Journal of Plant Genetics and Breeding

Singh et al., J Plant Genet Breed 2023, 7:6

Research Article Open Access

To Estimate the Genetic Variability in Taramira Germplasm

Sukhjot Singh[1]*, Manohar Ram[2], Deepak Gupta[3], Manoj Kumar Meena[4], Pravat Kumar Nayak[5] and Rahul[6]

[1]*Department of Genetics and Plant Breeding, MPUAT, Udaipur, India*
[2,3,4,5]*Department of Plant Breeding and Genetics, SKNAU, Jobner, India*
[6]*Department of Agronomy, SKNAU, Jobner, India*

Abstract

The present research was carried out to estimate the genetic variability for 13 characters among 30 different germplasm of Taramira (Eruca sativa Mill.) in a randomised block design with three replications over four artificially created environments through different dates of sowing (timely sown 17 Oct. and late sown 5 Nov) with (Orobanche free and Orobanche infested field) i.e. timely sown, Orobanche free (E1), timely sown, Orobanche infested (E2), late sown, Orobanche free (E3), late sown, Orobanche infested (E4) at Research farm of SKN College of Agriculture, Jobner (SKNAU, Jobner) during the rabi 2022-23. Pooled analysis of variance revealed significant differences among germplasm, environments and also G × E interaction significant for all the traits except days to maturity, primary branches per plant, silqua length (cm). Therefore, analysis of variance is carried out separately for each environment, which indicated significant differences among all the germplasm for 13 traits in all environments. In all four environments, the PCV value is higher than the GCV value for all characters. After comparing the mean and range for yield and different yield attributing traits in all four environments, it was found that both were highest in environment-1 for most of the traits. The high heritability coupled with high genetic advance as percentage of mean for all four environments revealed that characteristics such as height of first branch emergence (cm), seeds per siliqua, 1000-seed weight (g) and seed yield per plant (g) had high value. As a result, they might be under the control of additive gene action. Therefore, selection for these characters will be highly responsive.

Keywords: Genetic variability; Eruca sativa mill; Taramira; Genotypic coefficient of variation; Heritability; Phenotypic coefficient of variation and genetic advance as per cent of mean

Introduction

Taramira (Eruca sativa Mill) is an important rainfed winter season oil seed crop in the Brassicaceae family. Taramira is believed to have originated in South Europe and North Africa before being introduced to India [1]. It contains a diploid number of chromosomes (2n=22) and chromosomes are very small. Taramira possesses excellent characteristics, especially resistance to powdery mildew, which can be transmitted to Brassica campestris and Brassica juncea, both of which are important crops [2]. In India, it is known by many names such as tara, trara, schwan, duan, turra, tirwa, merha, merkai, chara, ushan and sondha Singh [3]. The oil content of taramira varies between 31.60 to 41.31 per cent [4]. Taramira oil is mostly used to increase the pungency of mustard oil. Taramira cake may be used as manure to improve soil physical condition and fertility, as well as nutritional feed for animals. The success of any breeding programme relies on genetic variability for economically important traits in the population and its management for exploitation. Germplasm with genetic variation are able to adapt themselves in changeable environment and insured the plants to meet the harsh environment conditions. Study of variability, heritability and genetic advance in the germplasm will help to ascertain the real potential value of the genotype. Hence an experiment was planned to assess the variability, heritability and genetic advance for yield and other characters in a set of taramira germplasm.

Materials and Methods

Genetic material

The material for the present investigation were consist of a set of 30 germplasm lines including five checks which were released varieties i.e. RTM-314, RTM-1351, RTM-1355, RTM-1624, RTM-2002 obtained from the collection being maintained at the AICRP Rapeseed-Mustard (Taramira Unit), Department of Plant Breeding and Genetics, S.K.N. College of Agriculture, Jobner (Table 1). This investigation was conducted during rabi, 2022-23 at Research Farm, S.K.N. College of Agriculture, Jobner (Rajasthan). Jobner is located at 26.97°N and 75.38°E. It has an average elevation of 400 metres above mean sea level (1312 feet).

These 30 germplam was sown in four different environments created by manipulating sowing date and Orobanche infestation. Envionment-1 (timely sown Orobanche free field), Envionment-2 (timely sown Orobanche infested field), Envionment-3 (late sown Orobanche free field), Envionment-4 (late sown Orobanche infested field) in randomized block design with three replications in each environment during rabi, 2022-23. The date of timely sown environment was 17th October, 2022 and date of late sown was 5th November, 2022. The inter row spacing's followed would be 80 cm and plant to plant distance were maintained at 15 cm by thinning after 15 days of sowing.

Five plants were randomly selected and tagged before flowering from each plot and data were taken on plant height (cm), primary branches per plant, height of first branch emergence (cm), siliqua on main shoot, siliqua density, siliqua length (cm), seeds per siliqua, chlorophyll content 35 DAS (SPAD), chlorophyll content 70 DAS (SPAD) and 1000-seed weight (g) while data relating to days to 50 per cent flowering and days to maturity was recorded on whole plot basis.

***Corresponding author:** Sukhjot Singh, Department of Genetics and Plant Breeding, MPUAT, Udaipur, India, E-mail: sukhu9211@gmail.com

Received: 28-Sep-2023, Manuscript No. jpgb-23-115072; **Editor assigned:** 03-Octo-2023, PreQC No. jpgb-23-115072 (PQ); **Reviewed:** 17-Oct-2023, QC No. jpgb-23-115072, **Revised:** 25-Oct-2023, Manuscript No. jpgb-23-115072 (R); **Published:** 01-Nov-2023, DOI: 10.4175/jpgb.1000175

Citation: Singh S, Ram M, Gupta D, Meena MK, Nayak PK, et al. (2023) To Estimate the Genetic Variability in Taramira Germplasm. J Plant Genet Breed 7: 175.

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Statistical analysis

The data were subjected to analysis of variance as per the procedure suggested by Panse VG and Sukhatme PV [5]. The genotypic coefficient of variation (GCV) and phenotypic coefficient Variation (PCV) computed by the formula suggested by Burton GW [6]. The PCV and GCV values were ranked as low (0-10%), medium (10-20%) and high (>20%). Heritability (h^2) in the broad sense was calculated according to the formula given by Johnson HW et al. [7]. Heritability values are categorized on the basis of range of percentage as low (<30%), moderate (30-60%) and high (>60%). Genetic advance for each character was predicted by the formula given by Johnson HW, et al. [7]. Genetic advance as percent of mean was classified as low (0-10%), moderate (10-20%) and high (>20%).

Table 1: List of germplasm lines.

S. No.	Germplasm
1	RTM-314
2	RTM-644
3	RTM-715
4	RTM-754
5	RTM-1119
6	RTM-1120
7	RTM-1206
8	RTM-1351
9	RTM-1355
10	RTM-1396
11	RTM-1475
12	RTM-1530
13	RTM-1587
14	RTM-1591
15	RTM-1598
16	RTM-1613
17	RTM-1616
18	RTM-1624
19	RTM-1626
20	RTM-1651
21	RTM-1660
22	RTM-1822
23	RTM-1826
24	RTM-1829
25	RTM-2002
26	RTM-2107
27	RTM-2110
28	RTM GP-35
29	RTM GP-41
30	RTM GP-47

Results and Discussion

The pooled analysis of variance was estimated from pooled data of three replications of four environments for all germplasm. Pooled analysis of variance showed highly significant difference among the germplasm for each character. The environmental effects were, also highly significant for all characters. The majority of the parameters with the exception of days to maturity, primary branches per plant and siliqua length (cm) were, significantly influenced by G x E interactions. It indicated differential effects of environments on the germplasm for all the traits. These results showed presence of substantial amount of G × E interaction (Table 2). Therefore, analysis of variance was carried out environment wise which revealed significant variance due to germplasm for all the characters indicating the presence of ample amount of variability in the germplasm (Table 3). These results are similar with earlier findings of [8-10].

Comparative study of different environments depicted that mean values in E2 and E4 were lower in relation to E1 and E3 for all the traits except height of first branch emergence (cm) indicated that late sowing, Orobanche infested had adverse effect on the performance of taramira germplasm for most of the traits. Further it was also observed that E1 had higher mean in comparison to E3 for most of the traits except height of first branch emergence and siliqua on main shoot whereas, E2 in comparison to E4 had similar trend for all traits except height of first branch emergence (Table 4). Based on the above result, it can be concluded that taramira germplasm should be tested under a timely sown, Orobanche free environment for a clear distinction between superior and inferior germplasm because this environment was found to be better for the expression of most of the component traits.

Comparison of range over environments for all the traits indicated that E1 was most favourable for the expression of traits viz. days to maturity, height of first branch emergence (cm), siliqua length (cm), 1000-seed weight (g) and Seed yield per plant (g) which revealed that these traits had higher range in this environment. Similarly, E3 was favourable for expression of siliqua on main shoot, siliqua density, seeds per siliqua and chlorophyll content 35 DAS (SPAD meter) and E4 had wider range for the traits days to 50 per cent flowering, plant height (cm) and primary branches per plant. E2 wider range for only trait Chlorophyll content 70 DAS (SPAD meter) (Table 4). Conclusively it can be advocated that to obtain clear-cut discrimination in screening of taramira germplasm for different traits should be carried out under timely sown, Orobanche free (E1) conditions.

In all four environments, the phenotypic coefficient variation was higher than the genotypic coefficient of variation for all characters. High PCV and GCV were observed for height of first branch emergence in E1 and E3 (Table 5). Similar findings pertaining to presence of high genetic variability were reported by Kumar S et al. [11] for first branch initiation

Table 2: Pooled analysis of variance for yield and yield determining traits in taramira germplasm.

Source	d.f	DFF	PH	DM	PBPP	HFBE	SMS	SD	SL	SPS	CC-35	CC-70	TW	SY/P
Environments	3	1654.24**	4456.27**	1091.89**	5.18**	0.15**	139.81**	0.119**	0.51**	457.04**	204.29**	2504.10**	19.98**	177.76**
Rep in Env.	8	9.76	35.83	18.18	0.25	0.04	2.33	0.003	0.06	2.3	10.32	8.03	0.01	0.04
Germplasm	29	82.60**	339.86**	253.47**	3.48**	0.99**	17.94**	0.022**	0.30**	72.63**	37.87**	33.51**	0.80**	1.03**
G X E Interaction	87	35.44**	55.61**	28.53	0.17	0.29**	4.07**	0.004**	0.01	4.00**	11.07**	18.05**	0.07**	0.26**
Pooled Error	232	7.48	26.53	25.59	0.2	0.02	1.22	0.002	0.03	1.46	6.63	6.63	0.02	0.05

*, ** = Significant at 5 % and 1 % levels, respectively.

DFF-Days to 50 per cent flowering; **PH**-Plant height (cm); **DM**-Days to maturity; **SL**-Silqua length (cm); **SPS**-Seeds per siliqua; **CC-35**-Chlorophyll content 35 DAS (SPAD meter); **PBPP**-Primary branches per plant; **HFBE**-Height of first branch emergence (cm); **SMS**-Siliqua on main shoot; **SD**-Siliqua density; **CC-70**-Chlorophyll content 70 DAS (SPAD meter); **TW**-1000 seed weight (g); **SY/P**-Seed yield per plant (g)

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Table 3: Environment wise analysis of variance for 30 germplasm of taramira tested under four environments.

Environment	Sourse	d.f	DFF	PH	DM	PBPP	HFBE	SMS	SD	SL	SPS	CC-35	CC-70	TW	SY/P
Environment-1 (Timely sown & *Orobanche* free)	Rep.	2	9.30	48.05	20.58	0.21	0.01	0.83	0.002	0.103	4.30	17.50	3.61	0.02	0.054
	Germ.	29	15.52**	102.60**	112.02**	1.23**	0.52**	7.06**	0.005**	0.102**	30.00**	21.66**	14.52**	0.39**	0.670**
	Error	58	7.06	31.64	26.53	0.21	0.02	1.48	0.002	0.037	1.81	7.59	4.34	0.04	0.092
Environment-2 (Timely sown &*Orobanche* infested)	Rep.	2	15.23	10.83	10.73	0.16	0.04	2.38	0.005	0.066	2.55	6.19	7.01	0.01	0.049
	Germ.	29	21.36**	168.39**	56.03**	0.66**	0.37**	6.27**	0.007**	0.079**	13.15**	15.36**	35.87**	0.25**	0.322**
	Error	58	9.18	23.58	26.16	0.18	0.03	1.01	0.002	0.032	1.09	6.10	12.33	0.02	0.032
Environment-3 (Late sown & *Orobanche* free)	Rep.	2	11.91	49.66	22.71	0.42	0.06	3.43	0.005	0.091	4.06	22.37	4.69	0.01	0.041
	Germ.	29	67.28**	82.44**	88.95**	1.11**	0.59**	9.28**	0.013**	0.095**	30.35**	21.04**	14.21**	0.21**	0.818**
	Error	58	9.27	29.78	25.85	0.20	0.03	1.46	0.002	0.034	1.84	8.72	4.03	0.02	0.058
Environment-4 (Late sown & *Orobanche* infested)	Rep.	2	2.61	34.78	18.71	0.20	0.05	2.67	0.002	0.070	2.09	7.15	16.82	0.01	0.002
	Germ.	29	84.78**	153.26**	82.04**	0.97**	0.36**	7.53**	0.008**	0.067**	11.13**	13.08**	23.05**	0.15**	0.008**
	Error	58	4.41	21.13	23.83	0.19	0.02	0.92	0.002	0.030	0.98	3.66	5.84	0.01	0.002

*, ** = Significant at 5 % and 1 % levels, respectively.

Table 4: Range and mean for yield and related traits in taramira germplasm in different environments.

S. No.	Characters	Range				Mean			
		E1	E2	E3	E4	E1	E2	E3	E4
1	Days to 50 per cent flowering	52-61.33 (9.33) IV	51-61.33 (10.33) III	42.33-59.67 (17.34) II	41.24-59.74 (18.50) I	57.23	56.1	49.66	48.95
2	Plant height (cm)	65.13-84.33 (19.2) III	51.6-75.93 (24.33) II	66.27-81.33 (15.06) IV	49-73.73 (24.73) I	76.01	63.94	74.23	62.18
3	Days to maturity	116.67-139.67 (23) I	119.33-135.33 (16) IV	114.33-134.67 (20.34) II	112.33-131.67 (19.34) III	128.76	127.52	123.54	121.24
4	Primary branches per plant	5.20-7.27 (2.07) II	5.07-6.47 (1.40) IV	05-Jul (2) III	4.13-6.40 (2.27) I	6.09	5.76	5.94	5.53
5	Height of first branch emergence (cm)	1.25-2.70 (1.45) I	1.35-2.51 (1.16) IV	1.43-2.87 (1.44) II	1.42-2.60 (1.18) III	1.86	1.92	1.96	1.92
6	Siliqua on main shoot	13.07-19.87 (6.80) II	11.33-16.47 (5.14) III	12.6-19.87 (7.27) I	11.13-15.93 (4.80) IV	15.72	13.87	15.81	13.39
7	Siliqua density	0.56-0.72 (0.16) IV	0.48-0.68 (0.20) III	0.31-0.69 (0.38) I	0.43-0.64 (0.21) II	0.63	0.57	0.6	0.54
8	Siliqua length (cm)	2.25-2.91 (0.66) I	2.21-2.81 (0.60) II	2.24-2.84 (0.60) II	2.15-2.71 (0.56) III	2.63	2.51	2.55	2.45
9	Seeds per siliqua	13.6-23.80 (10.20) II	11.27-17.67 (6.40) III	12.33-22.60 (10.27) I	11.20-16.93 (5.73) IV	18.69	14.5	17.36	14.01
10	Chlorophyll content 35 DAS (SPAD meter)	39.98-47.88 (7.90) III	37.85-46.27 (8.42) II	38.63-47.15 (8.52) I	37.36-44.75 (7.39) IV	44.12	41.57	42.52	40.57
11	Chlorophyll content 70 DAS (SPAD meter)	37.60-45.89 (8.29) IV	29.72-42.89 (13.17) I	36.92-46.16 (9.24) III	22.32-32.63 (10.31) II	41.12	36.15	39.73	29.32
12	1000 seed weight (g)	2.40-3.57 (1.17) I	1.85-2.80 (0.95) II	2.30-3.25 (0.95) II	1.56-2.30 (0.74) III	3	2.31	2.76	1.96
13	Seed yield per plant (g)	2.77-4.90 (2.13) I	1.64-3.09 (1.45) III	2.34-4.24 (1.90) II	0.43-0.63 (0.20) IV	3.61	2.28	3.39	0.54

(bracket value shows the difference between the highest and lowest values of ranges and I,II,III and IV shows ranking)

height. Moderate GCV and PCV were recorded for plant height (cm) in E2 and E4, also for traits siliqua on main shoot, seeds per siliqua, 1000-seed weight (g) and seed yield per plant (g) in all four environment. Similar findings have also been reported by Kumar S et al. [11] for plant height (cm), [12] for siliqua on main shoot, [13] seeds per siliqua, [14] for 1000-seed weight and [15] for seed yield per plant (g). The results demonstrated a significant level of genetic variability in the examined germplasm for the primary yield contributing characteristics, as well as seed yield, suggesting that further improvement for these traits is possible. Likewise, lower GCV and PCV were recorded for days to 50 per cent flowering, days to maturity, siliqua length (cm), chlorophyll content 35 DAS (SPAD meter) and chlorophyll content 70 DAS (SPAD meter) (Table 5). These similar findings were reported by Choudhary RR et al. [16] for days to 50 per cent flowering, days to maturity, [17] for days to 50 per cent flowering and days to maturity, [18] for siliqua length and [19] for chlotrophyll content.

Johnson HW et al. [7] suggested the heritability estimates combined with genetic advance would be more effective in estimating yield under phenotypic selection than heritability estimates alone. In the present investigation, estimate of high heritability along with high genetic advance as per cent of mean were reported for characteristics such as height of first branch emergence (cm), seeds per siliqua, 1000-seed weight (g) and seed yield per plant (g) in all the environments (Table 6). As a result, they might be under the control of additive gene action. Therefore, selection for these characters will be highly responsive. Similar findings have been recorded by Padra N and Lal GM [19] for test weight (g) and seed yield (g), [18] for seeds/siliqua, seed yield per plant (g) in, [20] for seeds per siliqua, test weight (g)

Table 5: Genotypic coefficient of variation and phenotypic coefficient variation for yield and related traits in taramira germplasm in different environments.

S. No.	Characters	Genotypic coefficient of variation (%)				Phenotypic coefficient variation (%)			
		E_1	E_2	E_3	E_4	E_1	E_2	E_3	E_4
1	Days to 50 per cent flowering	2.93	3.59	8.86	10.57	5.49	6.49	10.77	11.41
2	Plant height (cm)	6.4	10.87	5.64	10.67	9.78	13.26	9.27	12.98
3	Days to maturity	4.15	2.47	3.71	3.63	5.76	4.71	5.54	5.42
4	Primary branches per plant	9.58	6.99	9.25	9.24	12.23	10.12	11.97	12.14
5	Height of first branch emergence (cm)	21.9	17.7	22.16	17.49	23.14	19.54	23.64	19.03
6	Siliqua on main shoot	8.68	9.55	10.22	11.08	11.62	11.99	12.76	13.2
7	Siliqua density	4.55	7.74	10.38	8.69	8.74	10.5	12.77	11.41
8	Siliqua length (cm)	5.51	4.92	5.58	4.52	9.3	8.76	9.1	8.43
9	Seeds per siliqua	16.36	13.82	17.76	13.13	17.97	15.61	19.4	14.92
10	Chlorophyll content 35 DAS (SPAD meter)	4.83	4.23	4.77	4.37	8.03	7.29	8.42	6.43
11	Chlorophyll content 70 DAS (SPAD meter)	4.48	7.75	4.64	8.17	6.76	12.43	6.86	11.61
12	1000 seed weight (g)	11.45	12.01	9.31	10.82	13.12	13.21	10.38	12.33
13	Seed yield per plant (g)	12.16	13.66	14.83	8.53	14.78	15.78	16.44	11.32

Table 6: Heritability (%) and Genetic advance as per cent of mean for yield and related traits in taramira germplasm in different environments.

S. No.	Characters	Heritability (%)				Genetic advance as per cent of mean			
		E_1	E_2	E_3	E_4	E_1	E_2	E_3	E_4
1	Days to 50 per cent flowering	29	31	68	86	3.23	4.1	15	20.19
2	Plant height (cm)	43	67	37	68	8.62	18.35	7.08	18.07
3	Days to maturity	52	28	45	45	6.15	2.68	5.12	5.01
4	Primary branches per plant	61	48	60	58	15.45	9.94	14.72	14.49
5	Height of first branch emergence (cm)	90	82	88	85	42.68	33.03	42.79	33.13
6	Siliqua on main shoot	56	63	64	71	13.35	15.65	16.85	19.17
7	Siliqua density	27	54	66	58	4.88	11.74	17.39	13.65
8	Siliqua length (cm)	35	32	38	29	6.72	5.7	7.05	5
9	Seeds per siliqua	83	78	84	77	30.7	25.2	33.48	23.81
10	Chlorophyll content 35 DAS (SPAD meter)	36	34	32	46	5.97	5.05	5.56	6.11
11	Chlorophyll content 70 DAS (SPAD meter)	44	39	46	50	6.11	9.96	6.47	11.85
12	1000-seed weight (g)	76	83	80	77	20.58	22.5	17.19	19.56
13	Seed yield per plant (g)	68	75	81	57	20.62	24.36	27.56	13.23

and seed yield (g). The trait siliqua on main shoot and siliqua density showed high heritability along with moderate genetic advance (except in E1 for siliqua density) in all the four environments. This result was also reported by Choudhary RR et al. [16] for siliqua on main shoot.

Conclusion

The current study indicated that there was sufficient genetic variability present in the experimental material for most of the traits in all the environments. Therefore, this variability could be used to establish segregating generations by using these germplasm for both timely and late planting situations. After comparing the mean and range (over the germplasm and replications) for yield and different yield attributing traits in all four environments, it was found that both were highest in E1 for most of the traits. A review of heritability and genetic advance as per cent of mean for all four environments revealed that characteristics such as height of first branch emergence, seeds per siliqua, 1000-seed weight and seed yield per plant had high value. This suggested that these traits governed by additive gene action and direct selection based on these traits could be beneficial.

References

1. Bailey LH (1949) Manual of Cultivated Plants. The Macmillan Company, New York.
2. Sastry EVD (2003) Taramira (Eruca sativa Mill.) and its improvement. Agr Rev 24: 235-249.
3. Singh D (1958) Rapeseed and mustard, Indian Central Oilseed committee. Hyderabad 30-35.
4. Yadav TP, Kumar P, Yadav AK (1980) Stability analysis for oil content and yield components in groundnut (Arachis hypogea L.). Haryana Agri Univ J Res 10: 560-563.
5. Panse VG and Sukhatme PV (1985) Statistical methods for agricultural workers. 3rd Rev Edn, ICAR Publication, New Delhi.
6. Burton GW (1952) Quantitative inheritance in grasses. Proceedings of 6th International Grassland Congress 1: 277-283.
7. Johnson HW, Robinson HF, Comstock RE (1955) Estimation of genetic and environmental variability in soybeans. Agronomy J 47: 314-318.
8. Jat BL, Jakhar ML, Kumar P (2014) Estimation of variation, heritability and genetic advance in taramira (Eruca sativa Mill). Int J Plant Sci 9: 31-34.
9. Ola MP, Jakhar ML, Punia SS, Nehra MR, Kumawat G, et al. (2022) Genetic divergence analysis in Taramira (Eruca sativa Mill.) under different environment conditions with special reference to principal component analysis. Environ Conservation J 23: 387-394.
10. Kamdi S, Ingole H, Bhure S, Meshram M, Tajane D, et al. (2022) Stability analysis in Indian mustard. The Pharma Innov J 11: 4351-4354.
11. Kumar S, Bhardwaj R, Jhambhulkar SJ, Rai A (2023) Assessment of genetic variability, heritability and genetic advance in Indian mustard (Brassica juncea L.). J Oilseed Brassica 14: 38-43.
12. Chaurasia RK, Bhajan R (2015) Genetic diversity for seed yield and component traits in indian mustard [brassica juncea (L.) czern & coss.]. Trends in Biosci 8: 151-156.
13. Yadav MK (2017) Genetic variability for grain yield and its various components in Taramira (Eruca sativa Mill.). Chem Sci Rev Lett 6: 1133-1136.
14. Gadi J, Chakraborty NR, Imam Z (2020) To study the genetic variability, heritability and genetic advance for different quantitative characters in Indian

Mustard (B. juncea). Int J Curr Microbiol Appl Sci 9: 1557-1563.

15. Nishad C, Salam JL, Singh S, Singh DP (2022) Studies of genetic variability in Indian mustard (Brassica juncea L. Czern and Coss). The Pharma Inn J 11: 261-263.
16. Choudhary RR, Singh RAM, Bishnoi M (2023) Genetic parameters and correlation studies in Indian mustard (Brassica juncea L.). J Oilseed Brassica 14: 68-72.
17. Ola MP, Patel MK, Kumar A, Ram M, Pant NC, et al. (2023) Genetic variability for seed yield and its component characters in taramira (Eruca sativa Mill.). The Pharma Inn J 12: 3102-3105.
18. Akter S. (2020) Estimation of genetic variability and interrelationship between yield and yield contributing characters of bc_1 f_7 population in Brassica napus (doctoral dissertation, department of genetics and plant breeding).
19. Padra N, Lal GM (2021) Genetic variability and Heritability for morphological and physiological traits in Indian mustard genotype under heat stress condition. The Pharma Inn J 10: 2192-2197.
20. Rauf MA (2016) Genetic variability and character association among yield and its contributing traits in mustard (Brassica napus) (doctoral dissertation, department of genetics and plant breeding, sher-e-bangla agricultural university).