Texas Imported Fire Ant Research and Management Project
Final Progress Report - October 2001

Protecting Electrical/Electronic Equipment from Imported Fire Ant Damage

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Major Accomplishments to date:
A static electrical device (SED) was designed and tested in the laboratory for efficacy in repelling *S. invicta*. Criteria for the design were low cost, low maintenance, and no moving parts. Strips of conductive material were close together to allow ants to bridge and receive an electrical shock. Voltage was regulated by diodes, and current was supplied by alligator clips attached to a power source. Ants investigated the SED and consequently were shocked with 70-VAC current. Ants responded by gaster-flagging and releasing alarm pheromones that first attracted nestmates, then caused intra-colony defensive behavior which resulted in chaos and death of many members.

Two parallel research efforts resulted: (a) laboratory investigations to determine the actual mechanisms of ant responses to electrical shock, and (b) field trials to evaluate SED field reliability, efficacy, and importance in an integrated pest management program to reduce economic impact of *S. invicta* on the electrical utility industry.

1. Field trials to protect electrical transformers. This project required the assistance and good will of Texas Utilities-Electric, Inc. and of American Electric Power, Inc. Each site manager provided a technician or lineman to accompany the Texas Tech researchers and to open each transformer cabinet for placement of treatments and for subsequent observations and data recording. This can be dangerous work, and without the help of each utility company, this project could not have been accomplished.

Step-down transformers in residential areas typically reduce voltage from 65,000 to 220 volts alternating current (VAC). In all cases, underground cables delivered electricity to transformers

and to homes. *Solenopsis invicta* colonies cause problems in transformer cabinets because they build mounds against the primary and secondary electrical busses, cause corrosion to electrical connections, and frequently destroy transformers, thus compromising electrical service. In addition, *S. invicta* remove soil from beneath concrete or fiberglass pads and, consequently, cause tilting of transformers and stress on cable connections. Seven sites were used in field research (Table 1).

Table 1. Sites of Research on Reducing *Solenopsis invicta* Damage to Pad-Mounted, Electrical Transformers in Residential Areas. Cooperating companies were Texas Utilities-Electric and American Electric Power, Inc.

Site[a]	No. transformers	Date of Initial Treatment	Dates of Subsequent Observations		
Waco	64	June 98	Aug. 99	June 01	
Tyler	50	June 98	Aug. 99	Aug.01	
Idabel	27	Nov. 99	May 01		
Corpus Christi	33	Oct. 99	May 01		
Dallas	52	July 98	Dec. 98	Sept. 99	June 01
Ft. Worth	46	July 98	Aug. 99	June 01	
Arlington	36	July 98	Aug. 99	June 01	

[a] All sites were in Texas, except for Idabel, OK. *Solenopsis invicta* has been present in Idabel since approximately 1993.

During initial treatments, if *S. invicta* mounds were found inside transformer cabinets, soil was removed by shoveling or vacuuming before the treatment was applied. This was done to knock back any colonies and force colonies to re-establish within cabinets under the pressure of the treatment. Cabinets that had been treated with insecticide or had evidence of an oil leak were not used in this research.

When we approached an experimental transformer, a hammer or wrench was used to knock the metal cabinet on three sides. As *S. invicta* reacted to the disturbance and ran from under the cover, a visual estimation of numbers of ants was recorded. This test was called the "hammer test". After a cabinet cover was opened, viability of *S. invicta* colonies within were rated on a 0 - 5 scale (0: no ants; 1: 1-100; 2: 101-500; 3: 500-1000; 4: 1001-10000; 5: 10001-50000). Condition and position of *S. invicta* mounds were recorded, and mounds were ranked as small, medium, or large, regardless of number of ants. The amount of soil covering any static electrical device (SED) was also noted. On the last observation date at each site, SED were removed, and the project was terminated.

Data were entered into a MS Excel® file for Macintosh. Data from each transformer were compared between consecutive dates and were ranked as follows: 0: no change in ant populations; +: reduced ant activity from previous observation; -: greater numbers of ants were present than from previous observation. This somewhat subjective ranking system took into account all observations explained above.

Table 2. focuses on four sites with most reliable data. Early data from Dallas, Ft. Worth, and Arlington are still being analyzed, and unfortunately, later data were compromised by removal of SEDs and application of Dursban® insecticide by utility workers after 1999 observations.

Table 2. Four Study Sites and Evaluation of Treatment Effects on *Solenopsis invicta* Populations.

Site	No. transformers	Treat-ment [a]	Number of Rankings of Population Changes		
			no change	reduced	larger
Waco	64	control	19	2	0
		SED	29	4	5
		SED+S	26	4	6
		Sevin	14	0	5
		DE	2	1	0
Tyler	50	control	10	1	1
		SED	21	6	4
		SED+S	24	3	3
		Sevin	10	1	0
Corpus Christi	33	SED+S	7	9	1
		Sevin	4	4	1
		DE	3	0	0
		Bb	1	1	1
Idabel	27	control	2	3	2
		SED+S	1	3	1
		DE	3	5	6
pooled	174	control	31	6	3
		SED	54	10	9
		SED+S	58	19	11
		Sevin	28	8	6
		DE	8	6	6
		Bb	1	1	1

[a] control: mound removal by shoveling only; SED: static electrical device; SED+S: SED and 5% Sevin® dust (approx. 6 tablespoons); Sevin®: 5% carbaryl dust (6 Tbs); DE: diatomaceous earth (eight cups); Bb: *Beauveria bassiana* granules (approx. 5 grams).

A ranking of "no change" typically represented no presence of *S. invicta* in a transformer. Removal of soil at trial initiation by either shoveling or vacuuming had the dramatic effect of reducing *S. invicta* populations, no matter what subsequent treatment was applied. New mounds were frequently found in transformers, but typically, ants were not present during the seasons of this experiment. In Corpus Christi and Idabel transformers, all treatments tended to reduce ant populations. Colonies did not re-establish in transformers, again emphasizing the importance of stress caused by hot, dry weather.

During the years of the field research, summer weather was extremely hot and dry resulting in poor survival of *S. invicta* colonies, including colonies inside transformer cabinets. Consequently, if transformers did not have viable colonies at the beginning of the research, *S. invicta* colonies failed to establish in transformers, regardless of treatment. The extremely dry weather at all sites made evaluation of *S. invicta* mounds very difficult because colonies tend to be deeper in the soil and nearly impossible to evaluate viability. Many other field projects sponsored by the Texas Fire Ant Initiative Program suffered the same problems. Nonetheless, several conclusionary statements may be presented:

a. SEDs did cause reactions among *S. invicta* colonies. Many clumps of dead ants were observed upon SEDs. Also, SEDs were typically partially covered by soil brought by ants, perhaps in an attempt to "defeat" the negative stress caused by the foreign electrical device. Because of this burying activity, the majority of SEDs were short-circuited and non-functional when tested.

Reliabilty of SEDs can be improved with design changes.

b. Few *Solenopsis invicta* colonies re-established in transformers under any treatment.

c. Removal of mound soil from transformer cabinets has a decidedly negative effect on colonies.

2. Laboratory trials on SED effects on *S. invicta* colonies.

a. *Solenopsis invicta* colonies explored electrified SED, gaster-flagged when shocked by 70 VAC, and nestmates were attracted to the alarm pheromone environment.

b. When *S. invicta* colonies were given a choice, colonies did not significantly relocate near electrified SED as compared to near unelectrified SED. However in 63% of the trials, *S. invicta* moved into brood boxes near electrified SED (27 replications)

c. Olfactometer trials:

i. *Solenopsis invicta* were repelled by hexane; therefore we were confident that the olfactometer could be used to document responses of individual workers to odors emanating from test chambers.

ii. *S. invicta* workers did not significantly react to odors of crushed nestmates as compared to clean airstreams.

iii. Inherent odors of electrified SED and unelectrified SED components were neither attractive nor repellent to *S. invicta*.

iv. *S. invicta* workers were significantly attracted to gaster-flagging nestmates on electrified SED ($t = 2.34$; $df = 22$; $P = 0.021$).

d. Newbrough, J. K. 2001. Responses of the red imported fire ant, *Solenopsis invicta* Buren, to static electrical devices. M.S. thesis, Dept. of Plant and Soil Science, Texas Tech University, Lubbock. (successfully defended, 28 June 2001)

3. Additional information on SED technology has been filed with the Texas Tech University Ofice of Technology Transfer and Intellectual Property.

Goals Achieved:

Documentation of colony reaction to gaster-flagging nestmates has been more difficult than expected. No doubt *S. invicta* react to low-voltage electrical shock by gaster-flagging. Fire ants may be initially attracted to gaster-flagging chemicals and, perhaps, acoustics, in a defensive response. Ants may soon accommodate to the chemical environment and not be repulsed as we have hypothesized.

Field trials of SED design efficacy was hampered by extremely hot and dry weather conditions. Nonetheless, SED technology may be a tool in the integrated pest management of *S. invicta* populations in electrical equipment.

Relevance to the Texas Imported Fire Ant Research and Management Project:

Solenopsis invicta invade electrical and electronic equipment and cause damage that jeopardizes human safety. Ants may cause failure of electrical cicuitry that requires expensive repair or replacement. Elimination of *S. invicta* from step-down electrical transformers in residential neighborhoods will improve safety and reliability of electrical service. The integrated pest management technology will be adaptable to many electrical systems, including highway and airport signal lights, water pumps, health care equipment, and circuit-breaker boxes.

Publications, Citations, Paper Citations, Presentations, and other Citable Products:

Ipser, R., and H. Thorvilson. 2001. A pilot study testing the efficacy of a static electric device in pad-mounted transformers against *Solenopsis invicta* Buren. (submitted, J. Entomol. Sci.)

Ipser, R., and H. Thorvilson. 2001. Static electrical devices as repellents to *Solenopsis invicta* Buren colonies in electrical transformers. (in preparation)

Newbrough, J. 2001. Responses of the red imported fire ant, *Solenopsis invicta* Buren, to static electrical devices. M.S. thesis, Dept. of Plant and Soil Science, Texas Tech University, Lubbock.

Newbrough, J., and H. Thorvilson. 2001. Effects of static electrical devices on red imported fire ants (*Solenopsis invicta* Buren): laboratory studies with an olfactometer. Annual Imported Fire Ant Conference, San Antonio, Texas. 28 Feb.-2 March 2001

Newbrough, J., and H. Thorvilson. 2001. Responses of *Solenopsis invicta* Buren colonies to static electrical devices. Southwestern Branch - Entomological Society of American Annual Meeting, San Antonio, Texas. 26-28 Feb. 2001.

Newbrough, J., and H. Thorvilson. 2001. Effects of static electrical devices on the red imported fire ant , *Solenopsis invicta* Buren. Southwest. Entomol. (submitted 2 October 2001)

Newbrough, J., and H. Thorvilson. 2001. Behavior of *Solenopsis invicta* workers to alarm pheromone caused by electric shock. Southwest. Entomol. (submitted 2 October 2001)

Newbrough, J., and H. Thorvilson. 2001. Behavior of *Solenopsis invicta* colonies challenged by electrical shock. Entomological Society of American Annual Meeting, San Diego, CA. 9-12 December 2001. (poster presentation).

Vander Meer, R., T. Slowik, and H. Thorvilson. 2001. Semiochemicals released by electrically shocked red imported fire ants, *Solenopsis invicta* (Hymenoptera: Formicidae). Environ. Entomol. (submitted)