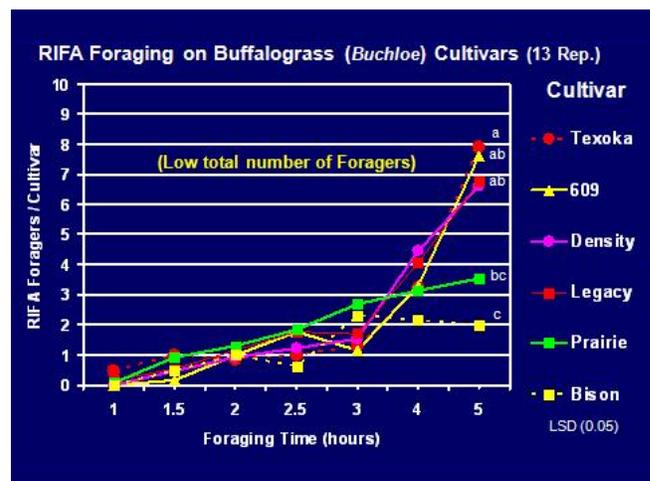


Figure 5. Red imported fire ant foraging behavior on five cultivars of buffalograss, Dallas, TX. Mean data points at 5 hours followed by the same letter are not significantly different by Fisher's protected LSD ($P \leq 0.05$).

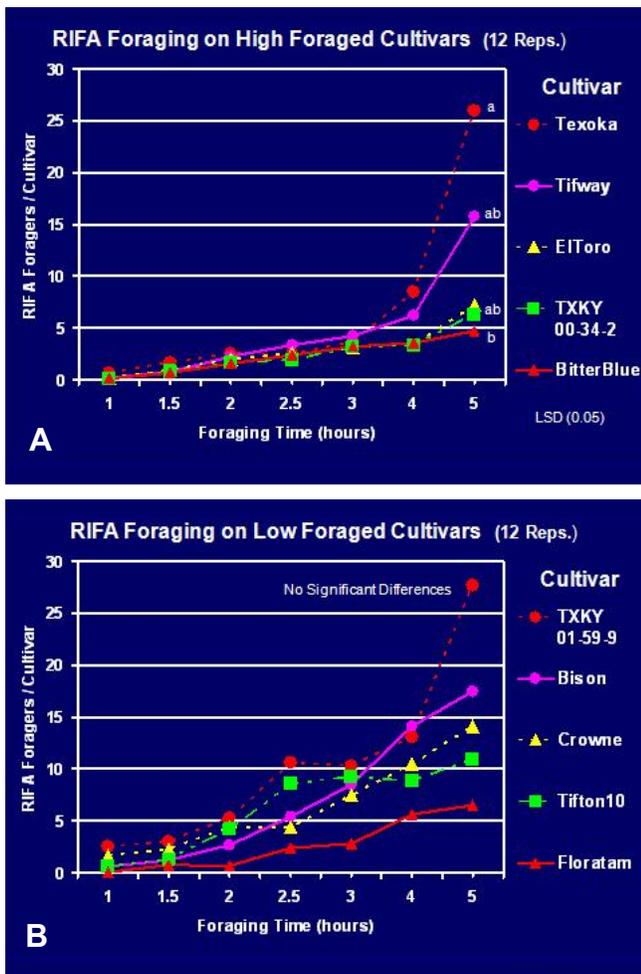


Figure 6. Red imported fire ant foraging behavior on the five high foraged grass cultivars (A) and five least-foraged grass cultivars (B) Dallas, TX Mean data points at 5 hours followed by the same letter are not significantly different by Fisher's protected LSD ($P \leq 0.05$).

earlier at the 2-hour reading. Surprisingly, foraging levels for the replicates of the high- and for the low-foraged grasses (means of 12.0 and 15.3, respectively) were very similar for the 2 groups of grasses.

Most of the separation among cultivars occurred during the period from 4 to 5 hours during the tests which may be a factor of the time it takes a forager to locate a new food source and then recruit additional ants to the location. The differences in preference for certain cultivars may be due to availability of various sugars, mineral salts, amino acids, amides, and other organic compounds in the various cultivars of grass (2, 9, 22). These plant components may be important food elements in red imported fire ants diet (20, 24),

and these relationships need to be investigated further. Resistance to many different species of chewing and sucking insects has been documented in certain cultivars for turfgrass and these are summarized by Reinert et al.(19). The present research represents another way to measure host preference among cultivars of grass.

Within each grass genus, there was a major difference between the most foraged cultivar and the least preferred. The differences between most- and least-preferred for bermudagrass, bluegrass hybrids, zoysiagrass, St. Augustinegrass, and buffalograss were 7.1, 5.1, 2.1, 3.4 and 4.0 times, respectively and they were significantly different for each genus of grass.

Also consider that the buffalograsses were not preferred when tested as a group, but when both the most- and least-preferred buffalograss cultivars were tested in the presence of other grass species, they attracted larger numbers of ants (greater than 20 ants per Petri dish), possibly because the ants were attracted to the other grass species and once in the vicinity they found the buffalograss to be attractive and provide a good food source as well.

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