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Variability and character association analysis in Taramira (*Eruca sativa*)

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Abstract

One hundred eight accessions of Taramira (*Eruca sativa* Mill.) evaluated for seed yield during rabi 2010-11 revealed highly significant differences among the accessions for days to 50% flowering, plant height, number of primary and secondary branches per plant, silique per plant, siliqua length, 1000-seed weight, seed yield per plant and oil content. High estimates of heritability along with high genetic advance were observed for siliquae per plant, number of secondary branches per plant and seed yield per plant. Whereas, high heritability and moderate to low genetic advance were observed for siliqua length, 1000-seed weight, days to 50 per cent flowering, plant height, number of primary branches per plant and oil content. The seed yield per plant was positively correlated with number of primary branches per plant (0.185), plant height (0.184), 1000-seed weight (0.097) and siliquae per plant (0.027). The path coefficient analysis revealed that on seed yield of plant height had highest direct effect followed by 1000-seed weight and number of primary branches per plant. Based upon correlation and path analysis it was concluded that plant height, 1000-seed weight and number of primary branches per plant are the most important yield contributing traits in taramira. Based on the *per se* performance the accessions RTM-809, RTM-815, RTM-814, RTM-845, RTM-855, RTM-861, RTM-844, RTM-862, RTM-874 and RTM-848 were found superior in seed yield while accessions RTM-831, RTM-869, RTM-808, RT-845, RTM-884, RTM-868, RTM-830, RTM-852, RTM-870 and RTM-821 showed maximum oil content in their seeds. These accessions may further be utilized in breeding programme aimed at improving high seed yield along with oil content.

Introduction

Taramira (*Eruca sativa* Mill.) is an important winter season oilseed crop of the family Brassicaceae has 2n=22. Taramira has desirable traits, particularly resistance to powdery mildew that can be transferred to *Brassica rapa* and *B. juncea* both which are important oilseed crops (Sastry, 2003). Taramira does not require much preparatory tillage due to its efficient and fast penetrating root system permitting extraction of soil water from relatively deeper layers of soil. It is a hardy crop that can be successfully grown on dryland area and in poor sandy soils with conserved moisture. Taramira oil is mostly used in the manufacture of grease, soap, plastics, lubricants, paints and chemicals. The cake is used as manure for improving the soil physical condition and soil fertility and can also be used as nutritional feed for animals. Due to lack of variability and a limited knowledge on genetics of yield and its contributing traits, no concerted efforts have been made on the genetic improvement of taramira. Development of new high yielding varieties requires knowledge of the existing genetic diversity and also extent of association among the yield contributing characters. The estimate of heritability alone does not provide an idea of the expected gain in the next generation, however the variation could be find along with the greater degree of accuracy when heritability in conjunction with genetic advance. Correlation and path analysis will establish the extent of association between seed yield and its component and also bring out the relative importance of their direct and indirect effect. The knowledge of the extent of existing genetic variability character and association on seed yield are important to carry out an efficient selection programme. Therefore present investigation was conducted to generate informations on seed yield in taramira (*E. sativa*) including path analysis.

Materials and Methods

The study was conducted using 108 accessions of taramira for seed yield and its related traits in augmented randomized complete block design during rabi of 2010-11 at the Research farm of SKN College of Agriculture, Jobner. The experimental material was grouped and each group consist of 27 accessions. Each group of accession was assigned to a separate block. Five check varieties i.e RTM-2002, RTM-314, T-27, RTM-1212 and RTM-1107 were also assigned to each block. In each block, accessions and check varieties were sown in a plot size of 5 x 0.60 m[accommodating 2 rows spaced 30 cm apart, after randomization the plant to plant distance was maintained at 10 cm by thinning. Ten plants were randomly selected and tagged before flowering from each plot to record the data on plant height (cm), number of primary branches per plant, number of secondary branches per plant, siliquae per plant, seeds per siliqua, siliqua length (cm), 1000-seed weight (g), seed yield per plant and oil content (%) while data relating to days to 50 % flowering was recorded on whole plot basis. Statistical analysis were done according to the standard statistical procedures (Federer, 1956).

Results and Discussion

Evaluation of 108 accessions showed significant differences for all the morphological characters indicating the existence of significant variation among the accessions. Hence the material had adequate variability to support the breeding programme for improvement of the seed yield. The blocks exhibited non significant variability for all the traits except days to 50% flowering. The check varieties differed significantly for number of secondary branches per plant, siliquae per plant, 1000- seed weight and oil content (Table 1). Checks vs accessions showed highly significant differences for all the characters except days to 50 per cent flowering and per cent oil content. This indicated that checks as a group differed significantly from accession as a group, this indicated that check varieties had moderate variability among them. The phenotypic variance was higher than the genotypic variance for each of the character studied, indicating positive effect of environment on the expression of a character (Table 2). Dar *et al.* (2010) had also observed same results in taramira indicating the role of environment in the expression of a character. The difference between the phenotypic and genotypic variances was less. This is expected in augmented design, as the error variance is based on the evaluation of checks. Due to less differences between the variances, the values of heritability are generally higher leading to higher GA estimates. The variation observed in present study may seek support from high magnitude of genotypic coefficient of variance reported by Yadav and Kumar (1984) for seeds per siliqua , test weight and primary branches per plant, by Khan and Khan (2003) for number of secondary branches per plant and siliquae per plant, by Dar *et al.* (2010) for siliquae per plant, by Doddabhimappa *et al.* (2010) for number of secondary branches per plant. Lowest variability for seeds per siliqua and oil content was observed by Singh *et al.* (2010).

High broad sense heritability (>70 per cent) was observed for days to 50 percent flowering, secondary branches per plant, siliquae per plant, siliqua length, 1000-seed weight and oil content. High heritability coupled with high genetic advance was observed for number of branches per plant, siliquae per plant and seed yield per plant. According to Lerner (1958), the estimates of broad sense heritability are reliable if combined with high genetic advance and indicate role of additive gene action which given better response to phenotypic selection than those characters having low values. Earlier Nehra *et al.* (1989) also reported high heritability with high genetic advance estimates for above traits. Thus the results of the present investigation are in line with the earlier reports. From the study of heritability and genetic advance it is inferred that simple selection among accessions can bring about significant improvement in seed yield and its component characters as the heritability and estimated genetic advance were high. The expected

Table 1: Mean squares and variances for different characters in taramira

Source of variation	d.f.	Days to 50 per cent flowering	Plant height (cm)	Number of primary branches per plant	Number of secondary branches per plant	Siliquae per plant	Seeds per siliqua	Siliqua length (cm)	1000 seed weight (g)	Seed yield per plant (g)	Oil content (%)
Blocks (b-1)	3	79.518*	23.010	0.248	2.921	46.949	2.833	0.007	0.037	0.358	0.091
Entries (c+g)-1	112	53.131**	58.756*	1.025*	57.439**	2500.37**	2.625	0.053**	0.199**	3.718**	1.785**
Checks (c-1)	4	9.000	29.817	1.094	36.719**	21159.600**	3.408	0.015	0.452**	2.476	1.679*
Accessions (g)	107	55.114**	56.716*	0.991*	58.267**	1392.827**	2.467	0.53**	0.165**	3.638*	1.803**
Checks vs. Accessions	1	17.506	392.649**	4.179**	51.658**	46371.060**	16.428**	0.161**	2.840**	17.319**	0.217
Error (b-1) (c-1)	12	13.766	18.821	0.376	5.424	18.812	1.605	0.011	0.037	1.052	0.333
Genotypic variance (v_g)		35.679	32.700	0.530	45.598	1107.981	0.743	0.036	0.110	2.231	1.269
Phenotypic variance (v_p)		49.446	51.520	0.906	51.022	1216.7929	2.348	0.047	0.147	3.283	1.601
Error variance (v_e)		13.766	18.821	0.376	5.424	18.812	1.605	0.011	0.037	1.052	0.333

* Significant at P = 0.05

** Significant at P = 0.01

Table 2: Overall mean value of accessions, their range, genotypic and phenotypic coefficient of variations, heritability (broad sense) and genetic advance as percentage of mean for different characters in taramira

Characters	Mean	Range	Genotypic coefficient of variation (GCV)	Phenotypic coefficient of variation (PCV)	Heritability in broad sense (%)	Genetic advance as percentage of mean
Days to 50 per cent flowering	53.76	46.95-95.15	10.00	11.80	72.16	17.50
Plant height (cm)	96.37	86.28-123.58	5.34	6.70	63.47	8.80
Number of primary branches per plant	5.32	3.44-8.38	12.33	16.11	58.56	19.43
Number of secondary branches per plant	23.18	11.93-43.33	26.22	27.73	89.37	51.06
Siliquae per plant	148.14	90.74-256.04	20.22	21.20	91.06	39.75
Seeds per siliqua	17.14	16.08-22.68	4.53	8.05	31.64	5.25
Siliqua length (cm)	2.30	1.84-3.38	8.27	9.46	76.32	14.88
1000- seed weight (g)	2.43	1.56-3.54	12.29	14.20	74.94	21.92
Seed yield per plant (g)	5.97	3.33-12.44	22.52	27.32	67.95	38.24
Oil content (%)	38.18	34.95-41.21	2.95	3.32	79.23	5.41

genetic advance might have been biased upward as it is based on the estimate of heritability in broad sense, secondly in the augmented design the estimation of mean square due to error is based on the performance of the check variety only and hence it might have given the high estimates of genetic variation due to compounding of error variance in it.

However, in the present investigation on the basis of heritability and genetic advance character of secondary branches per plant, seed yield per plant, siliquae per plant and number of primary branches per plant may be the best reliable traits that could be exploited for hybridization and selection for improvement. Since these characters recorded high heritability and genetic advance. In the present investigation the seed yield per plant showed positive association with plant height, number of primary branches per plant, siliquae per plant and 1000- seed weight, though the associations was non-significant (Table 3&4) .

Similar association of seed yield per plant have been reported with plant height, number of primary and secondary branches per plant, seeds per siliqua and 1000- seed weight by Sabaghnia *et al.* (2010), Sadet *et al.* (2010), Tuncturk and Ciftic (2007), Ivanovasca *et al.* (2007) and siliqua length by Yadav and Kumar (1984). Nehra *et al.* (1989) reported negative and non- significant correlation for days to 50 per cent flowering.

It is interesting to note that the characters like plant height, number of primary branches per plant, siliquae per plant and 1000- seed weight have exhibited positive association with seed yield per plant. Therefore, these characters may be simultaneously improved to increase the seed yield.

According to falconer (1981), it is often assumed that association between two characters is an evidence of pleiotrophy rather than linkage hence under such complex situations, path coefficient analysis is a powerful tool for studying characters association. In other words the path coefficient analysis measures the direct and indirect constribution of various independent characters towards a dependent character such as seed yield per plant. There is good agreement between the values of direct and indirect effects obtained at genotypic level. Further more, the path coefficient analysis revealed that the characters like plant height, number of primary branches per plant, siliquae per plant and 1000- seed weight, which had positive correlation with seed yield also exerted positive and high direct effects on seed yield per plant. Thus, it revealed that there is true relationship between seed yield and other characters and direct selection for this traits will be rewarding for field improvement.

Earlier, positive direct effect on seed yield has been reported by Yadav and Kumar (1984) and Nehra *et al.* (1989) ; for secondary branches per plant, while for siliquae per plant reported by Nehra *et al.* (1989). Thus most of these studies support theresults of present investigation .Thus it can be concluded that siliquae per plant, number of primary branches per plant, plant height and 1000- seed weight are the most important characters of seed yield. Hence selection on the basis of these character would bring about improvement in the seed yield.

The accessions were ranked based on *per se* performance for different characters and high seed yield per plant. Top ten accessions selected on the basis of performance are listed in Table 5.Among the accessions tested ten accessions namely ; RTM-809, RTM-815, RTM-814, RTM-845, RTM-855, RTM-861, RTM-844, RTM-862, RTM-874 and RTM-848 were attained high seed yield as well as high ranking for its component characters. The accessions namely ; RTM-831, RTM-869, RTM-808, RTM-845, RTM-884, RTM-868, RTM-830, RTM-852, RTM-870 and RTM-821 showed maximum oil content in their seeds. Hence, it is suggested that these accessions be tested over the locations to confirm their superiority and may also be used as parents in hybridization programme to develop high yielding varieties along with high oil content.

Table 3: Correlation coefficient on the basis of adjusted values between different characters in taramira

Characters	Plant height (cm)	Number of primary branches per plant	Number of secondary branches per plant	Siliquae per plant	Seeds per siliqua	Siliqua length (cm)	1000-seed weight (g)	Oil content (%)	Seed yield per plant (g)
Days to 50 per cent flowering	-0.077	0.043	0.046	-0.008	-0.073	0.081	-0.006	-0.109	-0.012
Plant height (cm)		0.270**	0.314**	0.131	0.433**	0.302**	0.077	-0.059	0.184
Number of primary branches per plant			0.263**	0.150	0.091	0.029	0.101	-0.043	0.185
Number of secondary branches per plant				0.155	0.112	0.057	0.178	-0.068	-0.043
Siliquae per plant					0.006	-0.134	-0.105	-0.026	0.027
Seeds per siliqua						0.288**	0.037	0.058	-0.077
Siliqua length (cm)							0.126	-0.224*	-0.209*
1000- seed weight (g)								0.156	0.097
Oil content (%)									-0.092

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

Table 4: Direct (diagonal) and indirect effects (non-diagonal) of different characters on seed yield per plant in taramira based on adjusted values

Characters	Days of 50 per cent flowering	Plant height (cm)	Number of primary branches per plant	Number of secondary branches per plant	Siliquae per plant	Seeds per siliqua	Siliqua length (cm)	1000 seed weight (g)	Oil content (%)	Genotypic Correlation with seed yield per plant (g)
Days of 50 per cent flowering	**0.0170**	-0.0260	0.0063	-0.0087	0.0003	0.0082	-0.0274	-0.0010	0.0187	-0.0124
Plant height (cm)	-0.0013	**0.3392**	0.0395	-0.0597	-0.0056	-0.0483	-0.1021	0.0123	0.0103	0.1841
Number of primary branches per plant	0.0007	0.0916	**0.1461**	-0.0500	-0.0064	-0.0102	-0.0098	0.0160	0.0074	0.1855
Number of secondary branches per plant	0.0008	0.1064	0.0383	**-0.1903**	-0.0066	-0.0126	-0.0193	0.0283	0.0118	-0.0432
Siliquae per plant	-0.0001	0.0443	0.0219	-0.0395	**-0.0426**	-0.0007	0.0454	-0.0166	0.0045	0.0266
Seeds per siliqua	-0.0013	0.1464	0.0134	-0.0214	-0.0003	**-0.1119**	-0.0974	0.0059	-0.0099	-0.0765
Siliqua length (cm)	0.0014	0.1023	0.0042	-0.0109	0.0057	-0.0322	**-0.3386**	0.0200	0.0386	-0.2094*
1000- seed weight (g)	-0.0001	0.0260	0.0147	-0.0338	0.0044	-0.0041	-0.0426	**0.1590**	-0.0269	0.0967
Oil content (%)	-0.0019	-0.0201	-0.0063	0.0130	0.0011	-0.0065	0.0759	0.0248	**-0.1722**	-0.0922

* Significant at P = 0.05 Residual factor (Genotypic level)= 0.7943

Table 5: Performance of top ten accessions based on seed yield

Entries	Seed yield per plant (g)	Days to 50 per cent flowering	Plant height (cm)	Number of primary branches per plant	Number of secondary branches per plant	Siliquae per plant	Seeds per siliqua	Siliqua length (cm)	1000 seed weight (g)	Oil content (%)
RTM-809	12.44 (1)	51.75 (7)	115.10 (11)	6.66 (16)	35.73 (9)	243.14 (2)	22.22 (2)	2.63 (23)	3.20 (12)	36.87
RTM-815	11.74 (2)	59.75 (26)	113.92 (18)	6.74 (15)	33.12 (12)	192.94 (25)	21.24 (8)	2.91 (2)	3.34 (4)	39.00
RTM-814	11.32 (3)	52.75 (9)	112.98 (17)	7.66 (6)	32.23 (15)	193.94 (23)	20.62 (14)	3.38 (1)	3.20 (12)	36.89
RTM-845	10.72 (4)	57.95 (21)	114.92 (12)	6.64 (17)	35.71 (10)	212.44 (12)	20.94 (10)	2.78 (4)	3.30 (7)	40.48
RTM-855	10.25 (5)	54.15 (12)	112.42 (19)	6.58 (18)	42.45 (2)	256.04 (1)	20.78 (12)	2.70 (7)	3.14 (13)	38.17
RTM-861	9.96 (6)	48.15 (2)	118.42 (8)	7.88 (14)	30.95 (20)	240.04 (4)	20.28 (20)	2.70 (7)	3.34 (4)	37.32
RTM-844	9.94 (7)	57.95 (21)	119.12 (6)	7.34 (8)	31.11 (19)	227.24 (7)	20.44 (17)	2.78 (4)	3.24 (10)	36.50
RTM-862	9.79 (8)	59.15 (25)	113.92 (13)	8.38 (1)	36.05 (8)	237.44 (5)	21.78 (4)	2.90 (3)	3.06 (17)	37.17
RTM-874	9.69 (9)	55.15 (15)	132.12 (4)	7.68 (12)	31.35 (18)	196.14 (22)	20.88 (11)	2.35 (24)	2.78 (26)	37.51
RTM-848	9.25 (10)	59.95 (27)	112.40 (20)	7.24 (7)	32.61 (16)	215.14 (10)	20.36 (18)	2.54 (12)	3.29 (8)	37.35

( ) Values in parenthesis is the ranking of respective character

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