Relationship between floral and agronomic traits in Indian mustard (*Brassica juncea* L.)

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Abstract

Thirty-four varieties of Indian mustard (*B. juncea*) were grown in replicated block design keeping plot size of 5 m long 5 rows grown at 45 cm row to row and 15 cm plant to plant spacings during crop season of 2004-05 and 2005-06. Observations were recorded on 20 plants from each variety on 13 characteristics including 4 floral traits *viz*. petal length, petal width, stamen length and style length. Remaining nine traits included plant height at the time of flower initiation, number of leaves at flower initiation, days to flower initiation, day to maturity, seeds per siliqua, 1000 seed weight (g), seed yield (g/plant), protein and oil content (%). Analysis of variance revealed the presence of significant variation for all the traits. The variability, as depicted by coefficient of variation, was high for seed yield, 1000-seed weight and plant height at the time of flower initiation, low for oil and protein content and days to maturity. Remaining traits showed moderate variability. Seed yield had significant and positive correlation with plant height at the time of flowering, petal length, petal width, stamen length, style length and 1000-seed weight. Significant but negative relationship was observed between seed yield and protein content. Oil content had significant and positive correlation with petal length. Days to flower initiation, days to maturity and protein content were found negatively correlated with oil content. Petal width had significant and positive correlation with number of leaves at flower initiation and plant height at maturity, negative correlation with plant height at flower initiation, petal width and style length. Days to flower initiation had positive correlation with plant height at flower initiation, plant height at maturity, petal length, petal width, stamen length and style length. Style length had positive correlation with petal width and stamen length. Stamen length had positive correlation with petal length and petal width. This information is useful for indirect selection for high seed and oil yield. It is recommended on the basis of these findings that plants bearing long and broad petals coupled with tall style and stamens should be selected for high seed and oil yield.

Key words: Indian mustard, *Brassica juncea*, correlation, variability, petal length, petal width, agronomic traits

Introduction

Indian mustard (*Brassica juncea* L) is widely grown in India as an oilseed crop. Enhancement of seed yield and oil content are two basic objectives of mustard breeding programmes. Efficiency of selection is mainly determined by the extent of variability for that trait in the existing material. Indirect selection based upon yield component traits is often advocated for yield improvement rather than direct selection. Selection based upon floral traits may be more practical because these traits may be observed visually for relative comparison, while selection based upon yield or yield contributing traits need measurement for recording of the data. A number of correlation studies between seed yield and yield-contributing traits have been conducted in mustard, which indicate strong relationship of seed yield with number of seeds per siliqua, seed weight and number of siliquae per plant (Singh *et al* 2003, Dubey and Khan 1996) however, reports on relationship between floral and agronomic traits are meager. Hence present investigation was conducted to estimate the extent of variability among existing cultivars of Indian mustard and to study the relationship among floral and agronomic traits.

Material and Methods

Material comprised of 34 varieties of Indian mustard (*B. juncea*) *viz*., Arawali, Basanti, CS 52, Geeta, GM 1, GM 2, Kanti, Kranti, Krishna, Laxmi, Maya, NDRE 4, PBR 91, PBR 97, Pusa Agrani, Pusa Bahar, Pusa Bold, Pusa Jagannath, Pusa Jaikisan, PCR 7, RCC 4, RH 30, RH 781, RH 819, RL 1359, RLM 619, Rohini, Sanjucta Asech, Saurabh, Swarna Jyoti, Urvashi, Vardan, Varuna and Vasundhara. These 34 varieties were grown in replicated block design with 3 replications. The plot size was 5 rows of 5 m length grown at 45 cm row to row and 15 cm plant-to-plant spacings. The experiment was conducted during crop season of 2004-05 and 2005 –06. Observations were recorded for 13 characteristics including 4 floral traits *viz.*, petal length (PL), petal width (PW), stamen length (STL) and style length (STYL). Flower buds of 20 plants were bagged prior to their opening and floral traits were observed on next morning on freshly opened flowers. Remaining 9 traits included plant height (PH) at the time of flower initiation, number of leaves (NOL) at flower initiation, days to flower initiation (DFI), days to maturity (DM), seeds per siliqua (S/S), 1000-seed weight (SW), seed yield (SY), oil content (OC) and protein content (PC). Seed yield was recorded on plot basis while, oil and protein content were estimated on the random bulk drawn from plot yield. Remaining 6 traits were recorded on 20 plants of each variety. The mean values were subjected for statistical analyses. The correlation coefficients were estimated as par the Dewey and Lu (1959). Heritability has been used as an index of transmissibility of a trait from the parent to its offspring (Dudley and Moll, 1969). Heritability in broad sense was estimated as ratio of genotypic variance to phenotypic variance and expressed in percent (Burton and Devene, 1953).

Results

Variability and heritability estimates

Analysis of variance revealed the presence of significant variation for all the traits. The mean values, range and phenotypic coefficient of variation (PCV) are presented in table 1. Highest variability as depicted by phenotypic coefficient of variation was recorded for seed yield per plot followed by 1000 seed weight, while low variability was observed for oil and protein content and maturity duration. Remaining traits however, represented moderate level of variability. Among the four floral traits, maximum range was recorded for style length ranging from 0.69 to 1.0 cm followed by petal width, which ranged from 0.55 to 0.80 cm. Oil and protein content had very narrow range. On the contrary, days to maturity which had low estimates of phenotypic coefficient of variation, had wide range (117.3 to 135.8 days). Heritability estimates were medium for petal width, style length, days to flower initiation, days to maturity, number of seeds per siliqua, 1000 seed weight, oil content, protein content and seed yield while, low for plant height at flower initiation, petal length, stamen length and number of leaves at flower initiation (Fig.1).

Table 1. Mean values, range and phenotypic coefficient of variation (PCV) for 13 traits in Indian mustard.

Trait	Mean	Range		PCV
		Minimum	Maximum	
Plant height at flower initiation (cm)	87.4	69.6	104.5	17.7
Number of leaves at flower initiation	11.1	9.9	12.4	9.7
Petal length (cm)	1.0	0.95	1.1	8.8
Petal width (cm)	0.63	0.55	0.80	10.8
Stamen length (cm)	0.86	0.77	0.94	7.6
Style length (cm)	0.83	0.69	1.0	12.8
Days to flower initiation	55.1	42.0	63.8	11.7
Days to maturity	125.4	117.3	135.8	4.4
Number of seeds per siliqua	15.7	13.2	19.6	10.9
1000-seed weight (g)	4.2	2.9	5.4	20.8
Oil content (%)	40.3	38.9	41.4	2.2
Protein content (%)	20.5	19.6	21.6	3.2
Seed yield per plot (g)	1037.6	628.0	1541	27.7

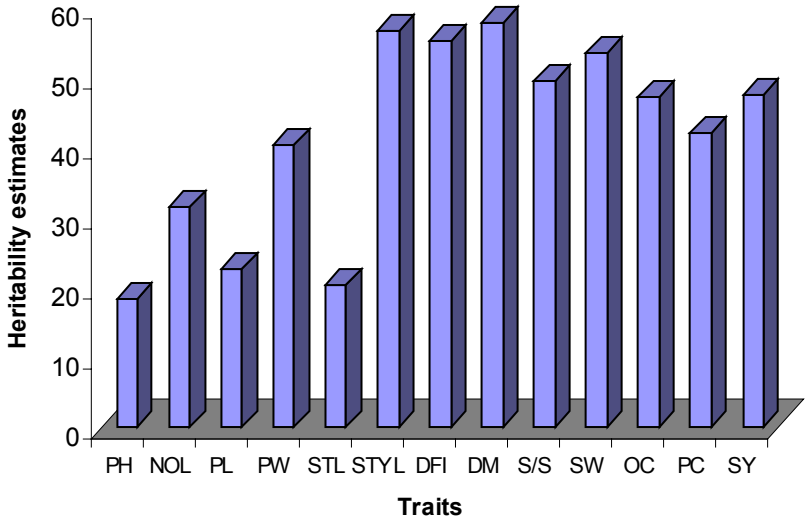

Fig. 1. Heritability (in broad sense) estimates for floral and agronomic traits

Correlation coefficients

Seed yield had significant and positive correlation with plant height at flower initiation, petal length, petal width, stamen length, style length and 1000-seed weight (table 2). The relationship between seed yield and protein content was negative. The correlation of seed yield with remaining traits were non significant. Oil content had positive and significant correlation with petal length but negative correlation with days to flower initiation, days to maturity and protein content. Petal length had positive and significant correlation with stamen length, days to flower initiation, oil content and seed yield. Petal width had positive and significant correlation with stamen length, style length, days to flower initiation, 1000-seed weight and seed yield but negative correlation with seeds per siliqua. Stamen length had positive and significant correlation with style length, days to flower initiation and seed yield but negative correlation with protein content. Style length had positive and significant

correlation with days to flower initiation and seed yield but negative correlation with seeds per siliqua and protein content. Plant height at flower initiation had positive and significant correlation with style length, days to flower initiation, days to maturity and seed yield but negative correlation with seeds per siliqua. Number of leaves at flower initiation had positive association with seeds per siliqua but negative association with petal width, stamen length, style length, and days to flower initiation.

Table 2. Correlation coefficients between floral and agronomic traits in Indian mustard.

Trait	NOL	PL	PW	STL	STYL	DFI	DM	S/S	SW	OC	PC	SY
PH	-0.12	0.11	0.07	0.11	0.21**	0.44**	0.29**	-0.18**	0.02	-0.07	-0.07	0.19**
NOL		-0.08	-0.15*	-0.18**	-0.29**	-0.19**	0.02	0.32**	0.01	0.01	0.11	-0.08
PL			0.13	0.19**	0.1	0.16*	-0.0	-0.01	-0.11	0.25**	-0.11	0.16*
PW				0.17*	0.28**	0.14*	0.03	-0.26**	0.15*	0.12	0.13	0.37**
STL					0.39**	0.14*	0.06	-0.13	0.05	0.09	-0.27**	0.18*
STYL						0.33**	0.03	-0.14*	0.01	0.02	-0.36**	0.21**
DFI							0.63**	-0.08	0.04	-0.14*	-0.10	0.04
DM								0.03	0.13	-0.19**	0.04	-0.04
S/S									0.14	-0.05	0.15*	-0.12
SW										-0.10	-0.23**	0.35**
OC											-0.20**	0.07
PC												-0.25**

*, ** indicate significance at 5 and 1 percent level, respectively.

Direct and indirect effects:

Direct effects of different floral and agronomic traits on seed yield are depicted in Fig. 2. Seed weight had the highest positive direct effect (0.3143) followed by petal width ((0.2896) and plant height at flower initiation ((0.2008). All four floral traits *viz*., petal length, petal width, stamen length and style length had positive direct effect on seed yield. Four traits viz., number of leaves at flower initiation, days to flower initiation, days to maturity and protein content had negative direct effects on seed yield though the correlation coefficients of these traits with seed yield were non significant except protein content. Indirect effects of all traits via other traits were low in magnitude. All these traits however could represent only 30 percent of the total components and 70 percent components as depicted by residual effect need to be further explored.

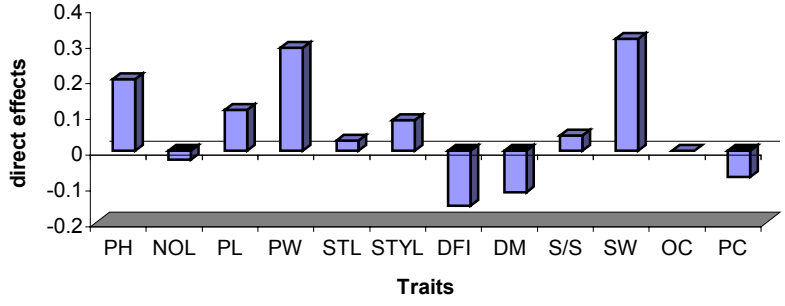

Fig. 2. Direct effects of floral and agronomic traits

Discussion

Existence of variability for all traits studied in present investigation is an indication of scope for further improvement for theses traits. Medium estimates of heritability in broad sense and wide range in the existing material for petal width, style length, days to flower initiation, days to maturity, number of seeds per siliqua, 1000-seed weight and seed yield indicated that hybridization may create large variability in segregating generations for these traits.

The positive correlation of all four floral traits *viz*., petal length, petal width, stamen length and style length with seed yeld establish linkage among these traits. Hence these floral traits may be used as markers for selection of high yielding genotypes. Looking the high estimates of direct effects of petal width and petal length, as revealed by path analysis, the flower size (long and broad petals) appears as reliable selection criteria for indirect selection of high yielding genotypes. The positive correlation between petal length and oil content further endorses the importance of flower size. Among the other traits, plant height at flower initiation, which reflects the fast vegetative growth and seed weight also seems promising traits for selection of high yielding genotypes as both traits had positive correlation with seed yield.

Conclusion

The positive correlation coefficients between seed yield and floral traits viz., petal length and petal width coupled with high estimates of their direct effects on seed yield establishes close relationship between flower size and seed yield. It is recommended on the basis of these findings that plants bearing long and broad petals coupled with tall style and stamens should be selected for high seed and oil yield.

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