DELTAPINE BOLLGARD AND ROUNDUP-READY COTTON VARIETAL RESPONSE IN ISRAEL

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Background

Israel is a small and intensified cotton producer. With an annual 30,000 hectares, production is highly mechanized and fully irrigated during a long dry summer season, very similar to that of California. Upland cotton is of Acala types and comprises about 80% of the cotton land. Pima is cultivated on the remaining 20% of land allocated to cotton. Cotton farming is a staple on the Israel field crop scene comprising 30% of the total irrigated farmland allocated to field crops.

Yield development has been on the rise consistently since the re-introduction of cotton in the early 1950's. An increase in upland lint yield of 23.3Kg/Ha per annum and a correlation factor of R^2 = 0.89 link yield increase with technological development over the years. Introduction of new technology (drip irrigation) has been a factor. A major switch to crop rotation since the early 1990's also had positive impact. However, introduction of new varieties and developments in pest control probably had the most impact on the development of lint yield and profitability of cotton in Israel during the past decade. Benefits from new biotechnology varieties from Monsanto and D&PL have the potential to provide: higher yields, a shorter growing season, Bt biotech insect control advantages, RR biotech weed control advantages, and higher profitability. These varieties thus provide a combination of agronomic and entomological traits that have proven so fruitful in the past. 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 trials during the 1998 season were DP 32B, Nucotn 35B, Nucotn 33B, DP 5415 and DP 5415RR. DP 5415 and the local Acala Sivon acted as controls for the transgenic cotton trials. Five trial locations were selected over a variety of production conditions and pest intensities. Bollgard varieties and the RR variety were tested separately.

Bollgard Trials

Four Bollgard trials were planted on April 23-26, 1998, towards the end of the optimum planting time in Israel. Trials were split-plot designed: 2 treatments - Spray or No-Spray against insects as main plots, Bollgard varieties and controls randomized as subplots within the spray treatments.

Roundup-Ready Trials

Roundup Ready trials were late planted on May 14, 1998 and fully randomized comprising the following treatments:

- DP 5415RR, no Roundup
- DP5415RR, 2 l/ha Roundup over the top @ 3-4 true leaves
- DP5415RR, 4 l/ha Roundup over the top @ 3-4 true leaves
- Nucotn 33B for comparison
- DP 5415 Control
- Acala Sivon Local Control

All beds were treated with 4L/Ha Prometryn (50% a.i.) pre-emergence. All trials comprised 6 - 9 replications. Plot size: 6 - 38 spaced rows by 15 meters in length per plot. 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. RR trials were fully treated for insect pests. 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.

Data Collection

Detailed insect counts were performed twice weekly for all major insect pests and beneficials. Final plant maps were characterized for Bollgard varieties. Weekly cumulative harvesting was performed and maturity earliness assessed. By plot mechanical harvesting and ginning supplied yield data. All treatments were quality assessed using HVI. Statistical analysis was performed using JMP (SAS Institute Inc. USA).

Results

Lint yields were generally high with most DP varieties equal to or above the local Acala Sivon (Table 1). Bulked data of the Bollgard trials reveal an advantage in lint yield for DP 32B, Nucotn 33B and DP 5415 of approximately 2% - 5%. Overall, they ranked at the top in these trials averaging 2050 Kg/Ha. Nucotn 35B consistently showed a statistically significant low yield of 1,750 Kg/Ha in the Israeli environment. Roundup over the top of DP 5415RR @ 2 or 4 l/ha on 3-4 true leaves had no effect on development or

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lint yield. Yields of the late-planted varieties did not differ from non-transgenic or local controls and averaged 2,000 Kg/Ha. Seedbeds treated with Prometryn before emergence suffered significant yield loss averaging 1,600 Kg/Ha. Infestation of fields with American bollworm (*Helicoverpa armigera*) was generally low in the trial fields, with peak pest populations of 2 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 (see separate report in these proceedings). Good field control of Spiny bollworm (*Earias insulana*) was also observed for both sprayed and non-sprayed treatments. 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. This data matches previous reports concerning exceptionally high efficacy against Pink bollworm. Analysis of plant mapping data revealed a significantly higher 1st fruiting branch occurrence for DP varieties, at node 9.5, in comparison to node 8.9 for the local control variety. Retention rate for 1st positions was 10% significantly higher for DP varieties resulting in 55% on average. Total number of nodes (21.5) and number of fruiting nodes (12.5) did not differ significantly between varieties. 2nd position retention was higher for DP 32 and Nucotn 33B and lower for Nucotn 35B, a columnar type. Despite the higher 1st fruiting branch and apparent boll load, DP varieties were early maturing. DP 32B was 90% open 20 days earlier than the local control. Lower staple length and strength characterized DP varieties in comparison to the Acala type control (Table 1). DP variety length was in the range of 1 1/16" – 1 3/32" in comparison to 1 1/8 – 1 5/32" for the Israeli Acala type. Strength ranging 24.5 – 26.5 gr./tex, was low for DP varieties in Israel. Sivon value was a significantly higher 27 g/tex. DP micronaire was equal to or higher than that of Sivon. DP 5415 marked a micronaire of 4.5 in comparison to 4.2 for Sivon and a range of 3.9 – 4.3 for the transgenic DP varieties (Table 1).

Conclusions and Summary

DP varieties demonstrate a good fit for the Israeli production environment. Agronomically, lint yield is high and has the potential to out-yield local control varieties. Development patterns are different for various varieties. Generally DP varieties developed fruiting branches at a higher node, had higher retention rates and matured earlier. This indicates a higher boll load during a shorter time span. Considering potential for high lint yield, these traits call for precise management to alleviate any possible stress during square formation and boll setting. Additional boll load due to the Bt transgenic trait call for further review of management fine tuning, i.e. irrigation, N fertilization and plant growth regulation. Entomologically, Bt transgenic varieties achieved good field control of the 3 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. Spiny bollworm infestation is sporadic and inconsistent in Israel, the number of treatments averaging 1/2 a spray per season. Bollgard efficacy is sufficient to control this pest for most cases. 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. 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. RR cotton functioned well at the recommended rate and time of Roundup application. Double rates (4L/Ha) did not affect cotton development or yield. Yield damage observed in the Prometryn-only treatment remains unexplained. Optimum weed control management with this product remains to be defined. Based on these findings, 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 varieties.

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. Earliness in maturity could save late season input costs and facilitate in avoiding autumn rains. Yet to be resolved remain fine-tuning of management and jassid control.

Issues of concern to Israel regard lint quality. Israel reputation at the marketplace is for Acala SJV type cotton that has traditionally fetched a premium price. DP varieties may or may not be penalized for quality in comparison to Acala types. The ongoing quality improvement apparent for D&PL varieties especially for lint strength could be a challenge for this difference in variety reputation. In this respect, the option for growers in California to switch to D&PL high yielding varieties will be interesting to follow. Israeli growers could benefit from D&PL varieties and should be given this option – if these results recur and are established.

Table 1. Yield and quality of DP transgenic varieties and Acala Sivon

	Sivon	DP 5415	Nucotn 33B	Nucotn 35B	DP 32B
Lint Yield Kg/Ha. *Prob>F <0.0001*	1,994	2,051	2,048	1,750*	2,053
Fibrograph *Prob>F =0.0092*	1.11*	1.07	1.07	1.07	1.05
Micronaire *Prob>F <0.0001*	4.2	4.5*	4.2	3.9	4.3
Strength *Prob>F =0.0457*	27.2*	26.1	26.3	26.5	24.5

* Significantly different from others on same line (alpha=0.05)