POTENTIAL OF NECTARILESS COTTON IN TODAY'S COTTON PRODUCTION SYSTEM

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Abstract

In the low spray environment created by the use of Bt transgenic cotton plants and the eradication of the boll weevil, tarnished plant bug may become a more prominent pest in the cotton production system. Nectariless cotton was evaluated in a small plot study in order to determine its potential as a host plant resistance factor against tarnished plant bug. The near-isogenic varieties DPL5415 (conventional, nectaried), NuCotn33 (Bt, nectaried), and DPL5415NE (conventional, nectariless) were compared when treated with insecticide as needed and untreated. Drop cloth, sweep net, and terminal samples were employed to measure insect populations. Retention and yield were also taken. 1997 provided little useful data concerning tarnished plant bugs due to low populations. 1998 populations of tarnished plant bug were very high. Tarnished plant bugs were significantly lower in the nectariless variety than in the Bt variety. Treated plots of nectariless cotton received one fewer applications of insecticide targeting tarnished plant bug than did conventional or Bt plots. Yield in treated plots was not statistically distinguishable. Yield in plots of nectariless cotton was significantly higher than in conventional but not Bt ($P<0.05$). Beneficial arthropods were less affected by variety than by application of insecticides.

Introduction

With the introduction of transgenic Bt technology into the cotton production system and the widespread adoption of boll weevil eradication, producers, consultants, and researchers have been faced with a new and changing cotton insect system. In the past, the tarnished plant bug (*Lygus lineolaris*) was often kept below treatment thresholds when fields were treated for caterpillars or weevils. Transgenic Bt technology has greatly reduced the number of applications made targeting caterpillars (Layton, in press), and areas in the maintenance phase of boll weevil eradication make virtually no treatments for weevils. Because of this, the tarnished plant bug will become a more prominent pest in post-weevil eradication areas, with a greater number of insecticide applications directly targeting plant bugs. It stands to reason that if a reduction in sprays for caterpillars and weevils is countered by an increase in sprays for other pests, we have lost some measure of benefit from transgenics and weevil eradication programs both in savings from reduced insecticide costs and in the destruction of beneficial insects which augment pest control efforts. Snodgrass reported in 1996 that insecticide resistant tarnished plant bugs were already present in field populations in Mississippi Delta cotton. Non-insecticidal controls are a fundamental tool in resistance management. Thus, control measures for plant bugs that are non-chemical in nature, soft on beneficials, and easy and cost effective to implement, such as a host plant resistance factor, may be more beneficial in Mississippi's evolving cotton system than in the past.

Cotton has floral nectaries, which are located within the flowers and produce nectar, just as other flowering plants do. However, most cotton varieties also have extrafloral nectaries located on the underside midrib of each leaf and also at the base of the calyx on squares or floral buds. Nectariless cotton is cotton that does not have extrafloral nectaries, but that does have floral nectaries like other flowering plants. Agronomic research has shown that the yield and fiber qualities of nectariless cotton are essentially the same as near-isogenic nectaried lines. Therefore, the use of nectariless cotton in a production system would not result in yield reduction as a result of poor agronomic qualities (Meredith, 1973). Previous research has also shown that the nectariless character of cotton causes what appears to be an ovipositional non-preference response in tarnished plant bug females in caged studies (Bailey, et. al., 1988). The same study revealed that nymphs resulting from eggs laid in nectariless cotton exhibited reduced survivability. Scott, et. al., in 1988 reported that in a large plot study tarnished plant bug adults and nymphs were significantly reduced. However, this study also revealed an apparent reduction in numbers of some predatory insects.

So, if the reported reduction in numbers and survivability of tarnished plant bugs in cotton outweigh the apparent reduction in beneficials, perhaps the nectariless character of cotton could be combined with transgenic Bt technology in order to produce a plant resistant to plant bug attack and still effective against caterpillars. The purpose of this study was to compare nectariless cotton to Bt and non-Bt nectaried varieties to evaluate its potential to lessen tarnished plant bug populations as well as to determine if meaningful reductions in populations of beneficial insects occurred.

Materials and Methods

1997 Design

The first year of research was conducted in Raymond, Mississippi at the Brown Loam Experiment Station. The varieties tested were near-isogenic lines of DPL5415 (conventional), NuCotn 33 (transgenic Bt, nectaried), and DPL5415NE (nectariless). These treatments were arranged in a modified randomized complete block. Main plots were 24 rows x 85 ft. and cotton was planted in 38-in. rows on May 16. Three treatments were solid plantings of each variety which were treated with insecticide for all pests as

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needed according to pest control recommendations in Mississippi's Cotton Insect Control Guide (Layton, 1997). In 1997, treatments were made to individual plots only when that plot exceeded treatment thresholds. A fourth treatment was all three varieties planted as 8-row strips within a single plot and was not sprayed with insecticide. However, beginning August 4^{th}, all plots were sprayed with 10 ounces of ULV Malathion on a regular basis as part of a newly implemented boll weevil eradication program. Only three replications were used in 1997 as a result of seed and space constraints.

1998 Design

The design in 1998 was similar to that of 1997. ULV malathion applications that were part of boll weevil eradication would have interfered with our experiment at the Raymond location in 1998. So, the study was moved to the Delta Research and Experiment Station (Stoneville, MS) in 1998. Also in 1998, main plots of the same variety were treated with insecticide simultaneously, rather than individually, based on average pest densities of all main plots of that variety. As in 1997, strip plots were not treated with insecticide except during August after insect sampling had ended. We also attempted to increase the numbers of tarnished plant bug in the plots during 1998 by planting corn, pigweed, and mustard between the replicates in the test. The corn served as a spray barrier and the mustard and pigweed as a nursery host for tarnished plant bugs (Furr, Harris, and Robbins, in press). Plot size was reduced in 1998 so that four replications could be accommodated in the space allotted. Main plots were 12 rows x 50 ft. Plots were planted during the first week of April on 38-in. rows. Beginning in early August, all plots were sprayed with several applications of methyl parathion (0.33 lbs. AI/A) or Vydate (0.25 lbs. AI/A) for boll weevil control. This was done to help preserve differences between varieties that were the result of plant bug damage.

Sampling and Analyses

Twice weekly each plot was scouted using drop cloths, sweep nets, and terminal counts for all relevant pests as well as selected beneficial arthropods. Insects sampled included tarnished plant bugs, heliothines, armyworms, boll weevils, insidious flower bugs, predatory stinkbugs, damsel bugs, big-eyed bugs, green lacewings, ladybeetles, ants, and spiders. Samples were taken in a manner such that 100 sweep net samples, 100 terminal counts, and 12 drop cloth samples were taken in each variety. Thus, in 1997 (three replications), 33 sweep net samples, 33 terminal counts, and four drop cloth samples were taken per replication in each variety. In 1998 (four replications), 25 sweep net samples, 25 terminal counts, and three drop cloth samples were taken per replication for each variety. Each variety within the untreated strip plots was sampled as though it were a separate whole plot. These strip plots were scouted but not treated. In 1998 the small size of the untreated strip plots made sampling with both a sweep net and drop cloth in a short period of time ineffective. Therefore, sweep net data and drop cloth data were taken only once weekly for untreated plots. In addition to these data, square retention data were collected once each week. Square retention was defined for this study as the percentage of first position squares remaining on the plant. Ten retention samples were taken in each plot in both 1997 and 1998. Yield data were taken at the end of each growing season by picking the center two rows in each plot, including each variety in the strip plots. Statistical analysis of data was done using split-plot ANOVA procedures and Fischer's LSD (α=0.05) for mean separation (SAS Institute, 1988). Main plots were varieties, and subplots were treatment, or the lack thereof, with insecticide.

Results and Discussion

Summary of Insecticide Applications

Exclusive of applications for boll weevil control, nearly all sprays in 1997 targeted tobacco budworm or cotton bollworm. Plots of Bt cotton were not sprayed for heliothines, whereas non-Bt cotton was sprayed five times.

In contrast, most sprays in 1998 targeted tarnished plant bugs. Bt cotton was not sprayed for heliothines, and heliothines exceeded treatment thresholds in non-Bt plots an average of only two times during the 1998 season. A total of 6 – 7 plant bug applications were made to all varieties for plant bugs, with one fewer application needed in plots of nectariless cotton. Choice of insecticide varied across application dates based on the occurrence of other pests in the plots. As would a grower, we attempted to choose the most practical and economic material considering the overall pest complex. So, materials used for plant bug control often had activity on boll weevils or other pests. For example, we used Vydate for plant bug control when weevils were near threshold levels. Bidrin was used when aphid populations were high. In this way we could better evaluate the potential impact of the nectariless trait on insect management and cotton production.

Summary of 1997

Conditions in 1997, including very low numbers of plant bugs, poor weather conditions, and the initiation of boll weevil eradication after August 1, made for a less than satisfactory test. The primary pests during this season were the tobacco budworm and the cotton bollworm. Because of this, untreated plots of conventional and nectariless cottons did very poorly in comparison to untreated Bt cotton. However, yield differences among varieties from treated plots were not statistically different (Fig. 1). As would be expected when high heliothine populations are present, there was a significant interaction between variety and insecticide treatment with respect to yield. A drastic reduction in yield occurred in untreated non-Bt varieties that did not occur in the Bt variety, indicating the importance of heliothines in reducing yields in the non-Bt cotton. No meaningful impact of nectariless cotton on tarnished plant bug populations or heliothines populations were observed. Populations of beneficials were affected to a much greater degree by insecticidal treatments than by variety, however, discussion in this publications has been limited to effects on pest species.

1998

The addition of nursery material in the plot layout in 1998 appeared to be highly effective, and tarnished plant bug numbers were very high in our test area. Numbers of tarnished plant bugs sampled are shown in Figs. 2 and 3 for drop cloth and sweep net samples, respectively. Mean separations for numbers of plant bugs by variety in drop cloth and sweep net samples are given in Table 1, along with mean separations for percent square retention, weevil damaged squares, and worms in terminals. Retention throughout the season can be seen in Fig. 4. Means for treated and untreated plots were combined due to the lack of an interaction between treatment and variety. However, it should be noted that treatment alone did have a significant effect on tarnished plant bugs, weevils, worms, and several beneficial arthropod species. It is also notable that the largest significant differences for both tarnished plant bug numbers and percent square retention between varieties were observed in the period prior to bloom (Julian dates 161 - 175), since floral nectaries become available on nectariless cotton in the post bloom period.

Yield for treated and untreated plots of each variety are shown separately and combined in Fig. 5 as there was no strip x variety interaction as was seen in 1997. This lack of interaction between variety and insecticide treatment indicates that heliothine populations and damage were low in 1998. Thus, the apparent yield reduction seen in untreated plots was primarily the result of either tarnished plant bug or boll weevil infestations because these were the only other pests of consequence in our plots. Numerically, the least reduction of yield in treated verses untreated plots was seen in the nectariless variety, and untreated nectariless cotton had higher yields than the other untreated nectaried varieties. There were large differences in boll weevil numbers between varieties that were treated or not treated with insecticide, but varieties within the same insecticide regime had similar levels of weevil damage. This would indicate that plant bugs were primarily responsible for differences in yield between the plots. It is notable that yield from NL plots was higher than conventional plots when data from treated and untreated plots was combined.

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Table 1. Season averages for tarnished plant bugs, boll weevils, and heliothines as well as square retention for insecticide treated and untreated plots combined.

	Conventional	Bt	Nectariless
Drop Cloth (TPB)	1.6 ab	1.8 a	1.4 b
Sweep Net (TPB)	2.6 a	2.8 a	2.4 a
Weev Dam Squares	1.9 a	2.7 a	2.7 a
Worms in Terminals	.82 a	.44 b	.80 a
% Sq. Retention	75.0 a	76.2 ab	80.4 b

Means not followed by the same letter are significantly different (LSD, $P<0.05$)

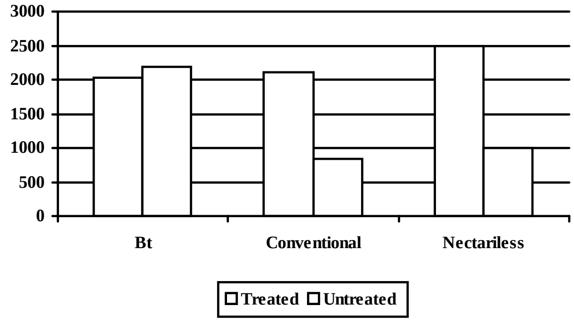

Figure 1. Yield for 1997 test in Raymond, MS (pounds of seed cotton per acre).

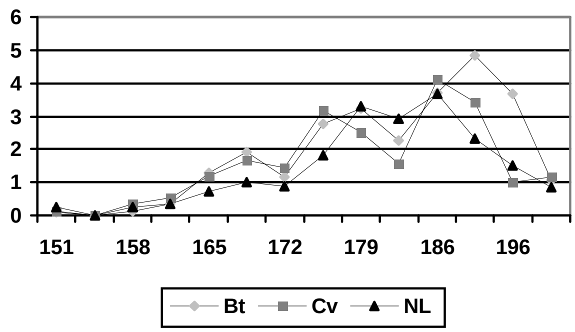

Figure 2. Tarnished plant bugs per drop cloth sample for 1998 test in Stoneville, MS, for insecticide treated and untreated plots combined (by Julian date). Bt = NuCotn33 Cv = DPL5415 NL = DPL5415NE

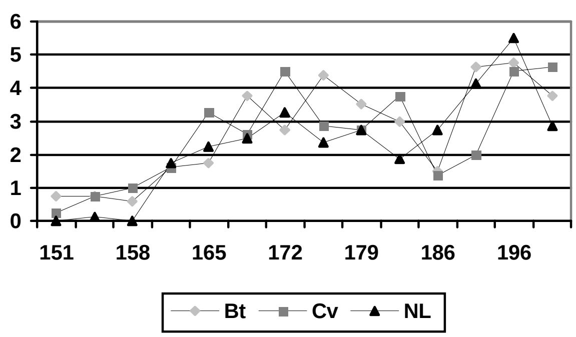

Figure 3. Tarnished plant bugs per 25 sweep sample for 1998 test in Stoneville, MS, for insecticide treated and untreated plots combined (by Julian date). Bt = NuCotn33 Cv = DPL5415 NL = DPL5415NE

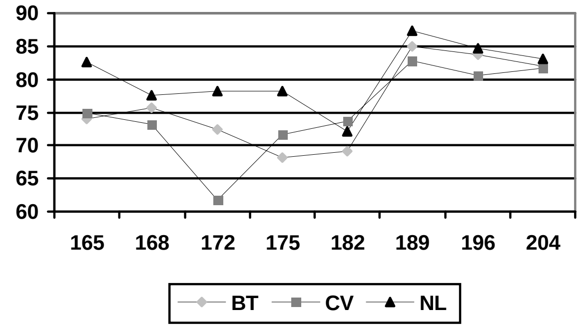

Figure 4. Percent square retention for 1998 test in Stoneville, MS, for insecticide treated and untreated plots combined (by Julian date). Bt = NuCotn33 Cv = DPL5415 NL = DPL5415NE

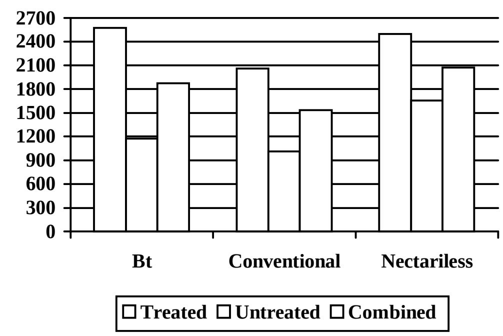

Figure 5. Yield for 1998 test in Stoneville, MS (pounds of seed cotton per acre).