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ARTHROPOD MANAGEMENT AND APPLIED ECOLOGY

Effect of Spinosad Mixed with Sucrose on Gustatory Response and Mortality of Adult Boll Weevils (Coleoptera: Curculionidae) by Feeding and Field Assessment

J. D. López, Jr., M. A. Latheef, B. K. Fritz*

ABSTRACT

Successful completion and long-term maintenance of eradication of boll weevil (BW), *Anthonomus grandis grandis* Boheman, in Texas would be improved by the development of adult control technologies to eliminate BW reproduction in active eradication zones and help prevent dispersal into and reproduction in post-eradication zones. Spinosad (Tracer®) mixed with 10% sucrose in ppm active ingredient (wt: vol) was evaluated as a toxicant when ingested by field-captured adult BW with additional field assessments of spinosad/feeding stimulant mixtures or bait formulations with grandlure as an attractant. Ingested spinosad was highly toxic to BW adults with a lethal concentration to kill 90% (LC_{90}) of 27.79 ppm after 24 hours. Ingestion of spinosad by BW at lethal concentrations ranging from 28 to 10,000 ppm was inhibitory compared to the sucrose solution alone, but the level of inhibition was not consistent relative to gender or concentrations. In field tests, bait formulations mixed with spinosad at 300 ppm and sprayed on individual yaupon shrubs baited with a pheromone lure killed BW in numbers similar to BW captured in individual traps baited with the pheromone lure alone. This study demonstrates that sugar-based adult control technologies with spinosad as a toxicant and grandlure as an attractant effectively attract and kill BW adults. This strategy may have potential to attract and kill BW in environmentally-sensitive non-cotton habitats, and may have application during the host free window to reduce populations and curtail movement of adults into eradicated zones, both goals of BW eradication programs.

J. D. López, Jr., USDA ARS Aerial Application Technology, 2771 F&B Road, College Station, Texas 77845; M. A. Latheef, USDA ARS Aerial Application Technology, 2771 F&B Road, College Station, Texas 77845; B. K. Fritz, USDA ARS Aerial Application Technology, 2771 F&B Road, College Station, Texas 77845
* Corresponding author: brad.fritz@ars.usda.gov

In Texas, considerable progress has been made in eradicating the boll weevil (BW), *Anthonomus grandis grandis* Boheman, from most of the eradication zones (Smith et al., 2011). However, major challenges still remain for successful BW eradication from all eradication zones and prevention of re-infestation of post-eradication zones. In recent years, the principal challenges have been in areas in which temperatures do not reach levels and durations to freeze cotton plants growing in cotton fields or volunteer cotton in non-cotton habitats. Also, BW native plant hosts are found in Texas and further south on which BW reproduction is possible. These areas represent potential sources of BW that can disperse or be dispersed into eradication zones further north (Westbrook et al., 2011). Dispersal of BW after the cotton-growing season while searching for cotton suitable for feeding/reproduction or for overwintering sites, and subsequent dispersal in the spring to colonize cotton fields are very important in the survival of the BW and are of special concern relative to BW eradication. There is evidence that supports the re-infestation and reproduction of BW via dispersal between eradication zones in Texas (Kim et al., 2010). Research has shown that BW foraging activities associated with feeding on non-cotton plants may play an important role in BW survival during dispersal (Jones and Coppedge, 1999; Showler, 2007). There is also extensive data showing that BW is highly responsive to the pheromone, grandlure, during dispersal (eg., Guerra, 1988; Bull et al., 1973; Johnson et al., 1974; Hardee and Mitchell, 1997; Showler, 2006).

Successful completion and long-term maintenance of BW eradication in Texas depends upon complete elimination of BW reproduction in active eradication and post-eradication zones. As such, prevention of dispersal into and reproduction in post-eradication zones is critically important. The development of control technologies designed to prevent re-entry and subsequent reproduction would contribute greatly to completion and sustainability of BW eradication. Adult control technology using pheromone as an attractant and a feeding stimulant mixed with toxicant may be a viable suppression technique in non-cotton areas between or in post-eradication zones. The aim is to reduce the potential for reproduction in post- eradication zones. Success in adult control has been documented for corn rootworm, *Diabrotica* spp., through use of a bait formulation (Cidetrak® CRW, Trécé Inc., Adair, OK; Invite EC, Florida Food Products Inc., Eustis, FL). The bait formulations consist of a semiochemical, cucurbitacin, contained in buffalo gourd, *Cucurbita foetidissima* HBK, root powder which can be mixed with carbaryl as a toxicant (Comis, 1997; French et al., 2007). A bait technology has also been developed for control of adult fruit flies (Mangan, 2009). Furthermore, feeding-based adult control technology for corn earworm or bollworm, *Helicoverpa zea* (Boddie), has been developed, but additional research is needed for field implementation (Joyce and Lingren, 1998; López et al., 1999; Younger, 2000).

There is a need to identify selective chemicals that are effective toxicants in the development of feeding-based adult control technology for BW. Spinosad is a commonly used insecticide in the cotton production system and has the potential to serve as a toxicant in a feeding stimulant formulation. Spinosad is derived from a naturally-occurring soil actinomycetes bacterium, *Saccharopolyspora spinosa* (Thompson et al., 1997) and is selective and considered to be safe for the environment. Spinosad is used as a toxicant in the GF-120® NF Naturalyte® Fruit Fly Bait labeled for selective attraction and control of multiple species of tephritid fruit flies (Dow AgroSciences LLC, Indianapolis, IN) in conventional and organic production systems. Spinosad has also been formulated by the same company as Entrust® Naturalyte® Insect Control. Both products are listed by the Organic Materials Review Institute (OMRI) for use in organic production. Additionally, López et al. (2011) reported that spinosad mixed with sucrose is highly toxic when ingested by adult bollworms, affects reproduction at sublethal concentrations, and is compatible with an adult control feeding approach.

This paper summarizes the results of a laboratory study to determine the lethal concentration (LC) of spinosad mixed with a feeding stimulant when ingested by pheromone trap-captured BW. Subsequent to LC determination, female and male BW was evaluated for gustatory response to toxic concentrations. Then field studies were conducted. The objective of these studies was to determine whether spinosad could be used in formulations for adult control technology using pheromone and a feeding stimulant for suppression of dispersing BW between eradication zones or as a barrier into eradicated zones. Successful development and use of this technology might have application in suppressing BW in eradication zones, and also in environmentally-sensitive areas where conventional insecticide applications for BW may not be possible or practical. As part of this study, we report on evaluation of sugar-based bait formulations mixed with spinosad as a toxicant to kill field populations of BW using the pheromone as an attractant.

MATERIALS AND METHODS

Lethal Concentration Tests. Laboratory assessments of LC were conducted with field- trapped BW. Boll weevil pheromone traps conventionally used in BW eradication baited with 10 mg lure (Hercon®, a.i.: grandlure 1.2%, Hercon Environmental Corp., Emigsville, PA) and without a killing strip were placed adjacent to cotton fields and in other habitats prior to fruiting or after harvest in the Brazos Valley near College Station, TX during spring and fall, 2000. Traps were emptied daily, except during weekends, and adult weevils were placed in zip-top plastic bags and held in an environmental chamber maintained at 12.8º C. Pheromone trap-captured BW of both sexes were randomly removed from the bags within seven days of being captured for the LC bioassays and sexed for evaluation of gustatory response to toxic concentrations of spinosad.

Tracer® 4 SC (Dow AgroSciences LLC, Indianapolis, IN), a commercial formulation of spinosad was used to prepare test solutions of spinosad at 4, 8, 10, 12, 14, 16, 20, 25, 30 and 35 ppm (a.i. wt:vol) in 10% sucrose (Sigma, St. Louis, MO). These concentrations were determined based on preliminary evaluations across a wider range of concentrations. The 10% sucrose solution alone served as the control. Test solutions were stored in a refrigerator and warmed to room temperature before each use.

A clear square plastic box (6.35 x 6.35 x 5.72 cm) with hinged lid was used as a feeding apparatus to determine LC values (Figure 1). Five notches were made on each of two opposite sides of the bottom portions of the box and the notches were reinforced with a thin strip of rubber padding with a small cut corresponding to each notch on the sides of the walls. Using the thumb and forefinger, an individual BW was picked up from a sample of pheromone trap-captured BW and the snout was inserted into the tip of a 20 µl capillary tube broken in half and containing the test solution. Ten capillary tubes with BW feeding at the orifice were placed in position through the notches and cuts in the rubber at 25 to 45º angles, and thereafter, the lid was closed and taped. Upon completion of feeding, BW fell to the bottom of the box and all ten adults exposed to each treatment in a replicate were removed and placed inside a petri-dish containing four greenhouse-grown cotton squares. After 24 h in an environmental room maintained at 26.7˚ C, RH ≥ 60% and 14:10 h L:D photoperiod, BW in each treatment in each petri-dish were examined for mortality by pinching the snout of each BW with a forceps. Weevils were scored dead if there was no movement of appendages after pinching the snout.

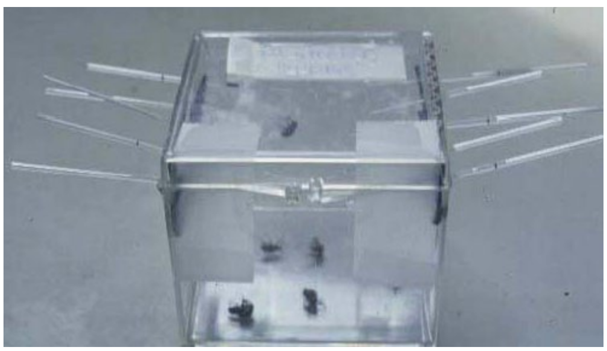

Figure 1. Square plastic box (6.35 x 6.35 x 5.72 cm) with hinged lid used in LC determination.

Gustatory Response. To determine the gustatory (ingestion) response, spinosad was diluted in 10% sucrose by serial dilutions of 1X, 2X, 5X, 10X, 100X, and 10,000X, X being the LC_{90} value. The feeding apparatus used to determine gustatory response of the BW was similar to that described earlier (López et al., 2009; Spurgeon et al., 2002). Briefly, the feeding apparatus contained six 10 µl Hamilton® micro-liter syringes from which the needles had been cut and the tips shaped into a cone. Syringes were inserted into a Plexiglass® plate with holes of sufficient size to hold the syringes. The plate was mounted on a wooden frame to hold the syringes at 25˚ to 45º angles. Female and male BW was individually fed by inserting the tip of the snout into the orifice of the syringe. The fluid level on each syringe was recorded before feeding was initiated. Boll weevils that stopped feeding and started wandering were considered to be satiated and were removed and killed. After feeding was completed, the fluid level on the syringe was again determined and the difference between the two readings was considered the amount ingested in µl.

Field Tests. Field evaluations of the efficacy of spinosad as a toxicant against BW when mixed with a feeding stimulant or bait formulations were conducted using yaupon, *Ilex vomitoria* Ait., shrubs. Yaupon is an eastern Texas evergreen that is commonly found and likely representative of shrubs or brush in various areas of Texas that may serve as landing sites along fence lines and in rangeland for BW dispersing from overwintering sites in the spring - or dispersing from mature or harvested cotton fields in the fall. The yaupon variety Pride of Houston was used for testing and the shrubs were purchased from a local nursery. The shrubs in 18.9 L (5 gal.) black plastic containers were over 1 m tall and were well branched. Two tests were conducted southwest of College Station, Texas in the Brazos River Bottom region and were separated from each other by 16 km. Test sites were located near wooded areas in close proximity to large plantings of cotton.

Figure 2. Potted yaupon shrub baited with pheromone lure at a height of 1 m showing the natural saran screen placed under the container and plastic cover on container opening . Each shrub was sprayed with spinosad and feeding stimulant formulation for evaluating efficacy in killing boll weevil adults by feeding.

For Test 1, a location was selected near a cotton field that was in pre-squaring stage. This site had been identified as having substantial BW activity as indicated by trapping in previous years. A yaupon shrub was placed at a site where surrounding vegetation had been removed or cut. The container with the shrub was placed at the center of the site and 2.9 x 2.6 m (L x W) natural saran screen (18x14 mesh) was placed under the container to cover the ground. One of the longer sides was wrapped around the shrub base above the container and lapped so as to completely cover the container and the ground beneath the shrub or the container was covered with a piece of plastic and sealed with duct tape at the base of the shrub and around the outside of the container. This was done to prevent dead weevils from falling into the shrub container where they would be very difficult to find. The screen was held in place with large stones. A 10-mg Hercon grandlure pheromone lure (Hercon Environmental, Emigsville, PA) was tied with thin copper wire to one of the branches close to the main stem of the shrub at a height of 1 m. A BW trap baited with a 10-mg grandlure lure and without a toxicant strip was installed 8 m from the shrub and 1 m above ground at a site prepared the same way as for the shrub. The two treatments within this experimental unit were assigned as to location randomly and treatments were alternated in a line with 5 replications. Each replication was established along a tree line in the study area, and was separated from each other by 30 m. The shrubs were treated with spinosad mixed with a feeding stimulant, holly sugar, highly concentrated food-based syrup obtained from a sugar beet plant in Hereford, TX. Spinosad was mixed at 300 ppm (a.i. wt:vol) which was 10X the LC_{90} value to ensure satisfactory kill of the insect. A backpack sprayer, Model T (R&D Sprayers, Opelousas, LA) containing a pressurized stainless steel beverage container, was used to apply the feeding stimulant/toxicant mixture on each yaupon shrub to the point of run-off. Spray pressure was supplied using a pressured cylinder of CO_2 with the spray pressure maintained at 68.9 kPa (10 psi). This test was conducted over the four-week period from April 26 through June 23, 2001. The locations of the trap and yaupon shrub within each replicate were rotated every time the test was checked and the pheromone lures replaced after two weeks. During this period, yaupon shrubs were sprayed weekly and sampled during nine occasions by checking the traps and thoroughly searching the screened area under each shrub for dead BW, which were then sexed and counted.

Test 2, was conducted to evaluate two other feeding stimulant or bait formulations. The test site was beside a wooded area and a narrow strip of corn near a wooded bank of the Brazos River. Again using spinosad as the toxicant, the Holly sugar solution and bait formulations: cotton seed oil (Lloyd et al., 1968) and a xantham gum/sugar mixture (D. W. Spurgeon, personal communication), were compared with BW traps baited with the pheromone lure alone. The cotton seed oil/sugar-bait mix, alternatively, "Lloyd bait formulation", was prepared using 1.3 L of water into which 300 g of crude cotton seed oil, 24 ml of Tween 80 (Wako Chemicals USA, Inc., Richmond VA), 26 g Natrosol (Ashland Inc., Covington, KY), 300 g of sugar, and 1.4 g of spinosad at 300 ppm (a.i. wt:vol) . The Spurgeon xantham gum/sugar bait mix, alternatively, "Spurgeon bait formulation", was prepared using 1.6 L of water into which 400 g of sugar, 10 g of xantham gum, and 1.4 g of spinosad at 300 ppm were mixed. The experimental units were assembled as a randomized block design with three replications of each treatment in the east-west direction of the field. Each replication was established along a tree line, and was separated from each other by 30 m. The study area had a trap at each end to remove bias in the capture of the boll weevils as a function of competition. Two liters of each bait formulations were prepared in the laboratory and using the backpack sprayer as described earlier, the yaupon shrubs were sprayed with the bait solutions until run-off. The test was conducted over a two-week period from May 12 through June 1, 2001, with the first spray occurring on May 12. The second and third sprays were conducted on May 17 and May 22, 2001. BW was sampled 24 h after spraying. Subsequent sampling of the shrubs and checking of the traps were conducted during six occasions. But unlike in Test 1, the treatments were not rotated within each replicate.

To process the collected data, lethal concentration data were analyzed by probit analysis (Finney, 1971) as adapted for PC use (LeOra Software, 1987). The goodness-of-fit of the curve was tested using the χ^2 statistic. Significant differences between any two LCs were determined by the criterion of whether or not the 95% CIs of the LCs overlapped. Slope values of probit mortality curves were tested for significant deviation from 0 using the *t ratio* statistic (Robertson and Preisler, 1992). Analysis of variance of gustatory response and field data were conducted using SAS (SAS Institute, 2008). When F-values were significant at the 5% level, means were separated using the Least Significant Difference (LSD) test at $\alpha = 0.05$. Paired comparison of gustatory response to toxicants between male and female BW was conducted using the *t* test at $\alpha = 0.05$. Field counts of the weevil were analyzed using PROC MIXED procedure with DDFM=KR in the MODEL statement for degrees of freedom option. Replication and days of servicing and counts (or day of year, DOY) were entered as RANDOM factors in the MODEL. When F-values were significant ($P<0.05$), least square means were separated using adjusted *P*-values using the Tukey-Kramer option.

RESULTS AND DISCUSSION

Lethal Concentration Tests. Control mortalities of BW in LC tests for spinosad did not exceed 0.5%. This indicated that the holding conditions for the trapped BW used in the tests did not have an impact on survival and that they were in good condition for testing. The goodness-of-fit test for dosage response equations for spinosad mixed in 10% sucrose indicated that the assumptions of the probit model were adequately described for both spring- and fall-captured BWs with χ^2 values being less than the tabular values at the 5% level (Table 1). Furthermore, the regression coefficient for spinosad was significant as the *t ratio* exceeded $t = 1.96$ ($\alpha = 0.05$; df = 4). The LC values for the BWs captured in the spring and fall were not significantly different from each other; therefore, pooled seasonal LC values for the spring-and fall-captured BWs are also presented in Table 1. The LC_{90} for both spring- and fall trap captured BW was determined to be 27.79 (95% CLs: 23.31-35.62) ppm (a.i. wt:vol). These data indicate that when ingested, a mixture of spinosad in 10% sucrose is highly toxic to adult BWs. The toxicity level of ingested spinosad mixed with sucrose to BW was lower than that reported for adult bollworm (Lopez et al., 2011), but the difference may be related to the different Orders involved: Coleoptera vs Lepidoptera. On its label, spinosad (Tracer ®) is identified as a Naturalyte® insect control product for control of lepidopterous larvae, leafminers, and thrips.

Table 1. Lethal concentration (ppm ai wt:vol) data for 24 h response for the toxicity of spinosad when mixed with 10% sucrose and ingested by mixed sexes of pheromone trap-captured boll weevils during spring and fall, 2000[z].

Regression Statistics	Spring[y]	Fall[x]	Seasonal[w]
Slope (±SE)	3.39±0.2985	2.88±0.2652	3.20±0.2132
t ratio	11.36	10.86	15.02
χ^2	7.69 (6)	6.24 (4)	11.00 (7)
LC_{10} (95% CLs)	4.72a (3.41-5.81)	3.88a (2.19-5.33)	4.40 (3.39-5.29)
LC_{50} (95% CLs)	11.26a (10.0-12.59)	10.82a (8.79-13.00)	11.06 (9.93-12.29)
LC_{90} (95% CLs)	26.90a (22.29-35.94)	30.12a (22.89-48.85)	27.79 (23.31-35.62)

[z] LC values were calculated using POLO-PC (LeOra Software 1987). LC values in the same row followed by same lower case letters are not significantly different based on the lack of overlap in 95% CI limits.

[y] Based on 693 weevils.

[x] Based on 548 weevils.

[w] Based on 1241 weevils.

Gustatory Response. When compared with 10% sucrose solution alone as control, the amount of spinosad ingested by male and female BW was significantly different between concentrations (males: F = 3.21; $P < 0.01$; df = 6, 63; females: F = 3.22; $P < 0.01$) (Table 2). There was no significant inhibition of gustatory response to spinosad up to 280 ppm (10X LC_{90}) for both male and female BWs; however, spinosad inhibited feeding by males alone at 28 ppm (1X LC_{90}). Also, gustatory response for both male and female BWs was significantly reduced at 2,800 and 10,000 ppm. Females ingested significantly more spinosad than males at 28 ppm and 140 ppm (5X LC_{90}), but the latter difference was significant only at the 10% level ($t = 1.78$; $P < 0.1$; df = 1, 18). Overall, there did not appear to be any consistent trends for differences between response of different sexes or increasing concentrations except at the two highest test concentrations. It is possible that this inhibitory effect may be overcome by increasing the concentration of sucrose in the solution tested. McLaughlin (1976) evaluated feeding formulations for BW and reported that the percentage of BW that started to feed was positively correlated to increased concentrations of sugar in the formulations they evaluated.

Table 2. Gustatotry response for spinosad when mixed with 10% sucrose and ingested by male and female boll weevils captured in pheromone traps during spring and fall, 2000[z].

	Mean[y] amount ingested (µl) ± SE	
Concentration (ppm)	Male	Female
0	4.05 ± 0.35aA	3.47 ± 0.45abA
28	2.28 ± 0.32cB	3.28 ± 0.20abcA
56	3.36 ± 0.21abA	3.85 ± 0.43abA
140	3.34± 0.23abB*	4.13 ± 0.38aA
280	3.29 ± 0.36abA	3.37 ±0.29abcA
2800	2.57± 0.45bcA	2.38 ± 0.34cA
10000	2.91 ± 0.30bcA	3.01 ± 0.41bcA

[z] Based on 10 weevils per sex per concentration.

[y] Means in the same column followed by the same lower case letter are not significantly different at 5% level (LSD test). Means in the same row followed by the same upper case letter are not significantly different at 5% level (t test). Means in the same row followed by different upper case letter are significantly different at 10% level (t test).

Field Tests. There were no significant differences, regardless of sex, in the number of dead BW collected from the screens located under the yaupon shrubs compared to numbers captured in the traps (*F* = 0.19; df = 1, 136; *P* > 0.66 for females; *F* = 0.19; df = 1, 136; *P* > 0.67 for males) during field test 1 (Figure 3). Also, when the weevil counts for both females and males were pooled, there were no significant differences in the numbers of dead BWs collected from the treated yaupon shrubs and those captured in BW traps (*F* = 0.00; df = 1, 136; *P* > 0.97 for both females and males). This suggests that spinosad did not inhibit BWs visiting yaupon shrubs sprayed with holly sugar. It is important to note that equal numbers of both sexes were killed in this test.

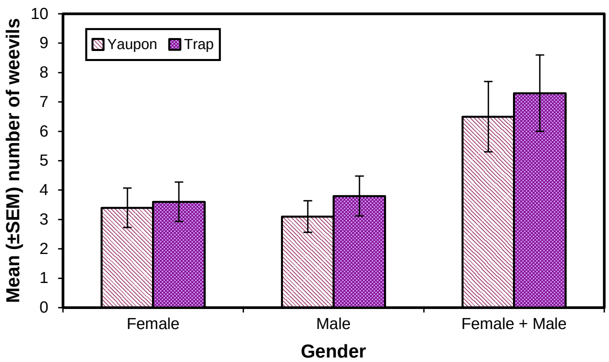

Figure 3. Mean number of BWs sampled on yaupon trees compared to those serviced in the pheromone traps.

In Test 2, there were no significant differences in dead BW counts between bait formulations due to sex, but significant differences were obvious between the trap and some bait formulations. Table 3 shows that the number of female BW captured in the traps compared to the number of dead BWs collected from the treated yaupon shrubs with the different formulations was not significantly different (F = 2.55; df = 3, 79; P > 0.05). However, the number of dead male weevils collected varied significantly between bait formulations compared to the number captured in the traps (F = 3.77; df = 3, 79; P < 0.05). The number of male weevils killed on shrubs treated with the Lloyd bait formulation was significantly fewer compared to those captured in the traps, but there were no significant differences between Lloyd, holly sugar or Spurgeon bait formulations. Also, when the counts of male and female weevils were pooled, the treatment differences were significant (F = 3.36; df = 3, 79; P < 0.05) and separation of treatment mean values were comparable to that obtained for the male weevils. Relatively high concentrations of sugar was a common characteristic among all bait formulations and may be important as a feeding stimulant as reported by McLaughlin (1976).

Table 3. Mean (± SE) number of boll weevils serviced in the trap and those sampled on different bait formulations.

Bait Formulations	Female[z]	Male[z]	Total[z]
Trap	4.86 ± 1.65a	4.90 ± 1.60a	9.76 ± 3.18a
Spurgeon	3.33 ± 0.97a	3.28 ± 1.22ab	6.62 ± 2.15ab
Lloyd	1.76 ± 0.67a	1.09 ± 0.46b	2.86 ± 1.10b
Holly	1.90 ± 0.47a	1.48 ± 0.39b	3.38 ± 0.78b

[z] Means followed by the same lower case letter within each column were not significantly different (P>0.05) according to Tukey-Kramer adjusted *P*-values (PROC MIXED procedure).

An important consideration relative to these field data is that design, baiting, and operational aspects of the BW trap used in eradication have been optimized for efficacy in capturing BW attracted to the traps and it is highly effective for monitoring BW activity. In contrast, efficacy of the use of the screen below each shrub to collect dead BW responding to the pheromone lure and feeding on the toxic bait is unknown.

CONCLUSION

This set of studies demonstrates that, when mixed with 10% sucrose solution and ingested, spinosad is highly toxic to BW adults. Gustatory response of BWs to toxic concentrations of spinosad was inhibitory, but the level of inhibition was not consistent relative to sex or concentration except for the highest concentrations evaluated. Field tests demonstrated that a holly sugar and two other bait formulations with spinosad at 300 ppm sprayed on individual yaupon shrubs baited with a pheromone lure, killed boll weevils in numbers comparable to individual traps with the pheromone lure alone. This study suggests that sugar-based adult control technology with spinosad as a toxicant may provide an adequate strategy to attract and kill boll weevils in environmentally sensitive areas where spraying may not be possible.

There are 3 major components of the adult BW control approach suggested. These are: 1) use of the pheromone grandlure as an attractant, 2) a feeding stimulant formulation that induces feeding of responding BW adults, and 3) and an effective toxicant that is compatible with the feeding approach. Development of this approach would require extensive effort because a sprayable formulation which could be applied by ground or aerially would have to be developed to be practical. The pheromone is a critical component of the attract- and- control system. It has been shown to be an especially effective attractant during spring and fall BW dispersal phases. A slow-release sprayable formulation of the pheromone would be necessary. This could contribute greatly to the success of the approach because the material could be applied in strips rather than broadcast, making the barrier more feasible from both economic and environmental perspectives. Also, use of pheromones in insect control is highly encouraged from a regulatory standpoint. Some research has been previously conducted on the feeding stimulant formulation as reported and cited by Lloyd et al. (1968) and McLaughlin (1976). However, cotton fields, not non-cotton habitats were the focus of this work. The presence of adult feeding resources is a major limitation to the success of attract-and kill technologies in cotton fields. Spinosad was evaluated as a toxicant in this study because of environmental and regulatory advantages. However, use of other toxicants would be possible.

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DISCLAIMER

Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the U.S. Department of Agriculture. USDA is an equal opportunity provider and employer.

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