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STABILITY STUDY ON BASAL AND NON-BASAL BRANCHING GENOTYPES OF INDIAN MUSTARD (*Brassica juncea* L. Czern & Coss) UNDER DIFFERENT MOISTURE REGIMES

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ABSTRACT

The present study was undertaken with 20 genotypes, under four environments conducted in Randomized Complete Block Design in 3 replications and evaluated 33 morpho-physio-biochemical traits suggested that significant G-E interaction including environment (linear), linear component of G-E interaction and pooled deviation (non-linear) were indicating considerable genetic variability for most of the studied traits. Role of the environmental variation has no influence on siliqua density (0.32), length of siliqua (1.50), chlorophyll content (0.49), proline (0.17), 1000 seed weight (1.51) and oil content (1.97). Out of eleven stable genotypes, seven (NRCDR-2, TM-151, Kranti, PKRS-28, TM-128, PM-28 and RAURD-78) in poor ($\overline{X} > \mu$, bi<1, NS S2di), two (Rajendra Suphlam and KMR 10-2) in average ($\overline{X} > \mu$, bi=1, NS S2di) and two (Rohini and RH8814) in rich ($\overline{X} > \mu$, bi>1, NS S2di) environments. For none of the 11 stable genotypes days to first flower open reflected stability and needs attention for ideotype development except RH-8814 (= 41.42, bi=1.69, S2di=0.42) in rich environments. The major outcome of research is that NRCDR-2 is the most stable genotype in poor whereas popular variety Rajendra Suphlam stable in average environments can be suggested to farmers and also yield determinants RV, RL and HFPB are most important for residual moisture – rainfed environments.

INTRODUCTION

The oilseeds scenario in the country had undergone a sea change in the last fifteen years while India changed from importer in the 1980s to a net exporter status during the early 1990s also termed as yellow revolution phase. Again, it has come back to net importer status importing more than 40 percent of its annual edible oil seeds which is mainly attributed to crop Brassicas because of low productivity of oilseed crops and year to year fluctuations in production in India which could be attributed to about 8.5 percent of the area under oilseeds is rainfed comprising mostly marginal and sub marginal lands with soils of poor fertility and also cultivated under resource constrained condition. Mustard seeds contain about 38-42 % oil, which is golden yellow, fragrant and considered among the healthiest and most nutritional cooking medium (Shekhawat *et al.* 2014).

Water stress is important abiotic factor (Campbell *et al.*, 1992). The effect of drought stress is a function of genotype, intensity and duration of stress, weather conditions, growth, and developmental stages of rapeseed (Robertson and Holland, 2001). For getting higher yield of mustard, irrigation and fertilizermanagement are two important agronomic practices (Ray *et al.*, 2014).The stable performance of genotypes for different plant characteristics, besides high yield, is very much desired for their commercial exploitation. However, the sensitive behavior of the existing varieties of mustard to different growing environments (critical and normal) leads to fluctuations in its yield. The differential performance of the genotypes in varied agro-climatic conditions is due to a significant effect of genotype x environment (G x E) interactions.

For assessing the genetic worth and stability of basal and non-basal branching genotypes for yield and its components in Indian mustard, the present study with objective that outsized acreage of Indian mustard under conserved residual moisture – rainfed condition on farmers' fields, so keeping this in view it is proposed to study the stability of promising basal and non-basal branching genotypes for grain yield and morphological yield determinants and to select the stable genotypes (basal and non-basal branching type) for yield and yield attributing traits exhibiting good performance under different water regimes.

MATERIALS AND METHODS

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications including check namely, Varuna (National Check) consisting of 20 genotypes for stability study, received from different All India Co-ordinated Research Project-Rapeseed and Mustard centres. During Rabi 2016-17, along with stability study, same set of entries (including check) under stability study were also subjected for evaluation of the physiological parameters by standardized protocols (at 75DAS).

During Rabi 2016-17 at Crop Experiment Farm, Pusa the stability trial was sown under residual moisture only (E1) inside the Rain-out shelter which strictly avoids moisture condition makes difference from rainfed (E2) condition (which supposed to receive rainfall during crop phenological stages). whereas, irrigation at pre flowering stage (E3 at 45DAS) and in E4, one irrigation at pre flowering (45DAS) stage and second at pod formation stage (65DAS).

Basal branching genotypes are those having initiation of branch from base of plant up to 30 cm (Kumar *et al*., 1996), medium basal branching genotypes, branch arises from more than 30 cm up to 60 cm but in high basal branching genotypes, it ranges from more than 60 cm up to 93 cm.

Investigation was conducted in the field, laboratory and subsequently observations were recorded for stability study, namely days to first flower open (DFFO), days to physiological maturity (DPM), Days to cessation of flowering (DCF),Primary branches plant-1 (PBP-1), Secondary branches plant-1 (SBP-1), Length of siliqua (LS), Number of siliqua on primary mother axis (SPMA), Length of Primary Mother Axis(LPMA), Siliqua density (SD),Height of first primary branch (HFPB), Number of seeds siliqua-1 (SS-1), Root volume (RV), Root length (RL), Root Mass (RM), 1000 seed weight (TSW), Biological yield (BY), Harvest index (HI), Oil content (OC) , Dry matter efficiency (DME), Relative Water Content (RWC), Leaf Membrane Stability Index (LMSI), Excised Leaf Water Loss (ELWL), Chlorophyll Content (CC), Catalase Activity (CA), Peroxidase Activity (PERO), Proline Accumulation (PRO), Relative Growth Rate (RGR), Leaf Area Index (LAI), Specific Leaf Weight (SLW), Drought Tolerance Index (DTI), Stress Intensity (SI), Oil Yield (kg/ha) (OY), and Grain Yield/Plot (kg/ha) (GY/P).

Relative Water Content (%)

The relative water content was determined in fresh 4-5 leaf discs of 2 cm. diameter, excluding midrib. Discs were weighed quickly and immediately floated on double distilled water, in Petri dishes to saturate them with water for the next 24 hrs., in dark. The adhering water of the discs was blotted and turgor weight was taken. Dry mass of these discs was obtained, after dehydrating them at 70 ºC for 48 hrs. Relative water content was calculated by placing the observed values in the following formula (Barr and Weatherley, 1962) in Ricinus communis

$$RWC = \frac{\text{Fresh mass} - \text{Dry mass}}{\text{Turgor mass} - \text{Dry mass}} X100$$

Leaf Area Index (m2 / m2)

For determining LAI, SYSTRONIC LEAF AREA METER 211 was used during measurement of length and width of leaf. Leaf area of one leaf was calculated by multiplying by total number of leaves present in a unit area to obtain total leaf area and was divided by unit ground area to get leaf area index. The leaf area index was calculated according to the formula given by Watson (1947) as mentioned below:

$$LAI = \frac{\text{Leaf Area}}{\text{Ground Area}}$$

Relative Growth Rate (g g -1day-1)

Five Plants were uprooted at 35 and 65 days during their growth period. Uprooted plants were kept inside the oven and dried under 40ºC for 72 hrs. Dried plants then weighed under electronic balance. The RGR was calculated by formula given by Williams (1946).

$$RGR = \frac{\text{Loge W2} - \text{Loge W1}}{t2 - t1}$$

Where,

W1 and W2 are whole plant dry weight at t1 and t2 respectively; t1 and t2 are time interval in days

Specific Leaf Weight (gcm-2)

Leaves from five plants were weighed under electronic balance and then area of the weighed leaves was taken by SYSTRONIC LEAF AREA METER 211. The SLW was calculated by formula given by Pearce *et al*. (1968) in alfalfa.

$$SLW = \frac{\text{Leaf weight}}{\text{Leaf area}}$$

Leaf membrane stability index (%)

800g of leaves were put in 40 ml of distilled water inside test tube in two different sets. One set was kept at 40ºC for half an hour and another set at 100ºC for 15 minutes under water bath.The conductivity was measured for both the sets with the help of Conductivity Meter. The LMSI was calculated by formula given by Premchandra *et al*. (1990), as modified by Sairam (1994) in wheat.

$$LMSI = (1 - C1/C2) \times 100$$

C1 = conductivity measured for sample at 40ºC for half an hour under water bath.

C2 = conductivity measured for sample at ºC for 15 minutes under water bath.

Excised leaf water loss (%)

The fresh weight of five leaves from each plant were weighed and incubated inside incubator for 6 hrs at 28 ºC and then weighed.The leaves were again kept for 24 hrs at 70ºC and weighed. The ELWL was calculated by formula given by Malik, 1995 in wheat.

$$ELWL = \frac{\text{Fresh weight} - \text{Weight after6 hrs at } 28^{\circ}\text{C under incubator}}{\text{Fresh weight} - \text{Dry weight after24 hrs at } 70^{\circ} \text{ undrer oven}} X100$$

Drought tolerance index (%)

In each replication, seed yield of five plants of all genotypes were calculated. DTI can be calculated as mentioned below by Fischer and Maurer (1978) in wheat.

S = (1-Y/Yp)/ (1-X/Xp)

Y = Mean seed yield of a genotype in a stress environment

Yp = Mean seed yield of a genotype in a stress free environment

X = Mean seed yield of all genotype in a stress environment

Xp = Mean seed yield of all genotype in a stress free environment

Stress intensity (%)

It is also known as Yield Stability Ratio (YS). SI can be calculated as mention below by Lewis (1954):

SI = (1- Ys/Yn) × 100

Ys = Yield under stress

Yn = Yield under normal condition

Harvest index (%)

It is the ratio of economic yield to the biological yield in per cent. Harvest index was calculated by following formula (Donald and Hamblin, 1976, Cereals).

$$H.I = \frac{\text{Economic yield}}{\text{Biological yield}} X100$$

Here,

Economic yield = Grain yield (g)

Biological yield = Total plant yield (g)

Proline Accumulation in Leaves (µg/g Dry Wt.)

For the quantification of proline the method developed by Bates *et al*. (1973) in soyabean and sorghum was used.

Peroxidase Activity in Leaves (unit /g Fresh Wt.)

The activity of peroxidase was determined by the method of Palmiano and Juliano (1973) in rice.

Catalase activity (unit/g Fresh Wt.)

The activity of Catalase was determined by the method given by Euler and Josephson (1927).

RESULTS AND DISCUSSION

The principle objective of mustard breeding programme aims at improvement in yield, reliability in performance, stability and adaptation over a wide range of environments. Jinks and Jones, 1958, were of the view that degree of yield potential was the result from the combination of the range of gene effects. The knowledge of genotype – environment interaction gives a better appreciation of the measure of adaptability of the variety, a better means of studying individual plasticity and better insight of physiological and developmental process and gene action. The G×E interaction has been shown to often reduce progress for selection (Comstock and Moll, 1963). Yield data and stability performance of genotypes across contrasting environments are essential to enable a breeder to select high yield and consistently performing genotypes.

Pooled analysis of variance (table 1) for different studied characters between the genotypes exhibited significant variation for most of the characters except for SD, LS, SPMA, SS-1, RM, LAI, CC, DTI, SI, PRO, TSW and OC which indicated genotypic variation in the studied genotype namely, Rajendra Suphlam, Pusa Mahak, KMR-10-1, Maya, Rohini, Kranti, TM151 developed at various AICRIP R and M centres located in mustard growing states across India(Schuster and Sra,1979). Environmental variation was observed for all the characters

Table 1: Analysis of variance for thirty - three morpho-physio-biochemical and quality traits used for stability studies in Indian mustard

Source	DF	Mean squares										
		Days to first flower open	Days to physiological maturity	Days to cessation of flowering	Height of first primary branch	Primary branches per plant	Secondary branches per plant	Number of siliqua on Primary Mother Axis	Length of Primary Mother Axis	Siliqua density	Length of siliqua	Number of seeds siliqua-1
Genotype	19	47.50**	19.40**	15.51**	586.09**	2.26**	45.64**	72.94**	92.08**	0.13	0.47	1.49
Environment	3	1.47	24.45**	114.59**	670.39**	8.02**	123.79**	467.04**	155.51**	0.32	1.5	3.84*
G×E	57	6.27**	1.75**	5.18**	50.12**	0.45	6.95**	24.12**	25.15**	0.093	0.19	1.32
E(Linear)	1	4.43*	73.37**	343.78**	2011.19**	24.06**	371.39**	1401.12**	466.53**	0.97	4.51*	11.52**
G×E(Linear)	19	7.57**	0.79	6.60**	55.17**	0.37	12.34**	36.52**	50.36**	0.093	0.24	1.78*
Pooled deviation	40	5.34**	2.12**	4.25**	45.21**	0.47	4.05**	17.02**	11.92**	0.089	0.165	1.044
Pooled Error	152	0.43	1.38	2.38	1.41	0.045	0.11	0.37	2.2	0.001	0.012	0.065

Table 1 : Continued

Source	DF	Mean squares									
		Tap root length	Root volume	Root mass	Relative growth rate	Leaf area index	Specific leaf weight	Chloro phyll content	Leaf membrane stability index	Relative water content	Excised leaf water loss
Genotype	19	14.70**	136.22**	1.84	67.95**	1.027	10.90**	0.031	93.94**	233.02**	88.96**
Environment	3	12.80**	18.36**	10.69**	390.67**	9.70**	56.26**	0.49	890.46**	9074.78**	380.16**
G × E	57	1.97**	1.24	0.44	6.48**	0.1	1.18	0.006	12.37**	28.89**	10.52**
E(Linear)	1	38.42**	55.08**	32.09**	1172.01**	29.10**	168.80**	1.47	2671.39**	27224.36**	1140.50**
G × E (Linear)	19	1.77*	2.52**	0.82	9.15**	0.223	2.090**	0.014	22.44**	55.39**	19.31**
Pooled deviation	40	1.97**	0.57	0.24	4.88**	0.0432	0.69	0.0018	6.97**	14.87**	5.82**
Pooled Error	152	0.058	0.104	0.0049	0.85	0.0301	0.048	0.0004	0.24	0.49	0.22

Table 1 : Continued

Source	DF	Mean squares Catalase activity	Peroxidase activity	Proline accumulation	1000 seed weight	Biological yield	Harvest index	Dry matter efficiency	Oil content	Grain yield ha^{-1}	Oil yield ha^{-1}
Genotype	19	2313.01**	1478.76**	0.026	1.098	201132.35**	18.43**	12.79**	0.52	121223.61**	18294.79**
Environment	3	4960.24**	346.21**	0.17	1.51	2022045.00**	42.6297**	26.4670**	1.9747	2904124.0000**	416008.9688**
G×E	57	266.31**	176.70**	0.0026	0.19	39335.77**	6.65**	4.59**	0.1001	12159.40**	1843.69**
E(Linear)	1	14880.72**	1038.63**	0.51	4.53*	6066135.00**	127.88**	79.40**	5.92*	8712372.00**	1248026.87**
G×E(Linear)	19	186.84**	126.68**	0.004	0.3	57685.87**	4.59**	3.44**	0.0782	26873.95**	4103.01**
Pooled deviation	40	290.73**	191.63**	0.0017	0.13	28652.69**	7.29**	4.90**	0.1055	4562.02**	678.33**
Pooled Error	152	1.8	5.35	0.0001	0.091	14327.93	1.98	1.4	0.0875	13039.2	1978.63

Table 1 : Continued

Source	DF	Mean squares Stress intensity	Drought tolerance index
Genotype	19	0.0104	0.1962
Environment	2	0.4355	15.9056**
G×E	38	0.0037	0.074
E(Linear)	19	0.8709	31.8112**
G×E(Linear)	20	0.0058	0.1148
Pooled deviation	114	0.0015	0.0316
Pooled Error	59	0.0045	0.0741

*Significant at P = 0.05 ** Significant at P = 0.01

(significant mean squares due to environments) indicated environmental conditions were fluctuating and variable except for SD, LS, SS-1, LAI, CC, SI, PRO, TSW and OC reflected that these traits are unaffected and their expression in response to over or across the environment remains same (Gazal *et al.*, 2013). Thomas *et al.* (1971); Baker (1969) and Byth *et al.* (1976) and Sagolsem *et al.* (2013) reported except for 1000 seed weight that significant G × E interaction including Environment (linear) effects for most of the characters except for SD, CC, SI, PRO, TSW and OC revealed that average performance of genotype with respect to yield and other characters varied significantly. The linear components of G × E interaction was found highly significant for morpho-physio-biochemical and quality traits, indicating that these characters were unstable and fluctuated in their expression with change in environment (Langer *et al.*,1979; Powel *et al.*,1986 and Ramagosa and Fox,1993). Moreover, predominance was observed from 12 traits out of 33 traits which might be responsible for adaptation in Indian mustard under moisture stress. Pooled deviation (non- linear) was significant for 19 traits out of 33 traits indicating considerable genetic diversity in the material. The highest pooled deviation (non-linear) was observed for traits namely, HFPB, SPMA, LPMA, RWC, PERO, BY, GY and OY which might be of practical value, to construct and test unity of multiple regression model to know more critically complex mechanism of adaptation (Langer *et al.*, 1979; Chaudhary *et al.*, 2004; Abou El-Nasr *et al.*, 2006 and Sah *et al.*,2015).

The significance of genotype and G-E (linear) component emphasize that genotypes deviating slightly from the regression line of unit slope could be identified. Accordingly, three kinds of linear responses, namely bi = 1; bi = >1 and bi = < 1 have been generally observed. However, in the present study negative bi (table 2) value were observed in characters namely, DFFO, DCF, HFPB, SBP-1, SPMA, LPMA, SD, LS, SS-1, RL, RV, RM, ELWL, PERO, TSW, HI and DME. Such type of linear response could be attributed due to inadequacy of the scale use for the analysis and / or the inherent behaviour of the genotypes investigated (Knight, 1970).

DFFO, LPMA, SD, SS-1, RL, PERO, PRO, HI and DME showed variable range of bi value indicated different environmental responses in the studied genotypes and visualized the environmental ability to a large extent. It also suggested the possibility of selection for specific genotype patterns (Pfakler and Linksen, 1979 and Abou-El- Nasar *et al.*, 2006).

Amongst 20 genotypes (table 4), 11 were stable in poor environment ($\overline{X} > \mu$, bi<1,NS S2di), 2 in average environment (>μ bi=1,NS S2di) and rest 2 in rich environment (>μbi>1,NS S2di) for grain yield ha^{-1}. All the stable 11 genotypes, exhibited their stability for yield in poor environment (7 genotypes namely, NRCDR-2, TM-151, Kranti, PKRS-28, TM-128, PM-28, RAURD-78; in average environment (2 genotypes, Rajendra Suphlam and KMR-10-2); whereas in rich environment (2 genotypes, Rohini and RH8814).

It is noteworthy that the high yielding mustard genotype, Rajendra Suphlam was stable in average environment followed by two genotypes, Rohini and RH8814 (stable in rich environment), NRCDR-2, TM-151, Kranti and PKRS-28 (stable in poor environment) and KMR-10-1(stable in average environment) co-shared the yield position with TM-151(Biwi *et al.*, 2016 and Tahira *et al.*, 2016 a & b.

Under different moisture regimes (*i.e.* over environments), although Varuna (National Check) exhibited regression coefficient (bi) near unity, non- significant deviation from the regression line (S2di) but its mean performance () for grain yield ha^{-1} was below population mean (μ). Hence, its average stability could not be confirmed due to less yield potential under moisture stress condition.

Out of four mustard genotypes (table 3) which have exhibited grain yield ha^{-1} stability in poor environment. Three genotypes namely, NRCDR-2, TM-151 and Kranti are medium non- basal branching whereas PKRS-28 is basal-branching genotype.

NRCDR-2 was best stable genotype for grain yield ha^{-1}in poor environment and subsequently exhibited stability in poor environment for RGR, LAI, SLW, HI, DME and OY; whereas stability in rich environment for DPM, HFPB, RV, CC, PRO and BY may be suggested to farmers for cultivation in residual moisture – Rainfed condition in Bihar.

TM-151, which showed stability for yield in poor environment has also exhibited similar stability for DCF, LAI, SLW, PRO, HI and DME; and for traits like DPM, SD, RV, RM, SLW, CC, BY

Table 2: Stability parameters for thirty - three morpho-physio-biochemical and quality traits in Indian mustard

Characters	Days to first flower open			Days to physiological maturity			Days to cessation of flowering			Height of first primary branch			Primary branches per plant			Secondary branches per plant			Number of siliqua on Primary Mother Axis		
Varieties	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di
DRMRLEJ902	40.75	-3.39	3.89**	122.33	1.16	2.36**	95.33	0.06	11.01**	45.04	1.7	90.52**	4.28	0.5	0.29	8.95	-0.56	8.46**	49.52	1.61	25.82**
DRMR150-35	44.33	-0.25	0.89	121.33	0.86	4.81**	96.33	1.1	-0.96	43.75	0.95	17.80**	4.18	0.79	0.29	8.7	-0.24	1.5	50.97	2.09	15.92**
NRCDR2	41.58	0.16	8.16**	120.92	1.35	-1.45	96.58	1.22	2.04**	46.01	1.39	-1.39	4.42	0.65	1	6.65	0.99	1.65*	46.42	0.61	31.36**
RH8814	41.42	1.69**	-0.42	120.83	1.21	-1.27	93.92	1.29	1.65	48.7	1.36	5.88**	4.35	0.41	0.13	6.4	1.03	0.09	46.75	0.86	50.73**
TM151	48.42	-11.3	3.66**	121.42	1.38	-2.06	92.92	0.67	0.54	54.18	1.73**	98.92**	3.93	0.3	0.01	6.55	-0.08	0.16	52.72	2.33**	6.32**
TM128	50.17	-2.49	0.37	122.17	0.86	-0.59	93.5	0.42	-1.87	51.45	2.27**	160.84**	4.03	1.12	0.14	8.73	-0.14	1.75*	53.92	1.35	46.27**
KRANTI	44	7.11**	4.73**	120.08	0.43	0.08	94.75	0.46	-0.64	56.34	1.93**	238.27**	4.22	1.35	0.21	8.2	0.95	0.63	47.45	1.11	-0.03
KMR10-1	45.58	3.86**	1.17	121.08	1.18	-1.9	94.08	0.06	-1.72	45.14	0.96	13.89**	4.45	0.96	0.94	7.03	1.03	4.03**	42.65	0.56	2.36**
MAYA	41.17	-0.99	0.18	122.17	1	5.49**	95.42	0.85	3.40**	54.05	1.11	65.49**	4.1	1.08	0.13	7.58	1.47	1.36	51.15	1.69**	10.60**
ROHINI	47.58	16.91**	51.00**	121.5	0.39	0.37	94.83	-0.03	-0.91	61.88	1.84**	13.68**	5.37	2.05**	0.6	14.32	1.17	0.01	53.52	2.22**	14.21**
PKRS28	47.75	4.88**	0.41	119.75	0.07	-1.37	95.58	1.72**	0.98	25.62	0.38	-0.47	4.72	0.43	0.13	17.32	1.69**	6.09**	48.23	0.87	31.96**
PUSA MUSTARD 25	46.08	-5.01	11.15**	119.83	1.26	-2.13	96.33	2.18**	-1.83	47.87	1.63	9.60**	4.43	0.68	0.47	10.65	1.24	1.56*	49.88	0.57	3.67**
PUSA MUSTARD 28(NPJ-124)	48.08	3.40**	-0.01	121.08	1.04	-0.13	96.83	1.69**	-0.34	25.7	-0.06	10.72**	4.63	0.64	0.09	11.22	2.32**	14.79**	51.07	1.6	0.52
RGN-13	50.83	3.92**	1.14	119.67	0.57	-0.66	97.75	1.52	8.48**	24.4	0.26	-1.15	4.42	1.84**	0.07	10.05	1.69**	1.62*	48.87	0.68	37.23**
RAURD 212	45.5	1.16	0.02	121.75	0.23	-1.79	97.83	0.55	18.13**	42.57	0.26	5.21**	5.3	1.69**	0.74	9.65	0.04	0.31	49.82	0	19.26**
RAURD 78	49.75	2.55**	-0.23	120.75	0.84	1.12	94.67	1.67**	-0.03	42.3	0.96	14.30**	4.57	0.64	-0.01	11.88	2.25**	5.03**	52.28	0.66	17.26**
VARUNA(CHECK)	46.42	3.78**	-0.2	130.17	1.7	-1.1	97.17	1.19	-2.27	27.16	0.28	-1.25	5.77	1.06	2.02*	11.53	1.49	3.03**	46.18	0.64	4.18**
PUSA BOLD(CHECK)	44.58	2.94**	-0.13	121.17	1.44	0.96	95.5	1.28	0.24	51.78	1.21	6.42**	3.98	2.27**	0.06	11.5	1.38	6.43**	50.7	0.54	-0.06
PUSA MAHAK(JD-6) (CHECK)	42.25	-0.9	0.74	122.42	1.69	-0.26	96.17	1.35	2.93**	52.29	-0.22	127.14**	4.65	0.74	0.6	14.43	1.57	17.86**	51.43	-0.13	0.27
RAJENDRA SUFLAM(CHECK)	38.83	-7.83	11.71**	120.25	1.34	-1.41	89.17	0.76	-1.72	20.72	0.07	-0.34	7.12	0.97	0.76	17.78	0.75	2.11*	64.14	0.16	15.19**
SE(bi)	4.9101			0.8			0.4975			0.6705			0.6308			0.4672			0.4929		
	45.254			121.533			95.233			43.348			4.645			10.457			50.383		

Table 2: Continued

Characters	Length of Primary Mother Axis			Siliqua density			Length of siliqua			Number of seeds siliqua-1			Tap root length			Root volume			Root mass		
Varieties	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di
DRMRLEJ902	61.49	-1.05	26.30**	0.98	1.86**	0.025	5.02	0.72	-0.002	12.35	0.51	1.24	9.14	1.41	0.04	7.17	0.97	0.49	1.25	1.05	0.075
DRMR150-35	63.51	1.18	-0.2	0.94	0.15	0.003	4.8	-0.2	0.23	11.87	0.64	0.32	9.02	1.62**	2.41**	10.9	1.90**	1.23	1.78	1.03	0.254
NRCDR2	61.21	1.13	20.65**	0.9	0.2	0.021	4.76	1.67**	0.144	11.83	3.98**	0.27	10.19	0.52	0.02	15.14	2.56**	-0.1	1.82	1.74**	0.133
RH8814	63	0.88	7.02**	0.83	0.46	0.002	5.03	-0.38	0.044	11.73	-0.37	1.18	9.15	1.32	1.76*	7.28	0.5	0.27	2.22	2.62**	0.399
TM151	60.07	2.73**	30.75**	1.25	2.60**	0.043	4.79	1.04	0.101	11.63	2.34**	3.04**	12.55	0.59	4.11**	10.52	1.16	0.03	1.99	2.07**	0.409
TM128	56.44	0.25	-0.86	1.15	0.82	0.006	4.66	1.89**	0.046	11.53	2.17**	2.96**	9.12	1.57	0.44	7.9	0.58	0.01	1.52	0.66	0.083
KRANTI	51.54	2.76**	4.55**	1.26	4.43**	0.098	5.2	0.2	-0.011	12.97	2.02	6.13**	9.06	0.79	1.63*	4.45	0.03	-0.11	1.89	1.16	0.002
KMR10-1	58.39	-2.25	1.98**	0.92	2.05**	0.099	5.13	0.48	0.211	13.2	0.71	0.76	9.34	1.44	1.82*	6.98	1.16	-0.03	1.82	-0.18	0.038
MAYA	53.43	0.26	1.64*	1.55	0.04	1.134	5.61	0.4	0.03	12.45	5.07**	0.71	10.13	1.32	2.33**	9.03	0.48	0.32	2.43	0.85	0.778
ROHINI	56.78	1.64	17.12**	1	-0.09	0.017	5.13	-0.14	0.968	12.16	-2.6	0.01	10.2	1.86**	3.80**	4.9	1.23	0.14	4.05	-0.35	0.335
PKRS28	62.97	2.39**	0.57	0.91	0.7	0.011	5.12	2.96**	0.003	11.3	-0.42	0.35	9	3.25**	0.22	6.39	0.77	0.15	1.54	0.29	0.573
PUSA MUSTARD 25	60.74	1.49	-0.27	1.14	4.15**	0.107	5.29	1.68**	0.355	11.35	0.78	0.09	10.24	1.08	0.15	2.93	0.47	0.24	1.88	0.76	0.143
PUSA MUSTARD 28(NPJ-124)	58.64	2.65**	7.76**	0.96	0.27	0.035	5.38	1.7	0.031	11.65	-0.69	0.42	9.51	0.32	1.28	5.17	1.38	0.75	1.79	1.03	0.066
RGN-13	58.63	1.36	31.80**	0.87	-0.46	0.007	5.31	2.05**	0.092	11.97	0.67	0.29	10.01	-1.06	0.79	3.84	0.24	-0.06	1.57	1.35	0.002
RAURD 212	54.64	0.21	0.5	0.99	0.49	0.011	4.78	0.01	0.119	11.46	-0.62	0.3	10.64	0.11	0.54	5.51	-0.27	1.74*	1.85	1.63**	0.202
RAURD 78	54.93	-0.31	6.71**	0.98	-0.73	0.026	4.72	1.77**	0.386	12	1.90**	0.62	10.2	2.11**	0.17	7.17	0.08	0.61	1.42	0.9	0.025
VARUNA(CHECK)	61.86	0.53	4.97**	0.82	0.82	0.003	5.14	-0.4	0.146	11.02	-0.66	0.04	10.54	-0.64	3.45**	6.45	0.74	1.97*	0.96	0.31	0.001
PUSA BOLD(CHECK)	62.19	4.01**	28.18**	0.89	0.56	0.059	5.37	1.49	0.042	12.12	2.31**	0.08	9.55	1.33	0.97	4.33	0.3	0.51	2.04	1.55	0.527
PUSA MAHAK(JD-6) (CHECK)	68	0.4	3.00**	0.9	1.2	0.011	4.98	2.80**	0.153	11.69	1.85**	0.73	13.39	0.31	8.62**	19.77	3.71**	-0.04	2.3	0.96	0.741
RAJENDRA SUFLAM (CHECK)	71.5	-0.26	-1.31	1.15	0.49	0.04	6.11	0.36	-0.01	13.23	0.44	0.03	16.93	0.77	3.73**	26.67	2.02**	1.22	3.2	0.61	-0.004
SE(bi)	0.7151			1.3507			0.8567			1.3463			1.0129			0.4568			0.39		
	59.998			1.021			5.116			11.974			10.395			8.624			1.965		

Table 2: Continued

Characters / Varieties	Relative growth rate ($x * 10^{-3}$)			Leaf area index			Specific leaf weight			Chlorophyll content			Leaf membrane stability index			Relative water content			Excised leaf water loss		
	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di
DRMRLEJ902	22.42	1.46	-0.36	2.01	1.49	0.167	5.58	1.32	0.56	0.91	0.94	0.001	34.86	1.56	1.18	48.93	1.28	29.61**	34.18	0.25	2.10**
DRMR150-35	24.5	1.65**	3.34**	2.3	1.54	-0.028	6.56	1.53	0.15	0.99	1.34	0.001	37.66	1.68**	10.75**	53.09	1.35	37.55**	34.18	0.23	13.31**
NRCDR2	31.58	0.96	-0.46	3.05	0.83	-0.024	9	0.83	0.07	1.09	1.25	0.001	46.07	0.62	1.68*	66.33	0.83	4.58**	25.59	1.24	1.89*
RH8814	28.75	1.87**	11.46**	2.61	1.67**	-0.029	8.85	2.57**	0.6	1.1	1.86	0.001	40.68	1.55	9.04**	60.72	1.19	10.5	26.91	0.31	10.93**
TM151	30	1.23	2.93**	2.99	0.87	-0.025	8.53	1.01	0.4	1.06	1.33	0.001	43.48	1.05	3.93**	64.48	0.92	12.76**	27.83	1.12	2.18**
TM128	27.92	0.36	0.6	2.72	0.47	0.065	7.62	0.32	1.08	0.98	0.39	0.004	42.16	0.63	2.70**	62.78	0.71	-0.08	29.93	1.41	1.32
KRANTI	29.33	0.77	21.92**	2.91	0.44	0.052	8.5	0.45	3.57**	1.04	1.07	0.004	44.63	0.6	31.21**	65.23	0.81	27.21**	27.3	1.54	27.68**
KMR10-1	28.92	1.33	0.05	2.89	0.84	-0.004	8.05	1.37	0.01	1.07	1.47	0.001	42.39	1.16	0.89	62.43	1.01	1.66**	29.65	0.73	2.31**
MAYA	26.5	0.92	2.34**	2.51	1.01	0.006	7.21	1.05	0.1	1.01	1.15	0.001	40.29	1.17	-0.11	59.12	0.96	0.37	29.83	1.24	3.16**
ROHINI	33.08	0.69	0.22	3.12	0.83	-0.025	9.8	0.92	0.51	1.13	1.42	0.001	47.31	0.5	4.02**	67.87	0.83	0.13	22.35	1.75**	0.9
PKRS28	28.17	1.21	0.07	2.88	0.93	-0.021	7.88	1.18	0.35	1.04	1.25	0.001	41.85	1.14	2.85**	61.01	1.04	0.38	29.1	1.07	-0.08
PUSA MUSTARD 25	24.83	0.96	7.29**	2.26	1.21	0.035	6.64	0.97	0.82	0.97	0.44	0.002	38.44	1.2	13.98**	56.07	1.07	12.78**	31.29	1.13	0.08
PUSA MUSTARD 28 (NPJ-124)	28.17	0.58	16.21**	2.77	0.47	0.037	7.56	0.63	1.44	1.03	0.91	0.003	43.51	0.32	23.06**	63.28	0.73	16.20**	27.5	1.93**	14.40**
RGN-13	21.83	1.26	4.60**	1.97	1.1	0.015	5.45	1.15	0.97	0.91	0.7	0.002	35.32	1.38	3.85**	51.04	1.15	16.62**	34.79	0.45	3.56**
RAURD 212	21.25	0.66	-0.01	1.98	0.93	-0.017	5.37	0.56	0.14	0.92	0.32	0.001	34.07	1.11	0.15	49.68	1.02	14.22**	34.25	1.05	3.32**
RAURD 78	27	0.66	8.47**	2.72	0.52	0.026	7.21	0.77	0.82	0.99	0.82	0.003	40	0.76	12.68**	59.73	0.75	48.56**	29.68	1.37	4.55**
VARUNA(CHECK)	21.08	1.12	-0.12	1.76	1.35	0.02	4.86	1.2	0.09	0.89	0.66	0.001	33.63	1.29	-0.02	45.58	1.29	9.48v	36.8	0.32	11.05**
PUSA BOLD(CHECK)	19.25	1.03	-0.82	1.42	1.71**	-0.007	4.04	0.84	0.01	0.81	0.78	0.001	31.05	1.12	1.5	43.7	1.29	8.08**	40.14	-0.13	7.69**
PUSA MAHAK(JD-6) (CHECK)	23.75	0.48	2.76**	2.2	1	0.029	6.44	0.36	0.65	0.94	0.4	0.003	38.59	0.92	6.90**	56.06	0.91	15.23**	31.5	1.36	0.37
RAJENDRA SUFLAM (CHECK)	33.75	0.8	0.82	3.29	0.79	-0.003	10.11	0.99	0.63	1.16	1.53	0.002	49.11	0.27	3.37**	70.95	0.87	21.69**	20.65	1.62**	1.27
SE(bi)	0.2888			0.1723			0.2873			0.158			0.2285			0.1045			0.3197		
	26.604			2.518			7.263			1			40.254			58.403			30.172		

Table 2: Continued

Characters Varieties	Drought tolerance index			Stress intensity			Catalase activity			Peroxidase activity			Proline accumulation			1000 seed weight			Biological yield		
	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di
DRMRLEJ902	1.65	0.84	0.01	0.39	0.79	0	113.69	0.23	132.37**	206.61	-1.23	103.66**	0.81	0.63	0	5.06	2.06**	-0.05	1292.33	0.8	-6302.52
DRMR150-35	1.96	1.32	-0.07	0.45	1.41	-0.004	125.9	0.44	525.95**	216.52	0.55	506.60**	0.85	0.46	0.002	5.17	2.20**	-0.09	1666.67	1.32	16917.89**
NRCDR2	1.37	0.98	-0.06	0.31	1.05	-0.004	170.3	1.23	45.50**	248.08	2.81**	29.90**	0.99	1.2	0	4.43	1.02	-0.08	1514.17	1.25	-7040.82
RH8814	2.24	1.41	-0.06	0.52	1.44	-0.004	152.41	0.29	701.24**	237.3	0.33	332.73**	0.92	0.17	0.004	5.25	1.15	-0.07	1369.17	1.06	45689.87**
TM151	1.57	1.22	-0.06	0.36	1.36	-0.004	162.77	0.38	93.35**	240.38	2.78**	84.90**	0.96	0.71	0.002	4.9	1.48	0.12	1520.67	1.23	-7478.34
TM128	1.3	1.05	-0.06	0.29	1.18	-0.004	148.14	1.58	583.07**	234.29	3.22**	24.13**	0.91	1.63**	0.005	5.02	1.75	0.08	1598.33	1.90**	-15379.6
KRANTI	1.31	0.66	-0.05	0.31	0.54	-0.003	157.94	1.49	1283.19**	238.33	0.47	510.66**	0.95	1.62**	0.01	4.69	0.81	-0.07	1819.17	1.28	-6007.9
KMR10-1	1.78	0.94	-0.08	0.42	0.86	-0.005	153.9	0.82	129.46**	237.26	0.88	16.40**	0.93	0.76	0	5.25	1.27	-0.09	1197.5	0.56	18207.62**
MAYA	1.54	0.84	-0.06	0.36	0.8	-0.004	134.06	1.26	105.53**	225.6	0.41	61.69**	0.87	0.85	0	5	0.48	0.02	1780.83	1.90**	11802.91**
ROHINI	1.8	1.07	-0.08	0.42	1.05	-0.005	175.05	1.09	49.31**	254.42	2.23**	72.57**	1.01	1.31	0	4.21	-0.03	0.64	1869.17	0.74	3471.35**
PKRS28	1.44	1	-0.06	0.33	1.09	-0.003	149.82	0.92	261.72**	234.7	2.55**	32.47**	0.92	0.77	0.001	5.12	0.83	0.05	1610.83	0.95	-8833.57
PUSA MUSTARD 25	1.55	0.98	-0.05	0.36	1.01	-0.003	128.24	0.74	361.08**	223.4	2.00**	106.64**	0.84	0.81	0.001	4.27	-1.91	0.27	1229.58	0.84	10449.61**
PUSA MUSTARD 28 (NPJ-124)	1.25	0.61	-0.07	0.3	0.51	-0.004	148.4	2.07**	771.07**	236.3	0.69	600.18**	0.92	1.85**	0.003	4.9	0.73	-0.07	1634.58	0.19	48877.13**
RGN-13	1.75	0.58	-0.04	0.42	0.32	-0.004	111.58	0.74	159.52**	206.36	-1.49	56.24**	0.81	0.95	0.002	4.22	-1.53	-0.04	1234.17	1.04	-4035.16
RAURD 212	1.83	1.27	-0.06	0.42	1.34	-0.004	108.94	1.29	3.96**	206.17	-0.07	34.56**	0.79	1.12	0	5.24	1.73	-0.03	1423.33	0.7	64634.20**
RAURD 78	1.43	0.83	-0.05	0.33	0.79	-0.003	136.91	1.75**	254.84**	227.51	0.32	260.14**	0.88	1.34	0.001	5.41	0.9	-0.08	1543.33	0.83	87756.46**
VARUNA(CHECK)	1.75	0.98	-0.05	0.41	0.95	-0.003	105.93	0.83	31.98**	202	-0.68	45.02**	0.79	1.04	0	4.92	2.16**	0.06	1216.67	0.63	-12360.31
PUSA BOLD(CHECK)	1.6	0.65	-0.03	0.38	0.48	-0.003	99.62	0.6	10.98**	183.15	-1.46	756.39**	0.73	0.71	0.001	5.4	2.49**	0.31	1205	0.81	-9742.27
PUSA MAHAK(JD-6) (CHECK)	1.62	1.28	-0.05	0.37	1.42	-0.004	126.53	1.31	181.28**	222.34	2.50**	14.13**	0.83	1.1	0.002	5.81	2.05**	0.07	1368.33	0.54	-8214.94
RAJENDRA SUFLAM (CHECK)	1.98	1.49	0.12	0.45	1.6	0.005	180.05	0.95	92.47**	260.76	3.19**	75.89**	1.04	1.39	0	6.34	0.36	-0.08	1787.5	1.45	41713.45**
SE(bi)				0.1846			0.6			1.9			0.2606				0.7627		0.3		
	0.141																				
	1.636			0.38			139.508			227.074			0.887			5.03			1494.067		

Table 2: Continued

Characters	Harvest index			Dry matter efficiency			Oil content			Grain yield ha-1			Oil yield ha-1		
Varieties	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di	X	bi	S2di
DRMRLEJ902	19.25	0.61	3.73**	15.72	0.38	1.79*	38.32	2.56**	0.28	1384.12	1.1	-13964.49	527.7	1	-2017.16
DRMR150-35	15.58	1.53	-2.31	12.82	1.37	-1.69	38.88	0.94	-0.07	1421.15	1.16	-10512.5	552.74	1.18	-1671.01
NRCDR2	20.26	-0.13	0.84	16.77	-0.04	1.4	38.56	0.62	-0.09	1676.22	0.9	-13061.06	646.34	0.92	-2017.03
RH8814	22.23	-0.25	11.62**	18.38	-0.57	6.20**	38.81	1.29	-0.02	1698.9	1.75**	-11960.98	659.79	1.77**	-1748.61
TM151	19.41	-0.07	-2.2	15.99	-0.11	-1.37	39.3	1.88**	0.05	1620.21	0.98	-4901.22	637.86	0.97	-1053.39
TM128	18.78	0.12	28.57**	15.4	0.47	19.59**	38.81	1.14	-0.04	1555.4	0.65	-11666.29	604.59	0.65	-1669.87
KRANTI	16.22	1.18	2.96**	13.51	1.47	1.6	39.38	0.62	-0.08	1601.69	0.76	-1660.9	630.41	0.78	-348.2
KMR10-1	24.46	1.67**	11.76**	20.21	1.70**	7.95**	38.96	0.94	-0.1	1620.21	1.16	-10974.51	630.57	1.16	-1582.45
MAYA	15.81	1.02	12.87**	12.99	1.46	9.20**	38.77	0.99	-0.09	1485.96	0.98	-14756.43	575.49	0.97	-2245.56
ROHINI	17.39	0.76	4.78**	14.33	0.63	3.33**	39.27	0.39	-0.07	1816.95	1.34	-14443.24	713.45	1.39	-2239.42
PKRS28	17.56	0.61	-1.14	14.68	0.55	-0.54	38.56	0.82	0.14	1578.55	0.97	-4604.9	607.59	1	-959.89
PUSA MUST ARD 25	21.2	1.05	8.10**	17.69	0.96	5.60**	39.15	1.04	-0.1	1430.41	0.96	-11688.81	560.24	0.98	-1723.05
PUSA MUST ARD 28(NPJ-124)	17.71	2.48**	2.23**	14.65	2.62**	1.99**	39.26	0.4	0.03	1566.97	0.7	-8172.42	616.57	0.71	-1307.5
RGN-13	19.79	1.74**	3.42**	16.56	2.06	1.54	38.73	0.8	-0.06	1337.83	1.04	1648.03**	517.79	1.04	201.22**
RAURD 212	17.7	1.41	9.91**	14.55	1.34	7.21**	38.58	0.82	-0.03	1360.98	0.91	-14196.31	524.86	0.9	-2157.55
RAURD 78	18.7	2.87**	2.13**	15.51	3.11**	0.05	39.09	0.94	0.05	1532.25	0.76	-10434.9	597.95	0.73	-1585.34
VARUNA (CHECK)	19.72	1.51	2.55**	15.14	1.24	1.02	38.5	0.38	-0.1	1342.46	1.03	-14493.28	517.5	1.04	-2256.21
PUSA BOLD (CHECK)	17.6	0.85	-1.11	14.51	0.62	-0.88	39.12	1.33	0.11	1171.18	0.86	-12946.93	456.99	0.84	-1990.66
PUSA MAHAK (JD-6) (CHECK)	18.87	1.1	1.64**	15.4	0.82	0.73	38.58	0.88	0.07	1439.67	0.84	-12187.35	555.25	0.81	-2025.94
RAJENDRA SUF LAM(CHECK)	19.31	-0.04	-1.17	16.07	-0.07	-0.47	38	1.24	0.03	1897.96	1.08	-12170.33	720.08	1.17	-1876.95
SE(bi)	1.0685			1.1112			0.5968			0.1			0.1		
	18.876			15.545			38.83			1526.954			592.687		

Table 3: Stable genotypes (in poor, average and rich environments) for morpho-physio-biochemical and quality traits in Indian mustard under different moisture regimes

S.NO.	CHARACTER	STABLE IN POOR ENVIRONMENT	STABLE IN AVERAGE ENVIRONMENT	STABLE IN RICH ENVIRONMENT
		$\bar{x} > \mu$, bi<1, NS S2di	$\bar{x} > \mu$, bi=1, NS S2di	$\bar{x} > \mu$, bi>1, NS S2di
1	Days to first flower open	DRMR 150-35,MAYA,PUSA MAHAK	-	RH8814,PUSA BOLD
2	Days to physiological maturity	KRANTI,PKRS 28,RGN-13,RAURD 78	PUSA MUSTARD -28	NRCDR-2,RH8814,TM 151,KMR10-1,PUSAMUSTARD -25, PUSA BOLD, RAJENDRA SUPHLAM
3	Days to cessation of flowering	TM151, TM128, KRANTI, KMR10-1, RAJENDRA SUFLAM	-	RH8814, RAURD 78
4	Height of first primary branch			
a	BB TYPE	PKRS28, RGN-13 VARUNA, RAJENDRA SUFLAM	-	-
b	NBB TYPE	-	-	DRMR150-35
5	Primary branches per plant	PKRS28, PUSA MAHAK, RAJENDRA SUFLAM	-	RAURD 212
6	Secondary branches per plant	RAJENDRA SUFLAM	-	ROHINI, PUSA MUSTARD 25
7	Number of siliqua on Primary Mother Axis	PUSA MAHAK	-	PUSA MUSTARD 28(NPJ-124)
8	Length of Primary Mother Axis	RAJENDRA SUFLAM	-	DRMR150-35, PKRS28, PUSA MUSTARD 25
9	Siliqua density	TM128, RAJENDRA SUFLAM	MAYA	TM151, KRANTI, PUSA MUSTARD 25
10	Length of siliqua	KRANTI, KMR10-1, MAYA, ROHINI, VARUNA, RAJENDRA SUFLAM	-	PUSA MUSTARD 25, PUSA MUSTARD 28 (NPJ-124), RGN-13, PUSA BOLD
11	Number of seeds siliqua-1	DRMRLEJ902, KMR10-1, RAJENDRA SUFLAM	-	MAYA, ROHINI, PUSA BOLD
12	Tap root length	RAURD 212	-	-
13	Root volume	-	-	DRMR150-35, NRCDR2, TM151, PUSA MAHAK, RAJENDRA SUFLAM
14	Root mass	MAYA, ROHINI, PUSA MAHAK, RAJENDRA SUFLAM	-	RH8814, TM151
15	Relative growth rate	NRCDR2, TM128, ROHINI, RAJENDRA SUFLAM	-	KMR10-1, PKRS28
16	Leaf area index	NRCDR2, TM151, TM128, KRANTI, KMR10-1, ROHINI, PKRS28, PUSA MUSTARD 28(NPJ-124), RAJENDRA SUFLAM	-	RH8814
17	Specific leaf weight	NRCDR2, TM128, ROHINI, PUSA MUSTARD 28(NPJ-124), RAJENDRA SUFLAM	-	RH8814, TM151, KMR10-1PKRS28

and OC in rich environment.

Kranti had yield stability for poor environment and also exhibited stability for DPM, DCF, LS, LAI, OC and OY in poor environment, in average environment for CC and for SD, PRO, and BY in rich environment.

PKRS-28 exhibited poor environment yield stability and also reflected similar stability for DPM, HFPB, PBP, LAI, PRO, TSW, BY; RWC and OY in average environment and LPMA, RGR, SLW and CC in rich environment(Mariotti *et al.*,1975).

Rajendra Suphlam a popular mustard variety in Bihar exhibited high grain yield ha^{-1} and stability in average environment and also reflected stability for OY in similar environment; for DCF, HFPB, PBP-1, SBP-1, LPMA, SD, LS, SS, RM, RGR, LAI, SLW, TSW, HI, DME in poor environment and in rich environment for DPM, RV, CC, DTI, SI, PRO and BY may be a good option for farmers for cultivation in both agro- ecologies as average stable genotype.

Rohini showed yield stability in rich environment and also exhibited stability in poor environment for DCF, LS, RM, RGR, LAI, SLW, RWC and OC; stability for PBP-1, SBP-1, SS, CC, PERO,PRO and OY in rich environment.

RH-8814 reflected stability for yield in rich environment, stability for PRO in poor environment and for DFFO, DPM, DCF, RM, LAI, SLW, CC, RWC, DTI, SI, TSW and OY in rich environment. This genotype is only, which showed DFFO including LAI and SLW stable in rich environment and as third high yielder reflected that this genotype could perform

18	Chlorophyll content	-	-	NRCDR2, RH8814, TM151, KRANTI, KMR10-1, MAYA, ROHINI, PKRS28, RAJENDRA SUFLAM
19	Leaf membrane stability index	-	-	KMR10-1, MAYA
20	Relative water content	TM128, MAYA, ROHINI	-	KMR10-1, PKRS28
21	Excised leaf water loss	-	-	PUSA MUSTARD 25, PUSA MAHAK
22	Drought tolerance index	DRMRLEJ902, KMR10-1, RGN-13, VARUNA	-	DRMR150-35, RH8814, ROHINI, RAURD 212, RAJENDRA SUFLAM
S.NO.	CHARACTER	STABLE IN POOR ENVIRONMENT	STABLE IN AVERAGE ENVIRONMENT	STABLE IN RICH ENVIRONMENT
		$\bar{x} > \mu$, bi < 1, NS S2di	$\bar{x} > \mu$, bi = 1, NS S2di	$\bar{x} > \mu$, bi > 1, NS S2di
23	Stress intensity	DRMRLEJ902, KMR10-1RGN-13, VARUNA	-	DRMR150-35, RAURD 212, RAJENDRA SUFLAM
24	Catalase activity	-	-	-
25	Peroxidase activity	-	-	-
26	Proline accumulation	RH8814, TM151, KMR10-1, PKRS28	-	NRCDR2, TM128, KRANTI, ROHINI, PUSA MUSTARD 28(NPJ-124), RAJENDRA SUFLAM
27	1000 seed weight	PKRS28, RAURD 78, RAJENDRA SUFLAM	-	DRMR150-35, RH8814, KMR10-1, RAURD 212, PUSA BOLD, PUSA MAHAK
28	Biological yield	PKRS28	-	NRCDR2, TM151, TM128, KRANTI
29	Harvest index	NRCDR2, TM151, RAJENDRA SUFLAM	-	-
30	Dry matter efficiency	NRCDR2, TM151, RAJENDRA SUFLAM	-	-
31	Oil content	KRANTI, KMR10-1, ROHINI, , PUSA MUSTARD 28(NPJ-124), RAURD 78	PUSA MUSTARD 25	TM151, PUSA BOLD
32	Grain yield ha-1	NRCDR2, TM151, TM128, KRANTI, PKRS28, PUSA MUSTARD 28(NPJ-124), RAURD 78	RAJENDRA SUFLAM, KMR10-1	RH8814, ,ROHINI
33	Oil yield ha-1	NRCDR2, TM151, TM128, KRANTI, PUSA MUSTARD 28(NPJ-124), RAURD 78	PKRS28	RH8814, KMR10-1, ROHINI, RAJENDRA SUFLAM

Table 4: Stability parameters for grain yield and its morpho-physio-biochemical and quality traits under poor, average and rich environments

S.NO.	Genotypes/ stability	Bran ching behaviour	Pooled yield overenvironments (E1 + E2 + E3 + E4)	Eberhert russell (three parameters) model Stable in poor environment $\bar{x} > \mu$, bi < 1, NS S2di	Stable in average environment $\bar{x} > \mu$, bi = 1, NS S2di	Stable in rich environment $\bar{x} > \mu$, bi > 1, NS S2di
Stable in poor environment ($\bar{x} > \mu$, bi < 1, NS S2di): 7 Genotypes						
1	NRCDR-2	NBB	1676.22*	RGR, LAI, SLW, HI, DME, OY	-	DPM, HFPB, RV, CC, PRO, BY
2	TM -151	NBB	1620.21*	DCF, LAI, SL, PRO, HI, DME	-	DPM, SD, RV, RM, SLW,CC,BY,OC
3	TM-128	NBB	1555.40*	DCF, SD, RGR, LAI, SLW, RWC, OY	-	PRO, BY
4	KRANTI	NBB	1601.69*	DPM, DCF, LS, LAI, OC, OY	CC	SD, PRO, BY
5	PKRS-28	BB	1578.55*	DPM, HFPB, PBP, LAI, PRO, TSW, BY	RWC, OY	LPMA, RGR, SLW, CC
6	PM-28	BB	1566.97*	LAI, SLW, CC, OC, OY	DPM	SPMA, LS, PRO
7	RAURD78	NBB	1532.25*	DPM, DCF, TSW, OC, OY	-	-
Stable in average environment ($\bar{x} > \mu$, bi = 1, NS S2di) : 2 Genotypes						
8	RAJENDRA SUPHLAM	BB	1897.96**	DCF, HFPB, PBP,SBP, LPMA, SD, LS, SS, RM, RGR, LAI, SLW, TSW, HI, DME	OY	DPM, RV, CC, DTI, SI, PRO, BY
9	KMR-10-1	BB	1620.21*	DCF, LS, SS, LAI, DTI, SI, PRO, OC,	RWC, OY	DPM, RGR, SLW, CC, TSW
Stable in rich environment ($\bar{x} > \mu$, bi > 1, NS S2di) : 2 Genotypes						
10	RH8814	NBB	1698.90*	PRO	-	DFFO, DPM, DCF, RM, LAI, SLW, CC, RWC, DTI, SI, TSW, OY
11	ROHINI	NBB	1816.95*	DCF, LS, RM, RGR, LAI, SLW, RWC, OC	DTI, SI	PBP, SBP, SS, CC, PERO, PRO, OY
12	VARUNA	BB	1342.46	DTI, SI, LS, HFPB	-	-
	$\bar{x} < \mu$, bi = 1, NS S2di					

better in environment which is well irrigated(Rashid *et al.*, 2002; Chaudhary *et al.*, 2004; Gupta and Pratap, 2007; Yadava *et al.*, 2010; Priyamedha *et al.*, 2017 for stability of various morpho-physio-biochemical traits and Dar *et al.*, 2011 and Moghaddam and Pourdad (2011) for stability of oil yield along with seed yield/plant).

Rajendra Suphlam showed superiority for all flowering – maturity characteristics, height of first primary branch and siliqua, root parameters and grain yield ha^{-1}, Rohini showed superiority for late DFFO, DFF, DPM, low IL, dwarfness and NRCDR-2 for late DFFO, DPM were crossed to get three divergent crosses namely, Rohini/ Rajendra Suphlam, Rajendra Suphlam/ NRCDR-2 and Rohini / NRCDR-2. Among these crosses, only two crosses Rohini/ Rajendra Suphlam and Rajendra Suphlam/ NRCDR-2 they involve Late × Early (days to first open and days to physiological maturity), Basal/Non-Basal, High × Low placed siliqua, Low×High (harvest- index and dry matter efficiency) and Rich× Average and Average × Poor (stability for grain yield ha^{-1}) parents could through transgressive seggregants which may be stable across the environments.

It can be suggested to the farmers of Bihar that under moisture stress condition, NRCDR-2 (Variety 2007) is the best option for poor environment stability but, average stable genotype, Rajendra Suphlam (popular variety in Bihar) with highest grain yield ha^{-1} in individual (E1, E2, E3 and E4) as well as pooled over environments, may give choice of cultivation across the moisture regime environments in Bihar. However, under rich environment Rohini has provided second highest yield performance after Rajendra Suphlam(Dhillon *et al.*,1997).

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