Development of Imported Fire Ant Quarantine Treatments for Field-Grown Nursery Stock

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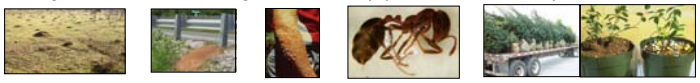
Introduction

History of Problem: Imported fire ants (*Solenopsis* spp.) now infest over 325 million acres in the U.S. and are still expanding their range. The Federal Imported Fire Ant Quarantine governs movement of regulated items (e.g. nursery stock) that can potentially move fire ants into new regions. Fire ants pose a direct threat to human health and harm livestock and wildlife. Their tunneling and mound building activities can also damage roads, farm equipment, and electrical systems.



Nursery Issues: Three quarantine treatments are approved for field-grown nursery stock:

1) Pre-Harvest Broadcast: Treatment requires a pre-harvest broadcast bait (e.g., Amdro, Award, Distance, or Extinguish) followed 3-5 days later with a pre-harvest broadcast granular chlorpyrifos (e.g., Dursban 2.32G or Dursban 2.5G).
2) Post-Harvest Dip: Treatment requires immersing balled and burlapped root balls in a chlorpyrifos solution (e.g., Dursban 4E, Chlorpyrifos Pro2 or Pro4 Insecticide).
3) Post-Harvest Drench: Treatment requires drenching balled and burlapped root balls twice-daily for three consecutive days in chlorpyrifos.

The pre-harvest broadcast method is the most feasible method, but the granular products are cost prohibitive (~ $320 to $400 / acre). The post-harvest dip or drench methods are impractical for treating large numbers of nursery plants, labor intensive, hazardous, and unfriendly to the environment. All current methods use chlorpyrifos, leaving growers with no alternatives. Chlorpyrifos has been under increasing scrutiny by the U.S. Environmental Protection Agency, and there are no alternative methods approved to certify field-grown nursery plants against fire ants if chlorpyrifos becomes unavailable in the future.

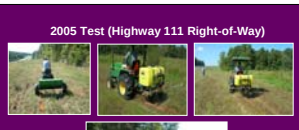
Objective: To develop new pyrethroid band treatments to eliminate fire ants from field-grown nursery stock and provide new options in the Federal Imported Fire Ant Quarantine.

Materials and Methods

Background: The USDA-APHIS Soil Inhabiting Pests Section, Gulfport, MS (SIPS) has been evaluating pyrethroids in combination with fire ant baits to eliminate imported fire ants from turf plots in Mississippi. The most promising treatment combinations identified by SIPS were tested in Tennessee field-grown nursery settings. Unlike SIPS sites, Tennessee sites varied by ground cover (i.e., herbicide killed weeds rather than turf), ant type (hybrid rather than red imported fire ants), colder temperatures, and soil type (clay rather than sandy soils).

Procedures: Treatments tested during 2005 to 2008 consisted of a broadcast bait application (hydramethylnon, fenoxycarb, or indoxacarb) followed 3-5 days later with a banded application of a pyrethroid (bifenthrin, lambda-cyhalothrin, or permethrin) or chlorpyrifos (Fig. 1). Insecticide bands ranged from 5 to 12 feet (i.e., 2.5 to 6 feet on each side of the nursery row) and were applied with a drop spreader, spray boom / flatfan nozzles, or a floodjet nozzle in 33 to 88 gallons per acre. Baits were applied with a Herd spreader. Each treatment was replicated 3 times in separate plots that varied in size depending on density of fire ants. Efforts were made to have at least 10 fire ant colonies per replicate. All colonies in a replicate were rated for activity before treatment and subsequently at weekly intervals for the first two weeks, then bi-weekly intervals up to two months, then bi-weekly to monthly up to 7.5 months post-treatment. Mounds were marked within nursery rows with flags and a global positioning system to facilitate monitoring. Monitoring consisted of inserting a metal wire into the mound to determine if any worker ants responded to the disturbance (sometimes in multiple locations if no response occurred). During winter months, monitoring was performed when weather conditions were suitable, which sometimes meant postponing sampling longer than one month.

2005 Test (Highway 111 Right-of-Way)



2007 and 2008 Tests (Shade Tree Nursery)

Herd Spreader

2006 Test (Spruce / Hemlock Nursery)

2007 Test (Floodjet Treatment)

Outcomes and Impacts

Fire ant control at Tennessee nursery sites using fire ant baits and pyrethroids have been variable and generally inconsistent (Fig. 1). In contrast, SIPS turf site evaluations at Mississippi have been very effective (i.e., 1 bait and 1 pyrethroid application eliminated fire ant colonies for 0.5 to 6 months post-treatment). We suspect soil type, nursery conditions, and ant type are factors in the differences between Tennessee and Mississippi sites. Our research has not identified an answer to the fire ant problem in field-grown nursery stock that will consistently and effectively eliminate colonies at rates that are cost effective and compliant with existing insecticide label requirements. Although we do not have an effective treatment, we have made several important findings during the project, including:

1) Two pyrethroid band sprays provided greater imported fire ant control than one application. A single application was unacceptable, even at a 2X rate. Clay soils may be interferring with insecticide activity and resulting in lower fire ant control in Tennessee than occurred in Mississippi.
2) The inclusion of a fire ant bait pre-treatment before the pyrethroid application provided greater imported fire ant control than using a pyrethroid alone.
3) Pyrethroid treatments in October, November, or December were more effective than September. It is likely increased rainfall improved late-season fire ant control by increasing insecticide movement into the soil and by enhancing fire ant activity resulting in more contact exposure.
4) Pyrethroid band size (5 to 12 feet) was not a major factor in fire ant control.
5) Total spray volume (33 to 88 gallons / acre) also was not a major factor in fire ant control.
6) Floodjet nozzles controlled fire ants as effectively as flatfan nozzles. Floodjet nozzles allow growers to spray both sides of a nursery row in one pass, saving time and money.
7) Pyrethroids like bifenthrin and lambda-cyhalothrin were effective at preventing re-infestation of plots (i.e., indicated by influxes of new fire ant colonies in control-plots, but not pyrethroid-treated plots). Pyrethroids were not as effective at eliminating existing fire ant colonies.
8) Fire ant colonies ranked as "large" were more difficult to eliminate than smaller-sized colonies.
9) Bifenthrin followed by lambda-cyhalothrin was the most effective band combination, suggesting that alternating pyrethroid types may be more effective than consecutive sprays of the same pyrethroid.

Impacts: The main project impact to date has been the identification of treatments that are not working and the use of this information to plan future research directions. New directions will include: 1) shorter spray intervals or tank mixes of different pyrethroid types, 2) directed baiting onto nursery rows to target the harvest zone and area where most colonies occur, and 3) targeted treatment of large colonies to eliminate the most difficult to colonies to control. The greatest impact of our research will occur when a consistent and cost effective treatment is identified that can be recommended for inclusion into the Federal Imported Fire Ant Quarantine (FIFAQ). A new treatment in the FIFAQ will be available to all growers affected by imported fire ants, resulting in rapid technology transfer. Our technology transfer is on-going now via extension personnel and multiple industry outlets like the Southern Nursery Assoc., Middle Tennessee Nursery Assoc., Tenn. Green Industry Field Day, Imported Fire Ant Conf., and ornamental workshops sponsored by TSU, Tenn. Dept. Agric., and Agrochemical companies. Other fire ant research performed with FNRI support is available on the USDA-APHIS annual reports website:

http://www.aphis.usda.gov/plant_health/plant_pest_info/fireants/gulfport.shtml

Fig. 1. Survival of imported fire ant colonies following various bait and insecticide treatments performed at turf and nursery sites from 2005 to 2008.

Site[A]	Test Year	Contact Insecticide Banding Procedures: GPA[B]	Width (feet)[C]	Method[D]	Treatment Applications[E]: Baits[F] Sep	Oct	Nov	Contact Insecticide[G] Sep	Oct	Nov	Dec	Feb	Number of Live Mounds (Weeks After Test Start)[H] 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
A	2005	87	6	Flatfan	1.5			0.2					24	7	4		1		1		1				1				1				1			1			1			1			1
A	2005	NA	6	Spreader	1.5			0.2					29	4	1		1		1		0				0				0				0				0				0				1
C	2007	45	5	Flatfan	1.5			0.1	0.05				26	24	23		14	12	10		11		0		0			0						0			0						0		
C	2007	45	5	Flatfan				0.2	0.2				39	38	31		18	9	8		10		0		0			0									1						0		
D	2008	45	12	Flatfan		1.5				0.2	0.05		62	43	29	31			28		10						0			0		0		0			1			1					
D	2008	45	12	Flatfan		1.5				0.2	0.05		59	43	41	36			32		15						0			0		0		0			0			0					
D	2007	44	6	Flatfan	1.5			0.2			0.2		27	24	23		24	20	20		21		10		4			0				1			0	0		0			0		0		
D	2007	44	6	Flatfan	1.5			0.2				0.2	24	21	18		19	24	18		21		4		11			12					14		1	0		0			0		0		
D	2007	33	10	Floodjet	1.5			0.2	0.2			1	34	30	28		19	22	21		20		5		2			6					5			0	0		0			0		0		
B	2006	88	6	Flatfan	1.5			0.2				0.2	67	29	20		7		2		6				6		4			4				4	0	1	0	0		0			0			0
D	2008	45	12	Flatfan	0.75	0.75			0.2	0.2			64	60	50	52			50		44						3			1			0		1			0			0				
D	2007	44	6	Flatfan	1.5			0.2	0.2				26	24	23		17	22	22		19		4		5			5				9			2	2		2			0		0		
D	2008	45	12	Flatfan		1.5				0.2	0.2		57	39	27	25			25		10						1			1			1			1			2			0				
C	2007	45	5	Flatfan	1.5			0.2	0.2				34	36	34		22	21	16		14		3		2			2							4			2					0		
C	2007	45	5	Flatfan	1.5			0.2	0.2				35	32	30		27	21	16		16		3		1			1							2			1					0		
C	2007	26	6	Flatfan	1.5			0.2	0.2			1	22	23	22		21	22	19		21		5		4			6				7			3	3		2			1		1		
D	2007	44	12	Flatfan				0.2			0.2		22	17	16		11	11	10		13		7		7			7				4			1	1		0			0		0		
D	2007	44	12	Flatfan				0.2	0.2				23	22	20		13	12	11		11		8		6			5				5			3	3		2			1		1		
C	2007	45	5	Flatfan				0.2	0.2				32	33	28		21	16	15		14		8		5			6							6			6					2		
D	2007	44	12	Flatfan				0.2				0.2	24	18	18		15	15	14		11		9		9			9				8			6	5		3			2		2		
D	2007	44	6	Flatfan	1.5			0.2					23	20	19		18	17	13		13		6		8			8				7			1	0		0			0		0		
D	2008	45	12	Flatfan		0.75	0.75				0.05		45	33	26	28			24		7						0			1					1			6			2				
D	2008	45	12	Flatfan		0.7 + 0.7				0.2			57	39	30	30			31		7							1			1		0		0			1			0				
D	2008	45	12	Flatfan		0.75	0.75			0.2			43	34	26	30			30		10							1			1		0		1			4			0				
D	2008	45	12	Flatfan		1.5				0.2			68	41	32	31			25		13							3			3		0		1			1			2				
D	2008	45	12	Flatfan		0.75	0.75			0.05			55	45	28	29			25		8							2			1		1		0			6			3				
D	2008	45	12	Flatfan		1.5				0.05			50	42	33	33			25		8							2			2		1		1			3			2				
D	2008	45	12	Flatfan		1.5				0.2			62	36	27	29			24		6							3			3		3		3			1			5				
D	2007	44	12	Flatfan				0.1					23	23	19		14	13	12		14		9		6			7				8			3	2		0			0		0		
A		Non-Treated Control (for flatfan and spreader trials)											26	21	21		21		18		18								19				15				16				19				15
B	2006	Non-Treated Control (for flatfan trials)											57	52	47		49		43		40				45		41			39				35	29	30	27	28		33		32			29
C	2007	Non-Treated Control (for flatfan trials)											38	39	44		49	49	45		49		42		46			43							40			41					27		
D	2007	Non-Treated Control (for flatfan trials)											15	23	20		32	31	28		27		23		25			25				25			23	24		24			26		33		
D	2007	Non-Treated Control (for floodjet trial)											32	27	25		35	43	36		35		32		31			30				34			31	31		35			37		55		
D	2008	Non-Treated Control (for flatfan trials)											55	50	39	44			40		39							33			31		53		50			59			40				

Each row in the figure provides summarized data for a treatment replicated 3 times in separate field plots for the given site and test year.

[A] A = Highway right-of-way consisting of mowed grass and mixed weeds (Sequatchie and Hamilton Co., TN); B = Spruce and hemlock nursery with no irrigation (Grundy, Co., TN); C = Dogwood nursery with some plots on drip irrigation (Franklin County, TN); D = Mixed deciduous tree nursery with no irrigation (Coffee Co., TN).

[B] GPA = total gallons per acre used to apply treatment solution.

[C] Band width equals the total width of the contact insecticide sprays. In the case of nursery sites, the tree row was centered in the middle of the specified band width. Baits were broadcasted over the entire test site to a distance at least 10 feet past the band area.

[D] Flatfan applications were applied by tractor using a fixed boom containing TeeJet nozzles (8003VS, 8004VS, or 8005VS) using ~ 30 psi by making a pass on each side of the nursery row to get the total band width. The floodjet treatment was applied by tractor using an Evergreen No. 125 nozzle at 28 psi making a single pass centered on the nursery row. The single granular treatment was applied with a Gandy drop spreader pulled by a lawn tractor.

[E] Numbers on the colored squares refer to pounds of product per acre for baits or pounds of active ingredient per acre for contact insecticides. Color-codes refer to the following:

Baits	Contact Insecticides
= Hydramethylnon	= Bifenthrin (EC or F)
= Fenoxycarb	= Bifenthrin G
= Indoxacarb	= Lambda-Cyhalothrin (F Capsule Suspension)
= Indoxacarb + Fenoxycarb	= Permethrin (EC)
	= Chlorpyrifos (EC)

[F] Baits were always applied at least 3 to 5 days before contact insecticides during the specified month. During 2005, 2007, and 2008 tests, baits were applied with a Herd spreader calibrated to deliver 1.5 pounds product per acre (single application) or 0.75 pounds product per acre (split applications). During the 2006 test, an Earth-Way push spreader was used because the tree rows in the spruce-hemlock nursery were too narrow to use a tractor-mounted Herd spreader.

[G] Hydramethylnon = Amdro Pro Fire Ant Bait; Fenoxycarb = Award Fire Ant Bait; Indoxacarb = Advion Fire Ant Bait; Bifenthrin = Talstar Nursery F (2005 and 2006 tests), Up-Star SC (2007 test), or Onyx Pro Insecticide (2007 and 2008 tests); Bifenthrin G = Talstar Nursery Granular; Lambda-cyhalothrin = Scimitar CS; Permethrin = Perm-Up 3.2EC; Chlorpyrifos = Dursban 4E.

[H] Numbers within a square indicate the number of live fire ant mounds totaled among 3 replicated plots for the given week after treatment. The zero column is the number of live fire ant mounds before bait and contact insecticide treatments were applied. Magenta-colored areas indicate periods where all fire ant colonies were dead.

[I] A single fire ant colony remained active during the entire test period of this trial. The colony was at the very beginning of the test plot, and therefore, it was suspected the colony did not receive a full treatment. Because the colony did not exhibit typical symptoms of poisoning that occurred with other colonies receiving pyrethroid treatments (i.e., reduction in ant numbers, lack of mound rebuilding activity, etc.), USDA-APHIS recommended this mound be excluded from our plot counts. Therefore, if this colony is excluded from counts, this particular treatment had the most effective control of all the treatments studied during the 2005 to 2008 tests (i.e., no live colonies for 4 to 32 weeks).