

# The Red Imported Fire Ant, *Solenopsis invicta* Buren (Hymenoptera: Formicidae). A Pest of Florida Citrus and Its Management

M 290

J.L. Knapp

University of Florida, Citrus Research and Education Center, 700 Experiment Station Road, Lake Alfred, FL 33850 U.S.A.

D.P. Wojcik

United States Department of Agriculture, ARS-MAVERL, Gainesville, FL 32604, U.S.A.

*Additional index words.* chemical control strategies - ant trapping

**Abstract.** Since the 1920's, ants have been reported as pests of nonbearing Florida citrus. Results from chemical control trials were negative due to a decline in ant populations in untreated areas following pesticide applications to treated plots and a wide variation in ants trapped between replicates of the same treatment.

Small black ants were identified as a problem on budded citrus trees by Watson in 1926 (Watson, 1926). Control recommendations included banding the tree with a mixture of lard or black axle grease mixed with flowers of sulfur. Watson again in 1937 mentioned ants as a problem and observed them tending scale, aphids, and mealybugs. Use of sodium arsenate obtained from the local druggist (Watson, 1937), was recommended as an additional control agent. Several ant species were reported by Griffiths and Thompson (1957) to be harmful to citrus including the fire ant, *Solenopsis germinata* (Fab.) and the little fire ant, *Wasmannia auropunctata* (Roger). The latter is not a pest of citrus trees but possesses a sting so severe that its presence may prevent grove labor from entering infested groves (Griffiths and Thompson, 1957). Chlorinated hydrocarbon insecticides were recommended for their control (Brogdon and Lawrence, 1960).

The use of chlorinated hydrocarbon insecticides, primarily Aldrin, every five years to control citrus root weevil larvae, prevented any buildup of appreciable ant populations until these products were banned by the U.S. Environmental Protection Agency in the late 1970's.

The Cooperative Extension Service began receiving complaints in the early 1980's of young citrus trees being killed by the red imported fire ant (RIFA), *Solenopsis invicta* Buren. Ants nesting at the base of young citrus trees within tree wraps, in soil banks, and under permanent PVC irrigation pipe were observed feeding on bark and cambium to obtain sap, often girdling and killing individual trees. The ants also fed on young shoot growth, flowers, or developing fruit (Smittle et al., 1988; Banks et al., 1991). Styrofoam basal tree wraps were developed for cold protection containing a replaceable, slow-release packet of Diazinon which excluded insects, including ants, from entering the wrap (Reese and Reese, 1981).

In 1988, Knapp published various chemical control strategies for RIFA including advantages, disadvantages, and precautions of each (Knapp, 1988). A grower survey was conducted in 1989 by the Cooperative Extension Service and 71 percent of the respondents stated that RIFA was a moderate to severe problem (Summerhill et al., 1989). Chemical control recommendations for the RIFA were added to the annual Florida Citrus Spray Guide in 1990 (Knapp, 1990). Currently the problem is increasing as the citrus industry moves to southern Florida. Groves are being planted on land which included pastures previously infested with RIFA. Also, the development and spread of multiple queen colonies has resulted in greater nest density.

Economic problems are limited to worker reluctance to harvest infested groves because of stings, often requesting premium

wages or refusing to work.

The objective of these trials was to evaluate potential pesticides, rates, timing, and method of application to manage RIFA on nonbearing citrus.

## Materials and Methods

*Sampling of ants with traps.* Experiments I-V were evaluated by trapping ant species. Traps consisted of 1 oz. plastic cups with snap-on lids with a single (ca. 2 mm diam.) hole melted near the bottom with a soldering iron. Traps were baited with either hamburger meat (2/traps/replicate/treatment) or a 10% honey agar cube (2/traps/replicate/treatment) (Stinger et al., 1980). The two traps were placed near the center of each replicated plot in the morning hours and left for one hour. Tape was used to seal the entrance hole and the traps were returned to the lab where the ants were frozen and transferred to labeled vials for identification. All collections were identified to species and counted. Data recorded at trappings included time, air temperature, relative humidity, and temperature on the soil surface and at 2.5 and 10 cm depths.

Experiment VI was evaluated by visually inspecting trees and wraps for RIFA activity.

Six separate field trials were established between September 1987 and October 1991.

*Experiment I.* Contact products evaluated on nonbedded citrus grove in Lakeland, FL. Treatments included Lorsban (= chlorpyrifos) 4E (1.12 kg a.i./ha), Nemacur (= Fenamiphos) 3E (22.4 kg a.i./ha), Rotate (= Bendiocarb) 76WP (0.42 kg a.i./ha), and Orthene 75S (1.67 kg a.i./ha) and an untreated check. All materials were applied broadcast using a tractor mounted herbicide boom calibrated to deliver 469 liters finished spray/ha. Plots of 0.4 ha were randomly assigned in a completely randomized design and replicated three times. Pretreatment ant trappings were made on September 18, 1987. Treatments were applied on October 20, 1987; April 20, 1988; October 10, 1988; April 24, 1989; and October 31, 1989. Ants were trapped three to five times between applications at approximately one month intervals based on weather and ant activity. The trial was terminated on December 12, 1989.

*Experiment II.* The same treatments as in Experiment I were applied to 0.4 ha random plots of bedded citrus grove in Wauchula, FL using four replicates. Pretreatment ant trappings were made on June 1, 1988. Treatments were applied June 16, 1988; October 31, 1988; April 26, 1989; and November 1, 1989. Ant trappings were made as above. The trial was terminated on December 12, 1989.

**Experiment III.** Treatments included Logic (= Fenoxycarb) 1% bait (B) (69 g a.i./ha) and Affirm (= Abamectin) 0.011% B (0.12 g a.i./ha) and an untreated check. Chemicals were applied to a nonbedded citrus grove in Lakeland, FL using an Ortho whirlybird spreader calibrated to deliver 1.12 kg product per ha. Plots were approximately 0.4 ha in size replicated three times. Pretreatment ant trappings were made on September 18, 1987 with treatments applied October 20, 1987; April 20, 1988; October 10, 1988; and April 24, 1989. The trial was terminated on December 7, 1989. Ant trappings were made as above.

**Experiment IV.** The same treatments and methods as III above except for four replicates were applied to a bedded citrus grove in Wauchula, FL. Pretreatment ant trappings were made on June 1, 1988. Treatments were applied June 16, 1988; October 31, 1988; April 26, 1989; and November 1, 1989. Ant trappings were made as above. The trial was terminated on December 14, 1989.

**Experiment V.** Rotate 76WP (0.56 and 1.12 kg a.i./ha), Lorsban 4E (1.12 kg a.i./ha), Sevin (= Carbaryl) 80S (1.12 and 2.24 kg a.i./ha) were applied through a microsprinkler irrigation system to 0.18 ha plots with three replicates in a grove in Lake Alfred, FL. Each pesticide was diluted in 56.8 liters of water and continuously injected over a 10-minute period. The irrigation system was run for 30 minutes following injection. The irrigation system utilized a single 60 l/hr 280° jet/tree wetting approximately 18 m<sup>2</sup> around each tree. Pretreatment ant trappings were made on April 28, 1989. Treatments were applied September 6, 1989; June 21, 1990; October 30, 1990; and June 17, 1991. Ant trappings were made as outlined above. The trial was terminated October 23, 1991.

**Experiment VI.** The final trial evaluated Reese tree wraps with and without a slow release packet of Diazinon, Frostproof Grow-

ers' tree wraps with and without Pest Stop (mesh packet of Rotate 2.5% granules), and no tree wrap with 28 g/tree Rotate 2.5 g. Treatments were randomly assigned to five tree plots replicated five times to a citrus grove in Loughman, FL. Tree wraps were installed on May 25, 1990 and the experiment terminated December 14, 1990. Seven monthly observations for ant activity were made during this period.

## Results and Discussion

Ant populations decreased in all treatments including the untreated checks following pesticide application. Numbers of ants trapped by replicate within each treatment was extremely variable (Tables 1, 2, 3, 4 and 5).

Data from Experiments I through V were expressed as percent increase or decrease from the trapping counts prior to the previous application. Percentages were analyzed by replicate using Tukey's Studentized Range Test for variability. There were no significant differences between any of the treatments in any of the trials. Experimental protocols will have to be changed for future trials, i.e., larger plot size and more traps per replicate.

In Experiment VI, there was a wide range in ant activity depending on date of observation. The Reese Tree Insulator wrap with Diazinon was the best treatment followed by the Rotate 2-1/2 G sprinkled around the tree and the Frostproof Growers wrap with Pest Stop. The interesting results of this trial was that both types of tree wraps without pesticides consistently had more RIFA activity than did trees without any (Table 6).

Table 7 shows ant species other than *Solenopsis invicta* trapped during the studies.

Table 1. Summary of RIFA control results using contact sprays from Experiment I in a nonbedded citrus grove in Lakeland, FL.

Trap date	Treatments and rates									
	Lorsban 4E		Nemacur 3E		Rotate 76WP		Orthene 75		Untreated	
	1.12 kg a.i./ha		22.4 kg a.i./ha		0.42 kg a.i./ha		1.67 kg a.i./ha			
	Means <sup>a</sup>	StdDev	Means	StdDev	Means	StdDev	Means	StdDev	Means	StdDev
9/18/87	96.17	117.06	139.83	123.76	67.67	97.65	146.83	151.23	49.83	77.61
10/28/87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.83	19.19
11/16/87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.41
4/6/88	27.67	66.30	11.50	25.77	26.17	61.20	4.33	9.22	2.50	4.72
4/28/88	0.00	0.00	0.00	0.00	0.17	0.41	0.00	0.00	9.00	22.05
5/17/88	3.67	6.22	0.00	0.00	57.67	49.19	66.83	84.13	126.50	168.84
6/6/88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7/20/88	29.83	48.28	90.00	107.48	57.67	91.29	14.00	31.41	23.83	39.35
9/14/88	54.33	126.36	30.00	46.37	184.17	155.36	50.00	78.26	76.83	118.97
10/17/88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.83	18.70
11/14/88	0.00	0.00	6.17	15.11	0.67	1.63	0.00	0.00	32.33	69.42
4/14/89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.33	13.06
5/3/89	0.17	0.41	0.00	0.00	34.83	85.32	3.33	5.05	173.33	46.10
6/5/89	31.17	49.68	0.83	1.33	42.50	82.11	40.17	50.08	41.33	58.87
6/30/89	4.00	9.80	12.83	18.64	23.00	23.07	9.00	10.87	141.83	72.40
8/4/89	0.00	0.00	0.17	0.41	0.00	0.00	0.00	0.00	0.00	0.00
8/18/89	145.50	165.36	54.67	60.11	62.17	51.83	87.00	60.39	74.00	116.10
10/3/89	269.50	417.58	497.17	401.58	142.33	219.35	393.83	360.22	271.17	442.04
11/8/89	0.00	0.00	228.83	560.04	53.00	129.82	0.00	0.00	710.50	342.52
12/7/89	25.17	61.65	57.83	141.66	0.00	0.00	26.00	63.69	232.00	318.16

<sup>a</sup>Avg. number of RIFA per trap.

Table 2. Summary of RIFA control results using contact sprays from Experiment II in a bedded citrus grove in Wauchula, FL.

Trap date	Treatments and rates									
	Lorsban 4E		Nemacur 3E		Rotate 76WP		Orthene 75		Untreated	
	1.12 kg a.i./ha		22.4 kg a.i./ha		0.42 kg a.i./ha		1.67 kg a.i./ha			
	Means <sup>a</sup>	StdDev	Means	StdDev	Means	StdDev	Means	StdDev	Means	StdDev
6/1/88	15.00	27.76	0.00	0.00	47.33	112.53	0.17	0.41	18.83	41.88
6/24/88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7/15/88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9/19/88	2.17	1.94	52.83	54.04	28.50	47.26	9.33	10.71	3.17	5.53
10/25/88	0.67	1.63	2.67	3.01	0.50	0.84	17.33	25.81	28.50	47.69
11/8/88	0.00	0.00	0.00	0.00	5.50	12.06	7.33	12.19	20.17	32.08
4/20/89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5/5/89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	20.33	47.86
6/7/89	32.17	65.45	63.67	92.88	51.00	58.04	107.00	57.01	107.17	52.69
6/29/89	8.83	14.12	34.67	45.68	64.17	108.78	33.83	43.82	6.17	6.85
8/4/89	169.50	209.76	73.50	137.66	5.00	5.33	40.17	94.98	47.83	68.92
10/11/89	308.33	208.13	191.83	213.99	106.67	134.14	207.83	277.58	307.83	351.26
11/9/89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11/15/89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12/14/89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

<sup>a</sup>Avg. number of RIFA per trap.

Table 3. Summary of RIFA control results using baits from Experiment III in a nonbedded citrus grove in Lakeland, FL.

Trap date	Treatments and rates					
	Logic 1% B		Affirm 0.11% B		Untreated	
	69 g a.i./ha.		12 g a.i./ha			
	Means <sup>a</sup>	StdDev	Means	StdDev	Means	StdDev
9/18/87	101.83	50.43	120.67	101.14	51.17	77.72
10/28/87	28.00	44.69	0.50	1.23	2.33	3.93
11/16/87	4.00	9.80	0.00	0.00	0.00	0.00
4/6/88	1.50	3.67	0.67	1.21	1.00	2.45
4/28/88	2.67	6.53	1.17	2.86	5.67	13.88
5/17/88	25.33	42.81	0.17	0.41	0.00	0.00
6/6/88	0.17	0.41	0.00	0.00	3.33	8.17
7/20/88	12.17	19.29	25.17	33.80	12.50	19.37
9/14/88	115.50	155.42	119.17	98.32	10.00	23.53
10/17/88	52.33	128.19	0.00	0.00	32.17	78.79
11/14/88	52.83	82.68	0.00	0.00	0.33	0.52
4/14/89	0.00	0.00	197.67	201.46	35.50	86.96
5/3/89	67.67	53.76	38.33	71.38	78.33	103.88
6/5/89	1.67	2.73	0.00	0.00	98.17	89.46
6/30/89	0.83	2.04	1.00	2.45	53.50	71.69
8/4/89	0.00	0.00	0.00	0.00	0.00	0.00
8/18/89	1.00	2.45	13.33	32.66	295.17	351.51
10/3/89	0.00	0.00	209.00	506.56	363.83	379.02
11/8/89	0.40	0.89	162.00	208.39	579.83	337.67
12/7/89	0.00	0.00	0.00	0.00	0.00	0.00

<sup>a</sup>Avg. number RIFA per trap.

Table 4. Summary of RIFA control results using baits from Experiment IV in a bedded citrus grove in Wauchula, FL.

Trap date	Treatments and rates					
	Logic 1% B 69 g a.i./ha.		Affirm 0.11% B 12 g a.i./ha		Untreated	
	Means*	StdDev	Means	StdDev	Means	StdDev
6/1/88	9.83	14.99	7.17	12.62	18.83	41.88
6/24/88	0.17	0.41	0.00	0.00	0.00	0.00
7/15/88	0.00	0.00	0.00	0.00	0.00	0.00
9/19/88	20.00	27.12	60.33	80.26	3.17	5.53
10/25/88	1.50	3.21	21.00	32.45	28.50	47.69
11/8/88	13.00	26.25	13.33	14.92	20.17	32.08
4/20/89	0.00	0.00	0.00	0.00	0.00	0.00
5/5/89	0.00	0.00	0.00	0.00	20.33	47.86
6/7/89	30.00	45.36	2.33	4.80	107.17	52.69
6/29/89	1.83	4.49	0.67	1.21	6.17	6.85
8/4/89	0.00	0.00	5.33	12.11	47.83	68.92
10/11/89	69.33	65.74	141.83	174.23	307.83	351.26
11/9/89	0.00	0.00	0.00	0.00	0.00	0.00
11/15/89	0.00	0.00	0.00	0.00	0.00	0.00
12/14/89	0.00	0.00	0.00	0.00	0.00	0.00

\*Avg. number RIFA per trap.

Table 5. Summary of RIFA control results using chemigation from Experiment V in a nonbedded citrus grove in Lake Alfred, FL.

Trap date	Treatment and rates										Untreated	
	Rotate 76WP 1.12 kg a.i./ha		Rotate 76WP 0.56 kg a.i./ha		Lorsban 4E 1.12 kg a.i./ha		Sevin 4L 2.24 kg a.i./ha		Sevin 4L 1.12 kg a.i./ha			
	Means*	StdDev	Means	StdDev	Means	StdDev	Means	StdDev	Means	StdDev	Means	StdDev
4/28/89	4.17	8.40	56.83	109.88	6.33	9.83	7.17	11.18	0.83	1.33	47.00	80.85
8/15/89	114.00	145.33	58.83	80.85	18.83	18.48	5.67	9.56	26.00	28.49	67.17	112.42
9/8/89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	57.83	129.08
10/13/89	95.67	171.54	30.83	41.60	15.83	34.56	8.50	20.82	24.17	37.49	16.67	24.10
11/16/89	9.33	16.15	6.83	16.74	108.67	257.46	24.33	42.40	22.00	52.43	0.17	0.41
12/28/89	0.17	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5/4/90	25.33	28.02	88.50	96.89	202.50	283.96	82.33	128.96	26.00	42.20	43.33	70.12
5/24/90	224.83	348.31	74.33	127.97	257.00	358.96	361.50	335.24	186.50	253.19	366.83	322.91
6/29/90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.67	33.48	0.00	0.00
8/14/90	154.00	219.96	172.17	324.16	141.00	179.73	181.17	373.24	101.67	146.82	188.33	343.07
10/3/90	278.67	321.58	198.50	268.57	325.33	347.03	164.50	268.27	300.33	358.77	228.00	251.84
11/6/90	60.67	140.44	108.17	250.36	0.00	0.00	6.50	15.92	35.00	57.66	10.83	26.54
12/9/90	0.00	0.00	34.33	54.14	0.00	0.00	7.00	17.15	3.33	8.17	4.67	11.43
3/14/91	51.50	125.66	178.33	244.21	47.17	115.53	98.67	238.76	8.00	19.60	0.00	0.00
4/17/91	18.33	44.91	11.50	19.49	31.50	73.31	59.17	67.45	92.50	174.88	18.83	30.78
5/1/91	41.00	37.87	70.17	84.19	91.67	63.48	61.17	67.59	41.67	50.04	12.50	14.10
5/24/91	10.83	6.62	14.83	17.67	0.00	0.00	6.67	8.26	8.50	12.16	31.33	69.54
8/22/91	303.83	367.34	122.50	281.86	44.00	85.00	132.50	229.64	117.50	198.15	119.17	184.50
10/23/91	28.83	50.73	218.50	342.37	185.33	152.84	310.83	436.58	1.33	3.27	78.00	97.31

\*Avg. number of RIFA per trap.

Treatment	% infested
F.P. <sup>2</sup> wrap w/o Rotate	56.00 a <sup>1</sup>
Reese wrap w/o Diazinon	48.00 a
No wrap with Rotate	24.00 b
No wrap	24.00 b
F.P. wrap with Rotate	16.00 b
Reese wrap with Diazinon	4.17 b

<sup>1</sup> Frostproof Growers' wrap.

<sup>2</sup> Means in each column not sharing a common letter are significantly different at the 5% level (DMRT). Data transformed to LOG<sub>10</sub>(X + 1) for analysis. Nontransformed means presented for comparison.

Table 7. Ant species other than *Solenopsis invicta* trapped during the studies.

Agar	Meat
<i>Conomyrma bureni</i> (Trager)	<i>Conomyrma bureni</i> (Trager)
<i>Brachymyrmex obscurior</i> (Forel)	<i>Paratrechina bourbonica</i> (Forel)
<i>Conomyrma medeis</i> (Trager)	<i>Conomyrma medeis</i> (Trager)
<i>Paratrechina bourbonica</i> (Forel)	<i>Pheidole morrisi</i> (Forel)
<i>Pheidole morrisi</i> (Forel)	<i>Pheidole metallescens</i> (Emery)
<i>Pheidole metallescens</i> (Emery)	<i>Aphaenogaster ashmeadi</i> (Emery)
<i>Pogonomyrmex badius</i> (Latreille)	<i>Solenopsis geminata</i> (F.)
<i>Cardiocondyla emeryi</i> (Forel)	<i>Raratrechina faisonensis</i> (Forel)
<i>Paratrechina faisonensis</i> (Forel)	
<i>Cardiocondyla nuda</i> (Mayr)	

Banks, W. A., C. T. Adams, and C. S. Lofgren. 1991. Damage to young citrus trees by the red imported fire ant (Hymenoptera: Formicidae). *J. Econ. Ent.* 84(1):241-246.

Brogdon, J. E. and F. P. Lawrence. 1960. Control of minor pests of commercial citrus in Florida. Univ. of Florida, CES. Cir. 200. 3.

Griffiths, J. T. and W. L. Thompson. 1957. Insects and Mites Found on Florida Citrus. Univ. of Florida, Agri. Exp. Sta. Bull. 591: 67-68.

Knapp, J. L. 1988. Chemical control of red imported fire ants on Florida citrus. The Citrus Industry. May. 23-24.

Knapp, J. L. 1990. Florida Citrus Spray Guide. Univ. of Florida, CES. SP-43. p. 5.

Reese, S. L. and R. L. Reese. 1981. Slow release pesticide inside tree wraps for young tree trunk protection from insect damage. *Proc. Fla. St. Hort. Soc.* 94:14-15.

Smittle, B. J., C. T. Adams, W. A. Banks, and C. S. Lofgren. 1988. Red imported fire ants: Feeding on radiolabeled citrus trees. *J. Econ. Ent.* 81(6):1019-1021.

Stinger, C. E., W. A. Banks, and J. A. Mitchell. 1980. Effects of chlorpyrifos and Acephate on populations of red imported fire ants in cultivated fields. *J. Georgia Entomol. Soc.* 15(4):413-417.

Summerhill, W. R., J. L. Knapp, J. W. Noling, G. D. Israel, and C. L. Taylor. 1989. Citrus Pest Management Survey. Univ. of Florida, CES. PE-6. P. 17.

Watson, J. R. 1926. Citrus insects and their control. Univ. of Florida, Agri. Exp. Sta. Bull. 183: 412-413.

Watson, J. R. 1937. Citrus insects and their control. Univ. of Florida, Agri. Exp. Sta. Bull. 88: 119-121.