RESEARCH ARTICLE

SCREENING COTTON GENOTYPES AGAINST *BEMISIA TABACI* IN SOUTH WESTERN PUNJAB

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Abstract: Field evaluation of 47 genotypes was carried out for screening against whitefly (*Bemisia tabaci*) in South-western region of Punjab. The population of whitefly was recorded on each genotype after 60, 90, 120 days of sowing during 2015 and 2016. Damage index was calculated and these genotypes were categorized into 6 categories - most resistant, resistant, moderately resistant, susceptible, moderately susceptible and highly susceptible. The genotypes with highest damage index were categorized highly susceptible whereas the genotypes with lowest damage index were categorized as most resistant. During the present study, some of the genotypes were found resistant. In relation to climate, population of whitefly was reported highest during the month of August-September.

Keywords: Cotton, Genotypes, Whitefly, *Bemisia tabaci,* Damage index

INTRODUCTION

Cotton, a cash crop, is a natural fibre grown worldwide (Riaz *et al.*, 2013). It provides basic raw material for textile industry. The crop is of great economic importance as it plays a crucial role in agricultural and industrial development and is the main source of foreign income through export of its raw materials and refined products (Tuteja, 2014). Therefore, adequate production of cotton to fulfill the fibre needs of the increasing world population has become a necessity (Farooq *et al.*, 2013). Cotton productivity is influenced by many abiotic and biotic factors. Abiotic factors are mainly concerned with environment whereas biotic factors are related with insect-pest and diseases. During the whole growing period of the crop, attack of 1326 insect-pests has been estimated, which results in heavy quantitative and qualitative losses to the crop (Manjunath, 2004). For the control of the insect-pests, farmers depend on the use of chemical control (Arif *et al*., 2007) leading to increase in cost of production, reducing the population of natural enemies of the pest, development of pesticide resistant races of the pest and environmental pollution. One of the most hopeful ways to improve cotton productivity and quality is to grow resistant varieties, which is very efficient, inexpensive, economical and environment friendly approach (Pedigo, 1989).

Host plant resistance acts as an effective tool for controlling the insect pests by enabling the plant to avoid, tolerate or recover from insect-pest attack (Pedigo, 1996). Over the years, many Bt and non-Bt varieties and hybrids of cotton have been introduced. These commercialized transgenic Bt cotton cultivars though resistant to bollworm attack but are highly vulnerable to sucking insect-pests (Kranthi *et al.*, 2005). Among sucking pests, whitefly (*Bemisia tabaci* Genn. Homoptera: Aleyrodidae) plays an important role by sucking a large amount of plant juices (Oleveira *et al.*, 2001). It also causes indirect loss by secreting honeydew, closing respiratory pores, enhancing growth of sooty mold fungus and reducing the process of photosynthesis. Most importantly, it act as a vector of some dangerous plant viruses, which are acquired and transmitted between plants through this insect. Some of these viruses are Tomato leaf curl virus (TLCV), Cotton leaf curl virus (CLCV), Cucurbit yellow stunting disorder virus (CYSDV) and Sweet potato mild mottle virus (SPMMV) (Makkouk *et al.*, 1979; Byrne and Bellows, 1991; Ioannou, 1994; Ismail *et al.*, 2004).

Therefore, this pest is responsible for huge loss of quality and quantity of plants. A large number of Bt cotton hybrids developed by different private seed companies are being cultivated by the farmers in our country. But there is a great need for screening of these Bt cotton hybrids against disease/pest attack before recommending them to the farmers. With this purpose, 47 genotypes of cotton were tested against the attack of *Bemisia tabaci* in South-Western region of Punjab.

MATERIAL AND METHOD

The study was conducted at Regional Station of Punjab Agricultural University, Bathinda, Punjab, India for two consecutive crop seasons *i.e.* 2014-15 and 2015-16. The crop was sown at a site having 74º 18' E longitude, 30º 58' N latitude and 211m altitude. The site is characterized by semi-arid climate with three distinct seasons including hot and dry summer (April to June), hot and humid monsoon (July to September) and cold winters (November to January). The cotton seed was provided by different private seed companies. Sowing of 47 varieties of cotton was done in the month of May at a spacing of 67.5cm (row to row) and 75cm (plant to plant) in a plot size of 6.0m in a Completely Randomized Block Design

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(CRBD) following package of practices recommended by PAU.

The population of whitefly was recorded at three different time periods: 60, 90 and 120 days after sowing. The data was taken from three plants/ plot with three fully opened leaves of the upper canopy/plant before 10 a.m. Statistical analysis was done as per procedure laid down for completely randomized block design (CRBD). Analysis of variance, critical difference (CD) and variance components were calculated for interpretation of results following the study done by Panse and Sukhtame (1989). The recorded data was subjected to analysis with CPCS1 software developed by Department of Mathematics and Statistics, Punjab Agricultural University, Ludhiana. The mean and critical differences were calculated for finding the significance of the recorded data. The genotypes were categorized into six categories on the basis of rating scale of 0-5 which was calculated according to the formula given by Ahmad (1993) given below:

Rating 0 = $\bar{x}(A) < (\bar{X} - \sigma)$

Rating 1 = $(\bar{X} - \sigma) < \bar{x}(A) < (\bar{X} - \frac{\sigma}{2})$

Rating 2 = $(\bar{X} - \frac{\sigma}{2}) < \bar{x}(A) < (\bar{X})$

Rating 3 = $(\bar{X} + \frac{\sigma}{2}) > \bar{x}(A) > (\bar{X})$

Rating 4 = $(\bar{X}+\sigma) > \bar{x}(A) > (\bar{X} + \frac{\sigma}{2})$

Rating 5 = $\bar{x}(A) > (\bar{X} + \sigma)$

Where $\bar{x}(A)$ is the mean population of whitefly, $\bar{X}$ is the overall mean of whitefly population for all the 47 genotypes and σ is the standard deviation.

The reaction of different genotypes was noted down according to the table given below:

S. No.	Category code	Rating	Reaction
1	R1	0	Most resistant
2	R2	1	Resistant
3	R3	2	Moderately resistant
4	S3	3	Moderately susceptible
5	S2	4	Susceptible
6	S1	5	Most susceptible

Weightage percentage of resistance was calculated by considering minimum and maximum population of whitefly as 0 to 100 and applying the following formula:

$$WPR = \frac{MaLAF - LAFFC}{MaLAF - MiLAF}$$

where WPR is the weightage percentage of resistance, $MaLAF$ is the maximum whitefly population, $LAFFC$ is the population of whitefly in the concerned genotype and $MiLAF$ is the minimum whitefly population.

RESULT AND DISCUSSION

Field evaluation of 47 genotypes was carried out for screening against whitefly (*Bemisia tabaci*) in South-western region of Punjab. The population of whitefly was recorded on each genotype after 60, 90, 120 days of sowing during 2015 and 2016. Damage index was calculated according to the formula given by Ahmad (1994). Categorization of different genotypes was done on the basis damage index and is given in table 1 & 2. During 2015, the genotypes *viz*. Ankur 3228, Cotton H. Gold star BGII, KDCHH 541, Super 971 in which damage index was less than 32.17 after 60 days of sowing were categorized as most resistant and the genotypes *viz*. 6539-2, KSCH 211, PCH 877, RCH 314, RCH 653, SO7H 878, SWCH 4713 having damage index more than 76.59 after 60 days of sowing were categorized as most susceptible. The genotypes ABCH 244, Ankur 3244, JKCH 8935, JKCH 8940, MRC 7365, NSPL 2223, RCH 314, RCH 791, SO7H 878, SWCH 4713 in which damage index was less than 85.27 after 90 days of sowing were categorized as most resistant and the genotypes *viz*. ABCH 243, Ankur 3228, Cotton H. Solar-BGII, JKCH 0109, KSCH 213, MRC 7041, PCH 877, RCH 653, RCH 773, SWCH 4755 having damage index more than 138.09 after 90 of sowing were categorized as most susceptible genotypes. The genotypes in which damage index was less than 8.90 after 120 days of sowing were categorized as most resistant and the genotypes having damage index more than 12.02 after 120 days of sowing *viz*. 6539-2, KSCH 211, PCH 877, RCH 314, RCH 653, SO7H 878, SWCH 4713 were categorized as most susceptible.

During 2016, the data for population of whitefly was recorded on 60, 90, 120 days after sowing. After 60 days, the population of whitefly was found comparatively lower on Ankur 3028, Ankur Jassi, JKCH 8940, MH 5302, PRCH 7799 and these genotypes were found most resistant with a damage index ranging from <4.58. The genotypes having damage index >12.07 fall under the category of most susceptible genotypes and these were 6539-2, Ankur3224,Ankur 3244, JKCH 0109, RCH 314, RCH 791, SWCH 4707 and SWCH 4744. After 90 days, the population of whitefly was found comparatively lower on ABCH 243, Cotton H.Solar-75BGII, JKCH 8940, KDCHH 516, NAMCOT 616, PRCH 333, PRCH 7799, SWCH 4713 and these were found comparatively resistant with a damage index of <8.62 and three genotypes *viz*. Cotton H. Gold Star, RCH 653, RCH 773 (DI >11.13) with high population of whitefly were categorized as most susceptible. After 120 days, Ankur Jassi, MH 5302, MRC 7365, NSPL 2223, PCH 877, RCH 791, SWCH 4707, SWCH 4755 were found most resistant as population of whitefly was lower and damage index was also lower (DI < 8.62). The genotypes namely Ankur 3244, Cotton H. Solar-77 BGII, JKCH 1050, JKCH 1947, JKCH 8935, JKCH TARZAN, KDCHH 541, MRC 7041, Super 971, SWCH 4713 were categorized as most susceptible due to higher population of whitefly recorded after 120 days of sowing and consequent higher damage index of > 37.31. .

During these investigations, it was concluded that different genotypes possess differential response to *Bemisia tabaci* and no genotype escaped from its attack. However, differences in resistance level between different cultivars were found which may be due to the genetic makeup of the plant or certain morphological or physiological characters or due to some bio-chemical composition of the plant leaves. These genotypes can further be evaluated for mechanism of resistance. Present investigations are parallel to the study done by some of the workers. Mumtaz *et al*. (1997) identified resistant genotype among seven varieties tested against whitefly. Robert *et al*. (1997) observed differential response of *Bemisia argentifolii* (Homoptera: Aleyrodidae) to *Gossypium* genotypes. Various research workers namely Karar *et al.* (2013) worked on onion genotypes, Babar *et al.* (2013) and *Shahid et al.* (2015) on cotton cultivars, Karar *et al.* (2015) on mango cultivars and found that there is a variation in resistance level among different crops. Nath *et al.* (2000), Shad *et al.* (2001) and Amjad *et al.* (2009) reported differences of resistance levels in different crop genotypes against sucking pest complex. Vikas *et al.* (2007) also worked on cotton genotypes for screening their resistance to whitefly. Ali and Aheer (2007) observed varietal resistance of cotton genotypes against sucking insect-pests. Javaid *et al.* (2012) also carried out experiments for screening 10 cotton genotypes against whitefly and find differences in resistance/susceptibility.

Karar *et al.*(2016) observed difference in resistance of cotton genotypes. Variation in resistance level among different cotton varieties against sucking pests has also been reported by earlier workers (Ali *et al*., 1999, Nath *et al*., 2000). Acharya and Singh (2007) also did work on screening the cotton germplasm against whitefly and categorized them into four categories *viz*. resistant/tolerant, moderately resistant, moderately susceptible and susceptible based on the criteria of population. Khan (2011) also studied the varietal performance of nine varieties of cotton for screening against sucking pests. Seo *et al.* (2006) carried out field experiments for evaluation of cotton germplasm against whitefly but none of the genotype was found highly resistant which is in contrast to the present study in which differential response of different cultivars was observed and some of the genotypes were found resistant. The differences in resistance reaction to sucking pests of cotton in some new genotypes may be due to physico-morphic plant characters as reported by Raza and Afzal (2000) and Bashir *et al*. (2001). Though a lot of work has been done on screening of genotypes against *Bemisia tabaci* based on the population of whitefly and came to a conclusion that there are some differences in resistance level but none of them has calculated the resistance level with respect to damage index. In the present study, the resistant/ susceptible reaction of different cultivars was observed with respect to the damage index and some of the genotypes found resistant and gave quite promising results.

The weightage percentage of resistance was also calculated and its range varied from 0 to 85.93 for 60 days, from 0 to 63.09 for 90 days and 0 to 47.00 for 120 days in the year 2015 and from 0 to 94.38 for 60 days, 0 to 52.08 for 90 days and 0 to 42.20 for 120 days for the year 2016.

The comparison of data on population of *Bemisia tabaci* taken for different months suggested that the climate also affects the resistance/susceptibility of cotton genotypes to the attack of whitefly. During 2015, it was observed that the damage caused by *Bemisia tabaci* to cotton crop was highest in the month of August as compared to that in July and September. The damage index varied from 32.17 to 76.59 in July, 85.27 to 138.09 in August and from 8.90 to 12.02 in September. During 2016, damage caused by *Bemisia tabaci* was highest in September as compared to that in July and August. The damage index varied from 4.58 to 12.07 in July, 8.62 to 11.13 in August and from 28.31 to 37.31 in September. Some of the workers did a lot of work on the population build-up of whitefly in relation to climate. Idris (1990) found that susceptibility of cotton to *Bemisia tabaci* was highest in August-September in Pakistan. Javaid *et al*. (2012) also found the month of August as most favorable period for the growth of whitefly. However, Sharma and Rishi (2004a) observed high incidence of this insect in October-November in Northern India.

Hegde *et al*. (2004) also observed peak population of whitefly during October. These observations are quite contradictory to Anitha and Nandihalli (2008) who observed peak incidence of whitefly during last week of April under South Indian conditions. Variation in peak population of whitefly may be due suitable climatic conditions. High rainfall before seed setting results in higher population of whitefly due to abundant food supplies (Sharma, 2002). Further investigations may be carried out during field studies to observe the peak period for the build-up of whitefly population and prepare simulation models and hence suitable measures can be suggested for the management of the pest population prior to the damage caused by this deadly/harmful pest.

Selection and identification of resistant germplasm against whitefly and other insect-pest of cotton is pre-requisite for improving the quality and raising the yield attributes. Resilient genotypes outline one of the most critical components of integrated pest management. Cultivation of resistant cultivars is helpful in the reduction of use of pesticides, reduction in soil-water contamination; bring health benefits to farm workers and protection of natural enemies of insect-pests and non-targeted animals. The present findings also suggest the use of resistant varieties but these varieties should be tested against insect-pests and diseases before recommending them to the farmers so that loss could not occur at the farmer's end. Moreover, cultural practices and other measures can be modified according to the climatic factors for combating the pest population of whitefly. Different simulation models can be prepared for forecasting the outbreaks of pest population and farmers and other field workers can be guided accordingly.

In the present study, the difference in resistance levels of different cotton cultivars has been observed during their field performance which is suspected to be caused by difference in their genotypes. Some of the genotypes *viz.* Ankur 3228, Cotton H. Gold star BGII, KDCHH 541, Super 971 , ABCH 244, Ankur 3244, JKCH 8935, JKCH 8940, MRC 7365, NSPL 2223, RCH 314, RCH 791, SO7H 878, SWCH 4713 6539-2, KSCH 211, PCH 877, RCH 314, RCH 653, SO7H 878, SWCH 4713 during 2015 and genotypes Ankur 3028, Ankur Jassi, JKCH 8940, MH 5302, PRCH 7799, ABCH 243, Cotton H. Solar-75BGII, JKCH 8940, JKCH TARZAN, NAMCOT 616, PRCH 333, PRCH 7799, Ankur Jassi, MH 5302, MRC 7365, NSPL 2223, PCH 877, RCH 791, SWCH 4707 and SWCH 4755 during 2016 are found to have lower damage index leading to resistant reaction against cotton whitefly (*Bemisia tabaci*). The resistant germplasm from these genotypes can further be used in breeding program for developing new cotton strains which are resistant to this notorious pest *Bemisia tabaci.*

Table 1. Categorization of different genotypes with reference to their damage index during 2015

60 DAS		90 DAS		120 DAS	
DI	**GENOTYPES**	**DI**	**GENOTYPES**	**DI**	**GENOTYPES**
<32.17	6, 9, 21, 42	<85.27	3, 7,17, 18, 26, 30, 34, 39, 40, 44	<8.90	14, 15, 23, 32, 39, 40
32.17-43.61	2, 11, 12, 14, 16 , 18, 19, 20, 25, 28, 41, 43, 45, 46	85.27-98.47	4, 9, 10, 29, 32, 35, 47	8.90-9.68	5, 10, 13, 16, 18, 22, 26, 28, 30, 31, 34, 37, 42, 44
43.61-54.60	3, 8, 10, 15, 24, 27, 33, 35, 38,39	98.47-111.68	1, 5, 8, 19, 28, 33, 38, 41, 42	9.68-10.46	3, 4, 35, 36
54.60-65.60	4, 5, 7, 13, 17,23, 26, 30, 32	111.68-124.88	12, 20, 21, 22, 24,43	10.46-11.24	6, 12, 19, 20,21, 27, 29, 33, 38, 43
65.60-76.59	29, 37, 47	124.88-138.09	13, 15, 16, 27, 45	11.24-12.02	1, 2, 7, 9, 11, 24, 47
>76.59	1, 22, 31, 34, 36, 40, 44	>138.09	2, 6, 11, 14, 23, 25, 31, 36, 37, 46	>12.02	8, 17, 25, 41, 45, 46

Table 2. Categorization of different genotypes with reference to their damage index during 2016

60 DAS		90 DAS		120 DAS	
DI	**GENOTYPES**	**DI**	**GENOTYPES**	**DI**	**GENOTYPES**
<4.58	4, 8, 18, 24, 33	<8.62	2, 11, 18, 19, 27, 32, 33, 44	<28.31	8, 24, 26, 30,31,39, 43, 46
4.58_6.45	6, 15, 16, 17, 20, 25, 27, 29, 32, 40,46	8.62-9.25	15, 20, 45	28.31-30.56	1, 3, 4, 10, 29, 38
6.45-8.33	3, 9, 19, 21, 22, 26, 30, 37	9.25-9.88	6, 13,16, 17, 31,34, 38,39, 43, 46, 47	30.56-32.81	5, 11, 14, 20, 23, 27, 28,32, 33, 35, 40, 41, 45, 47
8.33-10.20	2, 10, 11, 13, 23, 28, 31, 35, 36, 38, 41, 42, 44	9.88-10.50	4, 5, 7, 8, 10, 14, 21, 22, 23, 42	32.81-35.06	34, 36
10.20-12.07	12	15.50-11.13	1, 3, 12, 24, 25, 26, 28, 29, 30, 35, 40, 41	35.06-37.31	2, 6, 9 , 13, 18, 22, 37
>12.06761	1, 5, 7, 14, 34, 39, 43, 45	>11.13	9, 36, 37	>37.31	7 , 12, 15, 16, 17, 19, 21, 25, 42, 44

*****DAS refers to days after sowing

Table 3. Population of whitefly at 60, 90, 120 days after sowing (DAS) during 2015

Code No.	Entry	60 DAS	90 DAS	120 DAS
1	6539-2	109.17(10.49)	107.16(10.39)	11.33(3.51)
2	ABCH 243	40.17(6.41)	139.17(11.84)	11.83(3.59)
3	ABCH 244	44.67(6.70)	84.17(9.22)	10.17(3.34)
4	ANKUR 3028	60.50(7.84)	88.83(9.47)	11.83(3.58)
5	ANKUR 3224	56.83(7.60)	102.67(10.17)	9.17(3.18)
6	ANKUR 3228	29.67(5.53)	138.17(11.78)	11.17(3.49)
7	ANKUR 3244	56.83(7.60)	80.66(9.02)	11.33(3.50)
8	ANKUR JASSI	51.67(7.25)	104.00(10.24)	13.83(3.80)
9	Cotton H. Gold Star BGII	26.83(5.26)	90.83(9.57)	11.83(3.59)
10	Cotton H. Solar -65 BGII	51.33(7.23)	121.67(11.07)	9.67(3.26)
11	Cotton H. Solar -75 BGII	43.00(6.61)	149.33(12.26)	11.67(3.56)
12	Cotton H. Solar -77 BGII	38.17(6.26)	123.33(11.14)	11.16(3.49)
13	DPC 3083	61.50(7.90)	125.17(11.21)	9.50(3.23)
14	JKCH 0109	39.67(6.38)	146.33(12.13)	8.16(3.00)
15	JKCH 1050	52.50(7.31)	133.17(11.59)	8.00(3.10)
16	JKCH 1947	40.67(6.45)	133.67(11.60)	9.50(3.22)
17	JKCH 8935	54.83(7.47)	59.66(7.74)	12.50(3.28)
18	JKCH 8940	33.00(5.80)	82.67(9.13)	9.67(3.27)
19	JKCH TARZAN	43.33(6.64)	103.83(10.23)	10.83(3.42)
20	KDCHH 516	34.33(5.90)	114.00(10.72)	12.00(3.59)
21	KDCHH 541	21.83(4.74)	121.17(11.05)	10.67(3.41)
22	KSCH 211	87.00(9.38)	114.33(10.73)	9.50(3.23)
23	KSCH 213	64.33(8.08)	145.33(12.08)	8.67(3.10)
24	MH 5302	49.17(7.08)	121.33(11.05)	11.33(3.50)
25	MRC 7041	40.50(6.43)	149.17(12.26)	13.83(3.86)
26	MRC 7365	63.50(8.02)	76.67(8.80)	9.50(3.23)
27	NAMCOT 616	47.00(6.88)	132.33(11.54)	11.17(3.49)
28	NAMCOT 617	32.67(5.80)	99.83(10.04)	9.00(3.12)
29	NCS 855	73.16(8.61)	91.83(9.61)	10.50(3.39)
30	NSPL 2223	58.50(7.71)	71.83(8.53)	9.33(3.21)
31	PCH 877	82.33(9.13)	161.67(12.74)	9.17(3.18)
32	PRCH 333	54.67(7.45)	98.17(9.96)	7.33(2.89)
33	PRCH 7799	51.17(7.22)	111.50(10.60)	10.50(3.38)
34	RCH 314	111.67(10.61)	80.83(9.00)	9.67(3.27)
35	RCH 602	46.50(6.88)	89.17(9.49)	9.83(3.29)
36	RCH 653	97.83(9.94)	160.16(12.69)	9.83(3.29)
37	RCH 773	73.33(8.62)	139.67(11.86)	9.50(3.23)
38	RCH 776	50.50(7.17)	102.17(10.15)	11.17(3.49)
39	RCH 791	53.83(7.40)	74.50(8.63)	8.83(3.13)
40	SO7H878	86.00(9.33)	74.17(8.67)	7.50(2.90)
41	Super 931	34.83(5.93)	111.33(10.60)	12.33(3.64)
42	Super 971	20.00(4.58)	110.33(10.54)	9.33(3.221)
43	SWCH 4707	42.67(6.60)	117.00(10.86)	11.00(3.44)
44	SWCH 4713	103.83(10.23)	83.67(9.14)	9.17(3.18)
45	SWCH 4744	39.66(6.36)	126.50(11.30)	12.83(3.71)
46	SWCH 4755	40.00(6.39)	159.33(12.67)	13.17()3.74

47	VICH 309	71.17(6.49)	96.33(9.86)	11.83(3.58)
	CD(p=0.05)	(1.07)	(1.15)	NS
	CV(%)	7.28	5.47	8.76

*****Figures in parentheses are transformed values

Table 4. Population of whitefly at 60, 90, 120 days after sowing (DAS) during 2016

Code No.	Entry	60 DAS	90 DAS	120 DAS
1	6539-2	13.00(3.72)	11.11(3.48)	29.89(5.56)
2	ABCH 243	12.33(3.63)	8.33(3.05)	36.22(6.07)
3	ABCH 244	7.33(2.86)	10.83(3.45)	30.11(5.53)
4	ANKUR 3028	5.33(2.49)	10.22(3.33)	29.44(5.50)
5	ANKUR 3224	13.00(3.71)	10.33(3.36)	31.00(5.62)
6	ANKUR 3228	6.00(2.62)	9.67(3.26)	35.33(6.01)
7	ANKUR 3244	23.67(4.97)	10.22(3.33)	43.44(6.64)
8	ANKUR JASSI	5.00(2.44)	10.22(3.35)	26.89(5.27)
9	Cotton H. Gold Star BGII	7.00(2.81)	13.44(3.78)	35.78(6.06)
10	Cotton H. Solar -65 BGII	9.67(3.27)	10.33(3.33)	29.67(5.53)
11	Cotton H. Solar -75 BGII	9.67(3.26)	8.33(3.05)	31.22(5.67)
12	Cotton H. Solar -77 BGII	10.33(3.36)	10.56(3.40)	38.00(6.23)
13	DPC 3083	9.33(3.17)	9.78(3.28)	36.44(6.11)
14	JKCH 0109	11.00(3.46)	10.22(3.34)	31.56(5.66)
15	JKCH 1050	5.33(2.50)	8.89(3.12)	38.78(6.30)
16	JKCH 1947	7.00(2.82)	9.33(3.20)	38.33(6.27)
17	JKCH 8935	6.00(2.62)	9.78(3.26)	40.78(6.46)
18	JKCH 8940	1.33(1.52)	8.44(3.05)	35.56(6.04)
19	JKCH TARZAN	7.33(2.87)	8.00(2.99)	38.00(6.24)
20	KDCHH 516	5.33(2.51)	9.11(3.17)	31.22(5.64)
21	KDCHH 541	7.67(2.89)	10.44(3.39)	37.67(6.20)
22	KSCH 211	7.33(2.85)	10.33(3.37)	35.89(6.07)
23	KSCH 213	5.33(2.51)	9.89(3.26)	30.11(5.56)
24	MH 5302	4.00(2.23)	11.00(3.46)	25.56(5.12)
25	MRC 7041	6.33(2.67)	11.11(3.48)	42.44(6.59)
26	MRC 7365	7.33(2.82)	10.78(3.40)	27.22(5.30)
27	NAMCOT 616	6.33(2.66)	6.44(2.70)	31.89(5.70)
28	NAMCOT 617	8.33(3.04)	11.11(3.43)	30.89(5.63)
29	NCS 855	6.33(2.70)	10.67(3.41)	29.00(5.48)
30	NSPL 2223	7.33(2.88)	10.22(3.32)	27.33(5.28)
31	PCH 877	9.33(3.20)	9.33(3.18)	25.11(5.06)
32	PRCH 333	5.00(2.43)	7.00(2.82)	32.00(5.73)
33	PRCH 7799	4.33(2.30)	8.22(3.03)	32.78(5.80)
34	RCH 314	12.33(3.64)	9.67(3.27)	33.33(5.83)
35	RCH 602	10.67(3.41)	10.67(3.41)	32.22(5.76)
36	RCH 653	8.33(3.02)	12.11(3.61)	32.89(5.73)
37	RCH 773	8.00(2.99)	11.22(3.49)	36.44(6.10)
38	RCH 776	8.67(3.10)	9.44(3.22)	28.89(5.41)
39	RCH 791	10.00(3.31)	9.67(3.26)	25.67(5.10)
40	SO7H878	7.67(2.93)	11.00(3.44)	31.00(5.62)
41	Super 931	8.67(3.02)	10.67(3.40)	31.67(5.87)
42	Super 971	9.33(3.20)	10.22(3.34)	37.44(6.18)
43	SWCH 4707	14.00(3.71)	9.33(3.20)	27.89(5.37)
44	SWCH 4713	11.33(3.50)	7.89(2.97)	37.44(6.18)
45	SWCH 4744	16.33(4.14)	9.22(3.18)	30.67(5.62)
46	SWCH 4755	7.33(2.89)	9.67(3.22)	27.56(5.24)
47	VICH 309	3.33(2.06)	9.67(3.24)	32.33(5.77)
	CD(p=0.05)	(0.69)	NS	(0.86)
	CV(%)	14.12	10.42	9.13

*****Figures in parentheses are transformed values

Table 5. Weightage Percentage of Resistance (WPR) of different cultivars during 2014-15 and 2015-16.

		2014-15			2015-16		
Code No.	**Entry**	**60 DAS**	**90 DAS**	**120 DAS**	**60 DAS**	**90 DAS**	**120 DAS**
1	6539-2	2.24	33.72	18.08	45.08	17.34	31.19
2	ABCH 243	64.03	13.92	14.46	61.98	38.02	16.62
3	ABCH 244	60.00	47.94	26.46	69.03	19.42	30.69
4	ANKUR 3028	45.82	45.05	14.46	81.71	23.96	32.23
5	ANKUR 3224	49.11	36.49	33.69	45.08	23.14	28.64
6	ANKUR 3228	73.43	14.54	19.23	74.65	28.05	18.67
7	ANKUR 3244	49.11	50.11	18.08	0.00	23.96	0.00
8	ANKUR JASSI	53.73	35.67	0.00	83.10	23.96	38.10
9	Cotton H. Gold Star BGII	75.97	43.82	14.46	70.43	0.00	17.63
10	Cotton H. Solar -65 BGII	54.03	24.74	30.08	59.15	23.14	31.70
11	Cotton H. Solar -75 BGII	61.49	7.63	15.62	59.15	38.02	28.13
12	Cotton H. Solar -77 BGII	65.82	23.71	19.31	56.36	21.43	12.52
13	DPC 3083	44.93	22.58	31.31	60.58	27.23	16.11
14	JKCH 0109	64.48	9.49	41.00	47.91	23.96	27.35
15	JKCH 1050	52.99	17.63	42.15	77.48	33.85	10.73
16	JKCH 1947	63.58	17.32	31.31	76.05	30.58	11.76
17	JKCH 8935	50.90	63.10	9.62	74.65	27.23	6.12
18	JKCH 8940	70.45	48.86	30.08	94.38	37.20	18.14
19	JKCH TARZAN	61.20	35.78	21.69	69.03	40.48	12.52
20	KDCHH 516	69.26	29.49	13.23	77.48	32.22	28.13
21	KDCHH 541	80.45	25.05	22.85	67.60	22.32	13.28
22	KSCH 211	22.09	29.28	31.31	69.03	23.14	17.38
23	KSCH 213	42.39	10.11	37.31	63.37	26.41	28.38
24	MH 5302	55.97	24.95	18.08	83.10	18.15	41.16
25	MRC 7041	63.73	7.73	0.00	73.26	17.34	2.30
26	MRC 7365	43.14	52.58	31.31	69.03	19.79	37.34
27	NAMCOT 616	57.91	18.15	19.23	73.26	52.08	26.59
28	NAMCOT 617	70.74	38.25	34.92	59.15	17.34	28.89
29	NCS 855	34.49	43.20	24.08	73.26	20.61	33.24
30	NSPL 2223	47.61	55.57	32.54	69.03	23.96	37.09
31	PCH 877	26.27	0.00	33.69	60.58	30.58	42.20
32	PRCH 333	51.04	39.28	47.00	78.88	47.92	26.34
33	PRCH 7799	54.18	31.03	24.08	81.71	38.84	24.54
34	RCH 314	0.00	50.00	30.08	36.63	28.05	23.27
35	RCH 602	58.36	44.84	28.92	60.58	20.61	25.83
36	RCH 653	12.39	0.93	28.92	64.81	9.90	24.29
37	RCH 773	34.33	13.61	31.31	71.82	16.52	16.11
38	RCH 776	54.78	36.80	19.23	63.37	29.76	33.49
39	RCH 791	51.80	53.92	36.15	47.91	28.05	40.91
40	SO7H878	22.99	54.12	45.77	67.60	18.15	28.64
41	Super 931	68.81	31.14	10.85	63.37	20.61	27.09
42	Super 971	82.09	31.76	32.54	57.75	23.96	13.81
43	SWCH 4707	61.79	27.63	20.46	40.85	30.58	35.80
44	SWCH 4713	7.02	48.25	33.69	61.98	41.29	13.81
45	SWCH 4744	64.48	21.75	7.23	45.08	31.40	29.40
46	SWCH 4755	64.18	1.45	4.77	74.65	28.05	36.56
47	VICH 309	36.27	40.42	14.46	85.93	28.05	25.58

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