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COMPARATIVE OVICIDAL ACTIVITY OF VARIOUS NEONICOTINOIDS AGAINST CURRENT STANDARDS IN COTTON

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Abstract

This study was conducted in 2002 to evaluate the ovicidal properties of neonicotinoids against *Helicoverpa zea* (Boddie) in a field environment, located in Nash county, North Carolina. Newly laid (white) bollworm eggs were collected from leaves of cotton plants within respective treatments at 0, 1, and 2 days after insecticide application and transported to the laboratory for assessment of ovicidal and eclosion mortality. The neonicotinoids acetamiprid, imidacloprid, and thiamethoxam provided mortality for eggs present on the plants at application (0 DAT), comparable to that obtained with two ovicide standards, thiodicarb and lambda-cyhalothrin. Mortality of eggs deposited the night after application and collected 24 hr after application (1 DAT) dropped precipitously in all insecticide treatments, except thiodicarb. Egg mortality at 1 DAT was comparable for all neonicotinoids. For eggs collected at two day after application, ovicidal activity of the neonicotinoids had ceased and egg mortality in the standard treatments had declined to ca. 25%. This study confirmed ovicidal activity of the three neonicotinoids under field conditions; however ovicidal activity of neonicotinoids was ephemeral and not comparable to that of the ovicide standards.

Introduction

Every cotton field in North Carolina requires some level of control annually for the bollworm, *Helicoverpa zea* (Boddie), to prevent yield loss. Bollworm control is achieved either through the planting of Bollgard cotton varieties or through the application of insecticides or both. Pyrethroid insecticides have been the leading insecticide products of choice for bollworm control since the late 1970's. Pyrethroids have been used successfully because they are active against both egg and larval stages of heliothines (DuRant 1990) and they are cost effective. While recent studies have found that bollworm has become more tolerant to pyrethroids (Roof and DuRant 1998), they remain the most effective insecticides for control of bollworm. Thiodicarb is a carbamates insecticide that has also been used to control bollworm in cotton and other crops and has demonstrated ovicidal activity against heliothines (Brickle et al. 2001, Bradley & Agnello 1998, Leonard et al. 1990).

The neonicotinoids were recently introduced as a new class of insecticidal compounds which have found success in many commercial market niches throughout the World. The success of neonicotinoids is due to their unique chemistry and biological properties, including a new mode of action, low application rates, broad insecticidal spectrum, excellent systemic and translaminar properties, and low environmental and ecological risk concerns. The neonicotinoids have exhibited outstanding control of sucking pests of cotton and other crops, such as aphids and whiteflies (Natwick 2001, Parrish 2001). Acetamiprid is a representative of the neonicotinoid class that has shown excellent ovicidal activity against heliothines and other lepidoptera species in the laboratory and greenhouse (Parrish et al. 2001) and has demonstrated ovicidal activity against bollworm in the field (Ambrose et al. 2002).

The objectives of the study reported herein were: 1) to determine if the neonicotinoids imidacloprid and thiamethoxam would provide ovicidal control of bollworm under field conditions comparable to that of acetamiprid, and 2) to compare the ovicidal activity and persistance of three neonicotinoids with that of current standards, lambda-cyhalothrin and thiodicarb.

Materials and Methods

This study was conducted during the summer of 2002 in Nash County, North Carolina. Cotton (CV DP50) was at peak flower at time of test initiation and plants were ca. 40 inches in height. No foliar insecticides had been applied to the test site. Control of thrips had been accomplished through application of aldicarb (Temik® 15G, Aventis CropScience, Research Triangle Park, NC) at 0.75 lb. ai/a in-furrow. Plots 6 rows x 85 feet were established in a randomized complete block design with four replications. Rows were spaced 36 inches apart. Insecticide treatments were applied on 29 July using a CO2-backpack sprayer fitted with a single TX-12 nozzle per row delivering 10 gpa at 60 psi. The four middle rows of each plot were sprayed with either acetamiprid (Intruder® 70 WP, Aventis CropScience, Research Triangle Park, NC) at 0.05 lb. a. i./a, imidacloprid (Trimax® 4 SC, Bayer, Kansas City, MO) at 0.05 lb. a. i./a, thiamethoxam (Centric® 25 WG, Syngenta Crop Protection, Inc., Greensboro, NC) at 0.05 lb. a. i./a, thiodicarb (Larvin® 3.2F, Aventis CropScience, Research Triangle Park, NC) at 0.25 lb. a. i./a, or lambda-cyhalothrin (Karate Z® 2.08 CS, Syngenta Crop Protection, Inc., Greensboro, NC) at 0.025 lb. a. i./acre. An untreated control was also included that was sprayed water only.

Freshly laid bollworm eggs were collected from leaves in the upper 25% of the cotton plant canopy at 2, 24, and 48h after application. A subsample of eggs from the UTC were allowed to hatch and reared on artificial diet until the forth instar for heliothine species identification. Only newly laid eggs were collected as identified by their pearly white color and the absence of any darkening or ring formation. At least 100 eggs were collected from each treatment on each sample date. A small amount of cotton foliage bearing each egg was collected and placed in labeled paper bags and transported on ice to the laboratory. Small sections of leaf tissue bearing each egg were cut from the leaves and placed singly into #1gelatin capsules and held in the laboratory at 26°C. Mortality assessments were conducted four days after each egg collection date to ensure that egg hatch was complete. Each egg was categorized and recorded as hatched normally, failed to hatch, or that the larva died partially eclosed from the egg. Normally hatched eggs were those in which the larvae hatched and emerged completely from the eggshell. Ovicidal and eclosion mortalities were combined for the mortality values presented in Table 1.

All data were subjected to ANOVA using PROC GLM (SAS Institute 1990), and means for each treatment were separated (P•0.05) using Fisher's Protected Least Significant Difference test in SAS. Mortality for the control was corrected using Abbott's formula.

Results

At 0 DAT acetamiprid and lambda-cyhalothrin provided the highest levels of egg mortality; imidacloprid and thiamethoxam were intermediate. Egg mortalities were statistically comparable for eggs collected at 1 DAT (eggs deposited on treated plants the night following insecticide application) even though large numerical differences were recorded. At 2 DAT the neonicotinoids no longer exhibited ovicidal activity; however, the ovicide standards, particularly lambda-cyhalothrin, continued to show ovicidal activity. Larval identification from subsamples of eggs collected from the UTC confirmed that 98% were bollworm.

Discussion

The mode of insecticidal actions in insect eggs is not well understood and at least two types of mortality have been associated with death of the developing insect. The embryo in the egg may be killed and further development (embryogenesis) halted or the larva may die as it feeds on the chorion during eclosion. Bradley and Angello (1988) reported substantial mortality from thiodicarb in which the larvae died partially eclosed from the egg. They concluded that this mortality was due to sublethal doses of insecticide incapable of halting embryo development. Leonard et al. (1990) reported both types of ovicidal activity for heloithine eggs exposed to lambda-cyhalothrin. We observed both types of mortality in this study, but no attempt was made to differentiate between the two in the data presented in Table 1.

While the neonicotinoids exhibited ovicidal activity against bollworm eggs under field conditions in this test, their ovicide effects were ephemeral as compared to the ovicide standards, thiodicarb and lambda-cyhalothrin. These 2002 results are similar to those from a 2001 test (Ambrose et al. 2002) with the exception that overall ovicide mortalities recorded in 2001 were higher. Obviously, field environments (e.g. plant size, temperatures, humidity) vary from test to test with respect to factors critical to insecticide efficacy. The results from this test confirm that the use of insecticides that exhibit only ovicidal activity against bollworm is unrealistic under North Carolina conditions where bollworm infestations are typically high. In contrast, lambda-cyhalothrin and thiodicarb have been demonstrated to provide highly effective bollworm control because they possess both ovicidal and larvicidal activities. It may be practical to use neonicotinoids as an ovicide only on Bollgard cotton where supplemental control is all that is required. Such a situation may arise where threshold levels of aphids or some other sucking insect pest occur during a time when bollworm moths are depositing eggs on cotton. Having additional characteristics such as ovicidal activity against bollworms may increase the benefits of using neonicotinoids in situations where multiple pests occur simultaneously.

Literature Cited

Abbott, W. S. 1925. A method of computing the effectiveness of an insecticide. J. Econ. Entomol. 18: 26-27.

Ambrose, L. Margery, and J. R. Bradley Jr. and John Van Duyn. 2001. Comparative ovicidal activity of acetamiprid, thiodicarb and lambda-cyhalothrin against bollworm on cotton in a field environment. *In* H. McRae and D. A. Richter (eds.). Proc. Beltwide Cotton Conf., Atlanta, G. A.

Bradley, J. R., Jr., and a. M. Agnello. 1988. Comparative persistence of the ovicidal activity of thiodicarb, chlordimeform, and methomyl against *Heliothis spp*. (Lepidoptera: Noctuidae) on cotton. J. Econ. Entomol. 81: 705-708.

Brickle, D. S, G. Turnipseed, and M. J. Sullivan. 2001. Efficacy of insecticides of different chemistries against *Helicoverpa zea* (Lepidoptera: Noctuidae) in transgenic *Bacillus thuringiensis* and conventional cotton. J. Econ. Entomol. 94: 86-92.

DuRant, John A. 1990. Field evaluation of selected candidate ovicides against *Heliothis spp*. on cotton. pp. 265-267. *In* J. M. Brown and D. A. Richer (eds.). Proc. Beltwide Cotton Conf., Las Vegas, NV.

Leonard, B. R., J. B. Graves, S. Micinski, and G. Burris. 1990. Ovicidal properties of selected insecticides against *Heliothis spp*. in cotton. pp. 267-273, *In* J. M. Brow and D. A. Richer (eds.). Proc. Beltwide Cotton Conf., Las Vegas, NV.

Natwick, E. T. 2001. Comparison of neonicotinoid with pyrethroid insecticides for control whitefly in cotton. pp. 906-908. *In* P. Dugger and D. A. Richter (eds.). Proc. Beltwide Cotton Conf., Anaheim, CA.

Parrish, M. D. 2001. Assail™: a new tool for insect pest management in cotton. pp. 46-47. *In* P. Dugger and D. A. Richter (eds.). Proc. Beltwide Cotton Cong., Anaheim, CA.

Parrish, M. D., H. Ayak, and K. Holmes. 2991. Ovicidal activity of acetamiprid (Assail™ brand 70WP insecticide) on economic pests of cotton. pp. 904-905. *In* P. Dugger and D. A. Richter (eds.). Proc. Beltwide Cotton Conf., Anaheim, CA.

Roof, M. E., and J. A. DuRant. 1998. Experiences with *Bt* cotton under light to medium *H. zea* infestations in South Carolina, p. 964. *In* P. Dugger and D. Richter (eds.)., Proc. Beltwide Cotton Conf., Memphis, TN.

Table 1. Percent mortality[a] of bollworm (*Helicoverpa zea*) eggs collected from cotton plants at 0, 1, and 2 days after application of insecticides, Nash county, N. C., 2002.

Insecticide	Rate (lb. a. i./a)	0 DAT	1 DAT	2 DAT
imidacloprid	0.050	38.57 c	19.46 a	0.0 c
acetamiprid	0.050	62.01 a b	25.47 a	6.95 b c
thiamethoxam	0.050	46.48 b c	25.97 a	0.0 c
thiodicarb	0.250	32.06 c	58.26 a	26.46 a b
lambda-cyhalothrin	0.025	71.81 a	32.85 a	46.78 a

Means within the same column followed by the same letter are not significantly different, Fisher's Protected LSD, (P•0.05). [a]Treatment mortality data were corrected for control mortality using Abbott's formula (1925).