LABORATORY AND FIELD EVALUATION OF SORGHUM SEED TREATMENTS TO PREVENT DAMAGE BY THE RED IMPORTED FIRE ANT

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Drees *et al*. (1992) described methods of evaluating the effect of seed-protecting insecticides used to protect seeds from predation by the red imported fire ant, *Solenopsis invicta* Buren. The trials reported here were conducted in the laboratory and in the field to determine the effectiveness of sorghum seeds treated with lindane (Gammasan®, Wilbur-Ellis Company), lindane plus diazinon (Agrox Premiere, Wilbur-Ellis Company), tefluthrin (Raze®, Wilbur-Ellis Company), and imidacloprid (Gaucho®, Gustovson). Several of these treatments are experimental and are currently not registered for use on sorghum.

Materials and Methods

In trials conducted under laboratory conditions, temperature ranged from 69 to 75 degrees F. In each of these trials the following nine treatments, or subsets thereof, were included and are generally referred to by treatment number:

Treatment	Rate	Sorghum variety
1. lindane (Gammasan® *)	5.4 fl. oz./Cwt.	unspecified
2. tefluthrin (Raze®)	1.33 "	"
3. tefluthrin (Raze®)	2.67 "	"
4. tefluthrin (Raze®)	5.34 "	"
5. lindane + diazinon (Agrox Premiere**)	3.6 oz./Cwt.	"
6. lindane + diazinon (Agrox Premiere**)	5.4 "	"
7. untreated control	---	"
8. imidacloprid (Gaucho®)	Gustovson-treated	Pioneer 8500 95511 A1
9. untreated control	---	"

Trial 1. Four colonies of red imported fire ants were collected in 5-gallon plastic buckets and maintained in the laboratory. On 23 October 1995, test containers were constructed that were composed of sealed plastic Petri dishes with 1/8 inch diameter holes melted into the sides. Each dish contained a piece of dry filter paper and ten dry sorghum seeds. One set of seeds of each treatment was placed in each test container. A nine treatment set of Petri dishes was placed in each of the four fire ant colonies, constituting four replications. In addition, 25 seeds of each treatment were placed in petri dishes containing wet filter paper to determine percent germination. Seeds were inspected 48 hrs. after exposure of dry seeds to ant foraging. Ant-exposed seeds were inspected for damage and moistened seeds inspected for percent germination. This trial was

repeated from 25 to 28 October using 48 hr. water-soaked sorghum seeds as described above, although only six seeds were placed in each test container.

Trial 2. Six fire ant colonies were collected from the field and removed from the soil by slowly floating them in water, 10 November 1995. Colonies were provided no food, only water, for maintenance. On 13 November, ten dry seeds of each of the nine treatments were enclosed in plastic screen mesh packets. Each of four colonies received one set of treatment seed packets, constituting four replications. The remaining two colonies served as untreated controls. Packets were removed from ant colonies on 17 November (4 days exposure) and each seed was inspected for ant damage.

Trial 3. An additional six colonies, collected 9 November 1995, were maintained in 5-gallon plastic buckets and were provided no food, only water.. On 16 November, one colony was provided 48 hr. water-soaked (germinated) sorghum seeds from Treatments 7 and 9 (untreated controls) in plastic mesh packets buried in the soil. These seeds were inspected 24 hours later for ant-related damage. Thereafter, on 17 November, three colonies were provided packets containing ten 48 hr. water-soaked (germinated) seeds of each of the nine treatments. Seeds were inspected 20 November for ant-related damage.

Trial 4. Four fire ant colonies were marked in a vegetation-free field, 4 December 1995. Around each mound, 10 seeds of each of nine treatments were planted in furrows radiating away from each mound (four replicates), ending less than 10 inches from each mound's edge. On 14 and 19 December, these plots were examined for seedling plants. Results were analyzed using Analysis of Variance ($P \leq 0.05$) and means were separated using Tukey's Studentized Range Test.

Trial 5. Five fire ant colonies were collected from the field in 5-gallon plastic buckets and allowed to acclimate in the laboratory. On 27 March 1996, each colony received a metal screen sleeve containing ten untreated sorghum seeds (Treatment 9) and another sleeve containing ten imidacloprid (Gaucho®, Treatment 8) treated seeds, both imbedded in the soil in an 8 by 8 by 2 inch aluminum pie pan (a paired treatment comparison replicated five times). Each pie pan was watered with 250 mls. water to germinate the seeds. The pair of sleeves was allowed to remain in each colony bucket until 1 April, when sleeves were removed and seeds were evaluated for fire ant damage.

Trial 6. On 11 May 1996, ten fire ant colonies were established in 5-gallon plastic buckets in the laboratory (65% relative humidity). Treatments 1, 2, 3, and 7 were evaluated as a set in four of the colonies, while Treatments 4, 5, 6, and 7 were evaluated in a separate set of four colonies. Ten 24-hr. water-soaked seeds of each treatment were placed in separate 1 by 4 inch folded metal screen sleeves and placed randomly in the soil within a single colony bucket (a within colony four-treatment comparison replicated four times). The soil surface was then covered with a layer of potting soil (Baccto®) and watered with 1 cup water. Sleeves containing seeds were removed, 16 May 1996, and seeds were evaluated for ant damage. Results were analyzed using Analysis of Variance ($P \leq 0.05$) and means were separated using Tukey's Studentized Range Test.

Results and Discussion

Trail 1. Although numerous dead ants were observed within each Petri dish, no ant related damage to seeds was found in this trial. The colonies used in this trial were assumed to lack vigor and were discarded. Percent germination ranged from 84 to 100 percent (Treatment 1 = 22/25; 2 = 21/25; 3 = 23/25; 4 = 25/25; 5 = 25/25; 6 = 24/25; 7 = 24/25; 8 = 24/25; 9 = 23/25).

Trial 2. The four fire ant colonies receiving treated seeds declined dramatically. After one day of exposure, piles of dead ants were numerous and the ants did not respond to the stimulus of "blowing" into the colony trays. After three days, these colonies failed to recruit workers to honey water or frozen crickets as compared to untreated colonies. Apparently the majority of forager ants were eliminated from these colonies. Many ants remained in Petri dishes partially filled with moistened plaster and with holes melted in the tops which housed the queens, brood (eggs, larvae and pupae) and nurse ants. However, no damage to sorghum seeds was produced, even to untreated seeds (Treatments 7 and 9). Evidently, the insecticide treated seeds were overwhelming to colony vigor and foraging activity. In contrast to other trials reported here, trials 1 and 2 were conducted using dry, ungerminated seed. Such seed would probably have more product and be more toxic.

Trial 3. Untreated seeds exposed to an ant colony for 24 hrs. were damaged (Treatment 7 - 2/10 seeds damaged; Treatment 9 - 8/10 seeds damaged). After three days exposure of water-soaked (germinated) seed to ant colonies in soil:

Treatment	No. Damaged seeds/10
1. lindane (Gammasan® *)	0, 0, 0
2. tefluthrin (Raze®)	0, 0, 0
3. tefluthrin (Raze®)	0, 0, 0
4. tefluthrin (Raze®)	0, 0, 0
5. lindane + diazinon (Agrox Premiere**)	0, 0, 0
6. lindane + diazinon (Agrox Premiere**)	0, 0, 0
7. untreated control	5, 1, 0
8. imidacloprid (Gaucho®)	0, 0, 1
9. untreated control	4, 4, 0

These results were the first in this series of trials to suggest that seed treatments provided protection from fire ant foraging relative to untreated seeds.

Trial 4. On 14 December, seedling plants were just beginning to emerge in the field. By 19 December seedlings were approximately 1 inch tall. Differences between treated seeds are presented in **Table 1**. Tefluthrin Treatment 3 had significantly more germinated seedlings than lindane + diazinon Treatment 5.

Because of the difficulty of separating differences in ant damage to seeds in trials between all nine treatments, trials were conducted using smaller subsets of treatments.

Trial 5. After 5 days of exposure to fire ant foraging, more untreated sorghum seeds had been damaged than were imidacloprid-treated seeds:

	Replication (damaged/total sorghum seeds)				
Treatment	1	2	3	4	5
untreated seeds:	7/9	4/10	6/10	5/10	1/10
imidacloprid-treated seeds:	0/10	2/10	2/10	3/9	2/10

These results provide supportive documentation that imidacloprid seed treatment effectively protected seeds from predation by fire ants under these laboratory conditions.

Trial 6. Although most colonies involved in the two sets of treatment evaluations consumed untreated seeds, some did not. Consequently, high variability in Set #1 prevented statistical separation of means between treatments (**Table 2**). However, in Set #2, ants damaged significantly more untreated sorghum seed than treated seeds. These efforts failed to document differences between lindane, tefluthrin or lindane + diazinon seed treatments but did document, for the most part, that these treatments effectively protected seeds from predation by fire ants under these laboratory conditions.

Drees, B. M., R. Cavazos, L. A. Berger and S. B. Vinson. 1992. Impact of seed-protecting insecticides on sorghum and corn seed feeding by red imported fire ants (Hymenoptera: Formicidae). J. Econ. Entomol. 85(3):993-997.

Table 1. Number of sorghum seedlings emerged, 14 December 1995, around red imported fire ant mounds, Brazos Co. Texas.

Treatment		Mound 1	Mound 2	Mound 3	Mound 4	Means*
1. lindane	6		2	4	2	3.5ab
2. lindane	8		7	7	5	6.8ab
3. lindane	6		6	8	10	7.5a
4. lindane	5		10	4	4	5.8ab
5. lindane	2		1	2	2	1.8b
6. lindane	4		7	0	2	3.3ab
7. untreated control	3		3	7	0	3.3ab
8. imidacloprid	7		6	7	1	5.3ab
9. untreated control	2		0	6	0	2.0ab

* Means followed by the same letter are not significantly different using analysis of Variance ($P \leq 0.05$) and means separated using Tukey's Studentized Range Test ($F = 2.77$; $P = 0.0174$; MSE = 5.289352; MSD = 5.5276; d.f. = 24; crit. val. = 4.807).

Table 2. Number of fire ant damaged sorghum seeds following 5 days of exposure to fire ant predation in laboratory colonies (four colonies per treatment set), 1996.

Treatment	Number of damaged seeds/total seeds recovered					Mean*
	Colony no. 1	2	3	4	5	
Set #1						
1. lindane (Gammasan®)	0/10	0/9	0/10	0/10	5/8	1.0a
2. tefluthrin (Raze®)	0/10	0/9	0/10	0/10	0/9	0.0a
3. tefluthrin (Raze®)	0/9	0/9	0/9	0/9	0/10	0.2a
7. untreated control	2/6	0/7	8/9	0/10	0/0	4.0a
Set # 2						
4. tefluthrin (Raze®)	0/10	0/9	0/10	0/10	0/8	0.6b
5. lindane + diazinon (Agrox Premiere)	0/10	3/9	0/9	0/10	0/8	0.0b
6. lindane + diazinon (Agrox Premiere)	0/10	0/10	0/8	0/10	0/9	0.0b
7. untreated control	5/9	2/3	3/8	0/0	0/0	3.8a

* No significant differences between Set #1 treatments. For Set #2, mMeans followed by the same letter are not significantly different using analysis of Variance (P # 0.05) and means separated using Tukey's Studentized Range Test ($F = 18.97$; $P = 0.0001$; MSE = 0.875; MSD = 1.6926; d.f. = 16; Crit. Val. = 4.046).