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RESPONSE OF VARIOUS COTTON GENOTYPES AGAINST SUCKING AND BOLLWORM COMPLEXES

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ABSTARCT

In the present study, eighteen cotton genotypes were screened out for their relative resistance against sucking insect pests (jassid, whitefly and thrips) and bollworms (spotted and pink) at the experimental farm of Nuclear Institute of Agriculture (NIA), Tandojam. The experiment was conducted under Randomized Complete Block Design (RCBD) with three replications. The result of overall mean revealed that NIA-HM-323 had comparatively greater resistance to the attack of jassid (0.52/leaf), followed by 0.53 and 0.58 insects per leaf on NIA-H-13 and NIA-81, respectively. Appreciably, low infestation of thrips (2.25/leaf) and whitefly (0.43/leaf) was recorded on NIA-H-13. Moreover, the genotypes NIA-Noori and NIA-Ufaq proved to be the most efficient genotypes rendering the lowest infestation of pink (1.93%) and spotted (2.14%) bollworms with highest recorded yields (2468 and 2295 kg/ha) but moderate in their degree of resistance against sucking pests compared to other tested genotypes. Whereas, higher infestation of insect pests and lowest cotton yield were recorded in genotypes NIA-M-34 and NIA-85. Furthermore, it was observed that jassid showed peak activity in the month of June, while the infestation of thrips and whitefly was highest in July and August, respectively. However, the month of September was found to be the most favorable for bollworms.

Keywords: bollworms, cotton genotypes, screening, sucking pests, yield

INTRODUCTION

Cotton, *Gossypium hirsutum* L. commonly recognized as “silver fiber”, is the major fiber and cash crop. It is also considered as the main strength of the Pakistan’s economy (Tayyib *et al.,* 2005). Being the king of natural fiber, 68% foreign exchange earning of the country is contributed by this crop (Economic Survey, 2009). Pakistan ranks 4th among all the cotton producing countries (Anonymous, 2013), however per acre yield of cotton is very low compared to other countries. Insect pest attack is the main cause for low yield of cotton in Pakistan (Ahmad *et al*., 2011). Worldwide, a total of 162 insect pest species have been documented which feed on cotton during different growth stages (Kannan

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et al., 2004). The overall pest composite on cotton crop is mostly divided into two categories; sucking and chewing. Jassid *(Amrasca devastans)*, thrips (*Thrips tabaci*) and whitefly (*Bemisia tabaci*) are the most perilous pests that suck cell sap from leaves directly and ultimately damaging the food factory, while dusky cotton bug (*Oxycarenus laetus*) and red cotton bug (*Dysdercus cingulatus*) cause reduction in seed germination and quality of lint. On the other hand, pink bollworm (*Pectinophora gossypiella*), American bollworm (*Helicoverpa armigera*) and spotted bollworm (*Earis spp*.) are the boll feeders (Babar *et al*., 2013).

On an average these insect pests cause 5-10% yield losses which can increase up to 40-50% in severe situation (Chaudhary, 1976). Heavy losses from seedling to maturity in cotton caused by whiteflies resulted in lower yield and quality (Amer *et al*., 1999). Cotton thrips and jassid caused 38% (Baloch *et al*., 1986; Attique and Ahmad, 1990) and 24-50% reduction in yield, respectively. During 1998-99, the pest attack caused losses of 3.1 million bales (Ahmad and Poswal, 2000). To avoid such losses; farmers mostly depend on the use of insecticides. In addition to environmental pollution and health problems this practice also creates insecticidal resistance in insects (Mohyuddin *et al*., 1997). One of the potential measures to avoid such a situation is to develop resistant cultivars. The resistant variety offers protection against insect pests without any additional cost and is compatible with the other control measures (Chaudhary and Arshad, 1989). The breeders, in Pakistan, have focused their attention to increase the yield potential and evolved a number of varieties for this purpose. There are many morphological and physiological characteristics of plants which can affect negatively or positively on the insects and their natural enemies (Krips *et al*., 1999; Afzal and Bashir, 2007). Thus, there is a strong need to evaluate different cotton genotypes against sucking and chewing insect pest complexes.

MATERIALS AND METHODS

The study was conducted at experimental farm of Nuclear Institute of Agriculture (NIA), Tandojam under RCBD design, with eighteen genotypes (NIA-H-13, NIA-M-31, NIA-HM-323, NIA-HM-329, NIA-H-1, NIA-H-303, NIA-M-32, NIA-M-34, NIA-81, PST-I-12, Chandi-95, NIA-85, NIA-86, NIA-87, CRIS-342, Sohni, NIA-Ufaq, NIA-Noori) in three replications. The genotypes were sown in May, 2015 with a plot size of 30 m^2. The genotypes were grown under natural field conditions with recommended agronomic practices and no control method was used for the insect pests during the whole season even when the population of the pests reached at economic threshold level. The data were recorded at fortnightly intervals from the month of June till the end of September. The population of sucking complex i.e. jassid (*Amrasca devastans*), thrips (*Thrips tabaci*) and whitefly (*Bemisia tabaci*) were recorded from three leaves (one each from upper, middle and lower) selected randomly from three plants per plot and then converted into per leaf basis (Ahmad *et al*., 2011). Bollworms infestation was recorded by observing the buds, flowers and dissecting the bolls from three plants selected randomly per plot. Percent infestation of spotted (*Earis spp.*) and pink (*Pectinophora gossypiella*) bollworms was separately calculated by recording the total and damaged number of buds, flowers and bolls from three plants per plot using the formula:

$$\text{Infestation (\%)} = \frac{\text{No. of damaged fruiting parts}}{\text{Total no. of fruiting parts}}$$

The yield of each plot was recorded by harvesting the cotton twice during cropping season. The data were analyzed by ANOVA using software Statistix 8.1. Significance of difference in mean population of insect pests and yield was obtained at 5% probability level with Tukey's HSD test.

RESULTS AND DISCUSSION

The results showed significant difference among the tested genotypes regarding the population of jassids in different months (Table 1). Jassid infestation was found above ETL (1/leaf) in the month of June in most of the genotypes however, maximum infestation was observed on NIA-85 (2.62/leaf), followed by NIA-H-303 (2.14/leaf) whereas lowest on NIA-81 (0.74/leaf) and NIA-HM-323 (0.77/leaf). The month of July showed the population of jassid below ETL in all the genotypes except NIA-M-32 with highest jassid population of 1.11/leaf. Similarly, NIA-M-34 and NIA-85 showed the population of jassid above ETL (1.35/leaf) in August. The same pattern was also true for the month of September in which NIA-M-34 and NIA-85 again proved to be most susceptible genotypes. The overall seasonal mean population showed that NIA-HM-323 was found to be the most tolerant genotype and recorded the lowest number of jassids (0.52/leaf), followed by NIA-H-13 (0.53/leaf) and NIA-81 (0.58/leaf) whereas, NIA-85 was the most susceptible one showing higher pest attack of 1.26/leaf which was statistically at par to NIA-H-303 (0.99/leaf) and Sohni (0.93/leaf). The results in Table 2 indicate that there was no infestation of thrips on NIA-H-13, NIA-HM-323, NIA-H-1, NIA-H-303, NIA-M-32, NIA-M-34, PST-I-12, Cris-342 and NIA-Ufaq in the month of June. The peak activity of thrips was recorded in the month of July where NIA-M-31 gave significant results with reduced infestation (3.46/leaf), followed by NIA-M-32 (4.48/leaf) and NIA-H-1 (4.70/leaf). The genotype NIA-Noori performed excellently in August by showing lowest thrips infestation of 1.16/leaf, followed by NIA-Ufaq (2.83/leaf); whereas, maximum infestation was observed on NIA-M-34 (9.90/leaf). Similarly in September, NIA-M-34 proved to be the most susceptible genotype however lowest infestation of thrips was observed on NIA-H-13 (0.14/leaf). The overall seasonal mean population revealed that minimum number of thrips was observed on NIA-H-13 (2.25/leaf), followed by NIA-M-32 (2.46/leaf) and NIA-M-31 (2.49/leaf). The maximum population of thrips was recorded on NIA-M-34 (5.09/leaf), followed by NIA-85 (4.59/leaf) and Chandi-95 (4.27/leaf). Regarding the infestation of whitefly, results showed significant difference among different genotypes in the month of June (Table 3). The genotype NIA-H-13 was the most tolerant where no infestation of whitefly was observed, followed by NIA-HM-329 (0.14/leaf) however NIA-85 and PST-I-12 proved to be most susceptible by showing highest (1.25) infestation /leaf. Non-significant difference was observed among genotypes in the month of July. NIA-HM-329 proved to be most tolerant genotype whereas; NIA-85 was the most susceptible genotype with the infestation of 0.92/leaf. The data recorded in August indicated significant variation, however the minimum infestation (0.46/leaf) was observed on NIA-Noori and maximum infestation of

2.01/leaf on NIA-M-34. Same case was recorded in September where NIA-Noori attracted lowest (0.18/leaf) and NIA-M-34 (1.33/leaf). The overall seasonal mean revealed that highest infestation of whitefly (1.22/leaf) was observed on NIA-M-34, followed by NIA-85 (1.15/leaf) and Chandi-95 (0.91/leaf), whereas the minimum whitefly (0.43/leaf) was found on NIA-H-13 and hence it was confirmed as the more tolerant genotype against this insect.

Table 1. Mean jassid infestation per leaf on cotton genotypes.

Genotypes	Jassid infestation per leaf				Overall Mean
	June	July	August	September	
NIA-H-13	0.92 d	0.57 b	0.53 bcd	0.11 b	0.53 e
NIA-M-31	1.22 bcd	0.55 b	0.75 bc	0.11 b	0.66 bcde
NIA-HM-323	0.77 d	0.55 b	0.66 bcd	0.11 b	0.52 e
NIA-HM-329	1.14 cd	0.51 b	0.74 bc	0.25 b	0.66 bcde
NIA-H-1	1.18 bcd	0.51 b	0.72 bc	0.25 b	0.67 bcde
NIA-H-303	2.14 ab	0.61 b	0.83 bc	0.37 b	0.99 ab
NIA-M-32	1.55 bcd	1.11 a	0.66 bcd	0.22 b	0.88 bcd
NIA-M-34	0.74 d	0.75 ab	1.35 a	0.74 a	0.89 bcd
NIA-81	0.74 d	0.57 b	0.66 bcd	0.37 b	0.58 de
PST-I-12	1.11 cd	0.64 ab	0.64 bcd	0.25 b	0.66 bcde
Chandi-95	1.18 bcd	0.57 b	0.94 ab	0.40 ab	0.77 bcde
NIA-85	2.62 a	0.66 ab	1.35 a	0.40 ab	1.26 a
NIA-86	1.03 d	0.61 b	0.81 bc	0.29 b	0.68 bcde
NIA-87	1.25 bcd	0.79 ab	0.57 bcd	0.29 b	0.73 bcde
CRIS-342	1.29 bcd	0.57 b	0.94 ab	0.37 b	0.79 bcde
Sohni	2.03 abc	0.72 ab	0.66 bcd	0.29 b	0.93 abc
NIA-Ufaq	1.59 bcd	0.66 ab	0.42 cd	0.22 b	0.72 bcde
NIA-Noori	1.51 bcd	0.64 ab	0.24 d	0.07 b	0.62 cde
HSD Value	0.99	0.47	0.46	0.35	0.33

Means in a column sharing same letter are not significantly different at $P<0.005$.

Table 4 shows the significant difference in percent infestation of pink and spotted bollworms among all the genotypes. Infestation of bollworms appeared in the month of August, whereas high infestation was observed in September. The overall infestation of pink bollworm was maximum on NIA-M-34 (23.84%) followed by NIA-86 (15.18%) and NIA-85 (14.10%) whereas minimum was observed on genotype NIA-Noori (1.93%) and NIA-Ufaq (4.28%). The similar pattern of overall infestation was observed in case of spotted bollworm. The results revealed that the lowest infestation of spotted bollworm was recorded on NIA-Noori (2.14%), followed by NIA-Ufaq (5.81%) and NIA-M-32 (7.92%). NIA-81 performed poor with highest infestation of 31.31%, followed by NIA-M-34 (21.72%) and NIA-HM-323 (15.47%). The results showed variability in yield recorded from genotypes, which may be due to the difference in their ability to tolerate the infestation of insect pests (Table 5). Higher yield was recorded from NIA-Noori (2468 kg ha^{-1}), followed by NIA-Ufaq (2295 kg ha^{-1}) as these genotypes manifested some tolerance to the sucking and chewing pest complexes. The genotype NIA-M-34 performed very poor and it exhibited high pest infestation with minimum yield (1146 kg ha^{-1}), followed by NIA-85 (1671 kg ha^{-1}).

Table 2. Mean thrips infestation per leaf on cotton genotypes

Genotypes	Thrips infestation per leaf				Overall Mean
	June	July	August	September	
NIA-H-13	0.00 b	5.35 ab	3.51 ef	0.14 e	2.25 f
NIA-M-31	0.33 b	3.46 b	4.72 cdef	1.44 bcde	2.49 ef
NIA-HM-323	0.00 b	6.57 ab	5.20 bcde	1.55 bcd	3.33 cdef
NIA-HM-329	0.55 ab	5.24 ab	5.44 bcde	2.07 b	3.32 cdef
NIA-H-1	0.00 b	4.70 ab	5.18 bcde	1.48 bcd	2.84 def
NIA-H-303	0.00 b	7.05 a	4.79 bcdef	1.81 bc	3.41 cdef
NIA-M-32	0.00 b	4.48 ab	4.70 cdef	0.66 cde	2.46 ef
NIA-M-34	0.00 b	7.01 a	9.90 a	3.44 a	5.09 a
NIA-81	1.11 ab	7.33 a	4.64 cdef	1.29 bcde	3.59 bcde
PST-I-12	0.00 b	6.38 ab	4.24 def	1.00 bcde	2.90 def
Chandi-95	1.00 ab	7.09 a	6.94 b	2.07 b	4.27 abc
NIA-85	3.03 a	6.88 a	6.46 bc	2.00 b	4.59 ab
NIA-86	0.07 b	6.35 ab	5.51 bcde	2.14 ab	3.52 bcde
NIA-87	1.22 ab	6.09 ab	3.57 ef	1.22 bcde	3.02 def
CRIS-342	0.00 b	7.77 a	5.83 bcd	2.03 b	3.91 bcd
Sohni	0.40 b	6.66 ab	4.75 bcdef	1.66 bc	3.37 cdef
NIA-Ufaq	0.00 b	6.68 ab	2.83 fg	0.66 cde	2.54 ef
NIA-Noori	2.37 ab	6.12 ab	1.16 g	0.33 de	2.50 ef
HSD Value	2.49	3.31	2.19	1.31	1.17

Means in a column sharing same letter are not significantly different at $P<0.005$.

Table 3. Mean whitefly infestation per leaf on cotton genotypes

Genotypes	Whitefly infestation per leaf				Overall Mean
	June	July	August	September	
NIA-H-13	0.00 b	0.50 a	0.75 def	0.48 cd	0.43 e
NIA-M-31	0.25 ab	0.68 a	1.07 bcde	0.62 bcd	0.66 cde
NIA-HM-323	0.44 ab	0.90 a	1.09 bcde	0.51 bcd	0.74 cde
NIA-HM-329	0.14 b	0.44 a	1.07 bcde	0.70 bc	0.59 cde
NIA-H-1	0.55 ab	0.64 a	1.01 bcde	0.62 bcd	0.71 cde
NIA-H-303	0.18 b	0.70 a	1.12 bcde	0.51 bcd	0.63 cde
NIA-M-32	0.25 ab	0.83 a	0.81 cdef	0.40 cd	0.57 cde
NIA-M-34	0.70 ab	0.85 a	2.01 a	1.33 a	1.22 a
NIA-81	0.40 ab	0.81 a	1.03 bcde	0.44 cd	0.67 cde
PST-I-12	1.25 a	0.81 a	0.88 cdef	0.37 cd	0.83 bcd
Chandi-95	0.88 ab	0.81 a	1.27 bcd	0.66 bcd	0.91 abc
NIA-85	1.25 a	0.92 a	1.42 b	1.00 ab	1.15 ab
NIA-86	0.85 ab	0.53 a	1.01 bcde	0.66 bcd	0.76 cde
NIA-87	0.66 ab	0.75 a	0.925 bcdef	0.40 cd	0.68 cde
CRIS-342	0.22 b	0.81 a	1.31 bc	0.70 bc	0.76 cde
Sohni	0.81 ab	0.64 a	0.98 bcdef	0.55 bcd	0.75 cde
NIA-Ufaq	0.66 ab	0.83 a	0.64 ef	0.40 cd	0.63 cde
NIA-Noori	0.62 ab	0.75 a	0.46 f	0.18 d	0.50 de
HSD Value	1.02	0.55	0.53	0.49	0.36

Means in a column sharing same letter are not significantly different at $p<0.005$.

Table 4. Percent infestation of pink bollworm and spotted bollworm on cotton genotypes

Genotypes	Infestation % of pink bollworm			Infestation % of spotted bollworm		
	August	September	Overall Infestation %	August	September	Overall Infestation %
NIA-H-13	4.71 c	10.27 bcde	7.49 cdef	10.15 abc	13.24 b	11.69 ab
NIA-M-31	5.68 c	13.59 bcde	9.64 bcde	11.77 ab	12.83 b	12.30 ab
NIA-HM-323	3.65 c	18.31 ab	10.98 bcde	12.18 ab	18.75 ab	15.47 ab
NIA-HM-329	6.80 bc	16.92 abc	11.86 bcd	12.07 ab	18.59 ab	15.33 ab
NIA-H-1	6.18 c	11.69 bcde	8.93 bcdef	9.10 abc	14.07 ab	11.59 ab
NIA-H-303	5.88 c	7.37 bcde	6.62 cdef	11.75 ab	13.20 b	12.48 ab
NIA-M-32	3.10 c	6.45 bcde	4.78 def	6.35 bc	9.49 b	7.92 b
NIA-M-34	21.11 a	26.57 a	23.84 a	17.55 a	25.89 ab	21.72 ab
NIA-81	5.27 c	7.63 bcde	6.45 def	9.52 abc	53.11 a	31.31 a
PST-I-12	3.86 c	6.17 bcde	5.01 def	8.55 abc	10.40 b	9.48 b
Chandi-95	5.25 c	11.79 bcde	8.52 bcdef	11.25 abc	9.28 b	10.27 b
NIA-85	10.77 abc	17.42 abc	14.10 bc	12.11 ab	14.84 ab	13.48 ab
NIA-86	18.06 ab	12.31 bcde	15.18 b	11.24 abc	12.19 b	11.72 ab
NIA-87	4.08 c	6.28 bcde	5.18 def	9.36 abc	7.07 b	8.22 b
CRIS-342	5.20 c	14.77 abcd	9.99 bcde	11.21 abc	16.04 ab	13.63 ab
Sohni	5.06 c	4.99 cde	5.03 def	9.96 abc	7.97 b	8.97 b
NIA-Ufaq	4.23 c	4.33 cde	4.28 ef	6.55 bc	5.07 b	5.81 b
NIA-Noori	2.28 c	1.59 e	1.93 f	2.28 c	2.00 b	2.14 b
HSD Value	11.28	12.49	7.45	9.00	39.43	19.79

Means in a column sharing same letter are not significantly different at *P*<0.005.

Table 5. Yield of different cotton genotypes

Genotypes	Yield (kg ha^{-1})	Genotypes	Yield (kg ha^{-1})
NIA-H-13	2060 ab	PST-I-12	2186 ab
NIA-M-31	2057 ab	Chandi-95	1940 ab
NIA-HM-323	2051 ab	NIA-85	1671 ab
NIA-HM-329	1946 ab	NIA-86	1857 ab
NIA-H-1	2080 ab	NIA-87	2146 ab
NIA-H-303	2044 ab	CRIS-342	1864 ab
NIA-M-32	2224 ab	Sohni	2048 ab
NIA-M-34	1146 b	NIA-Ufaq	2295 ab
NIA-81	2115 ab	NIA-Noori	2468 a
HSD Value	1205		

Means sharing same letter are not significantly different at *P*<0.005.

Host plant resistance is the most significant tool in any IPM program. It primarily affects the insect pest behavior due to which pests accept or reject the plant as suitable host. Due to these provisions plants show resistance, immunity, tolerance or susceptibility against insect pests (Javaid *et al*., 2012). Screening trial is used to determine the plant resistance against insect pests under field, laboratory and green house conditions.

Based on the results of present study it was found that the months of July and August were favorable for the population buildup of thrips and whitefly. The present findings are in line with the findings of Khan *et al*. (2012) who reported that peak thrips population occurred during the month of July. Similarly, Javaid *et* *al*. (2012) reported that the month of August was most suitable for the population of whitefly. However, the results of our study revealed higher level of jassid population infestation in the month of June compared to the months of July, August and September. Contrary to these findings Aheer *et al*. (2006) reported maximum population in the month of July. The difference in results may be due to different genotypes and ecological conditions. The infestation of bollworms was highest in the month of September. These results are confirmed by Lanjar *et al*. (2014), who found relatively higher population of bollworms up to the mid of September.

The attack of sucking insect pests (jassid, whitefly and thrips) and yield varied substantially on all the tested genotypes. It is apparent from the results that the genotype NIA-HM-323 was most tolerant to the attack of jassid and genotype NIA-H-13 showed maximum resistance to the attack of thrips and whitefly. On the whole, it was observed that NIA-Noori and NIA-Ufaq exhibited least infestation of bollworms and higher yield but showed medium response to the attack of sucking pest complex. Many researchers who found significant results of host plant resistance against sucking complex and bollworms i.e. Rehman *et al*. (2001); Khan *et al.* (2003); Syed *et al.* (2003); Ahmad *et al.* (2004); Chandramani *et al.* (2004); Kulkarni and Sharma (2004); Razaq *et al*. (2004); Memon and Chang (2005); Ali and Aheer (2007) and Atta *et al*. (2015). Bhatnagar and Sharma (1991) determined the relative resistance of cotton varieties against the sucking insect pests i.e. whitefly, thrips and jassid that showed glandless varieties were more infested than frego bract and okra leaf cotton varieties. Likewise, Shahid *et al*. (2012) reported that minimum attack of thrips exhibited by FH-118, followed by GN-2085 while FH-177, FH-179 and FH-114 were most susceptible. Hernandez *et al.* (1999) assessed the whitefly incidence on some varieties of cotton and reported non-significant difference in yield between them.

CONCLUSION

The genotypes NIA-Noori and NIA-Ufaq were found resistant with respect to lowest infestation of chewing pest complex and higher seed cotton yield. These genotypes can be included in future breeding programs for resistance enhancement and also in integrated pest management (IPM) programs for control of these pests to avoid yield losses.

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