RESPONSE OF DELTAPINE TRANSGENIC VARIETIES IN THE YAQUI VALLEY, SONORA, MÉXICO

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Abstract

Transgenic varieties resistant to *Heliothis virescens* are new tools to reduce production costs due to insecticide application and to diminish environmental contamination. They have been implemented in the Yaqui Valley since 1998. In this valley, infestation levels of budworms do not reach the threshold level most of the time. New varieties were evaluated in 1999, under this condition, the outstanding yield performance of NuCOTN 33B and DELTAPINE 458 BRR is based on their overall genetic merit.

Introduction

Yaqui Valley is located in the southeastern corner of Sonora State, Mexico and its cotton production dates back to the beginning of this century. It is a privileged zone in Mexico regarding cotton pests, even though almost all known cotton pests can be found in the area, only boll weevil (*Anthonomus grandis*) is an ancestral primary pest. In the past five years Silverleaf Whitefly (*Bemisia argentifolii*) (SLWF) has occupied a prevailing place, classifying itself at the same level as boll weevil, as a primary plague, in this scenario *Heliothis spp* are a secondary plague. Since the boll weevil and SLWF are principal plagues, the strategies for their control, include chemical as well as cultural control, have obtained good results. Their combat requires two to five chemical applications per cycle depending on the sowing date and incidence level of both plagues. Under this pretense, *Heliothis spp* (*zea and virescens)* are controlled when there is an application against boll weevil and SLWF. On the other hand pink bollworm is considered as an almost nonexistent plague in the Valley, because the climate doesn't allow its development.

Heliothis spp are fought against in certain, very defined locations in the valley, and when certain management practices induce their population to explode, usually it is originated when the beneficial fauna that keep them in control are eliminated. When cotton is in the vegetative stage, secondary pests appear and unnecessary applications are carried out. These applications are dictated by "High Tech" criteria against thrips or aphids, which also kills beneficail fauna allowing development of dangerous *Heliothis spp* population.

Actual *Heliothis spp* population in Southern Sonora can be classified as "sub-threshold", and two specific insecticide applications, usually less, are done to control this insect. Under this scenario, transgenic Bollgard® varieties resistant to *Heliothis virescens* and *Pectinophora gossypiella* were presented in the Cultivar market in Yaqui and Mayo Valleys in 1997. Bollgard® varieties offer the opportunity to avoid the use of pesticides for *Heliothis virescens* and *Pectinophora gossypiella* control, this is extraordinarily interesting from an economic point of view and above all in its ecological perspective. Nevertheless its use implies an extra cost for the seed's price and a technology fee. The present investigation was designed to estimate yield response of new Bollgard® varieties in the Yaqui Valley, Sonora, Mexico.

Materials and Methods

Bollgard® variety evaluation was carried out in 1999 in two farm locations, January planting (DELTAPINE 458 BRR, DELTAPINE 428 B, DELTAPINE 688 BRR, DELTAPINE 20 B) and February planting (DELTAPINE 458 BRR), in comparison with NuCOTN 33 B (January) and SURE-GROW 821 (February). Variety evaluation was done in strips of a hectare in size per variety. In both locations hand thinning was not practiced, and a plant population of 180,000 – 200,000 plants/ha was detected. Incidence information of *Heliothis* spp population was collected by weekly inspections, from first week of squares and until first open boll week. Inspections were carried out in terminals, squares, and bolls to estimate *Heliothis* egg incidence, larvae of different instars, and damage in terminals, squares and bolls. Plant mapping data was collected at square and bloom initiation, and prior to harvest with the objective to estimate fruiting pattern.

Agronomic management was carried out on the basis of Cotton production guide recommendation for Yaqui Valley, Sonora. Insect management was conditioned by protocols that implied not using pesticide products that promoted Bollworm resistance. Nevertheless, the mentioned pest was not a problem during both cycles, only cotton boll weevil and silverleaf whitefly presented themselves in important levels that deserved control.

Yield potential estimation was done in one harvest, of 10 random $10m^2$ plots per variety, 10 boll samples were taken in those plots, to estimate boll characteristics and to estimate lint yield. Parameters were estimated also for the following variables: boll size, lint percent, seed index, precocity (first pick yield), and fiber quality (length, strength and micronaire index). The hypothesis of non-significant difference between genotypes was tested at 0.05 probability level.

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Results and Discussion

Rational pest management in the early stage of cultivar development (from emergence until before squaring) in Yaqui Valley helps beneficial fauna action. Secondary pests, such as aphids or thrips that are usually found in cotton from seedling stage until sixth leaf, are not controlled chemically; this helps the development of beneficial fauna that reduces significantly *Heliothis* complex population. In both locations very low *Heliothis* populations were observed. *Heliothis* egg oviposition was generally very low, at all the squaring stage, lower than 3%, far from economical thresholds. This situation is manifested in damaged square percentage that in general did not reach values superior to 1%. And as a consequence, low larvae levels were observed in terminals and fruiting structures at critical blooming stage: May 23rd to June 26th, where bloom damage was practically absent. As consequence of the previous situation, bolls damage was lower than 1.5% too, a value significantly under economical thresholds that define chemical control with pesticides. As a consequence of this situation, we did not have favorable conditions for resistance evaluation of the Bollgard® trait. On the other hand, no pink bollworm presence was noted, nowadays this pest is practically absent in Yaqui Valley. Because of this, the transgenic variety evaluation stands by it own merit, i.e. its intrinsic capacity or overall genetic potential to adapt itself and prosper under conditions, where only cotton boll weevil and silverleaf whitefly are a problem.

Yield

As a consequence of superior fruiting development, highly significant differences were detected for lint and seed cotton yield, NuCOTN 33 B (intermediate) and DELTAPINE 458 BRR (intermediate-full), had a significant superior yield than DELTAPINE 428 B (intermediate), DELTAPINE 20 B (early), and DELTAPINE 688 (full season) in the January location (Table 1), ranging from 8 – 28% more lint/ha. In the February location DELTAPINE 458 BRR showed also a superior yield potential (12%), over the conventional variety SURE-GROW 821 (Table 3), nevertheless this difference was not significant. As the results of yield evaluation of both locations were similar (Table 3) in the absence of *Heliothis spp*, we can conclude that these transgenic varieties have an excellent yield stability and production potential. This means that it can be used in conditions even when the pest is no problem, when infestation levels are below economical threshold, because the additional costs of technology and extra costs for seed, are compensated by a yield increase with NuCOTN 33^{B} and DELTAPINE 458 BRR. It is also convenient to stress that both varieties have an additional advantage, no notable damage from beet army worm and leaf perforator was observed, the first presented itself in low incidence at blooming stage, affecting foliage and fruits of conventional varieties, and the second one in medium intensity at the final stage of blooming.

Yield Components

Significant differences were detected on lint percent in the January location (Table 1); DELTAPINE 458BRR and DELTAPINE 20 B had a significantly higher value than the rest of the varieties. In the February location DELTAPINE 458 had a larger lint percent than SURE-GROW 821, but the difference was not significant.

Fiber Quality

Small but significant differences were detected for fiber length and micronaire index in the January planting date (Table 2). NuCOTN 33B, DELTAPINE 428B, and DELTAPINE 688BRR, had better fiber length than DELTAPINE 458 BRR and DELTAPINE 20 B. Regarding micronaire index, DELTAPINE 428B had a significantly higher micronaire value than the other varieties. In the February date, no significant differences were detected (Table 4).

Fruiting Development

NuCOTN 33^{B} showed similar plant height, average internodes length, and total main stems nodes as DELTAPINE 458 BRR in the January planting (Table 5); similar characteristics where observed in the February planting for DELTAPINE 458 BRR and SURE-GROW 821 (Table 7). NuCOTN 33B was earlier in fruit setting than DELTAPINE 458 BRR as boll number was significantly higher at blooming peak, while DELTAPINE 458 BRR had a significantly larger number of squares at the same period (table 5). On the other hand, DELTAPINE 458 BRR had a significantly higher and earlier boll setting than SURE-GROW 821 in the February planting site (Table 8). Total fruit retention was significantly higher in DELTAPINE 458 BRR when compared against NuCOTN 33B, due to a larger percent retention in second position at blooming peak (Table 6). Similar results were observed when DELTAPINE 458 BRR was compared with SURE-GROW 821 (Table 8), with DELTAPINE 458 BRR having a significantly larger difference in both first and second position.

Plant map data taken prior to harvest, indicates that DELTAPINE 458 BRR and NuCOTN 33B had similar plant height, average internodes length, and total main stems nodes in the January planting site (Table 9); similar results where obtained in the comparison of DELTAPINE 458 BRR and SURE-GROW 821 at the February planting site (Table 11). Total fruit retention and boll/plant was larger in NuCOTN 33B than in DELTAPINE 458 BRR, that explains in part its higher yielding capacity in the January planting site (Table 10). Likewise, DELTAPINE 458 BRR had larger open boll/plant count and total fruit retention percentage (Table 12), which also explains its higher yield in the February planting site in comparison with the conventional variety SURE-GROW 821. In both planting sites, the variety with the higher yield had significantly better boll retention at first and second positions. Boll setting across nodes was very similar in the January planting site, due to the fact that 85% of total boll yield was obtained in the 16 - 17 node range (Table 9). On the other hand, in the February planting site, DELTAPINE 458 BRR needed two more nodes than SURE-GROW 821 (Table 11) to obtain the 85% of the yield, indicating a full season and more productive cycle in opposition to an intermediate variety like SURE-GROW 821.

Summary

Resistance to *Heliothis spp* could not be evaluated, because there wasn't the necessary incidence of the pest. In the first test, NuCOTN 33B and DELTAPINE 458 BRR showed better lint yield and than DELTAPINE 428 B, DELTAPINE 20, and DELTAPINE 688 BRR. In a second test DELTAPINE 458 BRR had higher lint yield that SURE-GROW 821. Bollgard® varieties did not show notable damage from beet army worm or leaf perforator. Bollgard® varieties present high yield and agronomic expectancies and can be a tool, in an integrated pest management, even when *Heliothis virescens* specific pressure is at the sub-threshold level.

Table 1. Yield of new Bollgard® varieties. Yaqui Valley January location.

Variety	Yield, k/ha Lint	Yield, k/ha Seed cotton	Lint %
NuCOTN 33B	2,168	5,093	42.6
DELTAPINE 458 BRR	2,072	4,693	44.2
DELTAPINE 428B	1,921	4,542	42.3
DELTAPINE 20B	1,884	4,242	44.4
DELTAPINE 688BRR	1,681	4,078	41.2
Mean	1,950	4,536	43.0
L. S. D.(0.05)	142	309	0.7

Table 2. Fiber quality characteristics of new Bollgard® varieties. Yaqui Valley January location.

Variety	Fiber quality Length[1]	Fiber quality Strength[2]	Fiber quality Mike[3]
NuCOTN 33B	1 3/32	71,800	5.1
DELTAPINE 458 BRR	1 1/16	71,250	5.1
DELTAPINE 428B	1 3/32	67,300	5.3
DELTAPINE 20B	1 1/16	67,000	4.9
DELTAPINE 688BRR	1 3/32	70,700	5.0
Mean	1 3/32	69,673	5.1
L. S. D.(0.05)	1/32	NS	0.2

[1] inch, [2] lb/inch^2, [3] micronaire index, NS. = Non-significant at the 0.05 probability level.

Table 3. Yield of new Bollgard® varieties. Yaqui Valley February location.

Variety	Yield, k/ha Lint	Yield, k/ha Seed cotton	Lint %
DELTAPINE 458 BRR	2,111	4,966	42.5
SURE-GROW 821	1,891	4,520	41.9
Mean	2,001	4,743	42.2
L. S. D. (0.05)	NS	NS	NS

NS. = Non-significant at the 0.05 probability level.

Table 4. Fiber quality characteristics of new Bollgard® varieties. Yaqui Valley February location.

Variety	Fiber quality Length[1]	Fiber quality Strength[2]	Fiber quality Mike[3]
DELTAPINE 458 BRR	1 3/32	75,200	5.3
SURE-GROW 821	1 3/32	69,500	5.3
Mean	1 3/32	72,350	5.3
L. S. D. (0.05)	NS	NS	NS

[1] inch, [2] lb/inch^2, [3] micronaire index, NS. = Non-significant at the 0.05 probability level.

Table 5. Plant Characteristics of two Bollgard® varieties, at blooming peak. January planting. Yaqui Valley, Sonora. 1999.

Variety	Plant height cm	Average internodes length	Total main stem nodes	Squares In RB[1]	Squares In VB[2]
NuCOTN 33 B	80	3.3	24.1	0.8	2.1
DELTAPINE 458 BRR	80	3.5	22.9	3.4	1.4
Mean	80	3.4	23.5	2.1	1.7
P	NS	NS	NS	*	0

[1] and [2], reproductive and vegetative branches, respectively. NS and *, not significant and significant, respectively, at the 0.05 Probability level.

Table 6. Fruiting Characteristics of two Bollgard® varieties, at blooming peak. January planting. Yaqui Valley, Sonora. 1999.

Variety	Bolls In RB	Fruit retention % Total	Fruit retention % 1st. Pos.	Fruit retention % 2nd. Pos.
NuCOTN 33 B	14.0	40.8	57.4	36.4
DELTAPINE 458BRR	11.8	48.2	53.9	48.1
Mean	12.9	45.0	55.6	42.2
P	*	*	NS	NS

Table 7. Plant Characteristics of two Bollgard® varieties, at blooming peak. February planting. Yaqui Valley, Sonora. 1999.

Variety	Plant height cm	Average internodes length	Total main stem nodes	Squares In RB[1]	Squares In VB[2]
DELTAPINE 458 BRR	82	4.7	21.6	1.7	0.7
SURE-GROW 821	82	4.4	23.3	0.8	0
Mean	82	4.6	22.4	2.2	0.3
P	NS	NS	NS	NS	0

Table 8. Fruiting Characteristics of two Bollgard® varieties, at blooming peak. February planting. Yaqui Valley, Sonora. 1999.

Variety	BollsIn RB	Fruit retention % Total	Fruit retention % 1st. Pos.	Fruit retention % 2nd. Pos.
DELTAPINE 458BRR	16.6	52.2	67.4	58.3
SURE-GROW 821	9.9	45.9	52.8	46.0
Mean	12.9	45.0	55.6	42.2
P	*	*	*	0

Table 9. Plant Characteristics of two Bollgard® varieties, at blooming peak. January planting. Yaqui Valley, Sonora. 1999.

Variety	Height cm	Average internodes length	Total main stem nodes	Node Where 85% Of the fruit load is set
NuCOTN 33B	82	3.5	23.7	16
DELTAPINE 458BRR	89	3.5	25.6	17
Mean	85	3.5	24.6	17
P	NS	NS	NS	NS

Table 10. Fruiting Characteristics of two Bollgard® varieties, at blooming peak. February planting. Yaqui Valley, Sonora. 1999.

		Fruit retention %		
Variety	Bolls In RB	Total	1st. Pos.	2nd. Pos.
NuCOTN 33B	13.2	39.4	49.9	39.0
DELTAPINE 458BRR	11.3	30.9	37.9	27.6
Mean	12.2	35.1	43.9	33.3
P	NS	*	*	0

Table 11. Plant Characteristics of two Bollgard® varieties, at blooming peak. February planting. Yaqui Valley, Sonora. 1999.

Variety	Height cm	Average internodes length	Total main stem nodes	Node Where 85% Of the fruit load is set
DELTAPINE 458BRR	110	4.2	25.3	18
SURE-GROW 821	104	4.1	25.4	16
Mean	107	4.1	25.3	17
P	NS	NS	NS	NS

Table 12. Fruiting Characteristics of two Bollgard® varieties, at blooming peak. February planting. Yaqui Valley, Sonora. 1999.

		Fruit retention %		
Variety	Bolls In RB	Total	1st. Pos.	2nd. Pos.
DELTAPINE 458BRR	15.9	36.2	38.1	41.4
SURE-GROW 821	13.7	28.9	42.1	30.0
Mean	14.8	32.6	40.1	35.7
P	NS	*	*	0