FIELD COMPARISON OF GENETICALLY-MODIFIED COTTONS CONTAINING ONE STRAIN (BOLLGARD) AND TWO STRAINS (BOLLGARD II) OF *BACILLUS THURINGIENSIS KURSTAKI*

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Abstract

Bollgard II, Monsanto line 15985, that contains two strains of *Bacillus thuringiensis* (Cry1A(c) and CryX), was evaluated in field plots to determine efficacy against lepidopterous pests in cotton. Control of both the cotton bollworm, *Helicoverpa zea* (Boddie) and the soybean looper, *Pseudoplusia includens* (Walker), was significantly greater in Bollgard II compared with a Bollgard variety (DP50B) of cotton that contains only the Cry1A(c) endotoxin. Use of this new technology should provide growers a very low insecticide environment in cotton production where limited applications are needed to control lepidopterous pests.

Introduction

Bollgard cotton that has been genetically modified to contain the Cry1A(c) endotoxin of *Bacillus thuringiensis kurstaki* became available to growers in 1996. Bollgard varieties that contain this endotoxin have provided a wide range of control of lepidopterous pests. Bollgard has provided excellent control of the tobacco budworm, *Heliothis virescens* (Fabricius), and good control of the cotton bollworm, *Helicoverpa zea* (Boddie), which are primary pests in cotton (Meyers et al. 1997). However, control has been only fair to poor of secondary lepidopterous pests that include the soybean looper, *Pseudoplusia includens* (Walker), the fall armyworm, *Spodoptera frugiperda* (J.E.Smith), and the beet armyworm *Spodoptera exigua* (Hubner).

Bollgard II was derived by genetic modification of 'DPL50B' so that the resulting plants contain two different B.t. toxins, Cry1A(c) and a strain designated CryX (personal communication, J. Mann, Monsanto Co.). Varieties containing the two endotoxins were designed to improve control of lepidopterous pests. Several field tests on Bollgard II varieties were conducted during the 1999 season at the Clemson University Edisto Research and Education Center. The objective of these studies was to compare Bollgard II with Bollgard and conventional varieties for control of lepidopterous pests.

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Materials and Methods

Of three tests conducted, data are included from only one. This was due to exceptionally low numbers of lepidopterous pests during the 1999 season. The first test involved comparisons of 'DP50', 'DP50B' and Monsanto's Bollgard II lines 15985 and 15813 in replicated plots treated and untreated for the bollworm. The second test involved evaluation of the impact of beneficial arthropods in Bollgard II.

In a final test, different insecticides and rates were evaluated on DP50B and 15985 for control of lepidopterous pests. Four replications of 7 treatments were established in a complete randomized block design using plots that were 8 rows wide and 30 ft. long. Prior to the bollworm flight, all plots were treated with acephate on July 10 and July 24 to decrease the number of beneficial arthropods and thereby increase later populations of lepidopterous larvae. Rates of cyhalothrin (Karate®), thiodicarb (Larvin®) and spinosyn (Tracer®) that were ca. 1/4 and 1/8 of rates recommended for conventional cotton were compared with a check untreated for bollworm. Applications to both varieties were initiated when eggs reached 35/100 plants, and were continued as needed. Four samples were taken with a one meter beat cloth (Shepard et al.1974) at three days after the second and third applications and 10 days after the third application. Sampling included counts of large bollworms (>1/4 inch in length), soybean loopers, armyworms, and damaged fruit on the beat cloth. In addition to beat sampling, 25 bolls 1/4 to 1/2 inch in diameter with attached bloom tags were examined for bollworms and boll damage. Data were analyzed using the proc glm statement in the SAS statistical program.

Results and Discussion

No supplemental treatments were required for Bollgard II cotton genotypes whether or not beneficials were disrupted in early season. Bollgard did not require treatment when beneficials were present but did when they were disrupted. This was due to very low population levels of bollworm and other lepidopterous pests thoughout the season. In conventional cotton, applications were required for bollworm control whether beneficials were disrupted in early season or not. In the first test, DP50 had economic levels of bollworm which were significantly higher than levels in DP50B, Monsanto 15985 or Monsanto 15813. In the second test that involved 15985 sprayed in early season for beneficial disruption and unsprayed, populations of beneficials were significantly higher in unsprayed but very few bollworms survived under either scenario.

In the third experiment, with beneficials disrupted in early season in DP50B and 15985, there were no significant differences among insecticides or rates when applied for bollworm control in either genotype. However, in plots untreated for bollworm, there were significant differences in numbers of bollworm , soybean loopers, and damaged bolls between DP50B and 15985 (Tables 1 – 3). In Table 1, numbers of bollworms and soybean loopers were significantly lower in Bollgard II (15985) on three different sampling dates compared with Bollgard (DP50B). Numbers of dislodged damaged bolls counted on the beat cloth during sampling on the same dates (Table 2) were significantly lower in Bollgard II compared with Bollgard plots. Counts made by examining small bolls under attached bloom tags for bollworm damage (Table 3) were similar to the previous data (above). Mean number of damaged bolls was significantly lower in Bollgard II compared with Bollgard plots.

Summary

Bollgard II lines containing Cry1A(c) and CryX strains of *B. thuringiensis* Kurstaki provided excellent control of bollworm and soybean looper but at low population levels. DP50B plots treated for bollworm had significantly lower bollworm levels compared with all untreated plots. Under low population levels, in plots untreated for bollworm, numbers of large bollworms and soybean loopers were significantly lower in Bollgard II (15985) compared with Bollgard (DP50B) cottons. Similar differences were observed in damaged bolls. Additional research that compares conventional, Bollgard, and Bollgard II genotypes against all lepidopterous pests is needed under “normal” or higher population levels. With these limited data, Bollgard II cottons show considerable promise of controlling major lepidopterous pests with little need for applications to supplement their control.

References

Meyers, H.B., D.R. Johnson, T.L. Singer and L.M. Page. 1997 The survival of Helicoverpa zea (Boddie) on Bollgard cotton. pp. 1269-1271. *In* Proceedings, Beltwide Cotton Production Research Conferences, National Cotton Council of America, Memphis, TN.

Shepard, M, G.R. Carner, S.G. Turnipseed. 1974. A comparison of three sampling methods for arthropods in soybeans. Environ. Entomol. 3(2): 227-232.

Table 1. Mean number of large bollworms and soybean loopers per 12 row feet from beat cloth samples.*

	Aug 9		Aug 13		Aug 20	
	H. zea	**Loopers**	***H.zea***	**Loopers**	**H. zea**	**Loopers**
Bollgard	1.75 a	1.25 a	6.0 a	1.75 a	2.25 a	1.25 a
Bollgard II	0.00 b	0.0 0b	0.0 b	0.25 b	0.50 b	0.0 0b

*Means in columns within each variety followed by the same letter are not significantly different according to LSMEANS ($p \leq 0.05$)

Table 2. Mean number of damaged bolls dislodged in 12 row feet of beat cloth samples.*

	Aug 9	Aug 13	Aug 20
Bollgard	1.25 a	3.25 a	2.5 a
Bollgard II	0.25 b	0.25 b	0.0 b

*Means in columns within each variety followed by the same letter are not significantly different according to LSMEANS ($p \leq 0.05$)

Table 3. Mean number of damaged bolls under attached bloom tags (25 bolls ¼- ½ inch in diameter per plot).*

	Aug 9	Aug 13
Bollgard	3.25 a	2.25 a
Bollgard II	0.25 b	0.25 b

*Means in columns within each variety followed by the same letter are not significantly different according to LSMEANS ($p \leq 0.05$)