

## VARIABILITY AND CORRELATION STUDIES UNDER MOISTURE STRESS CONDITION IN INDIAN MUSTARD [*BRASSICA JUNCEA* (L.) CZERN. & COSS.]

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**Abstract:** Diverse genotypes of Indian mustard *Brassica juncea*, L with three checks were evaluated in Completely Randomised Design for different morphological characters under two conditions Non-moisture stress (Env.I) and Moisture Stress (Env.II) during Rabi 2014-15. Significant differences were observed among the genotypes for all the characters studied under both the conditions. In Env.I, analysis of variance revealed that mean squares due to genotypes were significant for all the parameters except number of primary branches per plant and seeds per siliqua. On the other hand in Env.II, analysis of variance revealed that mean squares due to genotypes were significant for all the parameters except days to 75 per cent maturity, siliqua length and seeds per siliqua. All the characters under study had exhibited a broad range of variability. The phenotypic Coefficient of Variance values was found to be higher than their corresponding GCV values. High heritability coupled with high genetic advance was observed for all the growth parameters viz, siliquae per plant, length of main shoot and siliquae on the main shoot. Seed yield per plant had a positive correlation with length of the main shoot, siliqua length, seeds per siliqua, 1000-seed weight, biological yield per plant and harvest index under moisture stress condition whereas under non-moisture stress condition seed yield per plant had significant positive associations with siliquae per plant, seeds per siliqua and harvest index.

**Keywords:** Heritability, Correlation, Moisture Stress, Genetic advance

### INTRODUCTION

Rapeseed-mustard have been important oilseed crop to Indian economy since long. Rapeseed-mustard is the second most important oilseed crop after groundnut. After China India is second largest rapeseed-mustard growing country in the world. Concerted efforts in conventional breeding programmes emphasizing towards selection within the existing germplasm have led to the development of a number of improved cultivars, but the yield levels have been virtually static owing to limited genetic variability in the cultivated varieties and their susceptibility to biotic and abiotic stresses. Since water stress is one of the most important environmental variable affecting growth and development, the study of genetic variation for drought tolerance and productivity under stress forms an important breeding objective in Indian mustard. Crops exposed to water deficit or salinity brings about severe growth retardation and yield loss. Since Brassica crops are important contributors to total oilseed production, it is urgently needed to develop tolerant cultivars to ensure better yields under such adverse conditions. Generally, *Brassica* species have been developed in the areas with high rainfall so perform poorly in the areas with low rainfall Resketo and Szabo (1992) Richards (1978). Seed yield can be primarily limited even by the relatively short period of soil moisture-stress during the reproductive development Mendham and Salisbury (1995). Water stress is a serious problem in 45 per cent of world's geographical area which leads to substantial variations in morphology, anatomy and physiology

of plants and ultimately, affects yield potential Garg *et al.* (1998). The crop is exposed to drought stress at one or more phenological stages which calls for screening and development of drought tolerant genotypes as yield and drought tolerance are controlled at separate loci Singh and Choudhary (2003). Breeding for drought tolerance involves identification and transfer of different morpho-physiological and biochemical traits that may impart drought tolerance to high yielding cultivars. The relative seed yield has also been proposed as a useful selection criterion for assessing drought response of a genotype Ahmed *et al.*, (1999).

### MATERIALS AND METHODS

The material for the present investigation comprised of 25 genotypes obtained from local, indigenous and exotic sources (TM-136, TM-172, Geeta, Heera, IC-355309, TM-204, Pusa Jaikisan, IC-355331, YRN-6, TM-215, IC-355337, TM-224, IC-347949, 03-456, Zem-1, NRC-1, OMK-3-29, RCC-4 x Zem-1, RH-8544, Bawal-151, NRC-2, Varuna (C), Kranti (C), RL-1359 (C), RCC-4 (C) were raised during the rabi season, 2014-15 under moisture stress (pot culture) Env.I, non-stress (pot culture) in the farm CSKHPKV Palampur department of Crop Improvement. Under moisture stress condition (pot culture) (EnvII) only life-saving amount of water was given at critical stages of growth whereas normal water was given to non-moisture stress condition (Pot culture). Data was recorded for different morpho-physiological traits viz., Days to flower initiation, Days to 50 % flowering, , Days to 75%

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maturity, Plant height (cm), Number of primary branches per plant, , Number of secondary branches per plant, Siliquae per plant, Length of main shoot (cm), Siliquae on main shoot, Siliqua length (cm), Seeds per siliqua, 1000-seed weight, Seed yield per plant (g), Biological yield per plant (g), Harvest Index (%), Relative water content (RWC), Oil content (%), Drought susceptibility index ('S'), Yield reduction (%). The mean data was analyzed in OPSTAT software. The relative drought tolerance of genotypes was quantified with respect to seed yield through the Drought Susceptibility Index according to Fischer and Maurer (1978). Analysis of variance (ANOVA) for Completely Randomized Block Design for all traits was done using statistical software, OPSTAT. Analysis of variance and the genetic parameters were computed by following standard statistical procedure. The Phenotypic Coefficient of Variation (PCV), Genotypic Coefficient of Variation (GCV) and heritability in broad sense were calculated using the formula suggested by Burton and de Vane (1953). The mean data were subjected to analysis of variance as per standard procedure outlined by Panse and Sukhatme (1967). Genetic advance was calculated by the method suggested by Johnson et al. (1955)

## RESULTS AND DISCUSSION

In Moisture stress condition mean average yield was lesser than compared to non-moisture stressed condition. Analysis of variance studies revealed that In Env.I mean squares due to genotypes were significant for all the parameters except the number of primary branches per plant and seeds per Siliqua (Table.1). On the other hand in Env.II, analysis of variance revealed that mean squares due to genotypes were significant for all the parameters except days to 75 percent maturity, siliqua length and seeds per Siliqua (Table.1). Based on analysis of variance, it is apparent that variation among genotypes was present for most of the characters and genotypic differences also existed for most of the morphological and yield contributing characters. Shalini et al. (2000), Patel and Patel (2006) also reported highly significant differences for days to 50 percent flowering and days to maturity, harvest index, number of secondary branches per plant, 1000-seed weight, plant height, and seed yield per plant. A wide range of variability was observed for all the characters studied in general, PCV values were found to be higher than their corresponding GCV values (Table.2). Similar findings with respect to PCV and GCV have been reported by (Mahla et al. (2003), Mahak et al. (2004), Kumar and Mishra (2007). Moderate estimates (10-30 %) were observed for most of the remaining characters except days to flower initiation, days to 50% flowering, days to 75% maturity and 1000 seed weight which had lowered PCV (<10%) (Table.2). High GCV (>30 %) was observed only for siliquae

on the main shoot. Estimates of GCV were moderate for the length of the main shoot, number of secondary branches per plant, siliquae per plant, seed yield per plant, plant height and siliqua length. The lowest GCV was recorded for the remaining characters. The results from the present study in this context indicated that both PCV and GCV were high for, siliquae on the main shoot Table.2). It indicated that simple selection for these characters might be advantageous in particular conditions. Similar findings were earlier reported by Singh et al., (2007). Heritability estimates for both the conditions were high (>60 %) for plant height, days to 75 percent maturity, 1000-seed weight, siliquae on main shoot, days to flower initiation, siliquae per plant, length of main shoot, harvest index, days to 50 percent flowering, and biological yield per plant except for Siliqua length, number of secondary branches per plant, and seed yield per plant recorded moderate heritability (30-60 %) estimates. These findings are in accordance with the results reported by Singh et al., (2009) and Meena et al., (2008). Moderate genetic advance (10-30 %) was recorded for days to flower initiation, days to 50% flowering, plant height, secondary branches per plant, siliqua length, 1000 seed weight, harvest index, biological yield per plant, and seed yield per plant. (Pant and Singh 2001; Mahak et al., (2003), Mahla et al. (2003), Kumar and Mishra (2007) also observed moderate genetic advance for seed yield per plant and other characters. The remaining characters exhibited low estimates of genetic advance (< 10 %). Based on the above findings, high heritability coupled with high genetic advance was observed for siliquae per plant, length of main shoot and siliquae on the main shoot Table.2). Earlier workers have also reported similar observations (Mahak et al., (2003), Mahla et al., (2003), Kumar and Mishra (2007). Ghosh and Gulati (2001) reported high heritability coupled with high genetic advance for harvest index, biological yield per plant, number of primary branches, number of siliquae on the main shoot, main shoot length and number of seeds per siliqua. This suggested the importance of additive gene action for their inheritance and improvement could be brought about by simple phenotypic selection. At phenotypic level under Env.I condition seed yield per plant had significant positive associations with the length of the main shoot, siliqua length, seeds per siliqua, 1000-seed weight, biological yield per plant and harvest index (Table.3). Earlier Sirohi et al., (2004) reported that seed yield had a significant and positive association with biological yield, harvest index and. Muhammad et al., (2007) showed a significant positive correlation of seed yield with siliquae per plant. (Uddin *et al.*, (1995), Patel et al., (2001), Kardam and Singh 2005). Acharya and Patil (2008) observed significant positive association of seed yield with days to flower initiation, days to maturity, plant height, number of seeds per siliqua and 1000-

seed weight. Verma and Mahto (2005) observed that seed yield per plant had positive correlation with the plant height, number of siliquae per plant, number of seeds per silique, and 1000-seed weight. Sirohi et al. (2008) reported that seed yield per plant was positively correlated with biological yield per plant and harvest index. On the other hand under Env.II condition at phenotypic level, seed yield per plant had significant positive associations with siliquae per plant, seeds per silique and harvest index (Table.4). Earlier workers Beena and Charanj (2003) also reported significant positive correlation of seed yield with siliquae per plant and harvest index. Verma and Mahto (2005) had similar results. Rameeh (2011) also observed positive correlation of seed yield with siliquae per plant. Among different parameters, siliquae per plant and biological yield per plant. Therefore, for judicial use of available water resource high yielding genotypes can be developed with

siliqua length, seeds per silique, 1000-seed weight, biological yield per plant and harvest index.

## CONCLUSION

On the basis of analysis of variance, it is apparent that variation among genotypes was present for most of the characters and genotypic differences also existed for most of the morphological and yield contributing characters. Broad range of variability was observed for all the traits under study. Higher PCV value was recorded corresponding to GCV in both the conditions for traits under study. In Env.I seed yield per plant had significant positive correlation with length of main shoot, siliqua length, seeds per silique, 1000-seed weight, biological yield per plant and harvest index. On the other hand at phenotypic level, seed yield per plant had significant positive associations with siliquae per plant, seeds per silique and harvest index.

**Table 1.** Analysis of variance for different characters under different environments

S. No.	Characters	Env.I		Env.II		
		Source	Genotypes	Error	Genotypes	Error
		df	24	50	24	50
1	Days to flower initiation	32.889*	0.558	20.709*	1.586	
2	Days to 50% flowering	27.625*	0.727	20.413*	1.781	
3	Days to 75% maturity	30.624*	0.255	128.469	164.788	
4	Plant height (cm)	419.809*	10.588	292.394*	9.957	
5	No. of primary branches/plant	1.021	0.843	2.661*	1.368	
6	No. of secondary branches/plant	5.538*	2.302	7.468*	3.998	
7	Siliquae /plant	557.187*	14.538	266.257*	19.405	
8	Length of main shoot (cm)	128.031*	11.573	133.028*	8.071	
9	Siliquae on main shoot	188.942*	7.567	94.146*	9.616	
10	Siliqua length (cm)	1.194*	0.386	0.488	0.429	
11	Seeds per silique	1.677	1.492	2.027	1.610	
12	1000-seed weight (g)	2.209*	0.002	3.960*	0.165	
13	Biological yield /plant (g)	17.330*	1.507	122.662*	5.509	
14	Harvest Index (%)	6.961*	1.267	71.010*	6.918	
15	Seed yield /plant	1.964*	0.788	1.547*	0.824	

Significance at  $P \leq 0.05$

Env.I Non- Moisture Stress, Env.II Moisture stress condition

**Table 2.** Estimates of different parameters of variability for various characters under Env.I, and Env.II

Characters	Env.I				Env.II			
	PCV (%)	GCV (%)	$h^2_{bs}$ (%)	GA (%)	PCV (%)	GCV (%)	$h^2_{bs}$ (%)	GA (%)
Days to flower initiation	7.82	7.63	85.10	15.32	5.37	4.79	79.68	8.81
Days to 50% flowering	6.08	5.84	81.25	11.55	4.51	4.03	80.16	7.44
Days to 75 % maturity	2.29	2.26	92.63	4.60	7.83	2.29	58.55	1.38
Plant height (cm)	13.49	13.00	92.88	25.81	8.35	7.95	90.73	15.60
Primary branches/plant	29.78	7.57	6.46	3.96	30.71	16.68	29.51	18.67
Secondary branches/plant	35.67	21.89	37.68	27.68	23.56	11.89	25.45	12.35
Siliquae/plant	16.32	15.70	79.48	31.10	6.80	6.12	81.09	11.36
Length of main shoot(cm)	29.03	25.50	77.14	46.13	19.25	17.69	84.49	33.50
Siliquae on main shoot	39.00	36.80	83.05	71.54	21.34	18.49	75.07	33.00
Siliqua length (cm)	15.52	11.78	57.60	18.41	12.82	5.15	16.16	4.27
Seeds/siliqua	11.01	3.38	19.40	2.13	9.81	5.08	26.80	5.42
1000-seed weight (g)	9.07	8.95	91.36	18.18	6.54	6.44	86.71	13.04
Harvest Index (%)	10.06	8.84	77.34	16.02	18.58	17.38	87.42	33.47
Biological yield/plant (g)	11.09	8.60	60.09	13.73	25.23	21.88	75.17	39.07
Seed yield/plant (g)	25.18	14.63	33.73	17.50	14.16	6.64	31.98	6.41

PCV: Phenotypic Coefficient of Variation; GCV: Genotypic Coefficient of Variation;  $h^2_{bs}$  (%): Heritability in broad sense; GA: Genetic advance (% of mean)

\*Significance at  $P \leq 0.05$  Env.I Non- Moisture Stress

Env.II Moisture stress condition

**Table 3.** Estimates of Correlation coefficients at phenotypic level among different characters under Env.I

Characters	Days to flower initiation	Days to 50% flowering	Days to 75% maturity	Plant height	No. of primary branches	No. of secondary branches	Siliquae per plant	Length of main shoot	Siliquae on main shoot	Siliqua length	Seeds per siliqua	1000 - seed weight	Biological yield / plant	Harvest Index	Seed yield /Plant
Days to flower initiation		0.696*	0.008	0.227*	0.188	0.229*	0.158	-0.145	-0.128	-0.063	-0.214	-0.029	-0.003	0.017	0.021
Days to 50% flowering			0.11	0.043	0.138	0.102	0.162	-0.408*	0.033	-0.127	-0.122	-0.124	0.085	-0.044	-0.146
Days to 75% maturity				0.025	0.146	-0.014	-0.218	-0.073	-0.139	0.082	0.042	-0.192	-0.309*	0.033	0.010
Plant height					-0.005	-0.057	0.005	0.084	-0.15	0.052	0.044	0.07	-0.013	0.155	0.102
No. of primary branches						0.358*	-0.043	0.175	0.024	-0.124	-0.04	0.026	-0.06	0.047	0.072
No. of secondary branches							0.109	0.269*	0.033	-0.191	-0.278*	-0.012	-0.115	-0.156	0.024
Siliquae per plant								-0.007	0.256*	-0.054	-0.044	0.331*	0.585*	0.300*	0.154
Length of main shoot									0.048	-0.024	0.001	0.025	-0.254*	0.027	0.275*
Siliquae on main shoot										0.035	0.112	-0.115	0.303*	0.015	0.134
Siliqua length											0.275*	0.303*	0.022	0.454*	0.287*
Seeds per siliqua												0.06	0.364*	0.468*	0.301*
1000 - seed weight													0.430*	0.662*	0.431*
Biological yield / plant														0.288*	0.234*
Harvest Index															0.594**

\*Significant at  $P \leq 0.05$

Env.I Non- Moisture Stress

**Table 4.** Estimates of Correlation coefficients at phenotypic level among different characters under Env.II

Characters	Days to flower initiation	Days to 50% flowering	Days to 75% maturity	Plant height	No. of primary branches	No. of secondary branches	Siliquae per plant	Length of main shoot	Siliquae on main shoot	Siliqua length	Seeds per siliqua	1000 - seed weight	Biological yield / plant	Harvest Index	Seed yield /Plant
Days to flower initiation		0.538*	-0.018	0.113	0.120	0.001	-0.057	0.080	0.114	-0.134	-0.138	0.145	-0.151	-0.021	-0.192
Days to 50% flowering			0.020	-0.137	-0.024	-0.064	-0.075	0.282*	0.064	-0.148	-0.023	-0.004	-0.051	0.005	-0.015
Days to 75% maturity				0.020	0.118	-0.144	-0.039	-0.092	0.041	-0.067	0.259*	-0.132	-0.110	0.090	0.012
Plant height					-0.060	-0.043	0.061	0.075	0.074	0.066	-0.039	0.154	0.096	-0.151	-0.087
No. of primary branches						0.345*	-0.144	-0.197	-0.058	0.092	0.028	-0.161	-0.178	0.011	-0.147
No. of secondary branches							0.076	-0.046	-0.104	0.079	0.034	-0.182	0.032	-0.100	-0.156
Siliquae per plant								-0.226*	-0.148	-0.281*	-0.060	0.218	0.240*	-0.098	0.061*
Length of main shoot								0.029	-0.047	0.144	-0.283*	-0.101	0.159	0.206	0.029
Siliquae on main shoot										0.133	0.325*	-0.178	-0.151	0.171	0.157
Siliqua length											0.179	-0.089	-0.086	0.156	0.083
Seeds per siliqua												-0.694*	-0.402*	0.650*	0.880*
1000 -seed weight													0.241*	-0.271*	-0.186
Biological yield / plant														-0.833*	-0.116
Harvest Index															0.553

\*Significant at  $P \leq 0.05$ 

Env.II Moisture stress condition

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