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STUDIES ON GENETIC RESISTANCE IN CHICKPEA (*CICER ARIETINUM* L.) TO BRUCHID BEETLE (*CALLOSOBRUCHUS CHINENSIS* L.) ATTACK

KHALIQUE AHMED, FEROZA KHALIQUE, IMTIAZ A. KHAN, MOHAMMAD AFZAL* AND BASHIR A. MALIK
National Agricultural Research Centre, Islamabad, Pakistan

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Susceptibility of 47 varieties of chickpea (*Cicer arietinum* L.) to infestation of the chickpea stored grain pest *Callosobruchus chinensis* L. was tested. The susceptibility of the grains was assessed using three parameters: (1). Number of damaged seeds, (2). Number of emergence holes (3). Seed coat texture. Two groups of genotypes were prevalent on the basis of morphological characteristics of the chickpea grains. Group 1 (susceptible) included varieties mostly with smooth, soft and thin (SST) seed coat characteristics and group 2 (tolerant) contained genotypes with mostly rough, hard, wrinkled and thick (RHWTK) seed coat characteristics. The characters showed enough variability to make selections on the basis of phenotypic manifestation for breeding programmes. Broad sense heritability for the number of holes caused by insects was high (0.639) indicating the heritable nature of the character. Genetic correlations were significant (0.9845) at the 1% level of probability.

Key words: *Cicer arietinum, Callosobruchus chinensis,* Resistance.

Introduction

Chickpea (*Cicer arietinum* L.) is the third largest food grain legume crop of the world [1]. In Pakistan, chickpea is grown over an area of about one million hectares (75% of the total area under pulses) with an average production of 0.37 million tonnes per annum. This crop is not only infested by various insect pests in the field but its grain is also heavily attacked by the stored grain pests *C. chinensis* L. and *C. maculatus* F. and these pests cause sizeable pre and post-harvest economical losses, respectively. Chickpea is also a major and cheap source of protein (20%) which meets the protein requirement of the majority of the rural people in Pakistan. Hence, the chickpea researchers in Pakistan are emphasizing the development of high yielding, disease and insect-resistant genotypes to compensate for and minimise pest losses and to provide more abundant, inexpensive, protein-rich food.

The damage caused to the stored chickpea by the bruchid beetle *C.chinensis* L. is of utmost importance in terms of economic loss. Many workers, [3-6, 8-17] conducted studies on comparative susceptibility and resistance (on a morphological basis) of various legumes including chickpea attack by the bruchid beetles *C. chinensis* L. and *C. maculatus* F. However, work on genetic parameters of resistance in chickpea to attack by *C.maculatus* F. was recently done by Afzal *et al.* [2] and Ahmed *et al.* [7]. The present investigation was also undertaken to assess genetic differences for resistance in chickpea to attack by *C. chinensis* L. (Bruchidae) to identify sources of resistance/tolerance for incorporation in the chickpea breeding programme.

*Pakistan Scientific and Technical Information Centre, Islamabad.

Materials and Methods

Stock cultures of *C. chinensis* were maintained at 27 ±2 C and 55-65% RH in round glass jars (10.0 cm x 14.0 cm) containing sufficient seeds of susceptible chickpea variety ILC 195. Seventy-five undamaged healthy seeds of each of the 47 varieties of chickpea were used (3 replicates of 25 seeds of each) for evaluation of susceptibility/tolerance.

A free choice test chamber was made using a thermopore sheet having 5.00 cm thickness and one square meter size. One hundred and forty one appropriate size cavities were made in the thermopore sheet to accommodate 25 seeds per cavity of each of the 47 varieties for 3 replications in a randomized fashion. A wooden frame corresponding to the size of thermopore sheet was placed on the sheet and an acrylic sheet was placed on the wooden frame, providing about 3.00 cm space between the thermopore and acrylic sheet for free movement of the bruchids to choose and infest the genotypes. One hundred and forty one male-female pairs of *C. chinensis* (24-48 hrs old) were released through 4 holes made at equal distances (25.0 cm apart) in all sides of the wooden frame to ensure equal distribution of bruchid adults in the test chamber. The bruchids were found moving around the varieties and the space in the test chamber.

The bruchids were allowed to lay eggs on the chickpea varieties till death and thereafter, they were removed from the test chamber. The experiment was conducted under semi-dark conditions at 27 ± 2C and 55-65% RH. The experiment was terminated after 38 days till completion of the bruchid development and emergence of adults from all the seeds of the varieties. The data were recorded on the following parameters:

1. Number of damaged seeds (susceptibility of the varieties (genotypes) to bruchids).
2. Number of holes (emergence of adult bruchid).
3. Seed surface texture and seed coat thickness.

The criterion of the surface texture of seed was based on our observation that all the kabuli type varieties (white seed) had small soft and thin seed coats (the seed coat was so thin that the impression of the cotyledons could be seen at places on the seed surface), while the classification of roughness, hardness, wrinkleness of seed surface and thickness of seed coat of desi type varieties (brown/black seed) was based on the comparison with the kabuli type varieties.

Analysis of variance, the genotypic (the genotypic value is value of a perticular assembly of genes possessed by the individual) and phenotypic (the phenotypic value is an observed value of a character which is measured on an individual) components of correlation "between the first two aforementioned parameters, as well as broad sense heritability estimates were determined on an IBM PC XT, using the methods suggested by Singh and Chaudhary [18]. Mean values of the characters for all varieties were also subjected to Duncan's Multiple Range Test (DMRT).

Results and Discussion

The DMRT results in Table 1 indicated the ranked order of the mean number of damaged seeds (replicates) and the bruchid adult emergence holes of the varieties tested. The ranked order of the varieties by the two variables was often appreciably different.

Seed damage (susceptibility/tolerance of the varieties). Table 1 indicated two groups of the varieties: group 1 (from var. 1 to 22) and group 2 (From var. 23 to 47) with respect to

TABLE 1. MEAN NUMBER OF DAMAGED SEEDS AND ADULTS (*C. CHINENSIS*) EMERGENCE HOLES IN 47 VARIETIES OF CHICKPEA (AVERAGE OF 3 REPLICATES).

S. No.	Seed texture	DMRT	Damaged seeds	Variety	Variety	No. of holes	DMRT	Seed texture
1.	RHWTK	A	24.67	810274	P51821	85.00	A	RSTK
2.	RST	A	24.67	KC53	F8240*	82.33	AB	SST
3.	RSTK	A	24.67	51821	Y2624*	80.67	AB	SST
4.	RSTK	AB	23.67	KC1269	F41*	76.33	ABC	SST
5.	SST	AB	23.67	Y2624*	KC1269	73.33	ABCD	RSTK
6.	RHWTK	AB	23.67	CM65	Y2628*	71.33	ABCDE	SST
7.	SST	AB	23.33	Y2606*	KC35	69.67	ABCDEF	RST
8.	RHTK	AB	23.33	P51945	810274	69.33	ABCDEFG	RHWTK
9.	RHWTK	AB	23.33	CM790	50994*	67.00	ABCDEFGH	SST
10.	RHWTK	AB	23.33	CM914	Y2606*	66.00	ABCDEFGHI	SST
11.	SST	ABC	23.00	Y2628*	82T77*	64.00	ABCDEFGHIJ	SST
12.	RSTK	ABC	23.00	800083	CM914	59.33	ABCDEFGHIJK	RHWTK
13.	SST	ABC	23.00	F8240*	CM790	57.67	BCDEFGHIJK	RHWTK
14.	RHTK	ABC	22.67	P51884	KC1266	57.00	BCDEFGHIJKL	RSTK
15.	SST	ABCD	22.33	F41*	CM65	54.67	CDEFGHIJKLM	RHWTK
16.	RHTK	ABCD	22.33	P50709	P51884	54.33	CDEFGHIJKLM	RHTK
17.	RHWTK	ABCDE	22.00	AU1433	P51945	54.00	CDEFGHIJKLM	RHTK
18.	SST	ABCDEF	21.33	IL2380*	800083	53.00	CDEFGHIJKLMN	RSTK
19.	SST	ABCDEF	21.33	50994*	Y2602*	53.00	CDEFGHIJKLMN	SST
20.	SST	ABCDEF	21.33	IL182*	IL2380*	52.33	CDEFGHIJKLMNO	SST
21.	SST	ABCDEF	20.67	IL2548*	IL182*	50.33	CDEFGHIJKLMNOP	SST
22.	SST	ABCDEF	20.67	Y2604*	Y2604*	47.67	DEFGHIJKLMNOPQ	SST
23.	RHWTK	ABCDEF	20.67	CM68	P51835	46.00	EFGHIJKLMNOPQR	RSTK
24.	RSTK	ABCDEF	20.67	KC1266	P50759	44.67	FGHIJKLMNOPQRS	RSTK
25.	RHWTK	ABCDEF	20.33	810323	CM84	44.00	FGHIJKLMNOPQRST	RHWTK
26.	RSTK	ABCDEF	20.33	P51835	AU1433	43.00	GHIJKLMNOPQRST	RHWTK
27.	RHWTK	ABCDEF	20.33	HAUC1	CM2	41.67	HIJKLMNOPQRST	RHWTK
28.	RHWTK	ABCDEF	20.33	P51811	IL2548*	40.33	IJKLMNOPQRST	SST
29.	RHWTK	ABCDEF	20.00	P50619	IL72*	39.33	JKLMNOPQRST	SST

(Cont'd.....)

(Table 1, continue...)

30.	RHWTK	ABCDEF	19.33	81307	CM68	35.00	KLMNOPQRST	RHWTK
31.	RHWTK	ABCDEF	19.33	P50812	HAUC1	35.00	KLMNOPQRST	RHWTK
32.	SST	ABCDEF	19.00	Y2602*	P50709	34.67	KLMNOPQRST	RHTK
33.	RHWTK	ABCDEF	19.00	810302	P51811	34.33	KLMNOPQRST	RHWTK
34.	RHWTK	ABCDEF	18.67	GG588	P50619	33.00	KLMNOPQRST	RHWTK
35.	RHWTK	ABCDEF	18.67	CM84	CM113	31.00	LMNOPQRST	RHWTK
36.	RSTK	ABCDEF	18.67	P50759	810323	30.00	MNOPQRST	RHWTK
37.	RHWTK	BCDEFG	18.00	CM1912	81307	27.00	NOPQRST	RHWTK
38.	SST	BCDEFG	18.00	IL72*	P50812	26.67	NOPQRST	RHWTK
39.	RHWTK	BCDEFG	17.67	CM113	P51808	26.33	OPQRST	RHWTK
40.	SST	BCDEFG	17.33	82T77*	CM1912	24.33	PQRST	RHWTK
41.	RHWTK	CDEFG	16.67	CM2	P50793	23.33	QRST	RHWTK
42.	RHWTK	CDEFG	16.67	P51808	GG588	22.67	QRST	RHWTK
43.	RHWTK	DEFG	16.00	PAG114	810302	22.00	QRST	RHWTK
44.	RHWTK	EFG	15.67	810129	P50621	19.67	RST	RHWTK
45.	RHWTK	FG	15.33	P50621	PAG114	19.00	ST	RHWTK
46.	RHWTK	FG	15.00	P50793	810129	17.68	T	RHWTK
47.	RHWTK	G	12.33	CM359	CM359	17.67	T	RHWTK
	S.E.		1.82			7.63		
	L.S.D.		5.11			22.44		

A category which shares common letters is not significantly different at P< 0.05. SST = (S) smooth, (S) soft and (T) Think, RHWTK = (R) rough, (H) hard, (W) wrinkled and (TK) thick. * = kabuli.

group wise susceptibility and tolerance, respectively. Group 1 included most of the Kabuli type varieties (with SST characteristics) and some of the Desi type varieties (with RST, RHTK and RHWTK) while the varieties of group 2 included all Desi type varieties (with mostly RHWTK characteristics). The maximum seed damage was noted in varieties 810274, KC 53 and 51821 (Desi types) which were significantly different from the varieties CM2, PK 51886, PAG 114, 810129, P 50621, P 50793 and CM 359 (with rough, hard, wrinkled seed surface and thick seed coat).

It was clearly observed that most of the varieties of group 2 had rough, hard, wrinkled seed surfaces and thick seed coats which were related to tolerance of the seeds to attack by bruchid beetles. The results are in agreement with the observations of Brewer and Horber [3], Podoler and Applebaum [12] and Gokhele [6]. Nowanze *et al.* [11] observed that bruchids can detect macroscopic differences in the seed coat texture which may be partially responsible for their choice of varieties.

Number of holes (bruchid emergence or developmental success). The results (Table 1) based on this parameter divided the varieties into two groups on the basis of their physical characteristics: group 1 from var. 1 to 24 and group 2 from var. 25 to 47. Group 1 included 11 kabuli type varieties out of a total of 13 (with SST characteristics) which supported the greatest bruchid development. Salunkhe and Yadhav [15] and Gupta and Mishra [8] reported similar findings with the kabuli varieties. Group 2 included 21 desi type varieties out of a total 23 (with RHWTK characteristics) had less bruchid emergence and thus found to be less preferred.

Raina [13] stated a possible factor for resistance in chickpea may be a very rough and spiny seed coat; Podoler and Applebaum [12] observed that the thickness of the seed coat seems to be the only limiting factor for the bruchid larvae to penetrate into the seed. Our findings correspond with these observations. The mean seed damage and emergence holes in the varieties also correspond to each other with the level of significance and susceptibility with respect to physical charac-

TABLE 2. VARIABILITY AND HERITABILITY OF BRUCHID DAMAGE PARAMETERS IN CHICKPEA.

Characters	Genotypic variance	Genotypic coefficient of variation	Phenotypic variance	Phenotypic coefficient	Heritability
No. of damaged seeds	5.22	11.24	15.16	19.14	0.345
No. of holes	309.98	38.02	484.82	47.54	0.639

TABLE 3. GENOTYPIC (rg) AND PHENOTYPIC (rph) CORRELATION COEFFICIENTS BETWEEN THE TWO CHICKPEA DAMAGE PARAMETERS ($P < 0.01$).

		No. of holes
No. of damaged seeds	rg	0.9845**
	rph	0.6061**

teristics and are also in close agreement with the work of Ahmed, Khalique, and Khan (unpublished data).

Variances and coefficient of variation at genotypic and phenotypic levels and broad sense heritabilities are presented in Table 2. Values of phenotypic variances (15.16 and 484.82) and coefficient of variation (19.14 and 47.54) were much higher than the corresponding genotypic values, indicating the masking effect of environment. Broad sense heritability values were medium (34.5%) for number of seed damaged and high (63.9%) for number of holes.

Correlation coefficients at the genotypic (rg) level were higher than the corresponding phenotypic (rph) values (Table 3). Genotypic correlation of damaged seeds with no. of holes was highly significant (0.9845). These results are in close agreement with an earlier report of Afzal *et al.* [2].

In conclusion, the screening of 47 Chickpea varieties through a free choice test indicated that the surface texture of the seed is an important factor responsible for resistance/tolerance (whether mechanical, physical and/or biochemical) limiting infestation of bruchid beetle. However, more investigation in this direction should be undertaken to identify further promising sources of seed resistance for incorporation in breeding programme to enhance factors that will limit insect infestation.

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