EFFECT OF NITROGEN AND VEGETATIVE GROWTH ON PLANT RESISTANCE TO BOLLWORM, *HELICOVERPA ZEA*, IN SELECTED BT COTTON VARIETIES

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Abstract

The effects of plant nitrate levels and vegetative growth on plant resistance to cotton bollworm, *Helicoverpa zea* were evaluated in 3 varieties of Bt cotton. Deltapine 90B, Deltapine 33B, Paymaster 1215 (DP5415, DP90B, PM1215) and two recurrent parents DP5415 and DP90, the recurrent parents of DP33B and DP90B respectively.

In August, under low bollworm pressure, the number of damaged squares was significantly lower in the low nitrogen/ low vegetation treatment in DP90 compared to high vegetation treatments and a high nitrogen / low vegetation treatment. In September, under higher pressure, the high nitrogen/high vegetation treatment had significantly more damage in both DP90B and its' recurrent parent. Plant only 7" taller produced significantly less lint. DP33B and DP90B high vegetation plots produced 7 and 13% less lint than the low vegetation plots. Bt varieties produced twice as much cotton as their recurrent parent varieties. Bt varieties had 5 times less minor bollworm damage and 20 times less severe damage to squares. There were no differences in damage among Bt varieties.

High vegetative growth may increase bollworm damage but is most likely due to higher egg deposition rather than a direct influence on expression of resistance. Damage may be higher at very high nitrogen levels, but this effect is not exclusive to Bt varieties, and was, in fact, more evident in the recurrent parent varieties. The effect of nitrogen is unlikely to affect very susceptible insects but can affect the level of resistance against less susceptible pests such as bollworm and beet armyworm.

Introduction

Bt varieties have performed exceptionally well against some pests such as pink bollworm, *Pectinophora gossypiella* and tobacco budworm *Heliothis virescens*. Control of some other insect pests has been more problematic. In many cases, multiple applications of insecticides have been necessary to control cotton bollworm, *Helicoverpa zea*, in BT cotton. (Hardee & Herzog 1997). Bollworm is approximately 10X less susceptible than tobacco budworm or pink bollworm (MacIntosh et al 1990) and some damage was expected with high populations (Mahaffey et al. 1994). However, routine applications were not expected.

Field observations suggested that lower levels of bollworm resistance might be linked to highly stressed plants, high rates of nitrogen or highly vegetative plants. Our objective was to determine if nitrate levels, and/ or high vegetative growth affect resistance levels in Bt cotton.

Results

Plants in the high vegetative treatments were significantly taller than plants in the low vegetation treatments (F=12.5 df 8,23 $P<0.0001$) (Table 1). DP90 plants in the low vegetation treatment, for example, were on average, 6 inches shorter than those in the high vegetation treatment (Table 1). All varieties were significantly different in plant height (df 4,95 F=394, P<0.0001). DP90 produced at 74 inches the tallest plants. PM1215 produced, at 37 inches, the smallest plants. Both of the recurrent parents were significantly shorter than their Bt varieties

Initial evaluations of bollworm damage were hampered by low populations. These counts were inconclusive due to very low, approximately 1% infestation levels. The sample size was increased to 200 squares per plot (24,000 total) in the August 11. In that sample with an average 2-3% infestation level, there were significant differences in damage in Bt vs. non-Bt varieties. (Table 2). Recurrent parents varieties had 20 times more squares with severe damage compared to the Bt varieties, and 5 times more squares with minimal damage. There was no difference in bollworm damage among the 3 varieties. The level of damage of any type was not significantly affected by the level of vegetation in DP33B, its' recurrent parent 5415, or in DP90B at this low infestation level (Table 3). However, the number of squares with severe damage, was significantly lower in the DP90 low nitrogen/ low vegetation treatment.

In September, the high nitrogen/ high vegetation treatment had significantly more damage than the low nitrogen/ low vegetation treatment in both DP90B and DP90 plots (df 1,22 F=10.6, $P<0.004$). Damage was related to both nitrogen and vegetation treatments in the recurrent parent, DP90 (df 2,11, F=5.7, $P<0.025$) (Figure 1).

The Bt varieties produced twice as much cotton as the recurrent parent varieties in 1998 (Table 4). DP33B produced the highest yield with 3.5 bales/acre followed by PM1215, with 3.2 bales /acre and DP90B with 2.6 bales /acre. The recurrent parent varieties DP5415 and DP90 produced 1.7 and 1.1 bales/acre. Yields of all varieties were significantly different from each other except DP33B and PM1215 with 3.5 and 3.2 bales /acre respectively. (df 5,114 F=132 $P<0.0001$). Yield was related to vegetation for the entire test (F=6.3. $P<0.01$). Tested individually, yields of DP33B and DP90B in low vegetation plots were

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significantly lower, 7 and 13% lower respectively, than yields in the high vegetation plots. Yields of PM1215 a short variety, were only 2% higher in the low vegetation treatment and was not significant. Yields of the recurrent parent varieties were 10% higher in the low vegetation plots but were more variable and not significant when tested individually.

Conclusions

Relatively small increases in vegetative growth may result in higher bollworm damage and lower yields. Taller DP90, DP90B, DP33B and DP5415 plants produced 8.8% lower yields than plants only 7" shorter. Most of this difference was likely due to physiological differences since there was not very high bollworm pressure until September when it would not affect yield. However, the taller DP90 and DP90B plants did have higher rates of bollworm damage when higher populations of bollworm were present, indicating that yield reductions in taller plants could result from both physiological effects and higher insect damage. This difference is likely due to bollworm moths laying more eggs in the taller plants rather than a difference in expression of resistance.

Very high rates of nitrogen may be associated with higher rates of bollworm damage, but this effect is not consistent and is not exclusive to Bt varieties. Lab tests in 1997 had indicated that high levels of nitrogen could decrease the level of resistance in BT cotton to beet armyworm. However the reduction in resistance was not consistent (Pierce et al. 1998). Nitrogen effects on resistance to bollworm are similar to beet armyworm. In this test very high rates of nitrogen was associated with higher rates of bollworm damage in one sample but this effect is slight and was under such high levels of nitrogen (160 lb/acre) that it is unlikely to be responsible for problems with field performance.

Bt varieties performed well in 1998 in SE New Mexico. Yields were more than twice as high as the unprotected recurrent parent varieties. Recurrent parent varieties had 20X more squares with severe damage compared to the Bt varieties, 5X more squares with minimal damage. It is important to differentiate the types of damage to properly evaluate the level of resistance or performance of Bt varieties.

Literature Cited

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Table 1. Height of DP90 plants from high and low nitrogen and vegetative growth treatments. [1.]

N	Vegetation	Plant height
low	high	77.3a
high	high	76.2a
high	low	71.7b
low	low	69.2b

[1]Means comparison with Tukey's multiple comparison $P<t<0.0004$

Table 2. Bollworm damage in small field plots with 3 varieties of Bt Cotton and their recurrent parents, August 11, 1998 in Artesia, NM. [1]

Variety	#Squares with Minimal Damage		#Squares with Significant Damage	
	BT+	BT-	BT+	BT-
DP33	23	107	6	57
DP90	24	106	0	68
PM1215	20	-	3	-
$\bar{x}$	22	106	3	63

[1] N= 4,800 per variety x Bt treatment.

Table 3. Bollworm damage in Bt cotton varieties and their recurrent parents sampled in small field plots August 11, 1998, Artesia, NM.[1]

		Bollworm Damaged Squares/Plot							
		Minimal Damage				Severe Damage			
		BT+		BT-		BT+		BT-	
		Vegetation							
Variety	N	High	Low	High	Low	High	Low	High	Low
DP33	High	6	7	27	21	2	2	12	10
	Low	6	4	36	23	2	0	22	13
DP90	High	5	5	21	23	2	0	19	20
	Low	2	8	35	27	0	1	20	9
PM	High	5	5			0	0		
1215	Low	8	6			0	0		

[1.] N=1,200 Squares / Variety x treatment

Table 4. Yield of Bt varieties and recurrent parents from high and low vegetation treatments.[1]

	Lint lb/A (bale/A) Vegetation		Difference
	high	low	lb/A (%)
Bt varieties			
DP33	1622 (3.4)	1732 (3.6)*	110 (7)
DP90B	1169 (2.4)	1322 (2.8)*	153 (13)
PM1215	1516 (3.1)	1540 (3.2)	24 (2)
Recurrent Parent Varieties			
DP5415	780 (1.6)	863 (1.8)	83 (11)
DP90	509 (1.1)	560 (1.2)	51 (10)

[1]Vegetation treatments within a variety are significantly different (t<0.05).

N=120 plots with 12 replications per vegetation (variety) treatment

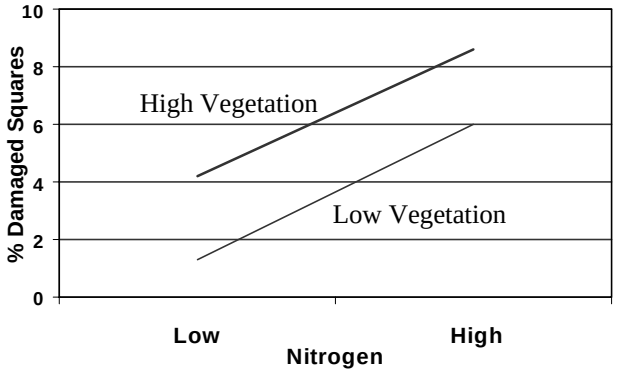

Figure 1. Bollworm damage in Bt cotton and recurrent parent plots related to nitrogen and vegetation treatments.