DELTAPINE BOLLGARD VARIETY RESPONSE TO THE ISRAELI PEST COMPLEX

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Background

Pest control has been a major factor in cotton production in Israel and improved control methods have reduced input costs and boosted yields. The major pest complex in Israel includes the cotton aphid, thrips, *Helicoverpa armigera*, jassids, *Earias insulana*, whitefly, the leafworm *Spodoptera littoralis* and the Pink bollworm - *Pectinophora gossypiella*. Control is obtained using various methods comprising threshold based chemical control, pheromones to disrupt Pink bollworm mating, consideration of beneficial insect populations as a factor in decision making (e.g. aphid control), and cultural methods such as a plow-down strategy for PBW control.. In the past, pest control comprised a large portion of the input costs for cotton production. However, during recent years these costs have dropped due to the introduction of novel control methods, new chemistry and a pest control policy including an Insect Resistance Management (IPM-IRM) effort within which resistance development is monitored routinely. Pest control still comprises the largest R&D effort and resource allocation for cotton. Reduction in chemical sprays has largely been due to the introduction of new chemistry for whitefly control (IGR's). Benefits from new biotechnology varieties from Monsanto and D&PL have the potential to provide further solutions for pest problems with emphasis on lepidopteran pest control and thus further boost yield and profitability. Objectives of the present effort are to import D&PL transgenic varieties to Israel for testing, evaluate agronomic and entomological compatibility with the view of increasing cotton sustainability and profitability.

Materials and Methods

Deltapine varieties imported for entomological trials during the 1998 season were Nucotn 33B and DP 5415. DP 5415 and the local Acala Sivon acted as controls for the transgenic cotton trials. Three trial locations were selected for field tests, over a variety of production conditions and pest intensities. Three Bollgard trials were planted on April 23-26, 1998, towards the end of the optimum planting time in Israel. Trials were split-plot designed or fully randomized: two treatments - Spray or No-Spray against insects as main plots, Bollgard varieties and controls were randomized as subplots within the spray treatments. All trials comprised four replications. Plot size: 18 - '38 spaced rows by 30 -50 meters in length per plot, to form a 600 – 900 square meter plot for purposes of entomological evaluation. Regular bed preparation and post-emergence cultivation practices were performed for all trials. Trials were treated uniformly for non-target Bollgard pests such as leafworms, whitefly, and jassids. Irrigation and fertilization were regular practice drip irrigation including an average of 500mm of irrigation water and 150 Kg/Ha added Nitrogen. Trials were chemically defoliated and mechanically picked at the beginning of October 1998.

An additional laboratory trial was conducted at the Agricultural Research Organization with the same varieties to determine efficacy under no-choice feeding conditions. In these trials No-choice 48 and 96 h exposure of leaf or flower bud bioassays in agar- scintillation vials (vials with 2-cm layer of gelled agar) were performed. Leaf, flower bud petiole or cotton bolls were inserted into agar for retaining the freshness of the plant parts. Insects: neonates of *H. armigera, E. insulana, S. littoralis* and 3rd/4th instar larvae were examined. For *P. gossypiella,* only neonates were tested and either penetration or mortality were checked 8 days after exposure. Leaf damage caused by *H. armigera* and *E. insulana* was measured by a scanner attached to a PC.

Data Collection

In field trials, detailed insect counts were performed twice weekly for all major insect pests and beneficials. Damage to bolls was sampled in the field in the late season. For each plot, 20 plants were randomly sampled and all the cotton bolls were examined for damage from either pink or spiny bollworms. By plot mechanical harvesting and ginning supplied yield data. All treatments were quality assessed using HVI. Statistical analysis was performed using JMP (SAS Inc. USA).

Results

Lint yields were generally high with most DP varieties equal to or above the local Acala Sivon. Bulked data of the Bollgard trials reveal an advantage in lint yield for Nucotn 33B and DP 5415. Overall, they ranked at the top in these trials.

Infestation of fields with American bollworm (*Helicoverpa armigera*) was generally low in the trial fields, with peak pest populations of two larvae per m^2 during mid-June, 60 DAP. Bollgard control for this infestation range was highly satisfactory, however a certain decline in efficacy was detected in no-choice feeding lab tests. Good field control of spiny bollworm (*Earias insulana*) was also observed for both sprayed and non-sprayed treatments. No-choice feeding reveal high Earias control on cotton leaves. Mortality rates of 80% and over were registered with no

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apparent decline in efficacy over time. Efficacy in bolls reveals a 7% infestation in Bollgard compared to 23% percent in non-transgenic controls. Other observations show surviving 3rd instar larvae weight gain of 24mg per 96hrs. down from 78mg per 96hrs. in non-transgenic controls.

Efficacy for control of Pink bollworm (*Pectinophora gossypiella*) was very good despite late season infestation and previously reported decline in Bollgard efficacy during boll maturation. Lab data reveal similar information with boll damage down to 3% and negligible penetration rates measured from an additional observation at maturation. This data matches previous reports concerning exceptionally high efficacy against Pink bollworm.

Jassid and whitefly infestation differed greatly between smooth leaf DP varieties and local controls, probably due to leaf hairiness. Jassid infestation was high whereas whitefly infestation was relatively low in comparison to the local control. Jassid infestation probably reduced lint yield in DP smooth leaf varieties.

Conclusions and Summary

DP varieties demonstrate a good fit for the Israeli production environment. Agronomically, lint yield was high and has the potential to out-yield local control varieties. Although development patterns are different for various varieties, it seems that these differences can be agronomically managed. Lint quality does not suit present Israel market reputation.

Entomologically, Bt transgenic varieties achieved good field control of the three main lepidopteran pests. American bollworm infestations are generally high during the early season (60-70 DAP) coinciding with high gene expression and generally before a reported decline in Bollgard efficacy. In the controlled no-choice feeding trials this decline was detected and calls for further attention to determine precise efficacy for possible late season or exceptionally high *H. armigera* infestation.

Spiny bollworm infestation is sporadic and inconsistent in Israel, the number of treatments averaging ½ a spray per season. Bollgard efficacy should be sufficient to control this pest for most cases or at least facilitate complementary chemical control.

Pink bollworm control was high and probably has the greatest potential to save production costs incurred by pests. Late season efficacy was sufficient to give good control of PBW. This has positive impact on PBW infestation, on the general pest control strategy and usage of materials and possibly on the long term and recurring infestation of PBW in Israel. No choice tests strengthen this finding.

DP varieties tested in these trials were smooth leaf types characterized by high jassid occurrence and relatively low whitefly populations. Due to lack of awareness, the 1998 trials in Israel were negatively affected by high jassid infestation. Obvious from typical symptoms and early leaf senescence and desiccation, this led us to believe that under an adequate jassid control regime, lint yields could be higher than obtained from these trials for smooth leaf varieties.

Bollgard technology could therefore greatly reduce the need for chemical control of *H. armigera, E. insulana* and *P. gossypiella.* Additional possible advantages may include a positive indirect impact on control of non-target lepidopteran pests (e.g. leafworms), aphids and whitefly control, through general reduction in chemical usage and retention of beneficials and the natural balance. No-choice controlled trials reestablished that Bollgard cotton does not control Egyptian leafworm (*Spodoptera littoralis*).

Thus, smooth leaf varieties require extensive jassid control. In contrast, smooth leaves provide an inferior environment for whitefly development. This could affect the IPM – IRM strategy followed in Israel, and a change of materials for adequate pest control. Specific materials for jassid control may be needed to substitute IGR's and other chemistry presently used for whitefly control. In contrast, milder materials may be adequate for whitefly control.

Based on these findings and conclusions, a lint yield increase of 2% - 5%, savings of 50% to pest control (including a technology fee based on the US experience) and a possible reduction in lint price of 3% - 5%, an increase in profit of 20% - 50% could be expected with D&PL - Bt transgenic cotton. Israeli growers could benefit from transgenic Bt varieties, especially growers experiencing recurring Pink bollworm problems.