DIFFERENTIAL PLANT MAPPING OF BT EFFICACY TRIALS

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Abstract

Plant mapping has been used quite extensively in recent years with various objectives. The objective of this study was to demonstrate the effect of insect infestation on site-specific boll retention and the subsequent plant response to boll loss. In 1999, two different colonies of tobacco budworm larvae, USDA at Starkville, MS (MS-TBW) and NCSU (NC-TBW), were used in separate trials to infest an experimental Bt cotton (MXB5) and a non-Bt check (Jajo9550). At the end of the season, 10 consecutive plants per rep were mapped for the presence or absence of bolls. The mapped data from the paired insect infested plots were compared differentially to that from the insect controlled plots. Both the MS-TBW and the NC-TBW larvae reduced the boll set of the Jajo9550 check, most notably at the 1st position bolls. MS-TBW infestation reduced 1st position boll set of Jajo9550 about twice that observed for NC-TBW and it reduced the boll set of 2nd position bolls from node 6 to 13. Jajo9550 partially compensated for the MS-TBW induced boll loss with higher boll set at 2nd position bolls above node 13 and at 3rd positions. Jajo9550 fully compensated for the lower NC-TBW induced loss at 2nd and 3rd position bolls. Both colonies slightly reduced the boll set on MXB5 at position 1 from nodes 10 to 15, but this loss was over-compensated for at other sites to yield more under insect infestation.

Introduction

Several cotton researchers have used plant mapping over the past several years with various objectives. Most notably, Jenkins, et al (1990) used plant mapping to demonstrate that the first position bolls of the middle nodes contributed 65-70% of the yield of the 8 varieties studied. Although Zelinski and Bates (1999) confirmed the importance to yield of the first position bolls in the middle of the plant, they also pointed out the limitations of using plant mapping data as predictors of actual lint yield. Jenkins and McCarty (1995) detailed the procedure used by the USDA at Starkville, MS to obtain "yield mapping" data. They used this technique to demonstrate that the earlier maturing varieties produced more of their yield at the lower nodes than did the later maturing varieties.

Several researchers have attempted to use plant mapping as a tool to demonstrate the effect of insects on boll set. Roof, et al (1991) obtained inconclusive results from the use of mapping to measure the effect of different levels of insecticide protection on yield. Parker, et al (1999) collected an extensive data set with in season insect scouting and end of season plant mapping to determine the effect of different budworm densities on boll set. They grouped the mapping data for the different sites into "cohorts" by their expected similarity in blooming date and evaluated cumulative mapped yield. Though the results were confounded by a natural infestation, the authors noted that plant mapping could be a useful tool to evaluate different levels of insect pressure. The objective of the present study was to determine the effect of insect infestation on site-specific boll set of Bt and non-Bt entries and the subsequent plant response to compensate for boll loss.

Materials and Methods

In 1999, a Mycogen experimental Bt line, MXB5, was planted along with a non-Bt check, Jajo9550, in Bt efficacy trials at Leland, MS and at Wayside, MS. The trials were set up in strip-plot designs with insect controlled and insect infested strips (for insecticide spray convenience) and with Bt entry sub-plots. All insect pests were controlled in the controlled plots; whereas, only non-lepidopteran pests were controlled in the infested plots. The infested plots at Leland were artificially infested weekly from mid-June through July with 1st instar tobacco budworm (*Heliothis virescens* F.) larvae from the NCSU insectary (NC-TBW) using the technique detailed in Jenkins et al. (1982). The infested plots at Wayside were likewise artificially infested with 1st instar tobacco budworm larvae from the USDA in Starkville, MS (MS-TBW).

At the end of the season, a section of row with uniform stand was mapped for each treatment combination. For each plot, 10 consecutive plants were non-destructively mapped for the presence or absence of bolls at the first 3 positions of all sympodial nodes. It took one person 8-10 min/plot to record the data into a voice-activated tape recorder. The data were later entered into an Excel worksheet. The average number of bolls at each site on 10 plants from the infested plot was subtracted from the corresponding set of averages from the insect controlled plot of that entry.

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Results and Discussion

Yield

The lint yields of the efficacy trials at Wayside and Leland are presented in Table 1. The only yield reduction observed from insect infestation occurred on Jajo9550 with MS-TBW. Jajo9550 yielded on average 12% less in the MS-TBW infested plots than in the insect controlled plots. Even though Jajo9550 was susceptible to TBW, this entry yielded 5% more in the NC-TBW infested plots. Interestingly, the Bt entry, MXB5, yielded 21% more in the MS-TBW and 18% more in the NC-TBW infested plots than in the paired insect controlled plots. The apparent yield increase, or over-compensation, in MXB5 in response to insect infestation may have been due to a slight shift in energy utilization early in the season from reproductive growth to more vegetative growth that subsequently produced even more reproductive growth.

MS-TBW Efficacy Trial

The differential plant mapping data from Wayside are presented in Table 2 where the difference was taken between the average boll set on 10 plants in the insect controlled and that in the MS-TBW infested plots. The boll set on Jajo9550 was reduced at position 1 of all nodes by a total of 51.6 bolls (on 10 plants) and at position 2 of nodes 5 to 13 by 10.6 bolls. This loss was partially compensated for by the plant with 4.4 more bolls at position 2 of nodes 14 to 21 and with 16.4 more bolls at position 3. This loss/compensation effect can be more easily visualized with the differential plant map graph in Fig. 1. The bars above the baseline are bolls lost to insect feeding and those below the baseline are additional bolls that were set by the plant in response to this injury.

The MXB5 graph illustrates a different pattern of boll loss/compensation in Figure 2. MS-TBW infestation slightly reduced 1st position boll set on MXB5 at nodes 10 to 15 by a total of 8.0 bolls on 10 plants (Table 2). This loss was over-compensated for with 9.6 more 1st position bolls at the other nodes, 5.2 more 2nd position bolls, and 6.0 more 3rd position bolls among the 10 mapped plants. This over-compensation effect was reflected in the yield data of Table 1.

NC-TBW Efficacy Trial

A similar trend of loss/compensation was observed for both entries with the NC-TBW infestation, but the magnitude of boll loss was much lower. A total of 19.8 1st position bolls on 10 plants of Jajo9550 were lost, but this loss was fully compensated for with 7.2 more 2nd position, and 6.0 more 3rd position bolls on the 10 mapped plants (Table 2 and Fig. 3). The yield data in Table 1 did not reflect a detrimental effect of infestation on yield; whereas, plant mapping demonstrated a significant reduction in boll set of 1st position bolls.

The effect of NC-TBW infestation on MXB5 (Fig. 4) was similar to that with MS-TBW, but again the magnitude was lower. There were 4.8 fewer 1st position bolls on nodes 11 to 15 of the infested plot, but this loss was compensated for with 4.6 more 1st position bolls at the other nodes and 3.2 more 2nd position bolls. The difference in boll loss between these two lab-reared TBW colonies could have been due to differences in feeding aggressiveness or in their ability to endure field conditions.

Summary

Artificial infestation of the non-Bt check, Jajo9550, with MS-TBW and NC-TBW resulted in a significant reduction in boll set, particularly at the 1st position bolls of all nodes. MS-TBW infestation induced about twice the total boll loss at 1st position bolls as NC-TBW and it reduced boll set at the 2nd position bolls of the lower nodes. This boll loss due to insect injury was partially compensated for by the plant with increased boll set at the other nodes. Despite clear differences in 1st position boll set, a yield loss was observed only with MS-TBW infestation on Jajo9550. The two colonies slightly reduced 1st position boll set on MXB5 at the middle nodes, but this loss was more than made up for with a higher set at other boll sites. MXB5 actually over-compensated for these few lost bolls to yield more under TBW infestation than when all insects were controlled.

Differential plant mapping proved to be a useful tool to demonstrate the effect of TBW infestation on boll set of both Bt and non-Bt entries of efficacy trials with paired insect controlled and infested plots. The effect of insect infestation on site-specific boll loss and the plant's response to injury was effectively demonstrated. Non-destructive plant mapping for the presence or absence of bolls was very time and labor efficient with one person recording the data on a small tape recorder within 10 min per plot. The mapping data can be collected at any time after the insects cease to have an effect on boll set and before machine harvest.

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Table 1. Lint yield of Jajo9550 and MXB in 1999 under insect controlled and infested conditions.

	MS-TBW		NC-TBW	
Insect	**Jajo9550**	**MXB5**	**Jajo9550**	**MXB5**
Controlled	1267	1146	1471	1390
Infested	1110	1323	1527	1619
% of Potential	88	121	105	118

Table 2. Average difference in boll set on 10 plants/ rep between insect controlled and MS-TBW infested plots of Jajo9550 and the experimental Bt line MXB5.

	Jajo9550			MXB5		
Node	**Pos 1**	**Pos 2**	**Pos 3**	**Pos 1**	**Pos 2**	**Pos 3**
5	0	0	0	**-0.6**	0	**-0.2**
6	0.6	0.6	**-0.2**	**-0.6**	0.2	**-0.2**
7	2.4	0.8	**-0.6**	0	0	**-0.4**
8	5.2	1.6	**-1.0**	**-1.8**	0	**-1.6**
9	3.6	2.6	**-2.4**	**-0.2**	**-1.0**	**-0.4**
10	5.0	2.0	**-1.6**	1.4	0.6	**-1.0**
11	5.2	1.0	**-2.0**	1.2	**-0.4**	**-0.6**
12	5.4	1.4	**-2.8**	1.6	**-0.4**	**-0.8**
13	6.8	0.6	**-2.2**	1.6	**-0.6**	**-0.2**
14	4.4	**-0.2**	**-1.0**	0.6	0	0
15	4.0	**-1.0**	**-1.8**	1.6	**-0.8**	**-0.4**
16	3.4	**-0.2**	**-0.8**	**-1.0**	**-1.2**	**-0.2**
17	2.6	**-1.4**	0	**-1.4**	**-1.2**	0
18	1.8	**-1.2**	0	**-2.8**	**-0.2**	0
19	0.8	**-0.2**	0	**-0.6**	**-0.2**	0
20	0.2	0	0	**-0.6**	0	0
21	0.2	**-0.2**	0	0	0	0
Sum	51.6	6.2	**-16.4**	**-1.6**	**-5.2**	**-6.0**

Bold indicates infested plot had higher boll set.

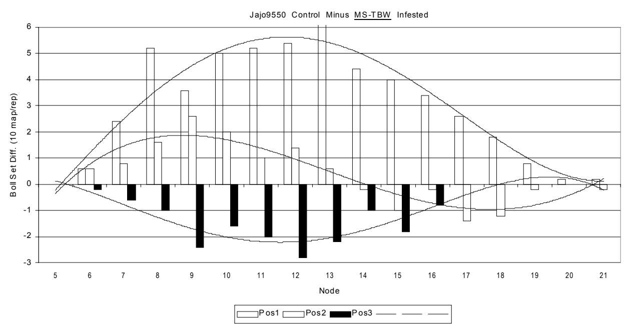

Figure 1. Difference in site-specific boll set on Jajo9550 between insect controlled and MS-TBW infested plots. Average number of bolls on 10 plants/rep of infested subtracted from that on insect controlled.

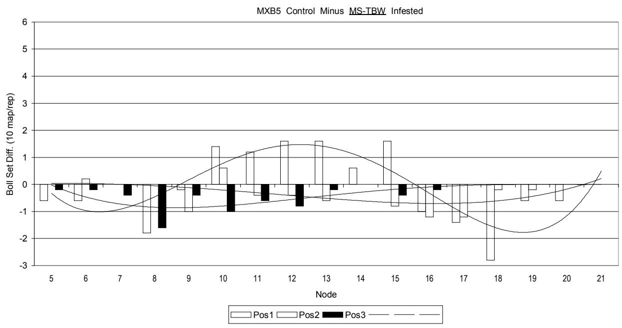

Figure 2. Difference in site specific boll set on MXB5 between insect controlled and MS-TBW infested plots. Average number of bolls on 10 plants/rep of infested subtracted from that on insect controlled.

Table 3. Average difference in boll set on 10 plants/ rep between insect controlled and NC-TBW infested plots of Jajo9550 and the experimental Bt line MXB5.

	Jajo9550			MXB5		
Node	**Pos 1**	**Pos 2**	**Pos 3**	**Pos 1**	**Pos 2**	**Pos 3**
5	**-0.2**	**-0.2**	0	**-0.2**	0.2	0
6	0.3	**-0.5**	**-0.5**	0.2	**-0.2**	0
7	**-0.7**	**-0.7**	0	**-0.2**	0.8	0.2
8	1.7	**-0.7**	**-0.3**	**-1.2**	0.2	0.3
9	0.2	0.3	**-0.5**	**-0.8**	**-0.3**	**-0.5**
10	2.5	**-1.0**	**-1.5**	**-0.5**	**-0.8**	**-0.5**
11	2.3	**-1.5**	0.7	0.5	**-0.5**	**-0.2**
12	3.5	**-0.3**	**-1.3**	2.2	**-0.3**	0
13	1.2	**-1.3**	**-0.8**	1.5	**-0.5**	0.2
14	2.2	**-0.8**	**-0.5**	0.3	**-0.8**	0
15	2.2	**-0.5**	**-0.2**	0.3	**-0.3**	**-0.2**
16	1.7	0.3	**-0.5**	0	**-0.7**	0
17	1.8	0	**-0.2**	0	0	0
18	1.2	0	**-0.2**	**-1.5**	0.2	0.2
19	0.2	**-0.2**	0	**-0.2**	0	0
20	0.2	0	**-0.2**	0	0	0
21	**-0.3**	**-0.3**	0	**-0.3**	0	0
Sum	19.8	**-7.2**	**-6.0**	0.2	**-3.2**	**-0.5**

Bold indicates infested plot had higher boll set.

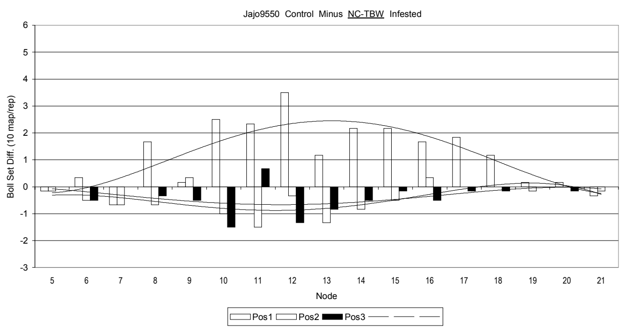

Figure 3. Difference in site specific boll set on Jajo9550 between insect controlled and NC-TBW infested plots. Average number of bolls on 10 plants/rep of infested subtracted from that on insect controlled.

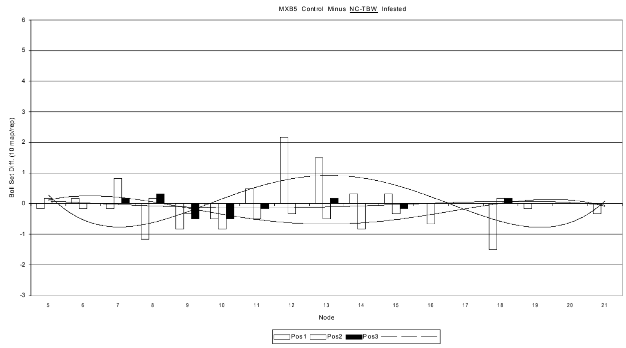

Figure 4. Difference in site specific boll set on MXB5 between insect controlled and NC-TBW infested plots. Average number of bolls on 10 plants/rep of infested subtracted from that on insect controlled.