Field Performance of Bt Cotton

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Delta and Pine Land Company has been working with Bt cotton since 1991. We are working collaboratively with Monsanto on a gene that has been trademarked as Bollgard™ in the U.S. and as Ingard™ in Australia. The gene encodes for the protein *Bacillus thuringiensis*. Cotton with the Bollgard™ gene provides in-plant, season-long control of many lepidopterous pests. The primary target insects of this gene include: American bollworm *(Helicoverpa armigera)*, tobacco budworm *(Heliothis virescens*), cotton bollworm *(Helicoverpa zea)* and pink bollworm (*Pectinophora gossypiella*).

Delta and Pine Land Company has backcrossed the Bollgard™ gene into commercially popular Deltapine varieties. Two cultivars are close to market in the U.S. The varieties are designated as NuCOTN 33^B and NuCOTN 35^B. DP5415 was the recurrent parent used in developing NuCOTN 33^B, while DP 5690 was used to develop NuCOTN 35^B.

Deltapine conducted its first wide scale field tests with these two NuCOTN cultivars in 1994. The two cultivars were compared against their recurrent parental varieties in 32 strip trials across the U.S. cotton belt from North Carolina to Texas. The number of trials per state were as follows: North Carolina 3, South Carolina 4, Georgia 5, Alabama 4, Tennessee 1, Missouri 1, Mississippi 5, Arkansas 2, Louisiana 5, and Texas 2.

The experimental unit ranged in size from 4 to 6 rows with the rows being between 180 to 365 meters in length. For statistical analysis, locations were used as replicates. There were three subplot treatments of interest for this presentation:

- The recurrent parent without the Bollgard™ gene with conventional lepidopteran control;
- The recurrent parent without Bollgard™ with no sprayed lepidopteran control;
- NuCONT 33^B and NuCOTN 35^B with no lepidopteran control.

All plots received the same pest management applications except for lepidopteran control.

Planting dates varied according to region, but were slightly later

than normal because the planting seed was generated at a winter nursery. Planting dates averaged May 4 with a range from April 17 to May 16. Seedling vigor ratings were taken within 10 days of emergence. Plant map data were collected. Varieties without the Bollgard™ gene were scouted and treated with insecticides for worms as needed. Yields were taken from either the center two or four rows and weighed with field scales. A minimum of 5.5 kg of seed cotton was shipped from each plot to Scott MS where it was ginned on a research gin with one lint cleaner to determine gin turnout percentage. Fiber samples were sent to the USDA Dumas Cotton Classing Office for HVI testing.

NuCOTN 33^B and NuCOTN 35^B have greatly improved seedling vigor compared to their recurrent parents. This is especially true of NuCOTN 33^B which has 9% larger seed size and 15 percent more seedling vigor than DP 5415.

Plant map data were collected at 28 locations early in the 1994 season when the plants averaged 10.7 nodes. The number of vegetative nodes prior to the first fruiting branch was not significantly different for any treatment.

The NuCOTN cultivars are slightly taller than the recurrent parents they were derived from. Node number, when 95 percent of the harvestable bolls were set, as well as Nodes Above Cracked Boll (NACB), suggests there were no maturity differences between the NuCOTN cultivars and the recurrent parents.

Fiber quality data were taken at 22 locations (Table 1). The two NuCOTN varieties are very similar to their recurrent parents. The NuCOTN cultivars had reduced micronaire and decreased lint percentage compared to the recurrent parents. Values for fiber strength, fiber length, and lint grade were similar. Cultivars derived from DP 5690 had fiber strength and length that was slightly greater than cultivars derived from DP 5415.

Lint yield data for the different treatments are given by lepidopteran pressure in Table 2. Averaged over all trials commercial lepidopteran sprays increased the yield over no sprays by an average of 149 kg/ha of lint. NuCOTN with the Bollgard™ gene increased yield (fiber) an average of 109 kg/ha over the commercial spray program. The increase was similar for both cultivar comparisons (i.e., there was no significant cultivar by treatment interaction). Fields with the highest pressure averaged 313 kg/ha more lint than the commercial lepidopteran spray program when no sprays were used. Yield of NuCOTN averaged 108 kg/ha more lint than the commercial spray program. The NuCOTN cultivars had equal improvement in yield over commercial spray treatments at both moderate and high lepidopteran pressure. The NuCOTN cultivars had higher yield than the conventional cottons even in areas with low insect pressure. This was not expected. The improvement could be due to benefits derived from subthreshold lepidopteran levels, to improved agronomic performance of the NuCOTN cultivars, or a combination of the two factors.

Other researchers have conducted trials in the U.S. with NuCOTN cultivars. Davis et al. (1995) designed trials to evaluate large plot comparisons of Bt transgenic cottons (NuCOTN) under "on-farm" situations. They found that "the non-Bt cotton received an average of 5.5 more treatments for the budworm\bollworm complex compared to no applications for the Bt cotton." In these trials the Bt (NuCOTN) cultivars averaged 222 kg/ha more fiber than the conventional cottons sprayed with insecticides. Dr. Johnie Jenkins, at Mississippi State University, conducted trials where plots were artificially infested with tobacco budworm neonates. He found that the Bt cottons provide "very effective levels of control of Heliothines." The Bt cotton cultivars averaged 1,901 kg of lint per hectare while the non-Bt counterparts averaged 732 kg of lint per hectare. Similarly, Dr. Theo Watson reported that "Bt transgenic cotton has proven extremely effective against the pink bollworm, tobacco budworm, cotton leafperforator and

Table 1. Fiber quality comparisons averaged over 22 locations.

	Fiber	Fiber †			Grade		Loan††
	Strength	Length	Mike	Lint%	Leaf	Color*	Value
DP5415 Spray	29.2	28.6	4.46	38.5	2.8	93.1	1.18
DP5415 No Spray	29.1	28.6	4.47	38.1	2.7	93.8	1.17
NuCOTN 33^B	29.0	28.5	4.28	38.2	2.8	93.8	1.19
DP5690 Spray	30.7	28.5	4.42	37.1	2.8	94.1	1.18
DP5690 No Spray	30.9	28.6	4.34	37.0	2.9	94.3	1.20
NuCOTN 35^B	30.6	28.8	4.29	36.6	2.9	93.7	1.20
LSD 0.05 Treatment	NS	NS	0.09	0.3	NS	NS	NS
LSD 0.05 Cultivar	0.3	0.13	NS	0.4	NS	NS	.01
LSD 0.05 Interaction	NS	NS	NS	NS	NS	NS	NS

* Color Grade is an index that combines color and preparation into an index where middling white (31) equals 100. Higher values have better grades while lower values have poorer grades.

†† U.S. dollars per kg of cotton

† Length in millimeters

Table 2. Lint yield (kg/ha) comparisons according to lepidopteran pressure.

	Lepidopteran Pressure			
	Average	**Low**	**Moderate**	**High***
	25 Loc	**11 Loc**	**7 Loc**	**7 Loc**
DP5415 Spray	1196	1139	1316	1197
DP5415 No Spray	1046	1080	1289	821
NuCOTN 33^B	1331	1268	1497	1309
DP5690 Spray	1144	1149	1315	1007
DP5690 No Spray	1006	1053	1254	756
NuCOTN 35^B	1225	1210	1382	1139
LSD 0.05 Treatment	66	83	NS	106
LSD 0.05 Cultivar	62	NS	NS	109
LSD 0.05 Interaction	NS	NS	NS	NS

* Lepidopteran pressure estimated as the average difference in retention of first position fruit between the non-sprayed recurrent parent and cultivars containing the Bollgard™ gene (i.e., NuCOTN). Differences averaged 0.2% for low, 9.0% for moderate, 19.1% for high and 7.9% for average.

salt-marsh caterpillar in small-plot field trials in Arizona."

Delta and Pine Land Company is very excited about the prospects of delivering more value to the farmers of the world through seed. The Bollgard™ gene in the Deltapine NuCOTN varieties is the first offering of some new and exciting technologies that are coming to farmers.

References

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