Seasonal Infestation by Pink Bollworm of Transgenic Cotton, NuCOTN 33, and Parental Cultivar DPL-5415 in Commercial Fields

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Abstract

Bolls from transgenic cotton, NuCOTN 33 (Delta and Pine Land Co.) containing the Bollgard ™ gene (Monsanto Co.) and from the parental cultivar DPL-5415 were examined for mature larvae of the pink bollworm (78,240 total bolls). Bolls from five paired fields were collected in one study (Queen Creek, Buckeye, and Gila Bend areas) and a composite of 10 fields of each cultivar were collected in a second study (Paloma Ranch area). Bolls were incubated for 2 weeks (dissected late season) or dissected to find mature larvae, respectively. Collections of 100 or 80 bolls per field were made weekly or biweekly from July through November, 1995. Numbers of pink bollworm larvae were very low in all fields through August and thereafter increased steadily in the control fields. Numbers of larvae found in transgenic cotton were extremely low or non-existent throughout the season, even in fields which were adjacent to heavily infested control fields. These results show that NuCOTN 33 retained a high degree of efficacy for preventing development of mature pink bollworm larvae (diapause larvae) during the late season. Most important, these data provide baseline information against which efficacy in subsequent years can be compared.

Introduction

The production of transgenic cotton for seed increase provided an opportunity to measure its effectiveness against pink bollworm in commercial fields. The primary objectives were to monitor pink bollworm infestations, particularly late in the season, and to establish baseline efficacy data for subsequent measurements of resistance.

Materials and Methods

Transgenic cotton, NuCOTN 33, containing the Bollgard ™ gene (Monsanto Co., St. Louis, MO) in a Deltapine 5415 (Delta and Pine Land Co., Scott, MS) background was planted in commercial fields for seed increase in central Arizona in 1995. Five paired comparisons were made of NuCOTN 33 and DPL-5415 in fields under the management of four growers. Paired fields were located at Queen Creek, Buckeye, and Gila Bend. Two of the comparisons were made between adjacent full-size fields. One comparison consisted of 5 acres of NuCOTN 33 grown in 35 rows planted down the center of a large field of DPL-5415. Two other comparisons used separate fields of NuCOTN 33 with a single large adjacent field of DPL-5415 divided in half to provide two controls. No details of planting and termination dates, fertilization, or insect control are provided. These practices were standard for the areas and similar for the two cultivars at each location.

Samples of 100 bolls were collected weekly from each cultivar and location from July until the end of the season. These collections were taken by walking directly through one half of the field and returning through the other half to complete four quadrants of 25 bolls each. From September onward, we often collected additional bolls to provide late season infestation data. We also took greater numbers of bolls from locations that had greater infestations of pink bollworm. We wanted to particularly address the question of late season boll infestations since these infestations relate to the numbers of potential overwintering larvae. Although laboratory analysis has indicated protein expression is greatest early in the crop life cycle, the Monsanto Company maintains late season protein expression is sufficient for season-long control (C. Reyes, Monsanto Co., personal communication).

Bolls were incubated in ventilated plastic boxes at about 80° F and ambient humidity (evaporative cooler) for 2 weeks before cut-out larvae (July to mid-September) were counted. After mid-September, most larvae are in diapause and are found only by dissection of bolls. Therefore, all late season bolls were hand dissected for larvae (mid-September onward). Larvae from both transgenic and non-transgenic bolls were given to Dr. A. C. Bartlett of our laboratory for his testing. As of this date, we have no data for these larvae.

In a second study, 10 fields of NuCOTN 33 and 10 of DPL-5415 in the Paloma Ranch area near Gila Bend/Painted Rock were sampled for pink bollworm under the direction of the Arizona Cotton Research and Protection Council (ACRPC) and the composite results reported here. Fields were selected for comparable planting dates and were representative of the area. Forty bolls from each of two quadrants of each field were collected weekly (80 bolls per field) and the alternate two quadrants sampled the following week. Bolls were dissected for pink bollworm larvae throughout the season.

Fields in both studies were trapped using five Delta traps per field placed in a line (150 foot separation) through the interior of the fields. All traps were baited with 4 mg of gossyplure on rubber septa baits (supplied by ACRPC) and traps were serviced weekly. Traps were replaced as needed and baits changed monthly (paired fields) or biweekly (20 fields).

Results

Very few pink bollworm larvae were obtained from any of the fields until mid-September and then only in some of the fields (Table 1). In paired fields D and E, where large numbers of diapause larvae were collected from control fields in October, two larva were found in the transgenic bolls. During this same period 4166 pink bollworm larvae were found in the same number of bolls from the paired control fields. In paired fields B and C no pink bollworm larvae were found in the transgenic bolls throughout the season and only 51 larvae were found in the paired control fields.

In the transgenic field of pair A, there were nine larvae found in October, more than were found in the control field. These larvae were in five bags of 50 bolls each, collected on three dates (1, 2, 3, 1, and 2 larvae/bag). We strongly suspect that the boll collectors accidentally wandered outside of the rows of transgenic cotton and took these bolls from the control area. In this field, NuCOTN 33 was planted through the center of a larger field of DPL-5415 with no distinguishing boundaries between the two cultivars. The rows of transgenic cotton were marked at each end of the field by small flags, not visible from within the field. The adults will be tested (along with controls) for resistance to BT toxin. The results of these tests may help clarify the origin of these particular larvae.

No mature larvae were found in the composite test samples collected from the Paloma Ranch area. Although control fields at Paloma Ranch had low numbers of larvae, the results for late season samples (particularly November) suggest that the transgenic cotton was exposed to infestation.

Trap catches in the two studies indicate comparable catches in NuCOTN 33 and DPL-5415 in the paired field study (Fig. 1) or generally greater catches in NuCOTN 33 than in DPL-5415 in the composite field study (Fig. 2). In the paired field study, growers routinely sprayed both cultivars and adult pink bollworm moths were equally controlled in the two cultivars. In the composite study, NuCOTN 33 was apparently not sprayed as often early and late season as DPL-5415 and had greater catches of adult pink bollworm moths and at these times.

Discussion

These results, taken in aggregate, indicate an extremely high level of efficacy of NuCOTN 33 against pink bollworm. The capability of mature larvae found in NuCOTN 33 bolls to complete diapause, pupate, and yield a reproductive adult moth is unknown The low late season infestations of NuCOTN 33 are particularly significant in that levels of toxin are acknowledged to be lowest in these senescent cotton plants. Also, any larvae in late season non-transgenic bolls are destined for infestation of the next year's crop, a decided advantage for NuCOTN 33 in comparison to DPL-5415 in several of the test fields. Most important, these data provide the baseline information for efficacy against which subsequent years can be compared.

Acknowledgments

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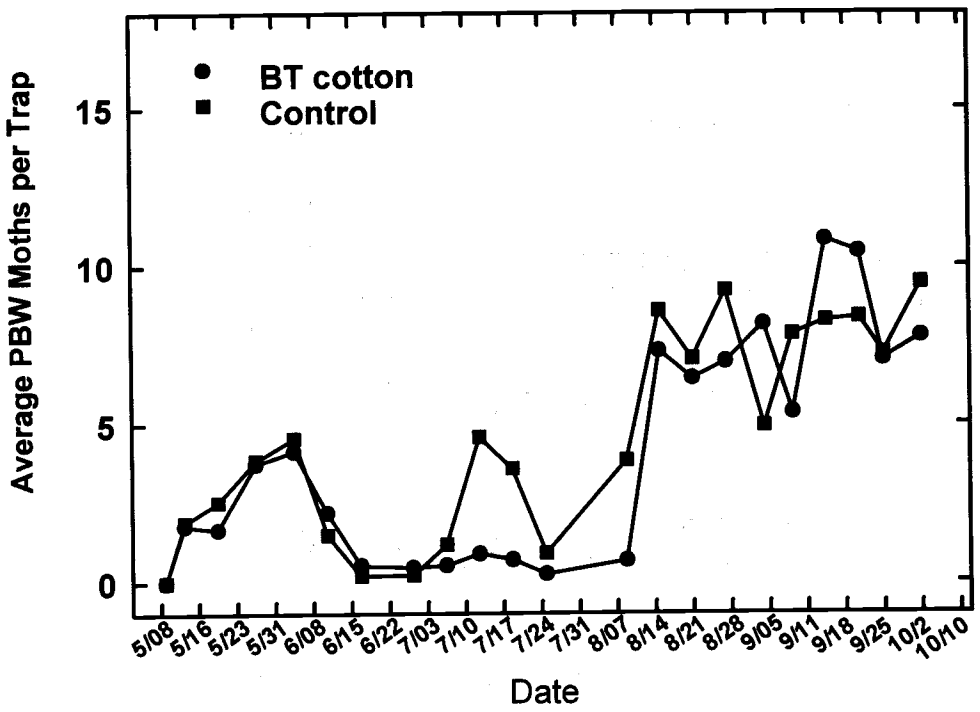

Figure 1. Average catch per trap of 5 traps in each of five fields for NuCOTN 33 (BT cotton) and DPL-5415 (control) in central Arizona, 1995.

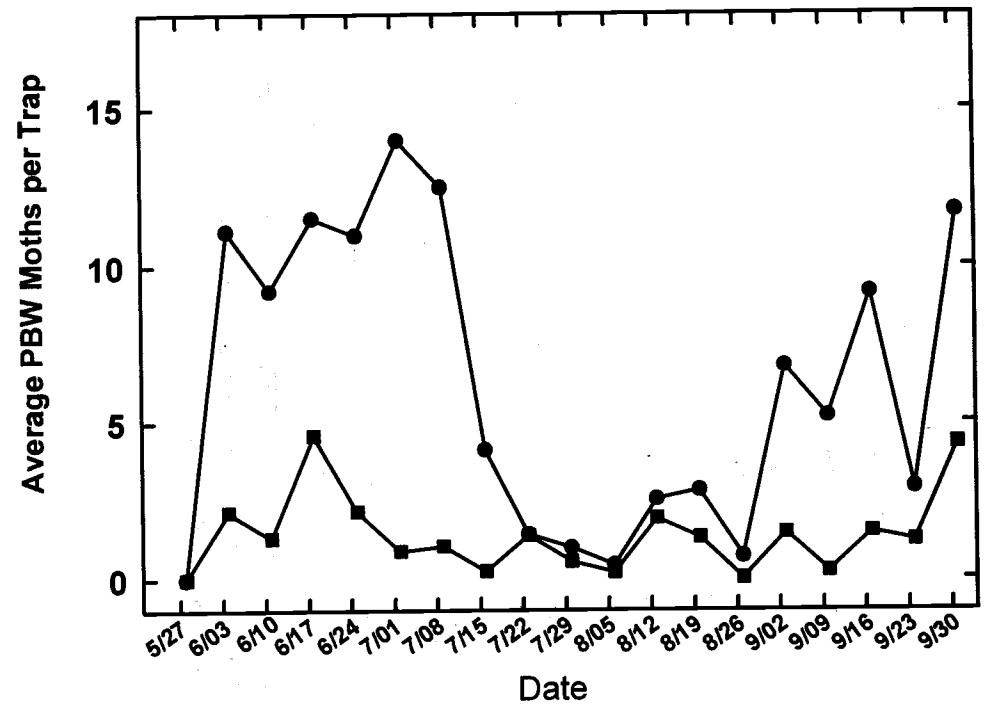

Figure 2. Average catch per trap of 5 traps in each of ten fields for NuCOTN 33 (BT cotton) and DPL-5415 (control) in the Paloma Ranch area of central Arizona, 1995.

Table 1. Infestation of pink bollworm in NuCOTN 33 (N33) and DPL-5415 (Cont.) in five paired fields in central Arizona and in a composite of 10 fields each of N33 and DPL-5415 at Paloma Ranch, Gila Bend, AZ, 1995.

Field		July		Aug.		Sept.		Oct.		Nov.	
Pair	Cotton	Bolls	PBW	Bolls	PBW	Bolls	PBW	Bolls	PBW	Bolls	PBW
A	N33	200	0	400	0	900	2	2200	9 [b]		
	Cont.	200	0	400	0	900	4	2200	7		
B	N33	200	0	400	0	900	0	2000	0	650	0
	Cont.	200	0	400	0	900	1	2000	5	650	10
C	N33	200	0	400	0	900	0	2000	0	650	0
	Cont.	200	0	400	0	900	5	2000	23	650	7
D	N33	200	0	400	0	2100	0	4800	1		
	Cont.	200	1	400	5	2100	256	4800	1591		
E	N33	200	0	400	0	1100	0	2400	1		
	Cont.	200	0	400	1	1100	81	2400	2575		
Composite [a]	N33	1400	0	3680	0	4480	0	3840	0	1320	0
	Cont.	2360	0	5000	1	4160	12	3200	45	1600	81

[a] Data from dissected bolls collected by the Arizona Cotton Research and Protection Council.
[b] These larvae may have inadvertently come from bolls of DPL-5415, see text.