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Assessment of losses due to various insect pests in Bt cotton hybrids in Malwa region of Madhya Pradesh

S.B. SINGH, G.S. CHUNDAVAT, A.K BADAYA AND S N. UPADHYAY

RVSKVV, College of Agriculture, Indore (M.P.)

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ABSTRACT

The experiment was undertaken during Kharif season of 2014 at College of Agriculture Farm, Indore in randomized block design with eleven selected hybrids with three replications and plant to plant spacing of 0.6 x 0.6 m. These hybrids were sown on 22nd July, 2014. The visual foliage losses due to all the sucking pests like aphid, jassid, thrips and whitefly were recorded at the successive crop growth stages on 5 observational tagged plants. Up to 50 per cent foliage loss was considered for tolerant hybrids and above this was treated as susceptible. The pod and locule damage was recorded at each picking in 5 tagged plants per plot. At 20 DAG the foliage loss ranged from 11.33 to 15.67 per cent. The foliage losses reached more than 50 per cent after 90 DAG in maximum hybrids whereas minimum leaf damage was recorded in PRCH-739 BG II (39.9%). At 100 DAG minimum foliage loss was noted in PRCH-739 BG II (47.3%) and differed non significantly with PRCH-779 BG II (55.6%). Rest of the hybrids exhibited more than 50 per cent leaf infestation. At 110 DAG the leaf damage again increased and all the hybrids showed more than 50 % foliage loss which ranged from 56.7 to 75.7 per cent. All the hybrids performed tolerance against sucking insect pests but after that increased leaf infestation. These hybrids were considered susceptible up to 80 DAG. The bollworm damage was noted in the range of 1.8 to 3.2 per cent. It was minimum in the PRCH-135 BG II (1.87%) and maximum in PRCH-737 BG II (2.5%). The least locule damage was found in the MRC-7918BG II Bt (1.80%) and maximum in PRCHB-601 BG II (2.3%). The highest seed cotton yield was recorded in PRCH-739 BG II (2066.55 kg ha^{-1}) whereas PRCH-331 BG II produced the lowest yield of 1527.35 kg ha^{-1}.

Key words: Bt cotton, hybrids, aphid, leafhopper, thrips, whitefly, bollworms, assessment

INTRODUCTION

Cotton (*Gossypium hirsutum),* the white gold, is an important *kharif* cash and fibre crop of India that exerts considerable influence on Indian economy. India is the second largest producer of cotton in the world after China accounting for about 18 per cent of the world cotton production. In India, area under cotton is 118.81 lakh ha along with production of 352 lakh bales and productivity of 503 kg lint ha^{-1}. In M.P. it is cultivated in 5.47 lakh ha area with total production of 17.0 lakh bales along with the productivity of 559 kg lint ha^{-1}**.** About 162 insect pests have been reported in India on this crop from the time of sowing till harvest**.** The insect pests cause 56-60% reduction in yield**.** Important insect pests of cotton crop are sucking pests and bollworm complex. Among the sucking pests, aphid (*Aphis gossypii* Glover), leafhopper (*Amrasca biguttula* Ishida), thrips (*Scirtothrips dorsali* Hood), and whitefly (*Bemisia tabaci* Gennedius) attack in the early stage of the crop, while, bollworms viz. spotted bollworm (*Earias vittela* Fabricius and *Earias insulana* Boisduval), American bollworm (*Helicoverpa armigera* Hubner) and pink bollworm (*Pectinophora gossyiella* Saunders) are the most serious pests during the fruiting stage of the crop. Thus, the major problem in getting maximum production per unit area is due to the infestation of various insect pests, particularly bollworms of cotton. Bt-cotton currently occupies over 93% of the area under cotton cultivation. Genetic makeup of the plant is very much important to confer tolerance to biotic and abiotic stress under natural conditions. In India, introduction of Bt cotton involving several hybrids, most of which were highly susceptible to sucking pests has resulted in increased crop damage (Nagrare *et al*, 2014). The pressure of sucking insect pests adversely affected the foliage loss and finally the cotton yield. Viewing the situation the experiment was planned to assess the performance of some selected Bt cotton hybrids.

MATERIALS AND METHODS

The experiment was carried out on medium black cotton soil in *Kharif* season of 2014 at College of Agriculture Farm, Indore in randomized block design with eleven selected hybrids in three replications with the plot size of 2.4x2.4 m and plant to plant spacing of 0.6 x 0.6 m. Hybrids were sown on July 22, 2014. These

Corresponding author Email: sbsmds@rediffmail.com

hybrids were T1 PRCH-135(BGII), T2- PRCH-331(BGII), T3- PRCH-703(BGII), T4- PRCH-709(BGII), T5- PRCH-737(BGII), T6- PRCH-739(BGII), T7- PRCH-779(BGII), T8- RCH-2(BGII), T9- PRCHB-601(BGII)(HxB), T10- PRCHB-603(BGII) and T11- MRC-7918(BGII) (check). The visual foliage losses due to all the sucking pests like aphid, jassid, thrips and whitefly were recorded at the successive crop growth stages *viz.* 20, 30, 40, 50, 60, 70, 80, 90, 100, and 110 days after germination (DAG) of the cotton on 5 observational tagged plants. The foliage losses were calculated based on following formula:

Foliage Losses (%) = No. of affected leaves/ Total no. leaves x 100

The locule damage caused by the bollworms was recorded at each picking in 5 tagged plants per plot. The total number of damaged and healthy locules were counted in each entry of each plot replication wise and converted into per cent and values were transformed. The cotton yield of various cultivars was recorded in each plot and converted into kg per hectare. All the received data were analysed statistically.

RESULTS AND DISCUSSION

Foliage losses caused by sucking pests

In present study (Table 1), the foliage loss was assessed in the range of 11.33 to 15.67 per cent after 20 DAG. The losses increased continuously and it reached more than 50 per cent after 90 DAG in maximum hybrids. On this stage, the minimum leaf damage was observed in PRCH-739 BG II (39.94%) and considered tolerant. Rests of the hybrids over 50 per cent leaf damage were treated as susceptible. At 100 DAG foliage loss increased. Only PRCH-739 BG II (47.33%) differed non significantly with PRCH-779 BG II (55.67%). Rest of the hybrids showed susceptibility against the insect pests as they exhibited more than 50 per cent leaf infestation.

Table 1: Foliage loss in Bt cotton hybrids at different successive growth stage

Hybrids	20 DAG	30 DAG	40 DAG	50 DAG	60 DAG	70 DAG	80 DAG	90 DAG	100 DAG	110 DAG
T1-PRCH-35(BGII)	15.67 (23.31)	20.67 (27.03)	26.33 (30.87)	31.17 (33.93)	37.00 (37.46)	42.33 (40.58)	50.67 (45.38)	58.33 (49.81)	66.33 (54.57)	75.77 (60.79)
T2-PRCH-31(BGII)	13.67 (21.68)	19.67 (26.31)	24.33 (29.54)	30.33 (33.41)	36.50 (37.17)	41.50 (40.09)	47.67 (43.66)	56.00 (48.46)	64.00 (53.15)	71.33 (57.78)
T3-PRCH-03(BGII)	14.33 (22.24)	19.33 (26.07)	24.00 (29.33)	29.67 (32.96)	34.67 (36.07)	39.67 (39.03)	48.00 (43.85)	55.00 (47.90)	63.67 (52.94)	70.70 (57.26)
T4-PRCH-09(BGII)	13.13 (21.24)	17.00 (24.34)	22.67 (28.42)	26.67 (31.08)	32.33 (34.65)	36.67 (37.26)	44.67 (41.94)	51.33 (45.76)	65.33 (53.97)	72.80 (58.57)
T5-PRCH-37(BGII)	11.50 (19.75)	15.00 (22.78)	19.33 (26.01)	24.00 (29.20)	31.33 (33.98)	38.00 (38.05)	44.33 (41.71)	50.00 (44.99)	59.57 (50.59)	67.47 (55.35)
T6-PRCH-39(BGII)	11.33 (19.66)	14.17 (22.09)	17.33 (24.57)	19.67 (26.18)	23.00 (28.54)	28.33 (32.14)	35.00 (36.24)	41.33 (39.94)	47.33 (43.46)	56.73 (48.90)
T7-PRCH- 79(BGII)	11.67 (19.94)	19.00 (25.63)	22.23 (28.15)	27.00 (31.24)	32.67 (34.85)	37.00 (37.45)	41.83 (40.30)	48.33 (44.04)	55.67 (48.30)	62.43 (52.28)
T8-RCH-2(BGII)	12.83 (20.97)	17.00 (24.33)	24.33 (29.55)	28.67 (32.36)	33.67 (35.46)	38.67 (38.41)	45.67 (42.51)	51.33 (45.77)	59.33 (50.42)	67.50 (55.32)
T9-PRCHB-601 (BGII)(HxB)	11.50 (19.76)	16.33 (23.74)	20.33 (26.63)	26.00 (30.50)	31.67 (34.07)	38.00 (37.99)	44.00 (41.54)	52.67 (46.53)	64.33 (53.41)	71.67 (57.98)
T10-PRCHB-603 (BGII)	14.50 (22.34)	20.33 (26.79)	25.00 (29.99)	30.67 (33.63)	35.53 (36.45)	40.33 (39.40)	47.00 (43.27)	53.33 (46.91)	66.00 (54.37)	75.43 (60.36)
T11-MRC-918 (BGII) (check)	15.17 (22.85)	21.17 (27.39)	25.33 (30.21)	31.00 (33.82)	36.67 (37.25)	41.67 (40.19)	48.33 (44.04)	59.00 (50.19)	65.67 (54.17)	73.53 (59.07)
SEm ±	0.84	1.13	1.12	1.48	1.51	1.44	1.48	1.81	2.05	2.16
CD at 5 %	2.65	3.55	3.53	4.68	4.77	4.54	4.66	4.71	6.48	6.82
CV %	6.85	7.75	6.79	8.11	7.46	6.51	6.08	6.75	6.87	6.60

Values in Parentheses are Transformed values $\left(\sqrt{x+0.5}\right)$*, *(Note: Damage % values are angular transformed)*

At 110 DAG the leaf damage again increased and all the hybrids showed more than 50 per cent foliage loss which ranged from 56.73 to 75.77 per cent. Although, PRCH-739 BG II exhibited least damage (56.73%) and found at par with RCH-2 (BGII) (67.50%) and PRCH-737(BGII) (67.47%). Rest of the hybrids showed higher susceptibility against sucking pests. All the hybrids performed tolerance against sucking insect pests up to 80 DAG but after that due to increased leaf infestation these were considered susceptible. In general, it is noticed that *Bt*. cotton hybrids are more susceptible to the sucking pest in comparison to the non *Bt* cotton hybrids. Aggarwal *et al* (2006) explained that it is well known fact that genetic makeup of genotype affects the response by pest and other stresses in a number of ways, including leaf curling, wilting, chlorosis or necrosis of photosynthetically active parts, stunted growth, or in some cases reduction in leaf area due to severe defoliation Nagrare *et al,* (2014) stated that more than 50% leaves on a plant turning red of 50% plant population was considered as susceptible hybrid for leaf reddening. Lu *et al.* (2013) reported the occurrence and damage caused by whitefly (99.17%), cotton aphid (98.33%), cotton thrips (74.58%), cotton mirid (43.10%) and cotton spider mite (20.95%). Compared with other pests, whitefly had the highest incidence at the flower and boll stage. Cotton aphid and cotton thrips showed the highest incidence at the bud stage.

Boll damage due to bollworms

Most of the hybrids did not show greater variation in relation to open boll damage and locule damage (Table 2).

Table 2: Per cent boll and locule damage due to boll worms and seed cotton yield

Hybrids	Open boll damage %*	Locule boll damage %*	Yield
T1-PRCH-135(BGII)	3.27 (10.41)	1.93 (7.98)	1826.36
T2-PRCH-331(BGII)	2.00 (8.13)	2.00 (8.12)	1527.35
T3-PRCH-703(BGII)	2.53 (9.11)	2.33 (8.75)	1754.85
T4-PRCH-709(BGII)	2.33 (8.74)	2.07 (8.20)	1639.27
T5-PRCH-737(BGII)	2.57 (9.20)	2.27 (8.65)	1514.41
T6-PRCH-739(BGII)	1.87 (7.85)	1.80 (7.60)	2066.55
T7-PRCH-779(BGII)	2.13 (8.39)	2.03 (8.17)	1989.30
T8-RCH-2(BGII)	3.07 (10.08)	3.00 (9.96)	1478.70
T9-PRCHB-601 BGII)(HxB)	2.67 (9.33)	2.47 (8.99)	1493.83
T10-PRCHB-603 (BGII)	2.37 (8.81)	2.30 (8.64)	1356.81
T11-MRC7918(BGII)(check)	2.07 (8.26)	3.27 (10.41)	1756.31
SEm ±	0.43	0.53	93.70
CD at 5 %	1.36	1.63	295.40
CV %	8.38	10.28	9.72

The bollworm damage was noted in the range of 1.87 to 3.27 per cent. It was minimum in the PRCH-135 BG II (1.87%) and maximum in PRCH-737 BG II (2.57%). Rest of the hybrids exhibited significantly greater open boll damage. Further the least locule damage was found in the MRC-7918BG II *Bt* (1.80%) and maximum in PRCHB-601 BG II (2.30%). Liu *et al.* (2002) revealed that transgenic cotton, producing insecticidal crystal protein Cry1Ac of *Bacillus thuringiensis* (*Bt*), has been effective in controlling pink bollworm, *Pectinophora*

gossypiella. Murugan *et al.* (2003**)** found that the *Bt* cotton could be an effective strategy in the management of *H. armigera* and fit into the IPM module of cotton insect pest management. Bambawale *et al.* (2004) reported a 50% overall reduction in the *H. armigera* larval population in Bollgard-MECH-162 compared to the non-*Bt* MECH-162. The locule damage caused by pink bollworm was found to be 58% lesser in *Bt*-cotton. Hegde *et al.* (2004) observed lowest boll damage in MECH-162 *Bt*. (15.67%). Lavekar *et al.* (2004) found that the per cent of damaged bolls and locules was lower in *Bt* crops (14.6-17.2%) and (9.5 to 12.3%) than their non-*Bt* counterparts (24.4-35.5%) and (17.83-25.4%) respectively. Shera *et al.* (2014) found that overall mean boll infestation was comparatively low in *Bt* cotton hybrids ranging from 0.0 to 1.51 and 0.0 to 0.92 per cent on boll and loculi basis, respectively.

Cotton yield

The highest seed cotton yield (Table 2) was observed in PRCH-739 BG II (2066.55 kg ha^{-1}) and showed non significant difference with PRCH-779 BG II (1989.30 kg ha^{-1}). The minimum seed cotton yield was recorded in PRCHB-603 BG II (1356.81 kg ha^{-1}.). Yousouf *et al.* (2002**)** explored that the *Bt* cotton hybrids exhibited higher yield due to less boll worms infestation. Qaim and Zilberman (2003) showed that pest resistant genetically modified crops can contribute to increase yields and agricultural growth. Similar findings were reported by Bennett *et al.* (2004) and Zahid *et al.* (2005) Further Shera *et al.* (2014) observed that RCH 134 *Bt* recorded the highest mean seed cotton yield (2342 kg/ha) as compared to other test *Bt* hybrids (851 to 2083 kg/ha). The above findings are in the line of agree with the present study. Contrary to our findings Chavan *et al.* (2010) observed that the avoidable losses due to major insect-pests (sucking pests+ bollworms) were 2.94 q/ha or 28.13 per cent. This might be due to increasing resistance in bollworm complex against Bt toxins and presence of already resistant strains in experimental region.

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