RESEARCH ARTICLE

REACTION OF BT COTTON HYBRIDS AGAINST SUCKING INSECT PESTS IN MALWA REGION OF MADHYA PRADESH

S.B. Singh*, R.P. Patel, and G.S. Chundavat

RVSKVV, College of Horticulture, Mandsaur (M.P.)
Email: sbsmds@rediffmail.com

Received-02.09.2018, Revised-20.09.2018

Abstract: The experiment was undertaken on medium black cotton soil in *Kharif* season of 2015 at College of Agriculture Farm, Indore in randomized block design with nine selected cotton hybrids in three replications with the plot size of 3 x 3 m and plant to plant spacing of 0.6 x 0.6 m. Hybrids were sown on July 1, 2015. These hybrids were ACH-1BG –II, ACH-104-2 BG-II, ACH-152-2BG–II, ACH-115-2BG-II, ACH-1133-2BG-II, ACH-1199-2BG-II, RCH- 2 BG-II (standard check), ACHB-90-1BG-II and MRC-7918 BG-II (standard check). The population of aphid, jassid, thrips and whitefly, were recorded at 20, 30, 40, 50, 60, 70, 80, 90, 100, and 110 days after germination (DAG) on 5 observational tagged plants from two lower, two middle and two upper leaves per plants. The cotton yield was recorded on whole plot basis and converted into kg per hectare. All the received data were analysed statistically. On the basis of overall mean of all the intervals the minimum jassid population was noted in ACH-1199-2BG-II (5.85**)** and found at par with standard Check MRC-7918 BG-II (6.29). The continuous increasing trend from first to last observation was observed for whitefly, aphid and thrips. The mean whitefly population was recorded least in ACH-1199-2BG-II (8.04) and found at par with standard check MRC-7918BBG-I**I** (8.51) and standard check RCH-2BGII (8.53). In relation to aphid, standard check RCH-2BG-II (17.57) showed minimum population and found at par with ACH-1199-2BG-II (17.83). The least thrips population was noted in ACH-1199-2BG-II (15.17) and found to be at par with standard check MRC-7918BBG-II (15.93), ACH1133-2BG-II (16.01) and standard check RCH-2BG-II (16.37). The Highest seed cotton yield was observed in ACH-1155-2BG- II (2669kg/ha) and showed no significant difference with ACH-1199-2BG-II (2602 kg/ha), ACH-152-2BG-II (2262 kg/ha) and other hybrids.

Keywords: Bt cotton, Hybrids, Aphid, Leafhopper, Thrips, Whitefly, Reaction

INTRODUCTION

Cotton (*Gossypium hirsutum)* the white gold is an important *kharif* cash and fibre crop of India that exerts considerable influence in 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}**.**

The pest spectrum of the crop is quite complex and about 162 insect pests have been reported in India on this crop from the time of sowing till harvest (Anonymous, 2002)**.** 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 final evalution report of the Central Institute for Cotter Research (CICR) showed that Bt cotton varities developed by Monsanto and marketed by Mahyco, were susceptible to jassids, aphids and other sucking pests and several crop diseases. Bollgard II cotton having Cry1Ac and Cry2Ab protein showing toxicity against lepidopterous insect pests (Anonymous, 2002). In such sconditions the load of sucking insect pests also increased. Viewing the situation the experiment was planned to assess the performance of some selected Bt cotton hybrids (Bollgard II) against sucking insect pests.

MATERIALS AND METHODS

The experiment was carried out on medium black cotton soil in *Kharif* season of 2015 at College of Agriculture Farm, Indore in randomized block design with nine selected hybrids in three replications with the plot size of 3 x 3 m and plant to plant spacing of 0.6 x 0.6 m. Hybrids were sown on July 1, 2015. These hybrids were T1 ACH-1 BG –II, T2- ACH-104-2 BG-II, T3- ACH-152-2 BG –II, T4- ACH-

*Corresponding Author

1152 BG-II, T5- ACH-1133-2 BG-II, T6- ACH-1199-2 BG-II, T7- RCH- 2 BG-II (CHECK), T8- ACHB- 901 BG-II(HYB) and T9- MRC-7918 BG-II(HYB)(CHECK. The population of 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 from two lower, two middle and two upper leaves per plants. The cotton yield was recorded on whole plot basis and converted into kg per hectare. All the received data were analysed statistically.

RESULS AND DISCUSSION

Sucking insect pests population

During the experimentation the jassid population (table 1) ranged from 3.53 (20 DAG- Days after Germination) to 14.07/leaf (90 DAG) with continuous increasing trend and later declined up to 4.27 at 110 DAG in all the hybrids. In 20, 50 and 80 DAG all the hybrids exhibited non significant variation and in remaining intervals, hybrid ACH-1BG-II showed significantly highest insect population followed by ACH-104-2BG-II. The least jassid number was recorded in ACH-1199-2BG-II at 40, 60, 70 and 90 DAG. On the basis of overall mean of all the intervals the minimum insect population was noted in ACH-1199-2BG-II (5.85) and found at par with standard Check MRC-7918 BG-II (6.29). The continuous increasing trend from first to last observation was observed for whitefly, aphid and thrips. Whitefly population ranged from 4.47 to 23.27/leaf (table 2) during all the intervals. In 20, 30 and 70 DAG all the hybrids exhibited non significant variation in whitefly population. Hybrids ACH-1BG-II and ACH-152-2BG-II expressed significantly highest population. ACH-1199-2BG-II showed least insect number in maximum intervals but was at par with rest of the hybrids. The mean whitefly population was recorded least in ACH-1199-2BG-II (8.04) and found at par with standard check MRC-7918BBG-II (8.51), standard check RCH-2BGII (8.53), ACH-104-2BG-II (9.08), ACH-1133--2BG-II (9.29) and ACH-115-2BG-II (9.87). Aphid population was recorded in the range of 3.87 to 41.00/leaf during all the observations (table 3). The non significant variation was noted in hybrids at 20, 40, 60 and 90 DAG. Hybrid ACH-1BG-II again showed poor performance with significantly highest aphid population in maximum intervals. From the overall mean it was revealed that standard check RCH-2BG-II (17.57) showed minimum aphid population and found at par with ACH-1199-2BG-II (17.83), ACH-1BG-II, ACH1133-2BG-II (18.12) and standard check MRC-7918BBG-II (18.77). The non significant variation in thrips population (table 4) was recorded at 20, 40 and 80 DAG in tested hybrids. Maximum thrips population with significant difference was observed in ACH-1BG-II (19.63) and ACH-104-2BG-II (18.24). Rest of the hybrids expressed lesser insect population with non significant variation. Based on the mean values the least population was noted in ACH-1199-2BG-II (15.17) and found to be at par with standard check MRC-7918BBG-II (15.93), ACH1133-2BG-II (16.01) and standard check RCH-2BG-II (16.37). The genetic resistance is the most outstanding and the cheapest technique in crop plants to control insects. The genetic resistance offers a capability of various cotton genotypes to provide an elevated production of superior prominence than susceptible varieties under same environmental conditions at the similar initial intensity of insects' incidence. In present study some recent *Bt* cotton hybrids have been tested which were not tested by earlier workers against the sucking pests which exhibited the presence of sucking pests but the findings of previous workers may support to present study in relation to the best performance of *Bt* cotton hybrids in reducing the sucking pest population and increasing the cotton yield. Vennila *et al.* (2004) stated that 134 *Bt* indicated tolerance response to jassids and white flies 138*Bt* had shown better tolerance to thrips and white flies and susceptible reaction of 144*Bt* to jassids, thrips and white flies were obvious. Saif-ur-Rehman *et. al.* (2013) and Sarwar *et. al.* (2013) explained that in general *Bt* cotton showed equal or higher sucking pest population than non *Bt* cotton verities. Mohapatra and Nayak (2014) reported that Sudarshan BGII was found highly susceptible to jassid, harbouring a maximum population of 4.95/leaf and closely followed by NCS 859 BGII (4.60/leaf), PRCH-331 BGII (4.56/leaf) and KDCHH 541 BG II (3.72/leaf). Muchhadiya *et al*. (2014) observed that jassid, white fly, thrips, and aphid were found damaging the *Bt* cotton throughout the season. Phulse and Udikeri (2014) reported the highest incidence of thrips, leafhoppers and whiteflies on MRC 7918 BG-II (17.3, 5.7 and 0.31/3 leaves respectively) followed by MRC 6918 non-*Bt*, RCH-2 BG-II and RCH-2 non *Bt*. Similar findings were also reported by Babu and Meghwal (2014) against thrips. The higher presence of sucking pest population might be due to less interspecific competition among sucking pests as *Bt* cotton hybrids are found resistant against bollworm complex.

Table 1. Jassid population in cotton hybrids during 2015-16

S.No	Hybrids	20 DAG	30 DAG	40 DAG	50 DAG	60 DAG	70 DAG	80 DAG	90 DAG	100 DAG	110 DAG	Over all mean
T1	ACH-1BG-II	5.13 (2.37)	6.13 (2.57)	7.07 (2.75)	8.07 (2.92)	8.80 (3.05)	9.67 (3.18)	11.50 (3.46)	14.07 (3.81)	6.13 (2.57)	6.40 (2.63)	8.12 (2.94)
T2	ACH-104-2BG-II	4.20 (2.16)	5.20 (2.38)	5.53 (2.45)	6.73 (2.68)	7.47 (2.82)	8.47 (2.99)	9.33 (3.13)	11.33 (3.43)	5.20 (2.38)	5.40 (2.43)	7.04 (2.75)
T3	ACH-152-2BG-II	4.87 (2.32)	6.00 (2.55)	6.33 (2.61)	7.13 (2.76)	8.20 (2.95)	9.27 (3.12)	10.33 (3.28)	12.17 (3.56)	6.00 (2.55)	6.20 (2.59)	7.79 (2.88)
T4	ACH-1152BG-II	3.87 (2.09)	4.60 (2.25)	5.47 (2.44)	6.53 (2.64)	8.40 (2.98)	8.33 (2.97)	8.60 (3.02)	11.10 (3.40)	4.60 (2.25)	4.60 (2.25)	6.82 (2.71)
T5	ACH-1133-2BG-II	4.13 (2.15)	4.93 (2.33)	5.67 (2.48)	6.80 (2.70)	7.53 (2.83)	8.60 (3.02)	9.43 (3.15)	10.67 (3.34)	4.93 (2.33)	4.33 (2.19)	6.73 (2.69)
T6	ACH1199-2BG-II	3.53 (2.00)	4.53 (2.24)	5.07 (2.35)	5.47 (2.44)	6.33 (2.61)	7.07 (2.74)	7.80 (2.86)	9.00 (3.08)	4.53 (2.24)	4.67 (2.27)	5.85 (2.52)
T7	RCH-2BG-II(CHECK)	3.93 (2.10)	4.87 (2.32)	5.40 (2.43)	6.40 (2.62)	7.40 (2.81)	7.67 (2.85)	8.33 (2.97)	10.83 (3.36)	4.87 (2.32)	4.27 (2.17)	6.46 (2.64)
T8	ACHB-901BG-II(HYB)	4.33 (2.20)	5.40 (2.43)	5.40 (2.42)	6.33 (2.61)	7.20 (2.77)	7.93 (2.90)	8.47 (2.99)	11.00 (3.39)	5.40 (2.43)	5.93 (2.53)	7.02 (2.74)
T9	MRC-7918BG-II (CHECK)	3.60 (2.02)	4.47 (2.22)	5.20 (2.38)	6.04 (2.56)	7.00 (2.74)	7.53 (2.83)	8.03 (2.92)	9.33 (3.13)	4.47 (2.22)	5.33 (2.41)	6.29 (2.61)
	SEm ±	NS	0.08	0.09	NS	0.09	0.09	NS	0.12	0.08	0.11	0.03
	CD at 5 %	NS	0.25	0.27	NS	0.28	0.28	NS	0.38	0.25	0.34	0.09
	CV %	-	5.81	6.02	-	5.38	5.17	-	6.18	5.81	7.92	1.86

Values in parentheses are square root transformed values $\left(\sqrt{x+0.5}\right)$

Table 2. Whitefly population of in cotton hybrids during 2015-16

S. No	Hybrids	20 DAG	30 DAG	40 DAG	50 DAG	60 DAG	70 DAG	80 DAG	90 DAG	100 DAG	110 DAG	Over all mean
T1	ACH-1BG-II	6.13 (2.57)	5.13 (2.37)	6.73 (2.69)	5.87 (2.52)	10.33 (3.29)	13.47 (3.74)	16.93 (4.17)	19.47 (4.47)	21.37 (4.68)	23.27 (4.87)	12.79 (3.65)
T2	ACH-104-2BG-II	5.20 (2.38)	4.20 (2.16)	5.47 (2.44)	5.40 (2.43)	7.73 (2.86)	9.80 (3.21)	11.60 (3.46)	12.83 (3.64)	13.77 (3.77)	14.83 (3.90)	9.08 (3.09)
T3	ACH-152-2BG-II	6.00 (2.55)	4.87 (2.32)	6.53 (2.65)	5.73 (2.49)	9.77 (3.20)	12.90 (3.66)	16.47 (4.12)	18.27 (4.33)	21.27 (4.66)	22.90 (4.84)	12.40 (3.59)
T4	ACH-1152BG-II	4.60 (2.25)	3.87 (2.09)	4.73 (2.28)	4.47 (2.22)	8.53 (3.00)	11.37 (3.44)	12.57 (3.60)	14.17 (3.83)	16.03 (4.06)	18.33 (4.34)	9.87 (3.22)
T5	ACH-1133-2BG-II	4.93 (2.33)	4.13 (2.15)	5.27 (2.40)	4.60 (2.25)	8.47 (2.99)	10.20 (3.27)	11.63 (3.47)	13.10 (3.68)	14.20 (3.83)	16.33 (4.10)	9.29 (3.13)
T6	ACH1199-2BG-II	4.53 (2.24)	3.53 (2.00)	5.33 (2.41)	4.67 (2.27)	6.23 (2.59)	8.43 (2.99)	9.67 (3.18)	11.33 (3.41)	12.17 (3.55)	13.73 (3.77)	8. 04 (2.92)
T7	RCH-2BG-II (CHECK)	4.87 (2.32)	3.93 (2.10)	5.07 (2.36)	4.67 (2.27)	7.17 (2.77)	9.33 (3.13)	11.00 (3.39)	12.27 (3.57)	13.10 (3.68)	14.37 (3.85)	8.53 (3.01)
T8	ACHB-901BG-II(HYB)	5.40 (2.43)	4.33 (2.20)	5.60 (2.47)	4.87 (2.31)	8.83 (3.05)	12.30 (3.56)	14.17 (3.83)	16.13 (4.08)	18.03 (4.30)	20.60 (4.59)	11.03 (3.39)
T9	MRC-7918BG-II (CHECK)	4.47 (2.22)	3.60 (2.02)	5.33 (2.41)	4.73 (2.29)	7.37 (2.80)	9.10 (3.05)	10.93 (3.31)	11.50 (3.39)	12.57 (3.50)	14.33 (3.73)	8.51 (2.97)
	SEm ±	NS	NS	0.06	0.06	0.11	NS	0.19	0.22	0.22	0.23	0.10
	CD at 5 %	NS	NS	0.20	0.19	0.36	NS	0.61	0.68	0.71	0.71	0.33
	CV %	-	-	4.54	4.56	6.63	-	9.21	9.80	9.72	11.29	5.58

Values in parentheses are square root transformed values $\left(\sqrt{x+0.5}\right)$

Table 3. Aphid population in cotton hybrids during 2015-16

S. No.	Hybrids	20 DAG	30 DAG	40 DAG	50 DAG	60 DAG	70 DAG	80 DAG	90 DAG	100 DAG	110 DAG	Over all mean
T1	ACH-1BG-II	5.80 (2.50)	11.23 (3.42)	13.10 (3.69)	19.47 (4.47)	13.77 (3.77)	20.67 4.59	27.37 (5.26)	32.67 (5.75)	33.17 5.80	41.00 (6.44)	21.53 (4.69)
T2	ACH-104-2BG-II	4.80 (2.30)	7.17 (2.75)	11.03 (3.40)	12.83 (3.64)	21.27 (4.66)	17.50 4.24	22.17 (4.76)	27.10 (5.25)	36.67 6.09	35.13 (5.97)	19.18 (4.44)
T3	ACH-152-2BG-II	5.20 (2.39)	10.70 (3.35)	13.57 (3.75)	18.27 (4.33)	16.03 (4.06)	24.37 4.98	24.27 (4.98)	29.00 (5.42)	31.30 5.64	38.20 (6.21)	19.18 (4.44)
T4	ACH-115-2BG-II	4.33 (2.20)	7.07 (2.75)	10.10 (3.25)	14.17 (3.83)	14.20 (3.83)	19.67 4.48	19.83 (4.51)	24.67 (5.01)	34.30 5.90	33.80 (5.85)	20.93 (4.63)
T5	ACH-1133-2BG-II	4.87 (2.31)	7.63 (2.83)	11.50 (3.45)	13.10 (3.68)	12.17 (3.55)	19.17 4.43	20.47 (4.58)	25.77 (5.12)	28.33 5.37	34.73 (5.93)	18.12 (4.32)
T6	ACH1199-2BG-II	3.87 (2.09)	6.53 (2.62)	9.33 (3.13)	11.33 (3.41)	13.10 (3.68)	15.90 4.04	25.30 (5.06)	29.33 (5.46)	29.33 5.46	39.13 (6.29)	17.83 (4.28)
T7	RCH-2BG-II (CHECK)	4.27 (2.18)	6.67 (2.68)	9.67 (3.19)	12.27 (3.57)	18.03 (4.30)	16.10 4.06	20.17 (4.54)	25.17 (5.05)	34.67 5.92	34.07 (5.87)	17.57 (4.25)
T8	ACHB-90-1BG-II	5.03 (2.35)	7.10 (2.75)	10.40 (3.29)	16.13 (4.08)	12.57 (3.50)	21.03 4.63	23.10 (4.86)	27.33 (5.27)	28.83 5.41	36.73 (6.09)	18.00 (4.30)
T9	MRC-7918BG-II (CHECK)	4.03 (2.13)	6.57 (2.65)	9.43 (3.13)	11.50 (3.39)	13.30 (3.71)	22.50 4.77	27.03 (5.24)	31.17 (5.62)	32.67 5.75	40.70 (6.42)	18.77 (4.39)
	SEm ±	NS	0.16	NS	0.22	NS	0.22	0.17	NS	0.16	0.18	0.05
	CD at 5 %	NS	0.51	NS	0.68	NS	0.70	0.55	NS	0.50	0.57	0.17
	CV %	-	9.73	-	9.80	-	8.55	6.19	-	4.79	5.11	2.12

Values in parentheses are square root transformed values $\left(\sqrt{x+0.5}\right)$

Table 4. Thrips population in cotton hybrids during 2015-16

S. No	Hybrids	20 DAG	30 DAG	40 DAG	50 DAG	60 DAG	70 DAG	80 DAG	90 DAG	100 DAG	110 DAG	Over all mean	Cotton yield
T1	ACH-1BG-II	6.00 (2.54)	5.20 (2.39)	9.80 (3.21)	12.83 (3.64)	21.37 (4.68)	25.10 (5.05)	28.73 (5.40)	28.17 (5.35)	33.17 (5.80)	37.33 (6.15)	19.63 (4.49)	1045
T2	ACH-104-2BG-II	5.60 (2.46)	4.33 (2.20)	12.90 (3.66)	18.27 (4.33)	13.77 (3.77)	17.50 (4.24)	23.67 (4.92)	32.67 (5.75)	36.67 (6.09)	43.33 (6.62)	18.24 (4.33)	1463
T3	ACH-152-2BG-II	5.40 (2.43)	4.87 (2.31)	11.37 (3.44)	14.17 (3.83)	21.27 (4.66)	24.37 (4.98)	27.37 (5.26)	27.10 (5.25)	31.30 (5.64)	35.13 (5.97)	18.76 (4.39)	2262
T4	ACH-1152BG-II	4.27 (2.18)	3.87 (2.09)	10.20 (3.27)	13.10 (3.68)	16.03 (4.06)	19.67 (4.48)	22.17 (4.76)	29.00 (5.42)	34.30 (5.90)	38.20 (6.21)	17.13 (4.20)	2108
T5	ACH-1133-2BG-II	5.00 (2.34)	4.27 (2.18)	8.43 (2.99)	11.33 (3.41)	14.20 (3.83)	19.17 (4.43)	24.27 (4.98)	24.67 (5.01)	28.33 (5.37)	33.80 (5.85)	16.01 (4.06)	2022
T6	ACH1199-2BG-II	4.20 (2.15)	5.03 (2.35)	9.33 (3.13)	12.27 (3.57)	12.17 (3.55)	15.90 (4.04)	19.83 (4.51)	25.77 (5.12)	29.33 (5.46)	34.73 (5.93)	15.17 (3.96)	2699
T7	RCH-2BG-II(CHECK)	4.47 (2.22)	4.03 (2.13)	12.30 (3.56)	16.13 (4.08)	13.10 (3.68)	16.10 (4.06)	20.47 (4.58)	29.33 (5.46)	34.67 (5.92)	39.13 (6.29)	16.37 (4.10)	1795
T8	ACHB-901BG-II(HYB)	4.33 (2.20)	7.30 (2.79)	9.10 (3.05)	11.50 (3.39)	18.03 (4.30)	21.03 (4.63)	25.30 (5.06)	25.17 (5.05)	28.83 (5.41)	34.07 (5.87)	17.24 (4.21)	1738
T9	MRC-7918BG-II(HYB)(CHECK)	4.20 (2.16)	8.03 (2.92)	9.53 (3.17)	12.67 (3.62)	12.57 (3.50)	17.60 (4.24)	20.17 (4.54)	27.33 (5.27)	30.00 (5.52)	36.73 (6.09)	15.93 (4.05)	2602
	SEm ±	NS	0.09	NS	0.22	0.22	0.19	NS	0.17	0.13	0.19	0.06	109.3
	CD at 5 %	NS	0.28	NS	0.70	0.71	0.59	NS	0.55	0.41	0.61	0.20	327.7

	CV %	-	6.42	-	10.24	9.72	7.24	-	5.71	4.90	5.47	2.67	9.75

Values in parentheses are square root transformed values $\left(\sqrt{x+0.5}\right)$

Seed cotton yield

The Highest seed cotton yield (table 4) was observed in ACH-1199-2BG-II(2699 kg/ha and found at par with standard check MRC-7918 BG-II(2602 kg/ha) followed by ACH-104-2BG- II (2262 kg/ha), ACH-1133-2BG -II (2022 kg/ha), ACH-152-2BG-II(2108 kg/ha), standard check RCH-2 BG-II (1795 kg/ha.), ACHB-90-1BG-II (1738 kg/ha.), ACH-104-2BG-II (1463kg/ha.) ACH-1BG-II (1045kg/ha). Bennett *et al.* (2004) reported that cotton growers have increased yield on adopting *Bt* cotton. Similarly, Zahid *et al*. (2004) revealed that *Bt* cotton recorded significantly higher yield than the non-transgenic cotton. Further Shera, et al (2014) also recorded the highest mean seed cotton yield (2342 kg/ha) in RCH 134 *Bt* recorded as compared to other test *Bt* hybrids (851 to 2083 kg/ha). In the same way The above findings are in the line of agreement with the present study.

REFERENCES

Anonymous (2002). All india co-ordinated cotton improvement project. Annual report, 85p.

Babu, S. R. and Meghwal, M. L. (2014) Population dynamics and monitoring of sucking pests and bollworms on *Bt* cotton in humid zone of southern Rajasthan. *The Bioscan* **9**(2):629-632.

Bennett, R. Ismael, Y. Morse, S. and Shankar, B. (2004) Reductions in insecticide use from adoption of *Bt* cotton in South Africa: impacts on economic performance and toxic load to the environment. *Journal of Agricultural Science* 142(6): 665-674.

Mohapatra, L. N. and Nayak, S. K. (2014) Performance of *Bt* cotton hybrids against sucking pests under rainfed condition in Odisha. *Journal of Plant Protection and Environment* **11**(2):115-117.12

Muchhadiya, D. V. Saradava, D. A. and Kabaria, B. B. (2014) Population dynamics of insect pests and some of their natural enemies and their correlation with weather parameters on *Bt* cotton . *Indian Journal of Agricultural Sciences* **84**(5):572-578.

Nagrare, V.S., Deshmukh, A.J. and Bisane, K.D. (2014) Relative Performance of Bt-Cotton Hybrids against Sucking Pests and Leaf Reddening under Rainfed Farming. *Entomol Ornithol Herpetol* 3:134.

Phulse, V. B. and Udikeri, S. S. (2014). Seasonal incidence of sucking insect pests and predatory arthropods in desi and *Bt* transgenic cotton. *Karnataka Journal of Agricultural Sciences* **27**(1):28-31.

Saif-ur-Rehman, Jamil S., Waseem A., Waqas A., Atiq, M., Suhail, A. and Iqbal, M. (2013) population dynamics of thrips on transgenic and non-transgenic cultivars of cotton. *Advances in Zoology and Botany* **1**(4):71-77.

Sarwar, M., Hamed, M., Yousaf, M. and Hussain, M. (2013). Identification of resistance to insect pests infestations in cotton (*Gossypium hirsutum* L.) varieties evaluated in the field experiment. *International Journal of Scientific Research in Environmental Sciences* **1**(11): 317-323.

Shera, P. S. Sohu, R. S. Gill, B. S. Sekhon, P. S. and Sarlach, R. S. (2014) Relative performance of different *Bt* cotton cultivars expressing single and dual toxin for pest infestation, yield and fibre quality parameters. *Vegetos* **27**(3):237-243.

Vennila, S., Bradar, V.K. Gadpayle, J.G. Panchbhai, P.R. Ramteke, M.S. Deole, S.A. and Karanjkar, P.P. (2004). Field evaluation of *Bt* transgeniccotton hybrids against sucking pests and bollworms. *Indian J. Plant Protection,* **32**(1): 1-10.

Zahid, Mahmood, Soomro, A.R. Khan, Kifayatullah Illahi, Noor and Muhammad, Ishaq (2004) Seed cotton yield comparison between transgenic *Bt*-cotton and non-transgenic commercial cotton. *Indus Cottons* **2**(1): 72-74.