

Original Research Article

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Field Evaluation of Genetic Variability of Cotton *Gossypium hirsutum* L. Genotypes against Sucking Pests and Bollworms

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A total of 27 cotton *Gossypium hirsutum* genotypes were field evaluated during 2018-19 at Regional Agricultural Research station Nandyal under AICRP-Cotton programme for their reaction towards sucking pests, leaf hopper *Amrasca devastans* Distant in particular and bollworms. Results revealed that all the test genotypes were moderately tolerant towards sucking pest particularly leaf hoppers and exhibited below economic threshold level populations but among them, genotype CNH-2052 had recorded lowest leafhopper population of 2.87/3 leaves which was statistically at par with majority of the genotypes. With regard to bollworm populations *Helicoverpa armigera* hub and *Earias vietella* were low during the season with regard to *Pectinophora gossypiella* saunders the genotype LC had recorded the lowest green boll damage of 9.70 % on boll basis by pink bollworm. Lowest open boll damage of 8.73, 9.65, 7.66, 9.41% was recorded by genotypes AKH 10-3, CPD 1851, RAH 1075 and RHC 1307 respectively.

Introduction

Cotton *Gossypium hirsutum* L. (Family: Malvaceae) is the major commercial crop cultivated in India, majority of the cotton area is occupied with Bollgard II cotton which contains crystal proteins of Cry I AC and Cry II AB which confers resistance to bollworms [1,2]. The Bollgard-I with a single Bt gene was followed in 2006 by Bollgard-II with two Bt genes. Currently Bt cotton hybrids expressing six events different combination of three Bt genes have been commercialized in India. These have been introduced into 780 cotton hybrids. From a low initial uptake in

2002, Bt cotton has spread to over 85% of the cotton area, covering 9.4 million hectares in 2010-11 [3]. Bt cotton performed satisfactorily during the initial years of release but off late during the last one decade there was wide spread attack of pink bollworm on Bt-II cotton throughout the country making it vulnerable to the pink bollworm. Resistance monitoring studies done at CICR have demonstrated that bollworm *Helicoverpa armigera*, the target pest of Bt cotton, has developed tolerance for it. Other studies have also shown bollworm surviving and reproducing in Bt cotton both single gene and double gene Bt [4]. Though Bt cotton has

been found successful in the management of bollworms to some extent barring pink bollworm, however, it has invited other insect pests especially sucking pests due to reduction in pesticide sprays at early stage. Resistance to Bt cotton in pink bollworm is now widespread in India, and resistance to insecticide in many pests is increasing [5]. Before the advent of Bt cotton in India i.e. prior to 20002 majority of the cotton area was covered with *Gossypium hirsutum* either with straight varieties of intra hirsutum hybrids which is known as American and upland cotton which produces about 90% of the total cotton production in the world. insecticide valued at US \$ 660 million are used annually on all crops in India, of which more than half are used on Bt cotton[6]. In India, cotton is grown as a staple cash crop and accounts for 126.07 M hectare area with 337 MT of production during 2018-19. Bt cotton off late is becoming increasingly susceptible to sucking pests particularly leaf hoppers *Amrasca devastans* Distant and other sucking pests like whiteflies, Thrips, Mealy bug and Mirid bug. Leafhopper alone can cause damage upto the extent of 38-44% during the period of heavy incidence. The cotton Mirid bug *Creontiades biseratense* (Distant) found as emerging pests of Bt cotton and found in Tamil nadu, Andhra Pradesh and Maharashtra[7]. Cotton Mirid bug *Creontiades biseratense* (Distant) causing heavy shredding of squares and bolls which lead to significant reduction in seed cotton yield [8] Monsanto disclosed that the cotton pest pink bollworm *Pectinophora gossypiella* saunders had developed resistance to the Cry 1Ac toxin (Bt) in Bollgard I in Gujarat [9]the first State where Bt cotton was planted commercially. Resistance monitoring studies done at CICR have demonstrated that bollworm *Helicoverpa armigera* the target pest of Bt cotton, has developed tolerance for it. Other studies have also shown bollworm surviving and reproducing in Bt cotton both

single gene and double gene Bt [10]. Emergence of secondary pests In his 2011 report Dr. Kranthi states Productivity in north India is likely to decline because of the declining potential of hybrids, the emerging problem of leaf curl virus on the new susceptible Bt-hybrids a high level of susceptibility to sucking pests (straight varieties were resistant) problems with nutrient deficiencies and physiological disorders and mealy bugs, whiteflies and miscellaneous insect problems that are likely to increase. Grey mildew once a serious problem in diploid cotton especially in central India has now become a major problem in Bt cotton hybrids in central and south zone in India [11]. Cotton is infested by a large number of insect pests right from the sowing till harvest in the early stages, sucking pests like aphids, thrips, leaf hoppers and white flies cause serious problem and resulting reduction in yield and quality of cotton. The sucking pests cause 22.58 per cent reduction in cotton yield [12]. Mealy bug not observed in India before, has spread in the cotton regions and farmers have been spraying extremely hazardous pesticides to eliminate this hard-to-kill pest.

The prolific spread of Bt cotton hybrids has created a conducive climate for the rapid spread of this pest. Looking at the inconsistent performance of Bt cotton hybrids since last few years under changing scenario of climate, group of farmers particularly cultivating cotton on marginal soils under rain fed conditions are looking forward to non Bt varieties or hybrids of *Gossypium hirsutum*, keeping in view of the short comings of boll gard II cotton it is time for refocusing our breeding research on straight hirsutum varieties which are comparatively more tolerant to insect pests than Bt cotton and also yields at par with Bt cotton under good management practices. Hence the present study was aimed at screening the cotton

hirsutum genotypes in field condition provided by AICRP- Cotton Coimbatore for their tolerance towards sucking pests and bollworms which in future may be used as parent material in developing an elite variety or non Bt hybrid.

Materials and Methods

A Field trial was conducted to screen the cotton hirsutum genotypes provided by the AICRP-Cotton, Coimbatore under initial evaluation trial of cotton genotypes at Regional Agricultural Research Station, Nandyal during kharif 2018. A total 27 cotton genotypes were field evaluated for their reaction against sucking pests and boll worms, trial was laid out in Randomized block design with three replications. Standard susceptible check for sucking pests DCH-32 hybrid and tolerant check NDH-1938 variety were used and tolerant check for bollworms BG-II (Jadoo) and susceptible check DCH-32 were used for comparison of genotypes. Each entry was laid in three meters row length with two rows for each entry with spacing of 60x30cm was maintained between the rows and plants respectively, after every three entries a row of bhendi crop was raised as infestor row to build up natural leafhopper population.

All the standard agronomic practices were adopted as prescribed by the university except plant protection measures. Sucking pests count was taken on five tagged plants from each entry on three leaves top, middle and bottom. Data on sucking pests was recorded at 30, 60, and 90 DAS, green boll damage by *Helicoverpa armigera*, *Earias vitell* and *Pectinophora gossypiella* were recorded at 100,110,140 DAS open boll damage and locule damage was recorded at 150 DAS. Yield of seed cotton in kg/ha was recorded at the time of harvest the data thus obtained was subjected to statistical analysis.

Results and Discussion

Under this trial, total of 27 entries along with four checks (B.G II, non Bt, NDH-1938, DCH-32) were screened for their resistance against insect pests of cotton. Among the 27 entries screened the entry CNH 2052 has recorded the lowest leafhopper population of 2.87 leafhoppers/ 3 leaves which was on par with majority of the entries. However, the highest leafhopper population (8.87 leafhoppers/ 3 leaves) was recorded in Standard susceptible check DCH-32. Jassid population was below ETL in all the entries. The other sucking pests like thrips and whiteflies were also recorded below ETL. No significant difference was observed among the entries with respect to natural enemy population.

Among the bollworms, the field incidence of *Helicover armigera*, *Spodoptera litura* and *Earias* spp was almost negligible. The entry LC has recorded the lowest green boll damage (boll basis) 9.70 % by pink bollworm which was on par with the majority of the entries. Standard tolerant check B.G-II had recorded a damage of 11.13%. However highest green boll damage of 20% was recorded in entry ADB 645. Standard check BG II had recorded a lowest of 6.11% open boll damage, which was on par with entries AKH 10-3, CPD 1851, RAH 1075 and RHC 1307 which recorded 8.73, 9.65, 7.66, 9.41% respectively.

The lowest open boll locule damage of 2.04 % was recorded in standard check B.G.II which was on par with entries CNH 1131, ADB 645, CNH 16300, CPD 1852, NH 704, BGDS 1077, ZC (NH 615/ NDH 1938), RAH 1076 which recorded 2.16, 2.22, 2.34, 3.19, 3.33, 3.56, 3.62 and 3.71% respectively. Whereas the highest open boll locule damage was recorded in check DCH-32 (7.39 %). (Table 1 & 2).

Table.1 Reaction of cotton hirsutum germplasm against sucking pests

Entrycode	Jassid injury Grade	Jassids /3leaves		Whitefly /3leaves		Thrips/ 3leaves	
		O.V	T.V	O.V	T.V	O.V	T.V
RHC 1306	I	3.60	2.02*	0.27	0.87*	0.00	0.71*
ZC (NH 615/ NDLH 1938)	II	4.20	2.15	0.13	0.79	0.00	0.71
RAH 1076	II	4.20	2.13	0.27	0.87	0.33	0.88
AKH 10-3	I	3.07	1.88	0.13	0.79	0.93	1.14
CPD 1852	I	3.67	2.04	0.00	0.71	0.27	0.85
ADB 645	I	3.93	2.10	0.00	0.71	0.00	0.71
NDLH – 2057-1	I	3.20	1.92	0.07	0.75	0.73	1.02
NH 704	I	3.93	2.10	0.13	0.79	0.40	0.91
CNH 2052	I	2.87	1.83	0.27	0.87	0.00	0.71
LC	II	4.27	2.17	0.00	0.71	0.00	0.71
CNH 09/11	II	3.87	2.08	0.13	0.79	0.27	0.85
CNH 2073	II	3.73	2.03	0.40	0.95	0.27	0.85
ARBH 1851	I	3.27	1.94	0.20	0.84	0.40	0.93
BS 5-18	II	4.13	2.14	0.20	0.83	0.20	0.82
GBHV 200	II	4.33	2.19	0.20	0.84	0.33	0.88
CPD 1851	II	3.87	2.09	0.07	0.75	0.20	0.82
CNH 1131	I	3.80	2.06	0.33	0.91	0.87	1.12
NDLH – 2035-5	I	3.53	1.99	0.33	0.90	0.60	1.02
BGDS 1077	II	4.60	2.26	0.27	0.87	0.40	0.93
BS 6-18	I	3.27	1.93	0.27	0.85	0.33	0.88
CNH 16300	II	4.13	2.13	0.13	0.79	0.73	1.06
CNH 09-73	I	3.40	1.95	0.20	0.83	0.07	0.75
RHC 1307	I	3.67	2.03	0.00	0.71	0.87	1.13
RAH 1075	II	4.60	2.25	0.13	0.79	0.40	0.93
GBHV 201	I	4.00	2.09	0.13	0.79	0.40	0.91
Quality Check (Suraj)	I	4.60	2.25	0.13	0.79	1.33	1.29
H 1525	I	3.00	1.87	0.27	0.87	0.40	0.93
BG-II	I	3.80	2.03	0.20	0.83	0.73	1.06
DCH-32	III	8.87	3.05	0.13	0.79	0.00	0.71
NDLH-1938	II	5.27	2.40	0.13	0.79	0.00	0.71
Non-bt	I	3.33	1.95	0.13	0.79	0.33	0.88
F-Test		S		NS		NS	
SEd		0.22		0.09		0.23	
CD(P=0.05)		0.45		NS		NS	
CV(%)		13.08		13.78		31.28	

TV are $\sqrt{(x+0.5)}$ transformed values ** TV are arc-sin transformed values

Table.2 Reaction of cotton hirsutum germplasm against bollworm complex

Entry code	Natural Enemies/plant		Percentage of boll damage						yield (kg/ha)
			Green boll damage (%)		Open boll damage (%)		Locule damage(%)		
	O.V	T.V	O.V	T.V	O.V	T.V	O.V	T.V	
RHC 1306	0.00	0.71*	14.11	21.99**	13.36	21.36**	4.04	11.49**	581
ZC (NH 615/NDLH 1938)	0.20	0.83	10.90	19.24	11.67	19.87	3.62	10.89	946
RAH 1076	0.07	0.75	12.00	20.10	12.05	20.19	3.71	11.09	579
AKH 10-3	0.13	0.79	13.35	21.39	8.73	17.13	4.47	12.14	820
CPD 1852	0.07	0.75	10.27	18.62	17.18	24.43	3.19	10.27	902
ADB 645	0.00	0.71	20.00	26.46	18.19	24.99	2.22	8.37	1067
NDLH –2057-1	0.00	0.71	11.33	19.49	13.66	21.60	6.45	14.62	859
NH 704	0.07	0.75	10.68	19.01	11.78	20.07	3.33	10.48	807
CNH 2052	0.00	0.71	19.85	26.31	20.13	26.63	6.27	14.40	1286
LC	0.07	0.75	9.70	18.09	12.63	20.78	5.08	13.00	873
CNH 09/11	0.13	0.79	16.44	23.87	12.37	20.57	4.75	12.47	531
CNH 2073	0.07	0.75	10.07	18.49	22.52	28.21	4.79	12.47	954
ARBH 1851	0.13	0.79	10.18	18.55	13.72	21.62	5.16	13.11	1584
BS 5-18	0.07	0.75	10.59	18.93	18.74	25.55	3.95	11.25	1438
GBHV 200	0.07	0.75	14.86	22.57	17.90	24.92	5.14	13.10	886
CPD 1851	0.00	0.71	17.25	24.28	9.65	17.99	6.00	14.11	953
CNH 1131	0.13	0.79	13.47	21.50	14.04	21.93	2.16	8.22	1056
NDLH –2035-5	0.00	0.71	12.33	20.51	13.59	21.61	5.25	13.09	1414
BGDS 1077	0.00	0.71	9.73	17.92	16.46	23.84	3.56	10.85	864
BS 6-18	0.07	0.75	17.07	24.30	15.19	22.89	6.55	14.68	1771
CNH 16300	0.07	0.75	10.94	19.26	15.59	23.25	2.34	8.80	937
CNH 09-73	0.07	0.75	16.22	23.65	13.49	21.44	5.42	13.35	800
RHC 1307	0.00	0.71	14.67	22.49	9.41	17.69	3.75	11.15	2070
RAH 1075	0.00	0.71	13.40	21.42	7.66	16.04	2.79	9.57	1827
GBHV 201	0.00	0.71	10.74	19.10	10.84	19.02	2.06	8.21	1274
Quality Check (Suraj)	0.00	0.71	17.75	24.67	16.13	23.62	4.06	11.57	1427
H 1525	0.00	0.71	10.37	18.73	13.15	21.24	4.68	12.34	799
BG-11	0.00	0.71	11.13	19.45	6.11	14.29	2.04	8.16	1202
DCH-32	0.13	0.79	12.61	20.79	28.61	32.28	7.39	15.65	755
NDLH-1938	0.07	0.75	12.17	20.25	12.47	20.66	7.31	15.56	1227
Non-bt	0.00	0.71	11.52	19.81	20.82	27.16	4.78	12.51	1194
F-Test	NS		S		S		S		S
SEd	0.06		2.25		2.21		1.51		367.73
CD(P=0.05)	NS		4.50		4.42		3.02		735.07
CV(%)	9.40		13.12		12.24		15.66		41.60

The above results indicate that some of the cotton *hirsutum* genotypes have the innate potential of tolerance towards sucking pests and bollworms and can be further exploited as parent material in future breeding programmes, the same was corroborated by Percival and Kohel 1990 [13] who studied extensive genetic variation among the members of genus *Gossypium*. The wild and cultivated species have wider adoptability and high degree of resistance to biotic and abiotic stresses, wild species have been utilized to transfer the resistance to various insect pest and diseases and improving cultivated cotton species especially *Gossypium hirsutum* [14] new germplasm if used in crop improvement programs can raise the ceiling of genetic yield potential, improve resistance to biotic and abiotic stresses, and add new developmental pathways and ecological adaptations[15] Some of the intra *hirsutum* cotton hybrids or straight varieties released by different state agricultural universities before the dawn of Bt cotton stands as testimony for potential of *hirsutum* genotypes they also ruled the cotton cultivation during pre Bt era. NHH 250 an intra *hirsutum* hybrid developed by cotton research station, Nanded [16] this hybrid is tolerant to Bacterial blight and *Alternaria* leafspot and also tolerant for sucking pests. NHH -44 [17] released by same station is having rejuvenation quality of flowering also drought tolerant, this hybrid dominated cotton cultivation scenario of the country for two decades and slowly moved out of chain with the introduction of Bt cotton. Productivity of Bt cotton in north India is likely to decline because of the declining potential of hybrids and the emerging problem of leaf curl virus on the new susceptible Bt-hybrids, high level of susceptibility to sucking pests (straight varieties were resistant) problems with nutrient deficiencies and physiological disorders and mealy bugs, whiteflies and miscellaneous insect problems that are likely to increase in Bt cotton. The variety NH-635 released by cotton research station Nanded [18] is found suitable for High density planting systems particularly in shallow soils. The different cotton genotypes have varying densities of trichomes on the leaves

absence of trichomes increased the attractiveness of the cotton plant to some major insect pests, thus increasing the reliance on pesticides [19]. The glory of these non Bt varieties or Hybrids may come back in the coming years as the conversion programme of the straight varieties /Hybrids under public/private partnership. Keeping this in background selection and screening of elite cotton genotypes tolerant to biotic and abiotic stress plays a pivotal role in future breeding programmes.

In conclusion as Bt cotton hybrids are increasingly becoming vulnerable to different emerging pests, new diseases, and physiological disorders and the yield levels are also becoming plateau, it is high time for breeders to evolve and screen new cotton germplasm which are tolerant to biotic and abiotic stress and which are high yielders which will become parent material for future breeding programmes. The selection of the best cotton varieties to be grown at farms level requires a detail comparison of germplasms in local tests that can match with growing conditions of a region. Thus, host plant resistance may be useful as a selection criterion in breeding programs with the objective of improving pests tolerance and yield in cotton which can help to escape the heavy attack occurring throughout the season.

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