Int.J.Curr.Microbiol.App.Sci (2021) *10*(01): 2562-2568

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 10 Number 01 (2021)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2021.1001.297

Assessment of Genetic Variability, Heritability and Genetic Advance for Morpho-physiological Traits in Early Maturing Genotypes of Indian Mustard

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ABSTRACT

Keywords
Indian mustard, *Brassica juncea* Morpho-physiological Traits

Article Info

Accepted:
15 December 2020
Available Online:
10 January 2021

Thirty advance breeding lines of Indian mustard [*Brassica juncea* (L.) Czern. and Coss.] genotypes including three check were evaluated in Complete Randomized Block Design (CRBD) with three replications during *rabi* 2019-20. The data were subjected to obtain estimate of genetic analysis of variance, heritability, genetic advance in relation to all fifteen morpho-physiological characters. The analysis of variance showed significant difference among genotype for all the characters. High estimate of heritability coupled genetic advance as percentage of mean was observed for 1000-seed weight, siliquae per plant and seed yield per plant. High genotypic and phenotypic coefficient of variation are studied for MSI, siliquae per plant, seed yield per plant and WRCL.

Introduction

Rapeseed- mustard constitutes an important group of oilseed Brassica crops, and of these, Indian mustard [*Brassica juncea* (L.) Czern and Coss] is an important edible oil yielding crop accounting for about 80% of the cultivated area in North- Western parts of India (Singh *et al.*, 2014). Amongst all the states in India, Rajasthan is an important producer of Indian mustard. Indian mustard is very sensitive to heat stress at early seedling stage. Although, early sowing has many advantages, the early sown-crop encounters high temperature stress, which results in a significant yield loss. High temperature stress is the most important abiotic stress affecting plant productivity around the world (Hall, 1992).).

Rapeseed mustard has the ability to grow under varied agro-climatic conditions relatively under low temperature as well as in the extremes of temperature regions (Downy 1983, Hanelts 2001). Indian mustard is an important edible oil yielding crop accounting for about 80% of the cultivated area in North-Western parts of India (Ram *et al.,* 2014). Amongst all the states of India, Rajasthan is an important producer of Indian mustard. It is very sensitive to heat stress at early seedling stage. Although, early sowing has many advantages, the early sown-crop encounters high temperature stress, which results in a significant yield loss. Indian mustard to have greater tolerance to heat and water stress than the canola quality Indian mustard.

The cultivation of Indian mustard is largely carried out under the rainfed farming systems where sowing commences after south-west monsoon rains (Venkateswarlu and Prasad 2012). Early rains may cause the farmers to sow the crop early in the season to take advantage of the conserved moisture in the soil. But high temperature prevailing at the time of sowing reduces seed germination and causes seedling mortality, resulting in poor crop stand and reduced seed yield (Azharudheen *et al.*, 2013).

Wide variations in diurnal soil temperatures ranging from 28 °C to 56 °C at the surface and from 33 °C to 37 °C at 300 mm depth were observed in Rajasthan (Gupta 1986). The average surface soil temperature may reach as high as 45 °C during second fortnight of September and first fortnight of October In Rajasthan. This may lead to situation where the crop needs to be re-sown before a final successful crop is established. This causes a lot of economic loss to the farmers (Salisbury and Gurung 2011). More frequent weather aberrations and high temperature events are expected due to climate change scenario resulting in greater impact of heat on mustard production. Efforts to strengthen resilience are required by utilizing diverse heat tolerant genotypes in *brassica* crop improvement programmes. This will help to stabilize the productivity and to meet the growing demands of edible oil of the country. Therefore, this study was designed to assess the genetic variability for seedling heat tolerance in the Indian mustard genotypes and to characterize the selected heat tolerant and susceptible genotypes. Thermotolerant genotypes identified in the study would have important bearing on *brassica* breeding programmes aimed at improving tolerance to heat stress at seedling stage.

Materials and Methods

The materials for the present investigation consisted of 30 genotypes of Indian mustard procured from the Directorate of Rapeseed-Mustard Research (DRMR), Bharatpur. These genotypes were evaluated in complete randomized block design with 3 replications under heat stress conditions. Each genotype was grown in a plot of three rows, each row consisting with 5-meter length and plant to plant distance were maintained at 15 cm by thinning after 15-20 days of sowing.

Five competitive plants were randomly selected at the time of maturity (except the days to 50 per cent flowering and days to maturity which were recorded on plot basis) from each plot to record the following observations, *i.e.* plant height (cm), primary branches per plant, secondary branches per plant, main shoot length (cm), siliquae per plant, siliqua length (cm), seeds per siliqua, seed yield per plant, 1000-seed weight (g), days to 50% flowering, days to maturity, relative water content (%), membrane stability index (%), excised leaf water loss (%), water retention capacity of leaves (%).

Determination of growth and physiological parameters

Membrane Stability Index (%)

Membrane stability index (MSI) was determined following the method of

Premachandra *et al.,* (1990) as modified by Sairam (1994). Leaf stripes (0.2 g) of uniform size were placed in test tubes containing 10 ml of double distilled water in two sets. Test tubes in one set were kept at 40 °C in a water bath for 30 min and electrical conductivity of the water containing the sample was measured (C_1) using a conductivity bridge.

Test tubes in the other set were incubated at 100 °C in boiling water in water bath for 15 min and electrical conductivity was measured as above (C_2). The MSI was calculated using the following formula:

MSI= $[1- C_1/ C_2] \times 100$

Excised- Leaf Water Loss (%)

For determining excised- leaf water loss (ELWL), the leaves were weighed at three stages viz. immediately after sampling (fresh weight); after drying in an incubator at 28 °C and 50% R.H. for 6 h; and after oven drying for 24 h at 70°C as suggested by Clarke, (1987). The ELWL was calculated using the following formula:

ELWL= [Fresh weight – Weight after 6 h) / (Fresh weight- Dry weight] × 100

Relative Water Content (%)

The samples for relative water content (RWC) were also weighed immediately to obtain fresh weight (FW); 2 cm leaf sections were floated in distilled water for 4 h, blot-dried and weighed to obtain turgid weight (TW);

The 2.0 cm leaf sections were oven dried at 60 °C for 24 h and weighed to obtain dry weight (DW). The RWC was calculated using the formula of Barrs (1968):

RWC (%) = [FW – DW) / (TW- DW] × 100

Water Retention Capacity of leaves (%)

The water retention capacity of leaves (WRCL) was estimated by the method proposed by Ashraf and Ahmad (1998).

WRCL = Wt. of excised leaf each hours / Wt. of turgid excised leaf X 100

Statistical analysis

The data so obtained were subjected further to analysis of variance and the test of significant was performed according to Singh and Choudhary (1985) and critical difference (CD) calculated at 5% probability level. The estimation of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) was calculated as per the formula given by Johnson *et al.,* (1955) and Burton (1952).

The heritability in broad sense (h^2_{bs}) was estimated as the ratio of genotypic variance to the total variance. It was calculated by the formula given by Johnson *et al.,* (1955). The expected genetic advance (GA) for each character was estimated by the formula as suggested by Johnson *et al.,* (1955).

Results and Discussion

The analysis of variance for fifteen characters in thirty genotypes of Indian mustard is presented in Table 1. The critical perusal of table revealed that the highly significant genotypic traits difference were observed for plant height (cm), primary branches per plant, secondary branches per plant, main shoot length (cm), siliquae per plant, siliqua length (cm), seeds per siliqua, seed yield per plant, 1000-seed weight (g), days to 50% flowering, days to maturity, relative water content (%), membrane stability index (%), excised leaf water loss (%), water retention capacity of leaves (%).

Table.1 Analysis of variance (ANOVA) for morpho-physiological characters of Indian mustard during *rabi* 2019-20

Source of variation	d.f.	Mean Square															
		Days to 50% flowering	**Plant Height (cm)**	**Primary Branch**	**Secondary Branch**	**Main Shoot Length (cm)**	**Siliquae/ plant**	**Siliqua Length (cm)**	**Seeds per Siliqua (g)**	**Days to maturity**	**Seed yield per plant (g)**	**1000 seed weight (g)**	**Days to maturity**	**RWC (%)**	**MSI (%)**	**ELWL (%)**	**WRCL (%)**
Replication	2	9.54	17.70	1.23	0.69	1.02	917.48	0.58	0.10	147.40	1.32	0.24	147.40	74.62	886.07	115.62	**202.96**
Treatment	29	23.06 **	124.42 **	0.63 **	10.10 **	25.55 **	7319.84 **	0.42 **	2.09 **	316.77 **	50.92 **	.88 **	316.77 **	44.21 *	217.27 **	8.64 **	**83.69 ****
Error	**58**	**4.55**	**24.57**	**0.44**	**3.40**	**11.44**	**1485.38**	**0.50**	**0.57**	**151.00**	**9.57**	**0.14**	**151.00**	**22.48**	**61.53**	**4.73**	**22.99**

Table.2 Genetic Variability of Morpho-physiological characters of Indian Mustard

Characters	Heritability (%)	GCV	PCV	Genetic Advance	Genetic Advance as per percentage of means
Days to 50% flowering	35.678	4.805	8.044	2.712	5.912
Plant height (cm)	57.533	3.563	4.698	9.015	5.568
Primary branch	8.752	3.809	12.875	0.128	2.321
Secondary branch	39.637	12.183	19.351	1.938	15.8
Main shoot length (cm)	28.74	3.606	6.726	2.484	3.982
Siliquae per plant	56.698	16.142	21.437	68.406	25.038
Siliqua length (cm)	61.042	7.87	10.073	0.523	12.667
Seeds per siliqua	46.774	5.322	7.782	0.999	7.498
Days to maturity	49.434	5.26	7.481	10.425	7.618
Seed yield per plant (g)	59.002	15.296	19.913	5.874	24.203
1000 seed Weight (g)	61.405	10.506	13.407	0.782	16.959
RWC (%)	24.364	3.277	6.639	2.737	3.332
MSI (%)	45.756	17.449	25.796	10.04	24.315
ELWL (%)	21.595	6.073	13.068	1.093	5.814
WRC (%)	46.806	13.315	19.462	6.34	18.765

Genetic variability parameters for morpho- physiological traits

Coefficient of variation

The genotypic and phenotypic coefficient of variation in fifteen characters in thirty genotypes of Indian mustard are furnished in Table 2. It was revealed that the GCV for MSI (17.44), siliquae per plant (16.14), seed yield per plant (15.29), WRCL (13.31), secondary branches per plant (12.18), were high. However, moderate GCV were observed for 1000-seed weight (10.50), siliqua length (7.87), ELWL (6.07), seeds per siliqua (5.32) and days to maturity (5.26).

The highest phenotypic coefficient of variation (PCV) was observed for MSI (25.79), siliquae per plant (21.43), seed yield per plant (19.91), WRCL (19.46) and secondary branches per plant (19.35). Moderate PCV were recorded for 1000-seed weight (13.40), ELWL (13.06), primary branches per plant (12.87), siliqua length (10.07) and days to 50% flowering (8.04).

Heritability and genetic advance

The estimates of heritability in broad sense and expected genetic advance for fifteen character in thirty genotypes of Indian mustard are present in table 2. The estimate of heritability in broad sense were recorded high for 1000-seed weight (61.40), siliqua length (61.04), seed yield per plant (59.00), plant height (57.53) and siliquae per plant (56.69). However moderate heritability were observed for days to maturity (49.43), WRCL (46.80), siliquae per plant (46.77), MSI (45.75), secondary branches per plant (39.63) and days to 50% flowering (35.67)).High heritability coupled with genetic advance as percentage of mean was exhibited by excised leaf water loss similar observation were reported by Ram *et al.,* (2017) and Tirpathi *et al.,* (2019). Thousand seed weight expressed high heritability accompanied with genetic advance as percentage of mean which is in accordance with genetic advance as percentage of mean. These same results have been reported by Ram *et al.,* (2015), Roy *et al.,* (2015), Ram *et al.,* (2017), Kumar *et al.,* (2018) and Tirpathi *et al.,* (2019).

The highest value of expected genetic advance as percentage of mean for siliquae per plant (25.03), MSI (24.31), seed yield per plant (24.20), WRCL (18.76) and secondary branches per plant (15.8). However, medium value of expected genetic advance as percentage of mean was obtained for 1000-seed weight (16.95), siliqua length (12.66), days to maturity (7.61), seeds per siliqua (7.49) and days to 50% flowering (5.91).

In conclusion, we report that Membrane stability index (17.44) showed maximum genotypic coefficient of variation followed by siliquae per plant (16.14), seed yield per plant (15.29), WRCL (13.31), secondary branches per plant (12.18). Heritability estimates (broad sense) was maximum for 1000-seed weight (61.40), siliqua length (61.04), seed yield per plant (59.00), plant height (57.53) and siliquae per plant (56.69).Expected genetic advance as percent mean was maximum for siliquae per plant (25.03), MSI (24.31), seed yield per plant (24.20), WRCL (18.76) and secondary branches per plant (15.8).

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How to cite this article:

Ajay Pal Yadav, Bhagirath Ram, Bhupendra Singh Yadav and Hariom Kumar Sharma. 2021. Assessment of Genetic Variability, Heritability and Genetic Advance for Morpho-physiological Traits in Early Maturing Genotypes of Indian Mustard. *Int.J.Curr.Microbiol.App.Sci.* 10(01): 2562-2568. doi: https://doi.org/10.20546/ijcmas.2021.1001.297