TOXICITY OF INDOXACARB, THIODICARB, AND SPINOSAD TO THE SOYBEAN LOOPER (LEPIDOPTERA: NOCTUIDAE) ON BT COTTON (CV. NUCOTN 33B) AND CONVENTIONAL COTTON (CV. DP 5415)

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Abstract

A series of laboratory tests were conducted in Northeast Louisiana during 1998 and 1999, to evaluate the efficacy of thiodicarb (Larvin 3.2F), spinosad (Tracer 4SC), and indoxacarb (Steward 1.25SC) against the soybean looper, *Pseudoplusia inlcudens* (Walker), on conventional cotton (cv. DP 5415) and transgenic *Bacillus thuringiensis* (Bt) (Berliner) cotton (cv. NuCOTN 33B). Plots within each variety received an application of either thiodicarb at 0.125, 0.25, 0.375, 0.5 lb AI/acre; spinosad at 0.012, 0.025, 0.037, 0.05 lb AI/acre; indoxacarb at 0.05, 0.07, 0.09, 0.11 lb AI/acre; or remained untreated. Foliage from each cultivar was placed into a 9.9 cm Petri dish along with three soybean looper larvae (L3 stage; 20 to 30 mg) within 1 hour after treatment (HAT). Larval mortality was rated at 72 hours after infestation (HAI). All rates of thiodicarb and all rates of spinosad (except 0.037 and 0.05 lb AI/acre) caused greater mortality when larvae were placed on treated foliage of NuCOTN 33B compared to DP 5415. Indoxacarb toxicity was not influenced by the two crop hosts. All rates of indoxacarb provided similar levels of soybean looper mortality on NuCOTN 33B and DP 5415.

Introduction

The soybean looper, *Pseudoplusia includens* (Walker), was first reported in the Southeastern United States, and it has become an economic pest of cotton and soybean (Hensley et al. 1964). In Louisiana, during the 1998 season, the soybean looper ranked sixth among pests causing yield losses in cotton, *Gossypium hirsutum* (L.) (Williams 1999). As a result, over 136,501 acres of cotton were treated for soybean looper damage (Williams 1999).

In recent years, the soybean looper has developed resistance to several classes of insecticides (Thomas and Boethel 1993). During the late 1980's, the pyrethroid, permethrin, provided unsatisfactory control of soybean looper populations (Felland et al. 1990, Leonard et al. 1990). Soybean looper resistance to insecticides may be associated with the common use of pyrethroids in cotton to control the bollworm, *Helicoverpa zea* (Boddie), and tobacco budworm, *Heliothis virescens* (F.) (Leonard et al. 1990, Thomas et al. 1994).

The utilization of transgenic *Bacillus thuringiensis* (Bt) cotton by producers is becoming more common in Louisiana. During the 1997 and 1998 growing seasons, 220,000 and 340,000 acres were planted to Bt cotton, respectively. In 1999, approximately 389,000 acres of cotton were planted to transgenic Bt cotton varieties in Louisiana (R. D. Bagwell, personal communication, Louisiana Cooperative Extension Service, Winnsboro, LA). Bt cotton has demonstrated activity against several lepidopteran pests that infest cotton (MacIntosh et al. 1990, Benedict et al. 1993). This may include the tobacco budworm, which is difficult to control with many foliar applied insecticides (Sparks 1981).

Bt cotton has been reported to suppress field populations of soybean looper (White 1995). Mortality and various sublethal effects, such as extended larval stadia, increased number of instars and lower pupal weights have been observed for larvae fed Bt cotton leaf tissue (Unpublished data, C. G. Clemens, Louisiana State University, Baton Rouge, LA). Foliar insecticides that are ineffective against the soybean looper in conventional cotton could possibly provide adequate control when coupled with fitness reductions associated with larvae feeding on Bt cotton. Lower insecticide rates could be utilized to control soybean loopers infesting Bt cotton as opposed to soybean looper populations in conventional cotton. This would benefit producers by reducing production costs. The objective of this research is to determine dosage mortality responses of selected insecticides on soybean looper infestations in Bt cotton compared to that in conventional cotton.

Materials and Methods

A fresh leaf tissue bioassay was conducted in 1998 and 1999 to evaluate the efficacy of spinosad (Tracer® 4SC; Dow Agrosciences, Indianapolis, IN), thiodicarb (Larvin® 3.2F; Rhone-Poulenc, Research Triangle Park, NC), and indoxacarb (Steward® 1.25SC; DuPont, E.I. de Nemours and Inc., Wilmington, DE) against the soybean looper on conventional cotton and Bt cotton. These studies were conducted at the Macon Ridge location of the Northeast Research Station (Louisiana State University Agricultural Center) near Winnsboro, LA. Plot size was 2 rows x 10 ft. Treatments were placed in a split-plot arrangement within a randomized complete block design, and were replicated three times. The main-plot factor was crop host and included conventional cotton (cv. DP 5415; Delta and Pine Land Co., Scott, MS) and Bt cotton (cv. NuCOTN 33B [Cry IA(c) protein]; Delta and Pine Land Co., Scott, MS). The sub-plot factor was insecticide treatment and included either spinosad at 0.012, 0.025, 0.037, 0.05 lb AI/acre; thiodicarb at 0.125,

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0.25, 0.375, 0.5 lb AI/acre; indoxacarb at 0.05, 0.07, 0.09, 0.11 lb AI/acre; or remained untreated.

A colony of soybean looper larvae was established from a soybean field near Jeanerette, LA (Iberville Parish) in 1998 and 1999. Larvae were transported to the laboratory and were held for one generation to eliminate parasitoids and pathogens. Survival to a discriminating concentration of a foliar Bt product (Condor XL; Ecogen Inc., Langhorne, PA) (130 ppm) was 42% and 36% in 1998 (Mascarenhas et al. 1998) and 1999 (Unpublished data, C. G. Clemens, Louisiana State University, Baton Rouge, LA), respectively. Larvae were placed into 29.6 ml plastic cups (2 larvae/cup), and fed a pinto bean wheat germ based diet (Thomas and Boethel 1993). Pupae were placed into 3.79 L cylindrical cardboard containers (40 pupae/container) with vermiculite and maintained at 27±2ºC. After adult eclosion, moths were fed a 10% honey water solution in 118.3 ml glass jars with absorbent wadding. The sides of the container were lined with paper towel strips (5.1 cm x 15.2 cm) to provide an adequate surface for adult oviposition and efficient egg retrieval.

Applications of thiodicarb and spinosad were made on 3 and 4 Aug, respectively, during 1998. In 1999, thiodicarb and indoxacarb applications were made on 16 and 17 Aug, respectively. Insecticide applications were made with a tractor-mounted boom and compressed air sprayer calibrated to deliver 10 GPA at 35 psi through TeeJet 8002 flat fan nozzles (2/row). Subtending leaves of first position cotton bolls from the top one-third of the plant were removed 1 hour after treatment (HAT) and placed into individual 9.9 cm polystyrene Petri dishes with filter paper. Three soybean looper larvae (L3 stage; 20 to 30 mg) were placed onto leaves and one ml of water was added to each dish to minimize leaf tissue desiccation. A total of 45 larvae were tested for each rate within each insecticide treatment. Larval mortality was rated at 72 hours after infestation (HAI). Larvae were considered dead if they did not respond to prodding with a blunt tipped instrument. Data for thiodicarb were combined across years. Data were subjected to regression analysis procedures to determine insecticide performance (SAS Institute 1989).

Results and Discussion

Rates of thiodicarb and spinosad applied to NuCOTN 33B resulted in consistently greater larval mortality compared to corresponding rates applied to DP 5415, with the exception of spinosad at 0.037 and 0.05 lb AI/acre (Fig. 1 and 2). In a similar study, Brickle et al. (1999) reported that recommended rates of thiodicarb (0.8 lb AI/acre) and spinosad (0.09 lb AI/acre) were more effective in controlling field populations of bollworm on Bt cotton than on conventional cotton. Also, bollworm mortality with the lower rates of thiodicarb, 0.2 and 0.4 lb AI/acre, resulted in 93.2 and 91.3% control, respectively, which was similar to the highest rate (0.8 lb AI/acre) when applied to Bt cotton. Thiodicarb at 0.125, 0.25, and 0.375 lb AI/acre on NuCOTN 33B and 0.25 and 0.375 lb AI/acre on DP 5415 demonstrated 84.0% mortality of soybean looper compared to 91.7% mortality for thiodicarb at 0.5 lb AI/acre. Similar results were observed for lower rates of spinosad. Spinosad at 0.012, 0.025, and 0.037 lb AI/acre on NuCOTN 33B and 0.037 lb AI/acre on DP 5415 demonstrated 80.0% mortality compared to the 86.4% mortality for spinosad at 0.05 lb AI/acre. In a greenhouse study, Clemens (Unpublished data, Louisiana State University, Baton Rouge, LA) reported significantly greater soybean looper larval mortality on NuCOTN 33B leaves compared to DP 5415 leaves. This may indicate that Bt cotton (NuCOTN 33B) may have synergistic or additive effects with an insecticide treatment for controlling the soybean looper. Rates of indoxacarb were not significantly different between crop hosts. All rates of indoxacarb provided similar mortality of soybean looper larvae on conventional cotton and Bt cotton (Fig. 3). Further studies should be conducted to confirm these results reported for indoxacarb. Lower rates of indoxacarb may indicate differences between Bt cotton and conventional cotton.

In conclusion, lower rates of thiodicarb, 0.125, 0.25, and 0.375 lb AI/acre, and spinosad, 0.012, 0.025, and 0.037 lb AI/acre, may provide similar control compared to recommended rates of these insecticides when applied to NuCOTN 33B. These data suggest lower rates of thiodicarb and spinosad may be used for soybean looper control on the Bt cotton NuCOTN 33B. Producers may have another strategy to protect their crop from soybean looper, reduce production costs, and eliminate unnecessary insecticides released into the environment.

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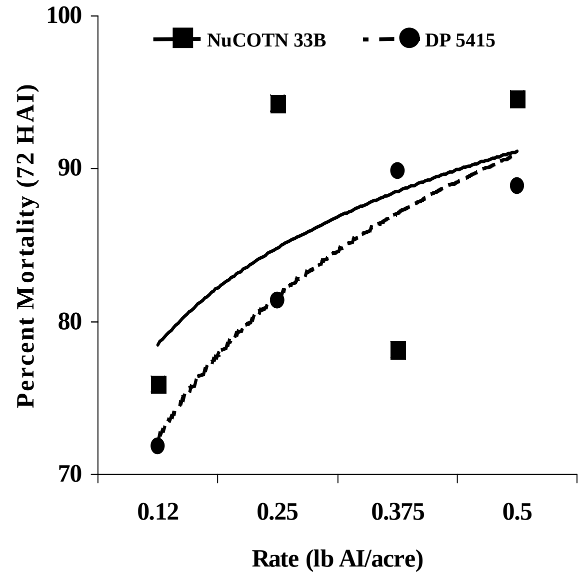

Figure 1. Thiodicarb efficacy against the soybean looper on NuCOTN 33B and DP 5415.

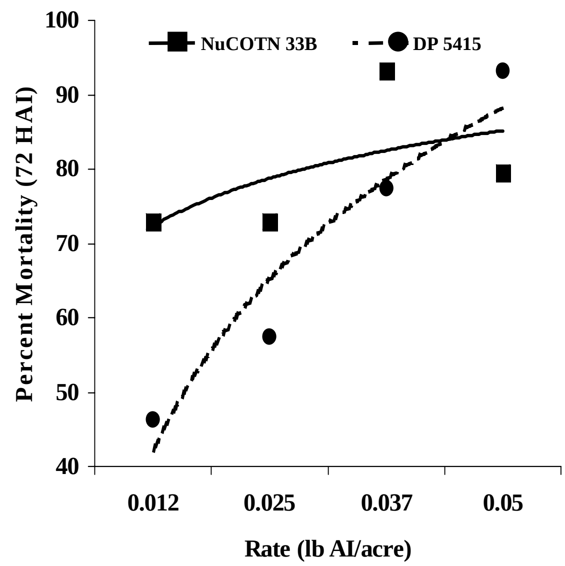

Figure 2. Spinosad efficacy against the soybean looper on NuCOTN 33B and DP 5415.

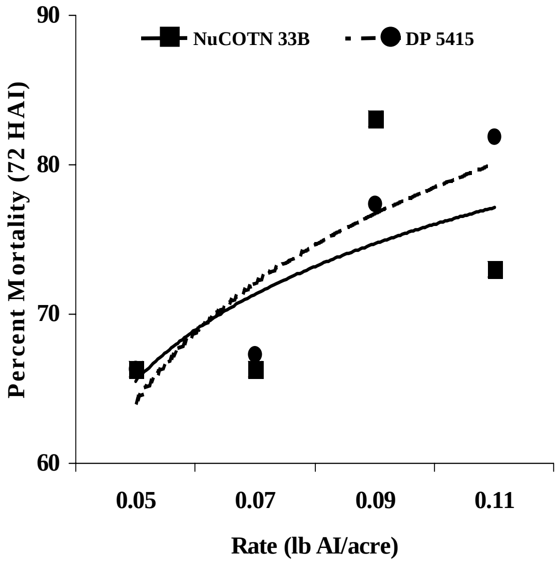

Figure 3. Indoxacarb efficacy against the soybean looper on NuCOTN 33B and DP 5415.