STABILITY OF THE CROSSES IN RELATION TO THE PARENTAL GENOTYPES IN INDIAN MUSTARD

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ABSTRACT

Ten parental genotypes and their 45 F_1 progenies generated through diallel crosses excluding reciprocals in Indian mustard (Brassica juncea L. Czern & Coss) were grown under four unpredictable environments to study genotype x environment interaction and stability of performance.

Genotype x environment interaction was significant for the crosses as well as the parental genotypes for seed yield, plant height, main shoot length, siliqua length, seeds per siliqua, number of primary and secondary branches and stem thickness, except for parental genotypes in respect of number of primary and secondary branches, siliqua length and seeds per siliqua. Linear and non-linear components, in general, contributed towards the genotype x environment interaction for various characters. The linearity was more pronounced for seed yield and plant height both for the crosses and the parental lines. Higher magnitude of linear component was also observed in the crosses for primary and secondary branches.

High stability for seed yield was shown by only four parents, namely, RL 18, RS 3, M 160 and P Rai 219 which appeared tc be due to plasticity in some of the important component traits like plant height, primary and secondary branches and siliqua length. These traits acted as important homeostatic devices for imparting stability to yielding ability. The parental genotypes stable for different characters transmitted their stability to the maximum number of crosses in their respective arrays. Further, high x high stability parental combinations produced more stable progenies than either high x low or low x low combinations which suggest the genetic control of stability of performance.

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INTRODUCTION

Productivity of a population is the function of its adaptability while the latter is a compromise of fitness (Stability) and flexibility. Stability may depend upon the steady behaviour of certain morphological and physiological traits and allowing others to vary, resulting in predictable genotype x environment interaction for the final economic trait like seed yield. A population which can adjust its phenotypic expression in response to environmental fluctuations in such a way that it gives high and stable economic return can be termed "well buffered". The study of individual components helps in understanding the genetic basis of stability of yield. This information will be valuable to the breeders in predicting the potential of different cultivars over a range of environments.

The present paper contains the results of the experiments, involving 10 parental lines and their 45 F_1 progenies from a diallel cross (excluding reciprocals) in Indian mustard, grown under four unpredictable environments, with the objectives (i) to evaluate the stability of performance of the crosses in relation to the parental genotypes and (ii) to examine the transmission of stability to their F_1 progenies.

MATERIAL AND METHODS

Ten parental lines namely, RL 18, BR 13, Varuna, M 160, RS 3, T6342, KR 5610, M 590, P 16-13 and Pant Rai 219 were crossed in all possible combinations, excluding reciprocals, during winter 1976. The same material was again produced in winter 1977. In all, 55 progenies (10 parents + 45 F_1's) were studied at two locations (Ludhiana and Gurdaspur) for two years i.e. 1977-78 and 1978-79. These experiments represented four environments and were sown by 20th October each year in each of the environments. The material was sown in randomised block design with four replications in one row plots of 2.25 m in length with a row to row and hill to hill spacings of 30 cm and 15 cm, respectively. The recommended package of practices were followed to raise the experimental material in each environment. Ten plants were randomly chosen from each row for recording observations. The data on individual plants basis were recorded for plant height, number of primary branches, number of secondary branches, main shoot length, number of siliquae on main shoot, siliqua length, stem thickness, number of seeds per siliqua and seed yield. The data then, were, averaged on single plant basis. The statistical analyses for genotype x environment interaction and stability were carried out according to the models of Eberhart and Russell (1966) and Perkins and Jinks (1968).

RESULTS AND DISCUSSION

Differences in the ability of 55 progenies comprising 10 parental lines and 45 F_1 crosses to interact with the variable environment were evident for various characters (Table-1), suggesting the necessity of evaluating the breeding material in different environments to derive precise information regarding its genetic potential. The parents did not exhibit significant interaction with the environments for primary and secondary branches, siliqua length and seeds per siliqua. It was further observed that, in general, both linear and non-linear components contributed towards genotype x environment interaction for various characters, however, linearity was more pronounced for seed yield and plant height both for the crosses and the parental lines. Besides, higher magnitude of the linear component was observed for primary and secondary branches in respect of the crosses. This indicated that most accurate prediction of the phenotypic performance can be made for seed yield and plant height in respect of parental lines and for primary branches, secondary branches and seed yield in respect of crosses.

Due to wide occurrence of genotype x environment interaction, the present material was further analysed for stability of performance for nine characters. A genotype was considered stable if its mean performance was high, regression coefficient (B_i) approaching zero and deviation mean squares (S^2_{di}) as low as possible. The parental lines which showed high stability for seed yield were RL 18, RS 3, M 160 and P Rai 219 (Table-2).

The variation in stability of different parents for the various characters reveal that the observed variation may be due to plasticity in certain plant characters. However, it was interesting to note that RL 18 was stable for most of the characters studied like a wheat variety C 306 (Das and Jain, 1971). Its high adaptability and stability for seed yield, obviously, was due to its high buffering ability for almost all the characters under study. RS 3 manifested plasticity for primary and secondary branches and seeds per siliqua ; M 160 for plant height, siliquae on main shoot and siliqua length ; P Rai 219 for plant height, main shoot length and siliquae on main shoot. These three parental lines were stable for rest of the characters in addition to seed yield. Stem thickness was observed to show stability in all the four stable parents. It seems that due to its correlation with lodging resistance, stability for this trait might have greatly contributed to the stability of seed yield. The stability behaviour of the parental lines, RS 3, M 160 and P Rai 219 showed plasticity for one or two important yield components. Thus the observed relationship of stability of yield with other plant characters lead to the conclusion that variability in the stability of the component traits could be successfully utilized in imparting stability to seed yield. Similar results were reported by Grafius (1956) in oats, Bains and Gupta (1974) and Talukdar and Bains (1982) in wheat. Bradshaw (1965) observed that stability in morpho-physiological trait results from plasticity in certain physiological processes involved in the expression of that trait. These physiological processes act in a compensating manner ultimately exhibiting high buffering ability of the resultant morpho-physiological character. Similar system of physiological plasticity has been exhibited by the highly stable parental lines RL 18, RS 3, M 160 and P Rai 219. The physiological activities of different important yield components in these parents were probably subjected to changes due to variation in solar radiation, temperature and humidity prevailing at two locations during two different years of testing. This expression responded to environmental fluctuations in such a manner that stability of performance was imparted for some characters in the stable parents. The process ultimately contributed to the stability of seed yield. Sufficient evidence has accumulated that mean performance and ability to perform consistently over variable environments are under genetic control (Bucio-Alanis et al., 1969) and Talukdar and Bains (1982). In this investigation, the stable parental lines for different characters transmitted their stability to the maximum number of F_1 progenies in their arrays (Fig. 1). It was further revealed that crosses between parents showing high stability (RL 18, RS 3, M 160 and P Rai 219) for seed yield produced F_1 progenies which were superior in buffering ability. Similar trend of giving superior F_1 progenies for other characters was also noticed (Fig. 2).

In contrast, the percentage of stable F_1 progenies was comparatively low in high x low stability combinations, whereas, low x low combinations produced very low number of stable progenies. Thus, these results further confirmed the genetic control of stability of performance. Similar findings have been reported in wheat by Bains and Gupta (1972) and Talukdar and Bains (1982).

REFERENCES

Bains, K.S. and V.P. Gupta. 1972. Indian J. Genet. 32, 306-312.

Bradshaw, A.D. 1965, Adv. Genet. 13, 115-155.

Bucio-Alanis, L. and J. Hill. 1966. Heredity. 21, 399-407.

Das, P.K. and S.K. Jain. 1971. Ind. J. Genet 31, 77-85.

Eberhart, S.A. and W.A. Russell. 1966. Crop Sci. 6, 36-40.

Grafius, J.E. 1956. Agron. J. 48, 419-423.

Perkins J.M. and J.L. Jinks. 1968. Heredity. 23, 339-356.

Talukdar, P. and K.S. Bains. 1982. Z. Pflanz. 89, 197-205.

TABLE 1 POOLED ANALYSIS OF VARIANCE & JOINT REGRESSION ANALYSES FOR SEED YIELD & OTHER CHARACTERS (Perkins and Jinks, 1968)

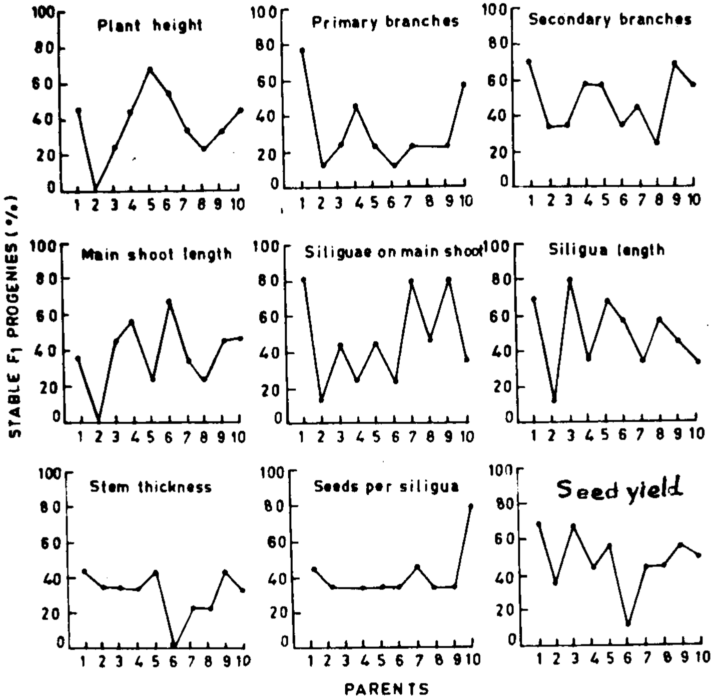
Item	D.F.	Plant height	Primary branches	Secondary branches	Main shoot length	Siliquae on main shoot	Siliqua length	Stem thickness	Seeds/siliqua	Seed yield
		MEAN SQUARES								
Genotypes	54	535.84**	1.83**	35.76**	34.89**	23.74**	0.14**	0.33**	1.12**	21.27**
Parents	9	1239.44**	3.43**	27.15*	88.90**	31.46**	0.13**	0.33**	1.05**	27.82**
F_1's	44	353.30**	1.40**	31.80**	31.76**	17.58**	0.13**	0.26**	1.02**	15.41**
Parents vs F_1's	1	1976.35**	12.37**	287.76**	245.24**	242.74**	0.52**	3.63**	0.68**	219.86**
Environments	3	9063.87**	98.51**	2336.34**	4566.57**	1661.38**	1.11**	108.91**	33.89**	1838.02**
Genotypes x Environments	162	176.20**	0.93**	27.53**	21.61**	13.70**	0.07**	0.16**	0.57**	15.17**
Heterogeneity between regressions	54	239.61**aa	1.79**aa	31.53**	21.64**	14.75*	0.09**a	0.13**	0.48**	21.53**aa
Remainder	108	144.52**	0.49**	25.54**	21.59**	13.17*	0.06**	0.18**	0.62**	11.98**
Parents x Environments	27	110.73**	0.34	13.36	26.29**	19.86**	0.02	0.10*	0.21	10.26**
Heterogeneity between regressions	9	251.90**aa	0.47	18.23	34.71**	18.55*	0.02	0.06	0.08	18.25*a
Remainder	18	40.15	0.28	10.93	22.09*	20.52**	0.02	0.12**	0.28	6.27a
F_1's x Environments	132	203.51**	0.81**	15.12*	25.79**	13.64**	0.08**	0.17**	6.60**	13.71**
Heterogeneity between regressions	44	235.68**	1.68**aa	24.37**aa	23.98**	14.90**	0.08**	0.10**	0.70**	24.43**aa
Remainder	88	187.39**	0.27	10.49	26.69**	13.01*	0.08**	0.20**	9.56**	8.35**
Parents vs F_1's x Environments	3	104.93*	3.54*	24.84	60.09**	29.83*	0.28**	0.52**	0.55	126.81**
Heterogeneity between regressions	1	314.80**aa	2.28*aa	74.51**aa	171.64*a*	6.91	0.59**	1.53*a*	1.74*	380.45**aa
Remainder	2	0.03	0.02	0.01	4.62	48.21**	0.15*	0.04	0.41	0.03
Pooled error	648	40.51	0.32	11.48	13.70	9.97	0.04	0.06	0.28	4.07

*,**, tested against pooled error. a,aa, tested against remainder mean squares. *,a = $p \leq 0.05$; **,aa = $p \leq 0.01$.

TABLE 2. STABILITY PERFORMANCE OF THE PARENTAL LINES FOR SEED YIELD AND OTHER CHARACTERS

Parental Genotypes	Stability Parameters†	Plant height	Primary branches	Secondary branches	Main shoot length	Siliquae on main shoot	Siliqua length	Stem thickness	Seeds/Siliqua	Seed yield
RL 18	m_i	170.98	7.17	23.96	50.99	41.41	3.98	2.42	10.61	16.96
	β_i	0.43	0.15	-0.59	-0.47	-0.01	0.74	-0.07	-0.14	0.52
	s^2d_i	23.04	0.52	23.70	21.86	3.10	0.03	0.07	0.28	2.04
BR 13	m_i	119.70	4.53	17.66	44.64	31.14	3.74	1.76	10.03	8.03
	β_i	0.12	0.07	0.37	0.55	0.20	-0.02	-0.40	0.29	-0.36
	s^2d_i	367.40**	1.17*	6.95	102.26**	28.81	0.04	0.32**	0.25	11.81
Varuna	m_i	145.98	4.44	16.68	57.96	35.82	3.95	2.18	10.49	10.83
	β_i	0.11	-0.48	-0.16	0.66	0.22	-0.86	-0.04	0.15	-0.08
	s^2d_i	15.40	0.56	5.91	21.62	15.80	0.02	0.07	1.31**	4.14
M 160	m_i	158.43	6.68	23.28	55.74	39.49	3.74	2.40	10.28	13.21
	β_i	0.48	0.05	0.07	-0.16	0.25	-0.88	0.02	0.02	0.00
	s^2d_i	105.17	0.11	2.01	18.52	23.04	0.02	0.14	0.04	3.91
RS 3	m_i	160.64	6.53	21.64	52.85	37.71	4.09	2.23	9.47	14.54
	β_i	0.44	0.54	-0.31	0.01	-0.09	-0.36	-0.22	-0.24	0.39
	s^2d_i	36.90	1.21*	49.19	22.48	16.67	0.05	0.09	0.25	10.44
T 6342	m_i	170.51	6.30	23.04	53.84	37.42	3.98	2.79	10.29	9.95
	β_i	-1.46	-0.27	-0.53	0.30	-0.39	-2.04	-0.19	-0.27	-0.63
	s^2d_i	17.44	0.07	12.13	38.86	15.60	0.00	0.29**	0.15	14.13
KR 5610	m_i	138.26	5.28	19.10	53.68	38.99	3.63	2.00	9.91	9.85
	β_i	0.26	0.08	-0.42	0.39	0.68	-1.10	-0.14	-0.36	-0.26
	s^2d_i	1.62	0.68	13.20	3.38	9.50	0.01	0.02	0.36	24.20*
M 590	m_i	125.77	5.59	19.38	46.65	33.13	3.98	2.06	11.18	10.32
	β_i	0.73	0.16	0.00	0.41	0.26	-0.71	-0.12	0.15	0.07
	s^2d_i	10.60	0.12	5.71	7.69	1.36	0.01	0.00	0.07	4.41
P 16-13	m_i	151.86	5.48	22.29	54.36	37.56	3.53	2.01	10.08	11.42
	β_i	0.55	0.32	0.25	0.55*	0.57	-0.52	-0.20	-0.33	0.11
	s^2d_i	81.63	1.17*	2.31	3.65	3.54	0.00	0.01	0.07	4.04
Pant Rai 219	m_i	159.14	6.44	23.19	48.49	35.51	3.69	2.34	10.98	13.17
	β_i	0.24	0.20	0.00	0.08	0.16	-0.80	-0.02	0.20	0.36
	s^2d_i	45.38	0.22	4.61	23.76	9.05	0.01	0.05	0.04	1.05

* $p \leq 0.05$; ** $p \leq 0.01$. † m_i = mean performance; β_i = linear regression; s^2d_i = deviation mean squares.



Parents:-

1=RL18, 2=BR 13, 3=Varuna, 4=M 160, 5=RS 3, 6=T 6342, 7=KR5610, 8=M 590, 9=P 16-13, and P Rai 219.

Fig. 1. Percent stabe F_1 progenies in each parental array for seed yield and other characters.

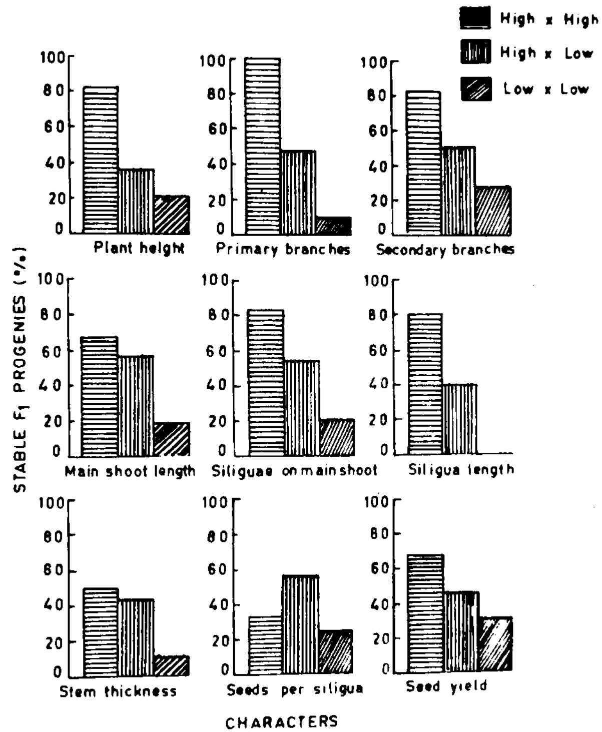


Fig. 2. Percent stable F_1 progenies in different parental cross combinations for seed yield and other characters