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

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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 paired fields were collected in the Queen Creek, Buckeye, Maricopa, and Marana, AZ, areas. Equal numbers of bolls were collected from the edges of each field each week July - October except for Marana where a single collection was made 30 October. Bolls were incubated for 2 weeks and/or dissected from 1 September onward. Numbers of pink bollworm larvae were very low in all fields through August and increased to extremely high levels (up to 3.4 larvae/boll at Marana) in some control fields in October. Numbers of pink bollworm found in NuCOTN 33 were extremely low or non-existent, even in fields immediately adjacent to heavily infested control fields. The overall numbers of larvae found in NuCOTN 33 were comparable to those found in 1995. In 1995, the percent worms of bolls were: NuCOTN 33 = 0.0003 (13 larvae/38320 bolls) compared to 11.80% for DPL-5415 (4711 larvae/39920 bolls). Overall percent worms of bolls for 1996 were: NuCOTN 33 = 0.0004% (14 larvae/33350 bolls) compared to 34.19% (11572 larvae/33850 bolls) in DPL-5415.

Introduction

This is a continuation of our 1996 report (Flint et al. 1996) on pink bollworm infestations in transgenic cotton in central Arizona. Our objective is to provide 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 DPL-5415 (Delta and Pine Land Co., Scott, MS) background was planted in commercial fields in central Arizona in 1996. Paired fields were selected in the Queen Creek, Buckeye, and Gila Bend areas in essentially the same locations and planted by the same growers as our 1995 study. In 1995, fields in these areas were planted with NuCOTN 33 for seed increase. Thus, the data reported here are for the second year of transgenic cotton production at these areas. All paired fields in the present study were 40 acres or larger and were adjacent unless otherwise noted. One pair of fields was located at Buckeye, 2 pairs at Gila Bend (2 growers) and 1 "pair" at Queen Creek. The latter pair were actually 3 fields, 2 of NuCOTN 33 and a single control field of DPL-5415. Initially, we had

divided the single control field in half and collected bolls from each half as controls for the two transgenic fields (one transgenic field was adjacent, one ca. 1 mile distant). We gave this up early in the season and simply collected twice as many bolls from the control field and considered the transgenic and control fields as a single pair for purposes of reporting.

We also surveyed bolls at two additional areas. At the Maricopa Agricultural Center (MAC) farm, we collected bolls from three, 5 acre plots each for NuCOTN 33 and DPL-5415 (see Ellsworth et al. this issue). These plots were part of a much larger whitefly test but were comparable in insecticide control. Bolls from the plots for each cultivar were combined in this report for a paired "field" comparison. Finally, we collected bolls from a pair of adjacent fields at Marana, AZ. The field of NuCOTN 33 was reported to have pink bollworm larvae and exit holes in a low percentage of bolls in October (personal communication, L. Antilla). We collected one large sample of bolls, just ahead of the cotton picker in the control field, on 30 October. All fields in this study were maintained by the growers and their pest control advisors and no information was obtained on insecticide treatments during the season.

Variable numbers of bolls were collected in most of the fields on a weekly basis during the season. Collections were taken from two or three borders of each of the fields rather than by walking through the fields (some fields were impenetrable by the end of July). Our objective was to collect large numbers of bolls from these fields. In our experience, bolls along and just within field borders may have higher infestation rates than found in field centers. In any case, we sampled transgenic and control fields by the same methods. Bolls were incubated in ventilated plastic boxes at about 80°F and ambient humidity for 2 weeks before cut-out pink bollworms were counted. After 1 September, all incubated bolls were held for subsequent hand dissection. From 1 October, bolls were hand-dissected only (not incubated). Bolls for dissection were held in a screened insectary subject to ambient outdoor weather conditions. These methods recognize that after 1 September, many (and later most) larvae are in diapause and can only be found by dissection. Dissections were completed in mid-January, 1997.

Results

Very few pink bollworm larvae were obtained in any of the fields until September (Table 1). Thereafter, some of the control fields became heavily infested. The control field of field pair B averaged 1.2 and 2.9 larvae per boll in September and October, respectively (total of 5886 pink bollworms in 3250 bolls). A total of 6 larvae were found in the transgenic field in the same number of bolls. This pair of fields was managed for short season production and, to our knowledge, was not sprayed late in the season. In 1995, this grower had virtually no bolls left on plants by late October. In 1996, there were abundant bolls left on plants in October. However, in 1996 the entire farm was planted with NuCOTN 33 except the single field of DPL-5415 that was our control. The other conspicuous example of heavy late season boll infestations was field pair F. In the only sample collected from these fields (1100 bolls each), the DPL-5415 field averaged 3.4 larvae per boll! The sample from the field of NuCOTN 33 yielded no larvae but about 10% (estimated) of the bolls had some visible internal damage due to pink bollworm feeding. Prior to dissection, 500 of the bolls from each field were examined for exit holes: NuCOTN 33 = 7 (1 per boll), DPL-5415 = 181 (some more than 1 exit hole per boll). Thus, some larvae were able to complete development and exit bolls in the field of NuCOTN 33. Additional damage occurred when larvae were unable to complete development but did cause the feeding damage we observed. It was our observation at the time of boll collection that the control field had very few remaining bolls on the plants (our estimate was 1 boll per 25 row feet). The field of NuCOTN 33 had numerous bolls remaining, several per plant. These two fields obviously reflect management practices that took into account the advantages of NuCOTN 33. Other paired fields had much lower infestation rates of pink bollworm. The percentages of pink bollworms of bolls were 0.0004% (14 larvae/33350 bolls) for NuCOTN 33 and 34.19% (11572 larvae/33850 bolls) for DPL-5415.

The larvae obtained in the above studies were given to Dr. A. C. Bartlett of our laboratory. Efforts were made to rear the larvae from transgenic and control plants to adulthood. Adults were to be used for genetic crosses and definition of their heritable resistance to the toxic proteins of NuCOTN 33. Most of the larvae had to be put through diapause-breaking procedures. Many failed to pupate, some misshapen pupae were obtained, and the adults obtained to date have failed to reproduce when crossed with colony moths. Similar failures to reproduce were

obtained with the much greater numbers of adults from control fields, which makes unclear the interpretation of the results for larvae from NuCOTN 33. These difficulties do not appear related to the use this year of growth regulating compounds for whitefly control, according to Dr. Bartlett. Thus, there is little that can be said for the level of resistance in pink bollworms surviving NuCOTN 33.

Discussion

Pink bollworm larvae collected from fields of NuCOTN 33 may have developed on non-transgenic plants. Various percentages of non-transgenic plants are said to occur in fields of NuCOTN 33. Percentages of 1% or less are quoted, but up to 3% has been rumored. Clarification is needed from the manufacturer. Internal damage to bolls of NuCOTN 33 occurred under heavy pressure from pink bollworms at Marana (field pair F). The observed internal boll damage certainly occurred in greater than 1 - 3% of the late season bolls. However, the percentage of accumulated exit holes (successful completion of larval development) found in NuCOTN 33 could be consistent with 1.4% of non-transgenic plants.

This year's results indicate little change from 1995. In 1995, NuCOTN 33 had an average of 0.0003% boll infestation (13 larvae/38320 bolls) compared to 11.80% for DPL-5415 (4711 larvae/39920 bolls). The conclusion for 1995 and 1996 is the same: NuCOTN 33 has had an extremely high and consistent level of efficacy against pink bollworm.

Reference cited

Flint, H. M., L. Antilla, and N. J. Parks. 1996. Seasonal Infestation by pink bollworm of transgenic cotton, NuCOTN 33, and parental cultivar DPL-5415 in commercial fields. Cotton: a College of Agriculture Report. Series P-103:296-300.

TABLE 1. Infestation of Pink Bollworm in NuCOTN 33 and DPL-5415 in Five Paired Fields in Central Arizona, 1996.

Field		Jul		Aug		Sep		Oct		Total	
Pair	Cultivar	Bolls	PBW	Bolls	PBW	Bolls	PBW	Bolls	PBW	Bolls	PBW
A	NuCOTN 33	800	0	1500	0	2300	2	1400	0	6000	0
	DPL-5415	800	8	1500	38	2400	97	1400	187	6100	330
B	NuCOTN 33	800	0	1600	0	2050	0	1200	6	5650	6
	DPL-5415	800	3	1600	20	2050	2466	1200	3420	5650	5909
C	NuCOTN 33	800	0	800	0	1600	0	400	0	3600	0
	DPL-5415	800	5	800	5	1600	13	600	204	3800	227
D	NuCOTN 33	200	0	3600	0	5400	3	600	0	9800	3
	DPL-5415	0	0	3600	4	5200	704	1200	1	10000	709
E	NuCOTN 33	1200	1	1800	1	2700	1	1500	2	7200	5
	DPL-5415	1200	0	1800	6	2700	420	1500	203	7200	629
F	NuCOTN 33	0	0	0	0	0	0	1100	0	1100	0
	DPL-5415	0	0	0	0	0	0	1100	3768	1100	3768
Totals	NuCOTN 33									33350	14
	DPL-5415									33850	11572