Research Paper :

Incidence of Boll Rot, Boll and Locule Damage in Different Bt Cotton Crops

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SUMMARY

Studies on boll rot due to pathogens, boll worm damage and primary boll rot in Bt cotton were initiated on 23 – Bt and 3 – non Bt cotton hybrids and 7 – Bt and 4 – non Bt hybrids. Observations on the incidence of boll rot on 23 – Bt and 3 – non Bt cotton hybrids and 7 – Bt and 4 – non Bt hybrids revealed that there was more boll rot on non Bt hybrids than that in Bt hybrids. Non-Bt hybrids showed higher secondary boll rot than Bt hybrids. The Bt hybrids suffered less boll and locule damage than non-Bt hybrids. The bollworms were capable of causing damage to non-Bt hybrids, because Bt gene imparted resistance to Bt cottons. The non-Bt hybrids suffered more bollworm damage than Bt hybrids.

Key words : · Boll rot, Locule damage, Primary invader, Cotton crop

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Cotton left by Indus valley civilizations among the three great civilizations of began era, silk by Chinese, flax by Nile valley and cotton by Indus valley civilization. Cotton fulfils one of the three sartorial needs of mankind. The crop in India occupied the largest area of 8.77 m ha among the countries of the world in 2006 – 2007 standing fourth (22.15 m bales) in its production. Indian economy continued to receive great support through this commercial crop known as "King of fibres" (or) " The White gold ", the world over. Cotton was susceptible to bollworms, which reduced the yield and fibre quality to a great extent. Introduction of transgenic cotton by incorporating Bt gene from *Bacillus thuringiensis* was done by USA in 1996 to control the bollworms. Bt cotton in turn is also expected to reduce boll rot and improve yield and fibre quality. The total area under Bt cotton cultivated has been estimated to be 9.8 m ha in 2006 accounting to 28% of the global area under cotton. In India the area under Bt cotton is 13 m ha with the corresponding figure for M.P. as 0.145 m ha in 2006 [ISAAA, 2006]. The present investigation was undertaken on boll rot in Bt cottons the primary boll rot incited by pathogens and possibly negligible boll worm damage due to incorporation of Bt gene resulting in reduced boll and locule damage.

MATERIALS AND METHODS

The experiments were carried out in the research fields of All India Coordinated Cotton Project and the P.G. laboratory, Plant Pathology Section, College Of Agriculture, Indore (M.P.).

Seed:

The seed of 26 hybrids (*i.e.*23 – Bt hybrids, coded as 6101 – 6122 and 6126 and 3 non Bt coded as 6123 – 6125) for testing from AIC improvement project for central zone.

Cleaning solution:

The cleaning solution contained chromic acid ($K_2Cr_2O_7$ 60 g + H_2SO_4 (conc.) 60 ml +water 940 ml) followed by thorough rinsing with water. The glass wares were dried in hot air oven at 60^0C for half an hour.

Chemicals and solutions:

$HgCl_2$, alcohol, Potato Dextrose Agar (PDA) medium, Czapeck's dox agar, Nutrient glucose agar, Mounting Medium, Gram's stain, Counter stain.

Methods:

Twenty-three Bt (6101 to 6122, 6126) and three non-Bt hybrids (6123 to 6125) were selected for studies on primary boll rot by pathogens, boll damage and boll rot due to primary invaders.

Collection of boll specimen:

Boll samples were collected from all the experimental plots from the 26 hybrids from

replications during September 2006 to February 2007.

Identification of primary boll rot:

(a) Bacterial boll rot (*X. a.* pv *.m*): Water-soaked lesions later changing to brown, extending deep in locule (s) causing discoloration and rotting of fibre.

(b) Rot due to pathogenic fungi: Brown, purple (or) red ashy lesions on capsular cover, infection extending deep in locule (s), discoloration and deterioration of fibre.

Identification of bollworm damage on bolls :

Bollworms made punctures and caused hole on the bolls. The infested bolls open pre maturely and produce poor lint.

Number of bolls collected per replication:

To count boll rot percentage in 26 treatments having three replications, 0.14 hectares area was observed. In each replication, 100 bolls on 10 random plants were observed to calculate the boll rot percentage during each blossom.

Sterilization :

The Petridishes and pipettes were sterilized in a hot air oven at 180 ± 2^0C for one and half hours and other instruments like inoculation needle, forceps, scissors, knife and blade were sterilized with 95 % alcohol followed by direct heating over the flame of a spirit lamp / Bunsen burner.

Isolation of pathogens and primary invaders:

The pathogens were isolated from infected bolls by tissue segment method and purified by hypal tip method and maintained on Potato Dextrose Agar (or) Czeapak's dox agar and the bacteria were maintained on glucose nutrient agar.

Estimation of boll damage (%) and locule damage (%):

Boll and locule damage was estimated by using standard methods.

Survey for occurrence of boll rot on Bt cotton hybrids: Locations:

The survey was carried out in 4 districts of M.P. The districts were Ratlam, Jhabua, Dhar and Badwani.

Hybrids:

The survey was conducted on 7 Bt and 4 non-Bt hybrids, which are given in Table 4.

Statistical analysis:

The data were subjected to statistical analysis following the procedure for Randomized Block Design (RBD) and coefficient of correlation was also worked out. The SEm and Critical Differences were worked out and the interpretations on findings were described using the 5% probability level .

RESULTS AND DISCUSSION

Boll samples from different Bt and non-Bt cotton hybrids belonging to 6101 to 6122 and 6126 (Bt), 6123 to 6125 (non- Bt) were collected from experimental field in All India Coordinated Cotton Project, Indore (M.P.). These hybrids were selected randomly to record the incidence of primary and secondary boll rot, boll damage and locule damage during 1st, 2nd and 3rd blossom.

Occurrence of primary boll rots on different Bt and non-Bt hybrids:

Observations on primary boll rot during 1st, 2nd and 3rd blossom (Table1) were recorded on 23 Bt (6101-6122, 6126) and 3 non Bt (6123-6125) hybrids. The data showed that the differences in incidence of primary boll rot on different Bt and non-Bt hybrids during 1st, 2nd and 3rd blossom were statistically significant. During 1st blossom, the maximum incidence of primary boll rot was recorded on 6102 (2.60%) followed by 6120 (2.26%), 6104 (1.54%), 6109 (1.53%), 6108 (1.32%), 6112 (1.25%), 6107 (1.04%), 6116 (0.95%), 6103 (0.90%), 6110 (0.86%), 6106 (0.71%), 6101 (0.66%) with the minimum incidence on 6105. No boll rot was recorded on 6111, 6113, 6114, 6115, 6117, 6118, 6119, 6121, 6122 and 6126.Among the non-Bt hybrids, the highest incidence was recorded on 6124 (2.91%) followed by 6125 (2.44%) both being statistically at par. The lowest incidence on 6123 (0.90%) being statistically significant. During 2nd blossom in Bt hybrids, highest primary boll rot incidence was observed on 6103 (4.79%) followed by 6121 (3.65%), 6102 (3.50%), 6120 (3.32%), 6116 (3.13%), 6104 (2.6%), 6110 (2.49%), 6108 (2.41%), 6109 (2.26%), 6119 (1.81%), 6112 (1.4%), 6107 (1.11%), 6106 (1.05%), 6115 (1.05%), 6101 (0.9%), 6118 (0.62%), 6114 (0.58%) with the lowest incidence on 6113 (0.33%). No boll rot was observed on 6105, 6111, 6117 and 6126.

In the case of non-Bt hybrids, maximum primary boll rot was recorded on 6123 (8.12%) followed by 6124 (4.15%) both being statistically significant, the minimum incidence on 6125 (4.07%) being statistically significant. During 3rd blossom 6109 showed the highest primary boll rot (7.51%) was followed by 6104 (7.50%), 6121 (7.48%) 6120 (5.95%), 6103 (5.88%), 6114 (5.25%), 6110 (4.60%),

Table 1 : Incidence of primary boll rot on different Bt and non Bt cotton hybrid

Sr. No.	Code No.	Boll rot (%) during			Average Boll rot (%)
		1st Blossom	2nd Blossom	3rd Blossom	
1.	6101(Bt)	0.66 (7.51)	0.90 (9.33)	3.10 (16.67)	1.55
2.	6102(Bt)	2.60 (15.53)	3.50 (17.95)	3.75 (18.73)	3.28
3.	6103(Bt)	0.90 (9.33)	4.79 (21.28)	5.88 (23.7)	3.85
4.	6104(Bt)	1.54 (12.12)	2.60 (15.68)	7.50 (26.7)	3.88
5.	6105(Bt)	0.00 (0.00)	0.47 (6.18)	1.38 (10.63)	0.61
6.	6106(Bt)	0.71 (6.76)	1.05 (7.68)	1.38 (10.63)	1.04
7.	6107(Bt)	1.04 (9.07)	1.11 (9.17)	1.85 (12.81)	1.33
8.	6108(Bt)	1.325 (10.4)	2.41 (13.91)	3.04 (16.83)	2.25
9.	6109(Bt)	1.53 (12.12)	2.26 (14.29)	7.51 (26.91)	3.76
10.	6110(Bt)	0.86 (8.26)	2.49 (14.53)	4.60 (21.05)	2.65
11.	6111(Bt)	0.00 (0.00)	0.00 (0.00)	1.38 (11.21)	0.46
12.	6112(Bt)	1.25 (10.24)	1.4 (10.82)	3.33 (17.75)	1.99
13.	6113(Bt)	0.00 (0.00)	0.33 (4.37)	4.0 (18.95)	1.44
14.	6114(Bt)	0.00 (0.00)	0.58 (6.18)	5.25 (22.44)	1.94
15.	6115(Bt)	0.00 (0.00)	1.05 (7.68)	1.94 (13.29)	0.99
16.	6116(Bt)	0.95 (9.33)	3.13 (17.2)	3.18 (17.5)	2.42
17.	6117(Bt)	0.00 (0.00)	0.00 (0.00)	2.0 (13.68)	0.66
18.	6118(Bt)	0.00 (0.00)	0.62 (6.93)	2.0 (13.68)	0.87
19.	6119(Bt)	0.00 (0.00)	1.81 (12.81)	3.08 (17.04)	1.63
20.	6120(Bt)	2.26 (14.29)	3.32 (17.75)	5.95 (24.18)	3.84
21.	6121(Bt)	0.00 (0.00)	3.65 (18.45)	7.48 (26.14)	3.71
22.	6122(Bt)	0.00 (0.00)	0.76 (7.51)	1.95 (12.8)	.90
23.	6123(nonBt)	0.90 (6.19)	8.12 (27.6)	8.90 (29.29)	5.97
24.	6124(nonBt	2.91 (13.02)	4.15 (19.8)	4.96 (21.7)	4.00
25.	6125(nonBt	2.44 (13.91)	4.07 (19.52)	5.64 (23.32)	4.05
26.	6126(Bt)	0.00 (0.00)	0.0 (0.00)	0.43 (6.18)	0.14
	Total	6.31	11.55	18.22	
S.E. ±	0.26	0.15	0.44	0.76	0.18
C.D. (P=0.05)	1.50	1.11	0.30	1.90	0.57

* Figures in parantheses indicate angular transformed values

6113 (4.0%), 6102 (3.75%), 6112 (3.33%), 6116 (3.18%), 6101 (3.10%), 6119 (3.08%), 6108 (3.04%), 6117 and 6118 (2.0%), 6122 (1.95%), 6107 (1.85), 6105, 6106 and 6111 (1.38%) with lowest incidence on 6126 (0.43%).Among non-Bt hybrids the maximum boll rot was observed on 6123 (8.90%) followed by 6125 (5.64%), both being statistically significant, lowest incidence on 6124 (4.96%) being statistically significant. During the three blossoms overall maximum primary boll rot was observed on 6123 (5.97%) and the minimum boll rot was observed on 6126 (0.14%).

Boll and locule damage on different Bt and non-Bt hybrids:

The data on per cent boll damage on 23 Bt and 3 non-Bt hybrids have been presented in Table 2. The data showed that the differences in per pent boll damage on different Bt and non-Bt hybrids were statistically significant. The maximum boll damage was recorded on 6115 (2.58%) whereas the minimum boll damage was observed on 6126 (0.73%), both were statistically significant. On the other hybrids the damage was as follows: 6116 (2.42%), 6120 (2.38%), 6119 (2.35%), 6122 (2.28%), 6109 (2.27%), 6114 (2.26%), 6106 (2.25%), 6107 (2.24%), 61111 (2.22%), 6105 (2.18%), 6123 (1.98%), 6110 (1.93%), 6108 (1.91%), 6112 (1.88%), 6101 (1.70%), 6103 (1.68%), 6113 (1.05%), 6117 (0.82%) and 6121 (0.8%). Among non-Bt hybrids highest boll damage was observed on 6125 (4.48%), 6124 (3.95%) being statistically at par but both being statistically significant with 6123 (1.98%).Thus non-Bt hybrids showed higher damage than the Bt hybrids. Among the Bt hybrids >2% boll damage was recorded on 6105, 6106, 6107, 6109, 6111, 6114, 6115, 6116, 6118, 6119, 6120, 6122.The minimum locule damage

Table 2 : Boll and locule damage by bollworms on different Bt and non-Bt cotton hybrids

Sr. No.	Code no.	Boll damage (%)	Locule damage (%)
1.	6101(Bt)	1.70	1.69
2.	6102(Bt)	1.80	1.77
3.	6103(Bt)	1.68	1.74
4.	6104(Bt)	1.96	1.98
5.	6105(Bt)	2.18	2.14
6.	6106(Bt)	2.25	2.26
7.	6107(Bt)	2.24	1.95
8.	6108(Bt)	1.91	1.98
9.	6109(Bt)	2.27	2.15
10.	6110(Bt)	1.93	1.93
11.	6111(Bt)	2.22	2.16
12.	6112(Bt)	1.88	1.89
13.	6113(Bt)	1.05	1.04
14.	6114(Bt)	2.26	2.50
15.	6115(Bt)	2.58	0.83
16.	6116(Bt)	2.42	2.46
17.	6117(Bt)	0.82	0.92
18.	6118(Bt)	2.12	2.22
19.	6119(Bt)	2.35	2.27
20.	6120(Bt)	2.38	2.48
21.	6121(Bt)	0.80	0.84
22.	6122(Bt)	2.28	2.32
23.	6123(nonBt)	1.98	2.16
24.	6124(nonBt)	3.95	3.85
25.	6125(nonBt)	4.48	4.38
26.	6126(Bt)	0.73	0.69
S.E. ±	0.85	0.66	
C.D. (P=0.05)	1.46	1.14	

was recorded on 6126 (0.69%), whereas maximum was observed on 6114 (2.5%). On other hybrids, the damage recorded as follows: 6120 (2.48%), 6116 (2.46%), 6122 (2.32%), 6119 (2.27%), 6106 (2.26%), 6118 (2.22%), 6111 (2.16%), 6109 (2.15%), 6105 (2.14%), 6104 (1.96) and 6108 (1.91%), 6110 (1.93%), 6112 (1.89%), 6102 (1.77%), 6103 (1.74%), 6101 (1.69/%), 6113 (1.04%), 6117 (0.92%), 6121 (0.84%) and 6115 (0.83%).Among non-Bt hybrids, highest locule damage was observed on 6125 (4.38%), 6124 (3.85%) being statistically significant and both being statistically significant with 6123 (2.16%).Thus non-Bt hybrids showed higher damage than Bt hybrids. Among Bt hybrids >2% locule damage was recorded on 6105, 6106, 6109, 6111, 6114, 6116, 6118, 6119, 6120, 6122 and 6123.

Bollworm damage on Bt and non-Bt cotton hybrids:

The data on survey of boll worm damage on 7 Bt and 4 non-Bt hybrids in 4 districts of M.P. have been given in Table 3.The observations were recorded on *Helicoverpa armigera*, *Spodoptera litura*. The damage of *Helicovera* was almost negligible on Bt hybrids. The highest damage was observed on Shakti-9 (0.27%), followed by RCH-2 (0.06%), Varlaxmi (0.05%), Kashinath (0.02%), MRC-6918 (0.02%) and the minimum was on RCH-138 and DCH-3 (0.01%).Among non-Bt hybrids lowest damage was recorded on H-8 (0.18%), which was followed by Kashinath (0.19%), RHB-388 (0.25%) and the maximum on DCH-32 (0.29%). Thus highest damage of *Helicoverpa* was observed on non-Bt hybrids than on Bt hybrids (Table 4). The damage of *Spodopterpa* was maximum on Shakti-9 (2.02%) followed by Varalaxmi (0.03%), RCH-138 (0.03%), DCH-32 (0.02%) and the minimum on RCH-2, Kashinath and MRC-6918 (0.01%).In non-Bt hybrids the highest damage was observed on H-8 (2.37%) followed by RHB-388 (1.03%) and DCH-32 (0.98%) with the minimum on Kashinath (0.76%) (Table 4). Thus, the bollworms damage was higher on non-Bt hybrids than that on Bt hybrids. Bt transformation of cotton hybrids aims at negligible damage to bolls because the feeding larvae of different bollworms are killed and in turn their population build up is checked. David (1998) observed that damage due to bollworm is considerably less in Bt cotton than on non Bt cotton. Moreira *et al*. (2003) showed that Bt technology substantially reduced the pest damage and increased the yield. Singh (2004) reported that Bt cotton was resistant towards bollworms. Zhang and Zhang (1992) observed that Bt cotton was highly resistant to bollworms. The present observation of negligible damage on Bt hybrids to bolls and locules is specifically recorded, which holds in agreement with these observations. Bt gene helps in

Table 3: Incidence of primary boll rot on different Bt ?non Bt cotton hybrids on cultivators fields

Sr. No.	Hybrid	Average boll rot (%)
1.	DCH-3	0.69
2.	V L (Bt)	1.10
3.	RCH (Bt)	0.41
4.	KN (Bt)	0.58
5.	S-9 (Bt)	1.29
6.	RCH (Bt)	0.69
7.	MRC (Bt)	1.09
8.	DCH (Non Bt)	1.04
9.	RHB (Non Bt)	0.66
10.	KN (Non Bt)	1.15
11.	H-8 (Non Bt)	1.18
S.E. ±	0.92	
C.D. (P=0.05)	1.91	

Table 4 : Boll worm damage on different Bt ?non Bt cotton hybrids on cultivators field

Sr. No.	Hybrid	Helicoverpa armigera	Spodoptera litura
1.	DCH-3	0.01	0.02
2.	V L (Bt)	0.05	0.03
3.	RCH (Bt)	0.06	0.01
4.	KN (Bt)	0.02	0.01
5.	S-9 (Bt)	0.27	2.02
6.	RCH (Bt)	0.01	0.03
7.	MRC (Bt)	0.02	0.01
8.	DCH (N Bt)	0.29	0.98
9.	RHB (N Bt)	0.25	1.03
10.	KN (N Bt)	0.19	0.76
11.	H-8 (N Bt)	0.18	2.37
	Total	1.35	7.27

reduction of boll rot losses, apart from providing inherent protection against bollworms. (Radhika *et al*., 2004; Hedge *et al*., 2004 and Bhosle *et al*., 2004; Sheo Raj *et al*., 2004).Incorporation of Bt gene also reduced the boll and locule damage however, it was unlikely to influence the incidence of foliar diseases. Moreover, reduced damage by bollworms is obviously expected to cast its shadow on invasion by secondary boll rot incidents. Mahabaleswar *et al*., and Bhosle *et al*. (2004) showed that lowest boll damage and locule damage were observed on Bt cotton. Surulivelu (2004) reported that on Bt cotton boll and locule damage was low as compared to non-Bt cotton.

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