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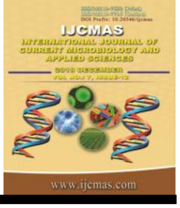

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Evaluation and Identification of Promising Lines for Rain Fed Conditions in Indian mustard (*Brassica juncea* L.)

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ABSTRACT

One hundred twenty five advanced lines (F_6) with four check varieties were evaluated in an augmented randomized complete block design for 13 different morphological traits under irrigated (E_1) and water stressed (E_2) conditions with five blocks during *rabi* 2015-16. Heritability was high (>50%) for all these characters except for test weight and oil content under E_1 condition and for fruit zone length and oil content under E_2 condition. The overall mean performance of progenies was comparatively higher in irrigated environment for plant height (PH), primary branches (PB), secondary branches (SB), fruiting zone length (FZL), main shoot length (MSL), siliquae on main shoot (SMS), siliquae per plant (SP), siliquae length (SL), seeds per siliquae (SPS), biological yield (BY) and seed yield per plant (SY). Seed yield per plant had positively and significantly correlated with PH (0.222), PB (0.641), SB (0.756), FZL (0.472), MSL (0.374), SMS (0.269), SP (0.722), SL (0.216) and BY 0.872) under irrigated condition while under rainfed condition seed yield per plant had positively and significantly correlated with all characters studied except oil content. On the basis of correlation study, it is suggested that PH, PB, SB, FZL, MSL, SMS, SP, SL and BY should be considered in selection programme for yield improvement in the segregating material generated by using selected advance lines. The values of DSI ranged from -1.544 (DRMR-1616-68-30-61) to 1.710 (DRMR-1722-45). The genotypes DRMR-1721-24, DRMR-1616-68-30-61 and DRMR-1676-71-32 had lower DSI values thus rated as drought tolerant.

Keywords

Heritability, Correlation, DSI, Rainfed, Indian mustard

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Introduction

Moisture stress during the crop growth is one of the main constraints for sustainable mustard productivity, especially in rainfed areas. Growth and seed yield production of Brassica species have greatly decreased due to drought conditions. In India, *Brassica juncea* is a predominant species which accounts for nearly 80% of the oilseed brassicas. The crop is mainly grown for its oil which is largely used in cooking and frying purposes. Oilseed cake or meal which is a byproduct during the extraction of oil from the seeds, is an important source of protein feed for animals while the leaves of the plant are used as vegetable as well as fodder for cattle. The magnitude of genetic parameters of seed yield and its component traits for different conditions is essential for an effective breeding programme. The genetic variability is the basic requirement for making progress in crop breeding. For improvement in yield, it would be desirable to understand the nature and magnitude of associations amongst yield and its component traits. The correlation coefficient is a measure of the degree of association between two traits worked at the same time (Hayes *et al.,* 1955). Based upon genotypic and phenotypic correlations, the breeder would be able to decide the breeding method to be used to exploit the desirable and break the undesirable associations. Drought Susceptibility Index (DSI) is calculated for each genotype as a criterion of drought tolerance. Genotypes with the lowest DSI, particularly for seed yield at both locations, would serve as useful donors in the breeding programme for improving the drought tolerance of existing Indian mustard cultivars.

Materials and Methods

The material for present investigation consisted of 125 advanced progenies (F_6-F_7) of Indian mustard selected on the basis of high yield under rainfed conditions in previous generation. The experiment was carried out at research farm of ICAR-Directorate of Rapeseed Mustard Research, Sewar, Bharatpur during 2015-16.

Experiment was done in an augmented block design (Fedrer, 1956) under normal (E_1) and water-stressed (E_2) conditions. The material was divided into five blocks consisting of 25 progenies and four check varieties in each block, namely, DRMRIJ-31, RH-749, NRCDR-02 and NRCHB-101. In each block, progenies and check varieties were sown in two row plots of five meter length, spaced 30 cm apart with plant-to-plant spacing of 10 cm achieved by thinning after 15-20 days of sowing. Border effect was removed by taking observations on middle plants in a row. Water-stressed (E_2) was grown as rainfed experiment and only pre-sowing irrigation was given, while normal (E_1) environment was irrigated twice during cropping season, one at 35 days after sowing and another at 70 days after sowing. Observations were recorded on 13 morphological characters *viz.,* plant height, primary branches per plant, secondary branches per plant, fruiting zone length, main shoot length, siliqua on main shoot, siliquae per plant, siliqua length, seeds per siliqua, biological yield, seed yield per plant, test weight and oil content. The mean data were subjected to analysis of variance (Fedrer, 1956) using SPAD (Abhishek *et al.,* 2004) software. Genetic parameters and simple correlations in all possible combinations were worked out as per standard procedure (Burton, 1952; Johnson *et al.,* 1955). The relative drought tolerance of genotypes was quantified with respect to seed yield through DSI according to Fischer and Maurer (1978).

Results and Discussion

In irrigated environment as compared to rainfed condition for all characters studied overall mean performance of progenies was comparatively higher except for test weight and oil content (Table 1). For test weight and oil content, mean performance was slightly higher in rainfed condition as compared to irrigated conditions. Kumawat *et al.,* (1997) described the decreased in translocation of assimilates and growth substances, loss of turgidity might be affect on mean performance of progenies under drought situations for most of the traits. In *Brassica juncea,* Singh and Choudhary (2003) and Chauhan *et al.,* (2007) reported up to 60% yield reductions under rainfed environments.

Under irrigated condition, progenies showed significant differences for all character studied except for fruit zone length and oil content while progenies differed significantly for all character studied except for oil content under rainfed conditions. This indicates that material has sufficient variability for these traits and response to selection may be expected in the breeding programme for irrigated as well as rainfed conditions.

Generally magnitude of phenotypic coefficient of variation (PCV) higher than magnitude of genotypic coefficient of variation (GCV). It was observed that siliqua per plant followed by biological yield and seed yield per plant under irrigated condition while under irrigated condition siliqua per plant followed by biological yield and secondary branches exhibited comparatively higher estimates of genotypic as well as phenotypic coefficient of variation (Table-1). It indicated that simple selection for these characters might be advantageous in particular condition. Since, in augmented design only the error variance of check varieties could be subtracted from the variance of genotypes a portion of it may be confounded with the genotypic variance used for calculating the heritability. The estimates of heritability in present investigation were of higher magnitude (>50%) for all the characters with significant variability except for test weight and oil content under irrigated condition and except for fruit zone length and oil content under rainfed condition. These result was also confirmed by Singh *et al.*, (2009) and Meena *et al.*, (2008).

The genetic advance was highest for siliqua per plant followed by biological yield and plant height under irrigated conditions whereas, under rainfed condition siliqua per plant followed by plant height and biological yield showed higher estimates of genetic advance. These findings indicate that there is good scope for development of genotypes having more number of siliquae per plant, biological yield, increased fruit zone length, higher number of siliqua on main shoot and which would perform better in irrigated conditions. Similarly, there is enough scope for development of promising genotypes having increased siliquae per plant, biological yield and more number of siliquae on main shoot for water stress conditions. High heritability with high genetic advance were observed for siliqua per plant, biological yield, fruit zone length and siliqua on main shoot under irrigated conditions while siliqua per plant, biological yield, siliqua on main shoot and main shoot length under rainfed. This indicates that selection will be more effective for these characters as compared to others. Similar reports of high heritability with high genetic advance for these characters (Patel *et al.,* 2006 and Singh *et al.*, 2011).

Simple correlations were estimated between seed yield and component traits in irrigated as well as rainfed conditions (Table 2). Under irrigated conditions, seed yield per plant was positively and significantly correlated with plant height (0.222), primary branches per plant (0.641), secondary branches per plant (0.756), fruiting zone length (0.472), main shoot length (0.374), siliqua on main shoot (0.269), siliquae per plant (0.722), siliqua length (0.216) and biological yield (0.872) while under rainfed conditions, seed yield per plant was significantly and positively correlated with plant height (0.455), primary branches per plant (0.465), secondary branches per plant (0.651), fruiting zone length (0.481), main shoot length (0.474), siliqua on main shoot (0.551), siliquae per plant (0.611), siliqua length (0.310), seeds per siliqua (0.339), biological yield (0.688) and test weight (0.267). These results were in agreement with the earlier reports of Kardam and Singh (2005), Meena *et al.,* (2008) and Singh *et al.,* (2009, 2011 and 2015). Therefore, for efficient use of scarce water resource high yielding genotypes can be developed with long siliqua length, more seeds per siliqua, test weight and fast growing seedling traits. Under irrigated conditions, seed yield per plant was negatively and significantly correlated with oil content (0.092). It was also noted that characters which exhibited positive association with seed yield per plant also exhibited positive association among themselves thus these characters could be simultaneously improved to increase the seed yield. Association between some characters was non significant which implies that the two variables are not linearly related on these two may be related but in a non linear fashion (Gomez and Gomez, 1980).

Table.1 Estimates of Mean, Range, GCV, PCV, Heritability (bs) and Genetic advance for seed yield and its components in advanced progenies of Indian mustard under rainfed and irrigated conditions

Trait	Condition	Mean	% reduction in mean values	Range	GCV	PCV	Heritability (broad sense)	Genetic advance as % of mean
PH	**IR**	192.88	11.42	148.20-233.80	11.49	11.81	94.61	31.96
	RF	170.85		121.60-202.20	7.94	9.91	64.25	17.14
PB	**IR**	6.21	28.50	3.80-11.40	4.65	4.70	97.81	2.36
	RF	4.44		2.60-6.80	3.35	3.58	87.17	1.35
SB	**IR**	10.75	64.47	3.60-28.00	11.38	11.44	98.85	7.64
	RF	3.82		0.20-8.80	9.29	9.54	94.70	3.63
FZL	**IR**	84.47	17.49	23.40-104.40	10.72	10.82	98.14	20.10
	RF	69.70		43.60-90.80	*	*	*	*
MSL	**IR**	77.89	18.65	51.20-100.40	7.83	8.75	79.94	12.72
	RF	63.36		45.80-92.40	8.26	9.76	71.58	11.45
SMS	**IR**	44.55	17.33	33.20-93.00	10.09	11.16	81.80	12.55
	RF	36.83		25.40-56.80	9.19	9.21	99.61	11.47
SP	**IR**	272.76	47.98	102.00-484.80	43.82	43.84	99.94	149.05
	RF	141.90		56.60-299.40	35.12	36.75	91.37	82.39
SL	**IR**	4.28	3.04	3.38-5.04	1.17	1.43	67.82	0.41
	RF	4.15		3.28-5.21	1.32	1.56	71.29	0.47
SPS	**IR**	14.13	7.64	10.88-18.40	3.13	3.16	97.87	2.39
	RF	13.05		9.88-15.92	2.49	2.97	70.32	1.55
BY	**IR**	76.21	52.29	38.00-150.00	24.32	24.54	98.23	43.34
	RF	36.36		15.00-65.00	13.68	16.56	68.26	14.04
SY	**IR**	15.93	56.18	5.09-35.72	14.18	14.77	92.20	11.20
	RF	6.98		1.92-15.44	8.47	9.48	79.90	4.12
TW	**IR**	4.73	-0.21	3.02-6.73	1.80	2.76	42.78	0.53
	RF	4.74		3.02-6.93	2.63	2.82	87.04	1.10
Oil	**IR**	42.00	- 1.09	40.10-44.21	*****	*****	*****	*****
	RF	42.46		40.55-43.96	*****	*****	*****	*****

* Mean sum squares were non-significant for these characters; hence genetic parameters were not calculated
I=Irrigated, RF=Rainfed, PH=Plant height, PB=Primary branches per plant, SB=Secondary branches per plant, FZL=Fruiting zone length, MSL=Main shoot length, SMS=Siliquae on main shoot, SP=Siliquae per plant, SL=Siliquae length, SPS=Seeds per siliqua, BY=Biological yield, SY=Seed yield per plant, TW= test weight

Table.2 Correlation coefficients between different characters in advanced progenies of Indian mustard under irrigated and rainfed conditions

Trait	*Condition*	PH	PB	SB	FZL	MSL	SMS	SP	SL	SPS	BY	SY	TW	Oil
PH	**IR**	1.000												
	RF	1.000												
PB	**IR**	0.279**	1.000											
	RF	0.375**	1.000											
SB	**IR**	0.114**	0.804**	1.000										
	RF	0.380**	0.582**	1.000										
FZL	**IR**	0.484**	0.297**	0.355**	1.000									
	RF	0.621**	0.415**	0.533**	1.000									
MSL	**IR**	0.447**	0.190**	0.305**	0.624**	1.000								
	RF	0.543**	0.182**	0.437**	0.666**	1.000								
SMS	**IR**	0.302**	0.159**	0.224**	0.295**	0.465**	1.000							
	RF	0.491**	0.370**	0.532**	0.608**	0.729**	1.000							
SP	**IR**	0.248**	0.730**	0.831**	0.453**	0.416**	0.283**	1.000						
	RF	0.434**	0.695**	0.684**	0.587**	0.450**	0.584**	1.000						
SL	**IR**	-0.080	-0.069	-0.018	0.054	-0.004	0.048	-0.031	1.000					
	RF	0.201**	0.079	0.222**	0.184**	0.253**	0.164**	0.146**	1.000					
SPS	**IR**	0.084	-0.028	-0.007	-0.034	-0.011	0.063	-0.074	0.351**	1.000				
	RF	0.177**	0.057	0.250**	0.238**	0.272**	0.199**	0.206**	0.544**	1.000				
BY	**IR**	0.409**	0.697**	0.793**	0.522**	0.486**	0.341**	0.778**	0.165**	0.007	1.000			
	RF	0.525**	0.365**	0.593**	0.486**	0.489**	0.504**	0.593**	0.426**	0.295**	1.000			
SY	**IR**	0.222**	0.641**	0.756**	0.472**	0.374**	0.269**	0.722**	0.216**	0.058	0.872**	1.000		
	RF	0.455**	0.465**	0.651**	0.481**	0.474**	0.551**	0.611**	0.310**	0.339**	0.688**	1.000		
TW	**IR**	-0.094*	-0.320**	-0.257**	0.012	-0.131	-0.032	-0.243**	0.411**	0.087*	-0.158**	0.044	1.000	
	RF	0.081	-0.047	-0.041	0.077	0.213**	0.198**	0.106*	0.330**	0.296**	0.288**	0.267**	1.000	
Oil	**IR**	-0.129**	0.013	0.113*	-0.013	-0.006	0.030	0.041	0.107*	0.035	0.047	0.092*	-0.185**	1.000
	RF	0.045	-0.041	-0.098*	0.016	-0.087*	-0.128**	-0.132**	-0.042	0.007	-0.166**	-0.230**	-0.367**	1.000

I=Irrigated, RF=Rainfed, PH= Plant height, PB = Primary branches per plant, SB= Secondary branches per plant, FZL=Fruiting zone length, MSL=Main shoot length, SMS=Siliquae on main shoot, SP=Siliquae per plant, SL= Siliquae length, SPS=Seeds per siliqua, BY=Biological yield, SY = Seed yield per plant, TW= test weight and oil content

Table.3 Classification of advanced lines of *Brassica juncea* on the basis of Drought Susceptibility Index (DSI)

DSI Values	Reaction	Progenies
<0.0	Drought tolerant	DRMR-1616-68-30-61, DRMR-1676-71-32, DRMR-1721-24,
>0.0-1.0	Moderately tolerant	DFS-11, DRMR-1688-55, DRMR-1686-25, YHS-33, DHS-23, YHS-26, DRMR-1721-30, DRMR-1680-327-100-73-80, DRMR-1480-12, DRMR-1686-150-21-68, DRMR-1686-49, DFS-21, DRMR-1724-77, DFS-22, DRMR-1678-26, DRMR-1722-40, DRMR-1686-163-23-15-75, DFS-18, YHS-43, DRMR-1724-68, DRMR-1686-24, DRMR-1684-57, DRMR-1688-54, DRMR-1721-27, DRMR-1686-38, DRMR-1722-52, DRMR-1722-42, DRMR-1716-10, DFS-2, DRMR-1688-53, DHS-14, DRMR-1686-48, DRMR-1722-50, DRMR-1716-8, DRMR-1716-4, DRMR-1717-12, DRMR-1679-22, DRMR-1684-42, DRMR-1692-37, DRMR-1334-17, DRMR-1686-50, DRMR-1684-58, DFS-1, YHS-113, DRMR-1686-39, DRMR-1722-49, DFS-9, DRMR-1334-18, DRMR-1679-21, DRMR-1724-79
>1.0-1.5	Moderately susceptible	DRMR-1672-5, DRMR-1724-72, DRMR-1722-53, 125, DRMR-1480-1, DHS-29, DRMR-1722-55, DRMR-1722-41, YHS-57, DRMR-1724-73, DRMR-1686-51, DHS-28, DRMR-1686-33, DRMR-1688-52, DRMR-1717-15, DHS-24, DRMR-1721-22, DRMR-1716-6, 124, DRMR-1724-67, DRMR-1723-58, DRMR-1723-63, DHS-13, DRMR-1724-65, YHS-44, DRMR-1721-32, DRMR-1716-3, DRMR-1716-2, DRMR-1686-34, DRMR-1721-38, DRMR-1721-33, DRMR-1721-29, YHS-36, DRMR-1686-32, DRMR-1724-74, DRMR-1723-59, DRMR-1721-25, DRMR-1678-303-5151-74, DRMR-1721-37, DRMR-1721-23, DRMR-1718-13, DRMR-1717-14, DRMR-1722-51, DHS-22, DRMR-1721-20, DRMR-1724-64, DRMR-1717-11, DRMR-1721-31, DRMR-1716-7, DRMR-1566-4, DRMR-1686-31, DRMR-1722-43, DRMR-1716-1, DRMR-1679-20, DRMR-1566-58-24-7, DHS-18, DRMR-1721-34, DRMR-1722-39, DRMR-1724-66
>1.5	susceptible	DRMR-1686-29, DRMR-1721-26, DRMR-1716-9, DRMR-1722-44, DRMR-1723-62, DRMR-1724-71, DRMR-1721-28, DRMR-1721-21, DRMR-1360-11, DRMR-1721-36, DRMR-1718-16, DRMR-1686-27, DRMR-1722-45

Drought Susceptibility Index (DSI) was calculated for each genotype as a criterion of drought tolerance. The lowest value indicates the highest level of drought tolerance and vice-versa. The values of DSI ranged from -1.544 (DRMR-1616-68-30-61) to 1.710 (DRMR-1722-45) (Table-3). The genotypes DRMR-1616-68-30-61, DRMR-1676-71-32, DRMR-1721-24, had lower DSI values (< or ~0.00), thus rated as drought tolerant. Total 52 genotypes were found moderately drought tolerant (>0.0-1.0) and 59 genotypes were ranked as moderately susceptible (>1.0-1.5) and 13 genotypes were ranked as susceptible (>1.5) (Table 3). Clarke *et al.,* (1984) opined that selection for yield under dry condition should alone be more productive avenue for improvement of drought resistance until more rapid and effective screening procedures could be developed. As DSI is a ratio, a genotype could have lower value of this index even when its mean seed yield under drought condition is significantly lower than better performing genotype (s).

Therefore, genotypes in the present investigation were selected on the basis of high mean seed yield along with lower DSI value. DSI values and seed yield under drought conditions as a selection criterion in Indian mustard used by Singh and Choudhary (2003) and Chauhan *et al.,* (2007). It is pertinent to note that the average performance of this genotype for all the traits was either higher than or at par with the mean performance of all the genotypes under drought condition.

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