RED IMPORTED FIRE ANTS: DETECTION OF FEEDING ON CORN, OKRA AND SOYBEANS WITH RADIOISOTOPES

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(Accepted for publication July 26, 1982)

ABSTRACT

Corn, okra and soybean plants were made radioactive by injection of a ^{32}P solution or by soaking okra seedling roots in a ^{32}P solution. Red imported fire ant workers, *Solenopsis invicta* Buren, obtained radioactivity from all three plants. Feeding was observed on corn and feeding damage observed on okra blossoms and pods. Feeding was not observed on okra seedlings or soybeans, but the high levels of radioactivity found in ants crawling on or tunneling at the base of these plants indicates extensive feeding on their roots.

Feeding on crops by the red (RIFA) and black imported fire ants, *Solenopsis invicta* Buren and *S. richteri* Forel (=*Solenopsis saevissima* var. *richteri* Forel; see Buren (1972)) was first reported by Lyle and Fortune (1948) and Wilson and Eads (1949). The latter authors, in a survey they conducted for the Alabama Department of Conservation, found that ants ate seeds of corn, peanuts and beans and the roots, stems and occasionally leaves of seedlings of corn, beans, Irish potatoes and cabbage. Seedlings of these plants, as well as collards, watermelon and squash were eaten by ants kept in artificial nests. Farmers they contacted reported that corn, Irish potatoes, sweet potatoes and cabbage were most severely affected. In contrast, Hays and Hays (1959) observed feeding by the ants on vegetative matter in the field in only one instance (an ear of corn) and that, when kept without food for several days in the laboratory, they fed on only a few species of seedling plants. They concluded that most colonies became cannibalistic rather than feed on plant material. They did not specify whether or not they worked with queen-right colonies (ones that contained a fertile queen and brood). Since the extent of ant foraging for food is directly related to the needs of the queen and brood, it is possible that this factor may have been the cause of their negative results.

Following these early reports there have been very few references to direct damage to crops by imported fire ants and, until recently, those that did appear referred to isolated incidents. Lofgren and Adams (1982) speculated that the paucity of reports of damage may have been due to the wide-scale use of the organochlorine insecticides for general control of crop insects. However, our recent studies (Lofgren and Adams 1981, Adams *et al.* 1983) have shown that yield of soybeans can be severely reduced by RIFA. During the past few years we have monitored for feeding of RIFA on corn, okra and soybeans using the radioisotope phosphorus-32 (^{32}P). This paper presents the results of the tests.

MATERIALS AND METHODS

The test plots were located near the Insects Affecting Man and Animals Research Laboratory, ARS, USDA, Gainesville, Florida in an area with sandy-loam soil. The corn and okra were planted in March, 1979 while the soybeans were planted in late May 1979 and 1981. Since the RIFA infestation in the plots was low, additional queen-right colonies were introduced to achieve a population density of 108 colonies per hectare. Plants selected for the tests were ones around which foraging workers were observed.

Mature plants were treated by injecting the ^{32}P in water with a 27-gauge hypodermic needle on a gas-tight syringe. Two-month-old corn plants were injected in the second node above ground with 12μCi of ^{32}P each, while Clemson Spineless okra plants (120 days old) were labeled by injecting 5 to 10μCi of the ^{32}P into the stem of the flower bud. Fifty seedlings each of Clemson Spineless and Dwarf okra were treated by immersing the roots for 24 hrs in well water containing 12.5μCi/ml of ^{32}P. Then the plants were removed, rinsed thoroughly, placed in well water for 1 hr and planted in soil in the field plots. Tests with soybeans (Bragg) were conducted in two different years. In the first two tests (1979), three plants were injected 2.5 cm above ground with 40 to 80μCi/plant just prior to, or immediately after, onset of flower formation. In the third test (1981), seven plants (Bragg) were labeled. Each labeled plant was separated from other labeled plants in the plot by at least 3.3 to 6.6 meters and they were distributed between three widely separated rows.

Radiation levels in the treated plants were measured periodically in the field with a portable radiation survey meter. One soybean plant was removed from the field 5 days after injection, dried in an oven at 25 C and 40% RH and then assayed for radioactivity. Soybean pods and flowers were collected 52 days after labeling and assayed. Leaf samples were also taken from the okra seedlings, weighed and assayed. All of the plant samples were assayed with a gas-flow proportional counter.

RIFA workers and other insects were collected daily with a portable vacuum device while foraging on the plants or on the soil near the plants. They were placed in a freezer for 1 hr. Then they were washed to remove external ^{32}P, placed individually in vials and assayed in a liquid scintillation spectrometer. All data are presented as the cpm above background.

RESULTS AND DISCUSSION

All leaves of the labeled corn plants were radioactive after 24 hrs but the activity decreased gradually and 13 days after the initial injection of ^{32}P only 37% the activity noted at 24 hrs was detected. Thirty-eight percent of the RIFA workers collected from the corn plants were radioactive; however, the activity averaged only 16.3 cpm (Table 1). Primary sites of feeding by the ants appeared to be small lesions on the leaves and leafy bracts covering the ear. It is not known whether or not the lesions were induced by the RIFA.

Assays of the okra pods showed that 49% of the radioactivity remained after 11 days. The RIFA workers fed avidly at the base of the okra flowers

Table 1. – Radioactivity of the red imported fire ants collected from plots with ^{32}P labeled plants.*

Plant	Labelling technique	Time of collection after treatment (wks)	No. ants		Radioactivity (cpm)	
			collected	radioactive	Avg.	Range
Corn	Injection	1	132	50	16.3	10.2-55
Okra	Injection	1	45	40	83.6	10.0-877.4
	Seedling soak	2	134	14	262.5	19.0-1402
Soybean	Injection	1	28	26	226.8	37.0-1741
	Injection	1	15	15	56.0	12.0-141
	Injection	2	376	142	601.4	11.0-16237

*All tests were conducted with growing plants just prior to or at the time of flowering and pod or ear development except the test with okra seedlings.

and on mucilagenous secretions of the pods. Workers collected from the pods averaged 83.6 cpm (Table 1). The leaves of the seedling Clemson Spineless okra plants averaged 11,163 cpm/mg while the Dwarf okra averaged 13,963 cpm/mg. Few worker ants were observed on the above ground portions of the seedlings; however, workers were observed tunneling around the base of many plants. Many of these workers were collected and they were found to average 262.5 cpm (Table 1). Two other species of ants were collected. *Conomyrma insana* (Buckley) nest openings were present in the rows of the seedling okra and 38 of 44 worker ants collected were radioactive. Workers of the other ant, an unidentified *Conomyrma* sp., were collected also and 11 of 29 were radioactive. Of 13 other insects collected, nine were radioactive and are listed below:

3 *Spanogonicus albofasciatus* (Reuter) (whitemarked fleahopper)
2 *Spodoptera eridonia* (Cramer) (southern army worm)
2 Aphids (unidentified)
1 *Aclelus vicinus* Scudder (mole cricket)
1 *Altica* sp. (beetle)

The three fleahoppers, two southern army worms and two aphids were collected on the last three days of the test while most of the 134 RIFA were collected before this time. All of our data and observations point to the RIFA obtaining the ^{32}P from feeding on plant tissue (probably the roots) rather than the few other insects present. At no time during the test did we detect RIFA attacking live or feeding on live or dead insects.

Analyses of the soybean plant which was removed from the field and dried revealed the following cpm/mg:

Tip of terminal leaf	723.6	
Base of terminal leaf	493.0	
Large lower leaf	178.3	
Roots (no nodules)	46.7	
Large root (one nodule)		31.5
Five nodules on root hairs		400.2

Flower buds 314.2

These data indicate the ^{32}P was well distributed throughout the plant and that the newer tissues contained the highest levels of radioactivity. Soybean pods removed 52 days after injection were radioactive with older pods averaging 10.2 cpm/mg and younger pods 55.8 cpm/mg. Flowers collected at the same time averaged 25 cpm/mg.

In the first 1979 tests RIFA were collected for 7 days and 93% were radioactive (avg. 226.8 cpm). In addition, one radioactive *Conomyrma insana* was collected. In the second test in the same plot only 15 fire ants were collected, but all were radioactive (avg. 56.0 cpm). The third test (1981) showed 38% of the RIFA collected during a 2-week period were radioactive, but the average level of radioactivity (601.4 cpm) was ca. 3 to 10 times that of the earlier tests. Thirteen other insects were collected of which the following four were radioactive:

3 *Spissistilus festinus* (Say) (three cornered alfalfa hopper)
1 *Spodoptera eridonia* (Cramer) (southern army worm)

Because of the low numbers of possible arthropod prey in comparison to the large number (142) of radioactive RIFA, it was evident that the RIFA were obtaining the ^{32}P directly from the soybean plants rather than indirectly from contaminated, plant-feeding arthropod prey.

Ants were observed tunneling around the roots of all treated soybean plants in the first test prior to flower set suggesting that feeding on the roots was the primary source of ^{32}P. During this period, few ants were observed foraging in the foliage prior to flower set. The second test, however, occurred after flower set and ants were frequently observed foraging in the foliage as well as tunneling around the roots. This suggested the possiblity of the ants feeding on both the roots and the flowers.

CONCLUSIONS

The data illustrate conclusively that RIFA workers obtain ^{32}P from labelled corn, okra and soybeans. Direct feeding of worker ants on lesions on the leaves of corn and leafy bracts of corn ears and the flower sepals and pods of okra was observed. In no instance did we observe obvious feeding on the soybean plants or okra seedlings. The ants probably obtained the ^{32}P by feeding on the roots of these plants. Since very few other plant feeding arthropods were observed, we concluded that they did not contribute significantly to the radioactivity detected in the ants. Feeding of ants on plant tissue other than flowers or nectaries may be more extensive than heretofore discovered.

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