SEASONAL CHANGES IN BAIT PREFERENCE BY RED IMPORTED FIRE ANT, SOLENOPSIS INVICTA (HYMENOPTERA: FORMICIDAE)

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ABSTRACT

Bait stations were established in four different vegetation habitats near Houston, Texas, to attract Solenopsis invicta Buren, the red imported fire ant (RIFA). Bait preferences were compared in each habitat for each monthly 24-h sampling period. Foragers located both the high carbohydrate and high protein baits, but greater numbers were recruited to the carbohydrate bait during the sampling periods of the year registering lower temperatures (mean = 17°C). In contrast, when the seasonal temperatures were greater (mean = 25°C), RIFA’s were collected in higher numbers on the proteinaceous bait. These findings must be considered when planning a field research project to collect RIFA’s.

RESUMEN

Para atraer a la hormiga de fuego roja importada, Solenopsis invicta Buren, se establecieron estaciones con cebo en cuatro diferentes hábitats vegetacionales en los alrededores de Houston, Texas. Se compararon las preferencias por los cebos en cada hábitat para cada periodo de muestreo (mensual-24 horas). Las forrajeras localizaron tanto los cebo ricos en proteínas como los ricos en carbohidratos, pero mayores números fueron atraidos hacia los cebo de carbohidratos durante los periodos de muestro que registraron temperaturas más bajas (media = 17°C). En contraste, cuando las temperaturas estacionales fueron más alta (media = 25°C), se colectaron mayores números

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The red imported fire ant (RIFA), *Solenopsis invicta* Buren, was introduced into the United States in the 1940's from South America (Lofgren et al. 1975). The range of the RIFA now encompasses ca. 33-101 million ha of the southern United States, including most of eastern and central Texas (Lofgren 1986a, D. P. Wojcik, personal communication). RIFA colonies are characterized by large mounds and the mass recruitment of worker ants to food sources (Lofgren et al. 1975, Wilson 1962).

Food collection is the major objective of RIFA foraging activity. RIFA's are opportunistic omnivores (Lofgren et al. 1975, Lofgren 1986b) that feed on alive and dead insects and other animal material (Hays & Hays 1959, Wilson & Oliver 1969), tend Homoptera for honeydew (Nielsen et al. 1971, Adams 1986, Wojcik 1986), and feed on various plants (reviewed by Adams 1986, Lofgren 1986b). RIFA's have been called an "oil-loving" species (Hays & Arant 1960, Lofgren et al. 1961, 1964), and oils have been incorporated in baits used for chemical control (Banks et al. 1978).

Fats, proteins, and carbohydrates attract RIFA foragers in the laboratory. However, foraging RIFA's exhibit little attraction to dry foods, or to foods that contain a minimum amount of liquid (Lofgren et al. 1961). Glunn et al. (1981) reported that sugar (0.1 M sucrose) was preferred over both 1:10 casein hydrolysate and soy oil, and feeding rates for aqueous solutions (sucrose and casein hydrolysate) were 7 to 10 times greater than for soy oil.

Field RIFA colonies in Florida showed great variation in their preference for carbohydrate, protein, and lipid foods (1.0 M sucrose, rat serum, and unrefined soybean oil, respectively) (Gunn et al. 1981). Seven different food preference hierarchies occurred among 10 colonies in April and May. In general, all colonies had a mean preference for oil, serum, and sucrose in decreasing order. However, greater time spent at the oil bait may not have reflected the volume of food consumed or returned to the colony.

In a June field study in Louisiana (Ali & Reagan 1986), molasses was more attractive than peanut oil to RIFA foragers when exposed over short exposure periods (30 min). However, peanut oil was more attractive and resulted in more ant recruitment when baits were exposed for a longer duration (120 min). The study also indicated that foragers were nonselective and searched for both carbohydrate and protein sources during June.

Food preference changes with time, long-term feeding history, stage and presence of brood, colony age, caste composition, and weather. For example, foragers gathered more protein for the colony when brood was present (Sorensen et al. 1983b) and fed it directly to larvae (Sorensen et al. 1983a). After a rainfall when RIFA's were rebuilding their mounds, a high rate of foraging for sucrose was observed by Glunn et al. (1981). Increased work output may have required more "adult food." Also, the materials upon which colonies had previously fed and food availability altered colony food preferences.

Tissue protein, lipid, and glycogen contents of field colony workers change during different periods of the year (Ricks & Vinson 1972). During early summer when brood production was greatest, worker tissue protein and lipid content decreased as these materials were distributed to the developing brood. Worker tissue protein content peaked in the fall and was correlated with cessation of colony brood production. A fall buildup of tissue lipid may have been important as an overwintering energy source. Glycogen content increased slightly during the summer months and was used probably as a food reserve during the cooler months (Ricks & Vinson 1972).
The major objectives of this research were to determine if foraging RIFA’s prefer a high carbohydrate or a high protein bait, and if preferences change during a 12-month study in selected habitats.

**Materials and Methods**

The study was conducted at the Sienna Plantation near the town of Arcola in Fort Bend Co., Texas. The Sienna Plantation is ca. 20 km southwest of Houston and is in the Gulf Prairie and Marshes vegetational region of Texas (Correll & Johnston 1970). Research plots were established in four habitats with designations based on major plant associations. Each habitat site was two to three km distant from other habitats.

The first habitat was designated as dense forest. Sugarberry (*Celtis laevigata* Willd.), cedar elm (*Ulmus crassifolia* Nutt.), and pecan (*Carya illinoinensis* (Wangen.) K. Koch) were the dominant tree species, and the understory consisted of mixed grasses and broadleaved plants. The second habitat was designated as lowland pasture and consisted mainly of several genera of broadleaved plants dominated by snow-on-the-prairie (*Euphorbia bicolor* Engelm. & Gray). The lowland pasture site was less than 1 km from the Brazos River. The third habitat was designated as forest-with-pasture. The forest section was similar in species composition to the dense forest; the pasture section was dominated by blackberries (*Rubus* spp.) and bermuda grass (*Cynodon dactylon* (L.) Pers.). The fourth habitat was designated as upland pasture, and common carpetgrasses (*Azonopus* spp.) and paspalum grasses (*Paspalum* spp.) were the dominant species (P. Grinnom, personal communication). The pastures were mowed once or twice a year, and all sites were grazed by cattle.

Within each habitat, three rectangular bait attraction plots were established >30 m apart. Each 45 x 75 m plot consisted of 24 bait stations spaced on 15 m centers from each other. Each bait station consisted of two 36-ml plastic bait cups spaced 30 cm apart.

**Table 1, Numbers of Red Imported Fire Ant Workers, *Solenopsis invicta* Buren, Collected in Four Habitats in Fort Bend County, Texas, July 1985 through June 1986.**

<table>
<thead>
<tr>
<th>Month</th>
<th>Dense Forest</th>
<th>Lowland Pasture</th>
<th>Forest with Pasture</th>
<th>Upland Pasture</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>5474 abc</td>
<td>23 310 ab</td>
<td>36 079 a</td>
<td>32 907 b</td>
<td>96 870</td>
</tr>
<tr>
<td>Aug.</td>
<td>9377 a</td>
<td>28 186 a</td>
<td>33 411 a</td>
<td>40 745 a</td>
<td>111 719</td>
</tr>
<tr>
<td>Sept.</td>
<td>6192 ab</td>
<td>22 053 b</td>
<td>23 707 b</td>
<td>25 290 c</td>
<td>77 212</td>
</tr>
<tr>
<td>Oct.</td>
<td>2942 bcd</td>
<td>1807 de</td>
<td>5408 c</td>
<td>2118 f</td>
<td>12 275</td>
</tr>
<tr>
<td>Nov.</td>
<td>1698 cd</td>
<td>1975 de</td>
<td>408 c</td>
<td>1758 f</td>
<td>5589</td>
</tr>
<tr>
<td>Dec.</td>
<td>1 d</td>
<td>2 e</td>
<td>0 c</td>
<td>102 f</td>
<td>105</td>
</tr>
<tr>
<td>1986</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan.</td>
<td>55 d</td>
<td>2664 de</td>
<td>510 c</td>
<td>3247 f</td>
<td>6476</td>
</tr>
<tr>
<td>Feb.</td>
<td>58 d</td>
<td>2444 de</td>
<td>789 c</td>
<td>1707 f</td>
<td>5064</td>
</tr>
<tr>
<td>Mar.</td>
<td>78 d</td>
<td>3026 de</td>
<td>1144 c</td>
<td>4392 ef</td>
<td>8640</td>
</tr>
<tr>
<td>Apr.</td>
<td>12 d</td>
<td>6014 d</td>
<td>5076 c</td>
<td>12 762 d</td>
<td>24 364</td>
</tr>
<tr>
<td>May</td>
<td>3255 bcd</td>
<td>18 058 bc</td>
<td>19 701 b</td>
<td>25 124 c</td>
<td>66 133</td>
</tr>
<tr>
<td>June</td>
<td>2473 bcd</td>
<td>13 181 c</td>
<td>17 041 b</td>
<td>10 291 de</td>
<td>42 986</td>
</tr>
</tbody>
</table>

**TOTAL** | 31 615 | 123 215 | 143 270 | 159 573 | 457 673 |

*Numbers followed by the same letter within habitats are not significantly different. ANOVA, LSD (P>0.05).*
One cup contained a mixture of agar and grape jelly (Welch’s; 1.25 cm cube), and the other cup contained 7.5 ml of tuna fish cat food (Topco brand). The first bait consisted mainly of carbohydrates (> 50%; Welch’s, Concord, MA 01742, personal communication). The tuna cat food bait was packed in water and contained no added oil (Topco Assoc., Skokie, IL 60076, personal communication). Tuna canned in water contains ca. 70% water, 28% protein, and 1% fat by weight (Leveille et al. 1983).

Bait cups were placed at three randomly designated bait stations within each plot and, after a 3-h interval, were collected, and newly baited cups were placed at three other randomly designated bait stations. Arthropods within cups were collected by quickly placing a tight-fitting lid on each cup. This procedure continued for a 24-h cycle and was repeated in all three plots in each habitat at approximately the same time. Before each collection, soil surface temperatures were measured by a thermometer at each habitat, and general climatic conditions and precipitation were recorded. The arthropods in cups were frozen for later identification and enumeration. Cups from which all bait was removed or missing and cups that were gnawed by scavenging vertebrates were omitted from the analysis. Sampling procedures were repeated each month from July 1989 through June 1990.

The total number of RIFA’s collected from each habitat each month was tabulated, and monthly data within habitats were compared by ANOVA and LSD (P = 0.05). The percentages of RIFA’s collected in each bait type for each 24-h period were analyzed by chi-square (P = 0.05) to test the hypothesis of equal bait preferences during each monthly sample within each habitat.

**Results and Discussion**

A total of 457,673 RIFA’s was collected during the study (Table 1). The greatest number was collected in the upland pasture habitat, and the least collected in the dense forest habitat. As expected, the greatest number was collected during the warmest sample period (August; mean = 30.8°C), and the least in December (mean = 11.6°C), the coolest sample period. The same trend was evident within each habitat.

Significant RIFA bait preferences (P < 0.05) were detected in each monthly sample period, except in December and May, in the dense forest habitat (Table 2). Bait preference could not be measured in December because of the sample size which violated Cochran’s (1964) rule. Grape agar bait was preferred by RIFA’s from October through February and in April in the dense forest habitat when the mean soil surface temperature during the 24-h sampling periods ranged between 12.5 and 25.0°C. Greater numbers of RIFA’s were collected on tuna cat food during the months when the mean soil surface temperature during the 24-h sampling periods ranged between 27.0 and 29.0°C.

Significant RIFA bait preferences (P < 0.05) were detected in each month except November and December in the lowland pasture habitat (Table 2). The grape jelly agar bait was preferred during the January and February sampling periods when the mean soil surface temperature was 16.0 and 17.0°C, respectively. During the March through October sampling periods, when the mean soil surface temperature ranged between 12.0 and 31.0°C, the tuna cat food bait was preferred.

Significant bait preferences (P < 0.05) were detected each month in the forest-with-pasture habitat (Table 2) except in December, when no RIFA’s were collected. The grape jelly agar bait was preferred during the January and February sampling periods (mean soil surface temperature equaled 15.0 and 17.0°C, respectively). During the March through November sampling periods when the mean soil surface temperature ranged between 11.0 and 30.0°C, the tuna cat food was preferred.

Grape jelly agar was preferred (P < 0.05) by RIFA’s during the October through February sampling periods in the upland pasture habitat (Table 2) when the mean soil
TABLE 2. PERCENT OF TOTAL RED IMPORTED FIRE ANT WORKERS, SOLENOPSIS INVICTA, COLLECTED IN GRAPE JELLY AGAR AND TUNA CAT FOOD BAITS DURING EACH MONTHLY SAMPLING PERIOD IN EACH HABITAT IN FORT BEND COUNTY, TEXAS, JULY 1985 THROUGH JUNE 1986.

<table>
<thead>
<tr>
<th>Month</th>
<th>Dense Forest</th>
<th>Lowland Pasture</th>
<th>Forest with Pasture</th>
<th>Upland Pasture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>jelly</td>
<td>tuna</td>
<td>jelly</td>
<td>tuna</td>
</tr>
<tr>
<td>1985</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>22</td>
<td>78</td>
<td>1</td>
<td>99</td>
</tr>
<tr>
<td>Aug.</td>
<td>33</td>
<td>67</td>
<td>1</td>
<td>99</td>
</tr>
<tr>
<td>Sept.</td>
<td>23</td>
<td>78</td>
<td>1</td>
<td>99</td>
</tr>
<tr>
<td>Oct.</td>
<td>98</td>
<td>2</td>
<td>2</td>
<td>98</td>
</tr>
<tr>
<td>Nov.</td>
<td>100</td>
<td>0</td>
<td>58</td>
<td>42$</td>
</tr>
<tr>
<td>Dec.</td>
<td>100</td>
<td>0$</td>
<td>50</td>
<td>50$</td>
</tr>
<tr>
<td>1986</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan.</td>
<td>100</td>
<td>0</td>
<td>98</td>
<td>2</td>
</tr>
<tr>
<td>Feb.</td>
<td>100</td>
<td>0</td>
<td>98</td>
<td>2</td>
</tr>
<tr>
<td>Mar.</td>
<td>3</td>
<td>97</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>April</td>
<td>100</td>
<td>0</td>
<td>1</td>
<td>99</td>
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<tr>
<td>May</td>
<td>50</td>
<td>50$</td>
<td>1</td>
<td>99</td>
</tr>
<tr>
<td>June</td>
<td>19</td>
<td>81</td>
<td>1</td>
<td>99</td>
</tr>
</tbody>
</table>

1Percent followed by $ within a month and habitat are not significantly different (Chi-square; P > 0.05).
2No RIFA's were collected in December.

Surface temperature ranged between 11.0 and 24.0°C. During the March through September sampling periods, the tuna cat food was the preferred bait. Mean soil surface temperature ranged between 15.0 and 33.0°C during the period.

In general, more RIFA's were attracted to and recruited in greater numbers to the grape jelly agar bait during periods of lower soil surface temperatures (mean = 17°C). Perhaps carbohydrates were needed by colonies for maintenance during periods of colder temperatures, and few natural sources of sugars were available. In contrast, when the mean soil surface temperatures were warmer (mean = 25.4°C), RIFA's were collected in higher numbers in the tuna cat food bait. Because most colony growth occurs during the warmer parts of the year (Markin et al. 1973) and during this time proteinaceous food collected is given preferentially to the developing brood (Sorensen et al. 1981, Vinson 1968), the present research supports the hypothesis of greater recruitment to protein food sources during periods of colony brood production.

These conclusions must be considered when planning a research program. A sampling study during a warm season may be more successful if a proteinaceous bait type is used; whereas, a carbohydrate bait may collect more RIFA's during the cooler months of the year.

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in pasture and pine forest areas of southeastern Louisiana. J. Econ. Entomol. 62: 1268-1271.


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COLORED SPHERICAL TRAPS FOR CAPTURE OF CARIBBEAN FRUIT FLY, ANASTREPHA SUSPENSA

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ABSTRACT

Colored spheres of five different sizes (6.3, 8.9, 14.0, 16.5, 20.0 cm diam) and five colors (orange, black, yellow, green, white) were coated with a trapping compound and presented to field-caged flies (males, virgin females, mated females). The most females were captured on the 20 cm orange, green, and white balls and the 8.9 cm yellow ball. There was no statistically significant preference on the part of males for any particular size or color. When the four most attractive spheres were presented simultaneously to mated and virgin females they were most likely to be captured on 20.0 cm orange and green spheres. More males were caught on the 20.0 cm orange ball. When data were summed, 20.0 cm orange balls were statistically superior overall. In a field release test, 20.0 cm orange balls, 20.0 cm orange balls with a protein hydrolysate bait, 20.0 cm diam orange balls with caged live males, and 10 cm yellow balls with food bait were compared to McPhail traps baited with protein hydrolysate. The orange sphere with males was superior to all the other traps.

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RESUMEN

Esferas de cinco tamaños diferentes (6.3, 8.9, 14.0, 16.5, y 20.0 cm de diámetro), y de cinco colores (naranja, negro, amarillo, verde, y blanco), se cubrieron con una substancia atrayente y ofrecida a moscas en jaulas en el campo (machos, hembras virgenes, y hembras fertilizadas). Se capturaron más hembras en las esferas color naranja, verdes y blancas de 20 cm, y la amarilla de 8.9 cm. Estadísticamente no hubo ninguna diferencia significativa en preferencia por parte de los machos hacia ningún tamaño o color en particular. Cuando las cuatro esferas más atractivas se les ofreció simultáneamente a hembras fertilizadas y virgenes, fue más probable que se capturaran en esferas de color naranja y verdes de 20.0 cm. Se capturaron más machos en la esfera color naranja de 20.0 cm. Cuando se sumaron las cifras, las esferas color naranja de 20.0 cm fueron generalmente estadísticamente superior. En una prueba de liberación en el campo, las esferas color naranja de 20.0 cm, esferas color naranja de 20.0 cm con un cebo de proteína hidrolizada, esferas color naranja de 20.0 con machos vivos enjaluzados, y esferas amarillas de 10.0 cm con cebo de comida, se compararon a trampas de McPhail rebanadas con proteína hidrolizada. La esfera color naranja con machos fue superior a todas las otras trampas.