Studies on Aphid Resistance and Some Quantitative Characters of Some Selected Lines of Indian Mustard (*Brassica juncea* L. *Czern and Coss*)

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Abstract

Eight lines of Indian mustard (*Brassica juncea* L. Czern and Coss) were evaluated in 2007-08 under unprotected condition with four replications in a randomized block design at the instructional farm of Bidhan Chandra Krishi Viswavidyalaya, Mohanpur. The objectives of the studies were to identify aphid resistant lines and to study the association of yield and yield attributing characters. The lines showed significant differences with respect to most of the traits excepting plant height, length of main raceme and aphid score at 86 days after sowing (DAS). The mean performances of aphid resistant lines indicated aphid infestation did not cause significant reduction in seed yield as compared to resistant check T-6342. Two lines AR-22 and AR-30 showed higher values of plant height, length of main raceme and aphid score at 86 DAS than the susceptible check Varuna. Length of main raceme, number of branches plant^{-1}, number of siliquae on branches, number of seeds siliqua^{-1} and number of filled siliquae on top 10 cm were the main determinants contributing to seed yield under aphid infestation.

1. Introduction

Rapeseed and mustard are grown in diverse agro climatic conditions in India ranging from north-eastern/north-western hills to plains of south under irrigated and rainfed conditions. These crops are affected by various biotic and abiotic stresses, which reduce the seed yield. Among the various pests attacking mustard, aphid (*Lypaphis erysimy* Kalt) is a serious pest and one of the main limiting factors of seed yield. The estimated yield loss due to this pest has been 45-96 % under different agro-climatic regions in India (Phadke, 1980; Singh et al., 1983). The extremely rapid rate of multiplication of the aphids stands as a big handicap in the effective control of the pest. This necessitates a number of insecticidal sprays that is much difficult and costly in the standing crop to keep it reasonably free from aphids. The excessive use of insecticides on different crop species leads to imbalances in the eco-system and invites various health hazards due to their residual effects. The search for better resistant sources, however, continues for getting better donor parents for utilizing them in the breeding programme aimed at evolving new varieties possessing aphid resistance in the desirable agronomic background. Several studies have revealed some resistance mechanism in some varieties of different *Brassica* species, but none of the varieties were immune to aphids (Malik and Anand, 1984; Sonkar and Desai, 1999; Kumar et al., 1999). Hence, the study was undertaken to identify some of resistant genotypes against this pest.

2. Materials and Methods

Six lines of Indian mustard (AR-19, AR-21, AR-22, AR-24, AR-27 and AR-30), maintained in the Department of Plant Breeding, Bidhan Chandra Krishi Viswavidyalaya, along with one resistant check (T-6342) and one susceptible variety (Varuna), constituted the base population of the study. The experimental materials were sown in the *rabi* season of 2007-08 at the instructional farm of Bidhan Chandra Krishi Viswavidyalaya, Mohanpur. All the genotypes were sown late, than the normal date of sowing, that is on 28th November 2007, in a Randomized Block Design with four replications to induce natural infestation of aphids. No prophylactic measures were adopted to control the aphid infestation. Data were recorded on ten randomly selected plants for thirteen quantitative characters. namely, plant height, length of main raceme, number of primary branches plant^{-1}, number of secondary branches plant^{-1}, number of siliquae on main raceme, number of siliquae on branches, number of filled siliquae on top 10 cm, number of seeds siliqua^{-1} of top region of main raceme, number of seeds siliqua^{-1} of middle region of main raceme, number of seeds siliqua^{-1} of bottom region of main raceme, 100 seed weight, aphid score and seed yield plant^{-1}. The mean data were used for statistical analysis. Aphid infestation score was done according to Bakhetia and Sandhu (1973).

3. Results and Discussion

Analysis of variance was done with respect to all the thirteen characters to test the significance of differences among the lines. The results (Table 1) showed that most of the characters differed significantly among the lines.

Plant height and length of main raceme did not show any differences among the lines. Significant differences in aphid score was also not recorded among the lines. The phenotypic coefficients of variation (PCV) for all the traits were higher than the corresponding genotypic coefficients of variation (GCV) in (Table 2).

High heritability in broad sense along with high genetic advance were recorded for number of seeds siliqua^{-1} of top region of main raceme (0.710 and 9.563), number of seeds siliqua^{-1} of middle region of main raceme (0.462 and 4.209), number of seeds siliqua^{-1} of bottom region of main raceme (0.803 and 8.144), number of primary branches plant^{-1} (0.412 and 5.268), number of secondary branches plant^{-1} (0.592 and 8.524), indicating that these characters were controlled by additive type of gene actions. Comparison of mean values of seed yield plant^{-1} and different yield attributing characters of the lines are presented in (Table 3).

It was evident that seed yield plant^{-1} of the resistant check 'T-6342' (3.502) was significantly higher than that of the susceptible check 'Varuna' while the other lines namely, AR-24, AR-21, and AR-30 were comparable to 'T-6342'. As the aphid infestation was not severe (ranging from 0.80-1.00), it had little effect on overall performance of the lines. In such a situation the yield potential of the advanced lines were higher than the susceptible check and were superior in terms of aphid score.The genotypic correlation coefficients among different characters are presented in (Table 4).

Seed yield plant^{-1} showed significant positive correlation with length of main raceme, number of primary branches plant^{-1}, number of secondary branches plant^{-1}, number of siliquae on branches, number of seeds siliqua^{-1} on top and middle of the raceme and number of filled siliquae on top 10 cm. Plant

Table 1: Analysis of variance of different characters of the lines under unprotected condition

Sources of variation	d.f.	Mean sum of square (MS)												
		A	B	C	D	E	F	G	H	I	J	K	L	M
Replications	3	8.677	8.206	0.042	0.006	11.292	2.615	0.301	0.346	0.057	0.056	0.002**	0.043	0.090
Treatment	7	19.388	9.762	0.098*	0.275**	12.108*	37.531**	2.264**	0.889**	1.440**	0.180*	0.0008*	0.193*	0.051
Error	21	10.257	3.947	0.026	0.040	3.904	7.491	0.210	0.200	0.083	0.060	0.0003	0.072	0.108

*$p<0.05$, **$p<0.01$, A= Plant height (cm), B= Length of main raceme (cm), C= Number of primary branches plant$^{-1,}$ D= Number of secondary branches plant^{-1}, E= Number of siliquae on main raceme, F= Number of siliquae on branches, G= Number of seeds siliqua^{-1} (top), H= Number of seeds siliqua^{-1} (middle), I= Number of seeds siliqua^{-1} (bottom), J= Number of filled siliquae on top 10 cm, K= 100 seed weight (g), L= Seed yield plant^{-1} (g), M= Aphid score on 86 DAS,

Table 2: Genetic parameters of different characters of the lines under unprotected condition

Parameters	A	B	C		E	F	G	H	I	J	K	L
PCV	2.780	4.052	6.203	6.996	6.402	3.427	6.536	4.420	4.924	3.692	7.110	9.688
GCV	1.195	2.102	3.983	5.381	3.757	2.425	5.508	3.005	4.412	2.124	3.828	5.282
h2 (BS)	0.182	0.269	0.412	0.592	0.344	0.501	0.710	0.462	0.803	0.331	0.290	0.297
GA (% mean)	1.050	2.247	5.268	8.524	4.542	3.534	9.563	4.209	8.144	2.517	4.246	5.932

BS=Broad sense, A= Plant height (cm), B= Length of main raceme (cm), C= Number of primary branches plant$^{-1,}$ D= Number of secondary branches plant$^{-1,}$ E= Number of siliquae on main raceme, F= Number of siliquae on branches, G= Number of seeds siliqua^{-1} (top), H= Number of seeds siliqua^{-1} (middle), I= Number of seeds siliqua^{-1} (bottom), J= Number of filled siliquae on top 10 cm, K= 100 seed weight (g), L= Seed yield plant^{-1} (g),

Table 3: Comparison of means of different characters of the lines under unprotected condition

A	B	C	D	E	F	G	H	I	J	K	L	M	N
AR-21	122.57	57.32	3.37	4.65	35.37	113.80	12.55	14.32	13.22	7.97	0.287	3.468	1.10
AR-22	128.90	55.50	3.45	4.60	40.30	114.55	13.40	13.52	13.72	8.12	0.265	3.163	1.10
AR-24	126.60	58.55	3.45	4.70	39.05	118.10	13.65	13.80	13.10	8.35	0.297	3.565	0.90
AR-27	125.62	56.20	3.25	4.25	38.78	114.85	11.75	14.25	12.20	7.80	0.295	3.152	1.10
AR-19	127.20	59.22	3.30	4.30	37.15	111.95	12.27	13.42	12.45	8.12	0.307	3.091	0.80
AR-30	124.27	57.82	3.10	4.55	39.95	109.52	13.35	13.20	13.82	8.27	0.290	3.334	0.85
Grand mean	125.86	57.44	3.32	4.51	38.43	113.80	12.83	13.75	13.09	8.11	0.290	3.296	0.97
T-6342	128.27	58.98	3.62	4.85	38.05	112.90	13.97	14.45	13.37	8.45	0.311	3.592	0.90
Varuna	128.35	55.22	3.25	4.07	36.30	108.52	13.12	13.52	13.70	8.02	0.294	3.041	1.00
CD at 5%	4.710	2.922	0.236	0.296	2.906	4.025	0.673	0.658	0.424	0.361	0.026	0.394	0.482

A= Characters Lines, B= Plant height (cm), C= Length of main raceme (cm), D= Number of primary branches plant^{-1}, E= Number of secondary branches plant^{-1}, F= Number of siliquae on main raceme, G= Number of siliquae on branches, H= Number of seeds siliqua^{-1}(top), I= Number of seeds siliqua^{-1} (middle), J= Number of seeds siliqua^{-1} (bottom), K= Number of filled siliquae on top 10 cm, L= 100 seed weight (g), M= Seed yield plant^{-1}(g), N= Aphid score on 86 DAS,

Table 4: Genotypic and Phenotypic correlation coefficients among different characters of the lines under unprotected condition

Characters		A	B	C	D	E	F	G	H	I	J	K
Plant height (cm)	G	-0.341	0.635*	-0.179	0.602*	-0.026	0.543	-0.250	0.190	0.549	0.130	-0.519
	P	-0.252	0.200	-0.094	0.029	-0.059	0.280	-0.023	0.116	0.109	-0.029	-0.159
Length of main raceme (cm)	G		0.396	0.733*	-0.130	0.322	0.252	0.415	-0.377	1.250**	1.364**	1.157**
	P		-0.016	0.263	0.039	0.080	0.136	0.265	-0.165	0.075	0.174	0.094
Number of primary branches plant^{-1}	G			0.688*	-0.061	0.806*	0.343	1.058**	-0.258	0.437	-0.106	0.649*
	P			0.354	0.101	0.395	0.197	0.417	-0.091	0.080	0.345	0.325
Number of secondary branches plant^{-1}	G				0.421	0.624*	0.696*	0.762**	0.325	0.810**	-0.048	1.214**
	P				0.072	0.264	0.495	0.422	0.212	0.544	-0.031	0.511
Number of siliquae on main raceme	G					0.301	0.422	-0.464	0.186	0.620*	-0.856**	0.161
	P					0.226	0.185	-0.186	0.167	0.028	0.039	-0.077
Number of siliquae on branches	G						0.097	0.603*	-0.474	0.071	-0.205	0.689*
	P						-0.148	0.542	-0.270	0.069	-0.077	0.237
Number of seeds siliqua-1 top	G							0.312	0.788*	1.077**	-0.021	0.642*
	P							0.201	0.676*	0.616*	-0.028	0.461
Number of seeds siliqua-1 (middle)	G								-0.166	0.325	0.407	1.105**
	P								-0.059	0.200	0.126	0.449
Number of seeds siliqua-1 (bottom)	G									0.519	-0.592*	0.190
	P									0.366	-0.215	0.136
Number of filled siliquae on top 10 cm	G										0.410	0.675*
	P										0.241	0.605*
100 seed weight (g)	G											0.245
	P											0.212

$^{*}p<0.05$, $^{**}p<0.01$, A= Length of main raceme (cm), B= Number of primary branches plant-1, C= Number of secondary branches plant^{-1}, D= Number of siliquae on main raceme, E= Number of siliquae on branches, F= Number of seeds siliqua^{-1} (top), G= Number of seeds siliqua^{-1} (middle), H= Number of seeds siliqua^{-1} (bottom), I= Number of filled siliquae on top 10 cm, J= 100 seed weight (g), K= Seed yield plant^{-1} (g), height showed negative but non-significant correlation with seed yield plant^{-1}. Number of siliquae on main raceme and 100 seed weight showed positive and non-significant correlation with seed yield plant^{-1}. 100 seed weight showed significantly positive genotypic correlation with main raceme length but significantly negative genotypic correlations with number of siliquae on main raceme and number of seeds siliqua^{-1} (bottom). Number of filled siliquae on top 10 cm of raceme also showed significantly positive correlation with length of main raceme, number of secondary branches plant^{-1}, number of siliquae on main raceme and number of seeds siliqua^{-1} (top).

The phenotypic correlation coefficients among different characters are presented in (Table 4.) Seed yield plant^{-1} showed significantly positive correlations with only number of filled siliquae on top 10 cm, plant height and number of siliquae on main raceme showed non-significant but positive correlation with seed yield plant^{-1}. Among other characters number of seeds siliqua^{-1} (top) showed significantly positive correlation with number of seeds siliqua^{-1} (bottom) and number of filled siliquae on top 10 cm raceme.

The phenotypic correlation coefficients among twelve characters were further partitioned into direct and indirect effects to establish the cause and effect relationship among yield and its contributing characters through path coefficient analysis. Direct and indirect effects of different characters on seed yield plant^{-1} were presented in Table 5. Labana et al. (1975) found seed yield to have significant positive correlation only with main shoot length. Path analysis revealed that number of secondary branches plant^{-1} had the maximum direct effect on yield.

In the present study path coefficient analysis (Table 5) showed that number of secondary branches exerted highest positive direct effect (0.724) followed by number of siliquae on branches (0.543), number of seeds siliqua^{-1} of bottom (0.507), number of filled siliquae on top 10 cm (0.402), length of main raceme (0.320) and number of primary branches plant^{-1} (0.312) as seed yield plant^{-1}. The highest negative direct effect on seed yield plant^{-1} was exerted by number of siliquae on main raceme (-0.577) followed by number of seeds siliqua^{-1}

of middle (-0.458), number of seeds siliqua^{-1} of top (-0.376), plant height (-0.326) and 100 seed weight (-0.151). The low value of the residual effect (0.696) indicated that most of the characters contributing towards yield were considered. Number

Table 5: Path coefficient analysis of different yield contributing characters on seed yield per plant, under unprotected condition

Characters	A	B	C	D	E	F	G	H	I	J	K
Plant height (cm)	-0.326	-0.109	0.199	-0.129	-0.348	-0.014	-0.204	0.115	0.097	0.221	-0.020
Length of main raceme (cm)	0.111	0.320	0.124	0.531	0.075	0.175	-0.095	-0.190	-0.191	0.503	-0.206
Number of primary branches plant^{-1}	-0.207	0.127	0.312	0.498	0.034	0.437	-0.129	-0.485	-0.131	0.176	0.016
Number of secondary branches plant^{-1}	0.058	0.235	0.214	0.724	-0.243	0.339	-0.262	-0.349	0.165	0.326	0.007
Number of siliquae on main raceme	-0.196	-0.042	-0.018	0.305	-0.577	0.164	-0.158	0.213	0.094	0.249	0.129
Number of siliquae on branches	0.008	0.103	0.252	0.452	-0.174	0.543	-0.036	-0.277	-0.240	0.028	0.031
Number of seeds siliquae^{-1} (top)	-0.176	0.080	0.107	0.504	-0.243	0.052	-0.376	-0.143	0.400	0.433	0.003
Number of seeds siliquae^{-1} (middle)	0.081	0.133	0.331	0.552	0.268	0.328	-0.117	-0.458	-0.081	0.131	-0.061
Number of seeds siliquae^{-1} (bottom)	-0.062	-0.120	-0.080	0.235	-0.107	-0.258	-0.296	0.073	0.507	0.209	0.089
Number of filled siliquae on top 10 cm	-0.179	0.400	0.137	0.586	-0.358	0.039	-0.404	-0.149	0.263	0.402	-0.062
100 seed weight (g)	-0.042	0.437	-0.033	-0.034	0.495	-0.111	0.008	-0.187	-0.301	0.165	-0.151

A= Plant height (cm), B= Length of main raceme (cm), C= Number of primary branches plant^{-1}, D= Number of secondary branches plant^{-1}, E= Number of siliquae on main raceme, F= Number of siliquae on branches, G= Number of seeds siliqua^{-1} (top), H= Number of seeds siliqua^{-1} (middle), I= Number of seeds siliqua^{-1} (bottom), J= Number of filled siliquae on top 10 cm, K= 100 seed weight (g) of filled siliquae on top 10 cm of the raceme exerted negative indirect effect via most of the traits.

4. Conclusion

In the present investigation, it was observed that aphid infestation did not cause significant reduction in seed yield as compared to the resistant check 'T-6342' when the crop was sown during the end of November. The aphid resistant lines did not show significant reduction in plant height, length of main raceme and aphid score at 86 days after sowing as compared to resistant check 'T-6342', High heritability was recorded for number of seeds siliqua^{-1} on top and bottom positions of main raceme. The genetic advance (% of mean) of these two traits were also high. Length of main raceme, number of branches, number of siliquae on branches, number of seeds siliqua^{-1} and number of filled siliquae on top 10 cm were the main determinants of seed yield under aphid infestation.

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