Genetic Variability and Correlation Studies on Germplasm of Yellow Sarson [*B. rapa* (L.) var. *yellow sarson*] for Seed Yield and its Component Traits

AK Misra*, SS Manohar and A Kumar
National Research Centre on Rapeseed-Mustard, Sewar, Bharatpur-321303, Rajasthan

Genetic variability and correlation in sixty three indigenously collected germplasm accessions of yellow sarson were evaluated for seed yield and its components traits. Analysis of variance for seed yield and its related components showed that there was significant variability among accessions. The maximum PCV was observed in seed yield per plant followed by seeds per siliqua. High heritability coupled with high genetic advance were observed for plant height, seeds per siliqua, 1000-seed weight, seed yield per plant and harvest index. The seed yield per plant was positively and significantly correlated with main shoot length, siliquae on main shoot, primary branches per plant, oil content, 1000-seed weight, harvest index and days to maturity. The accessions IC361512, IC342762 and IC334290 were identified as useful genotypes for various traits.

Key Words: Rapeseed-mustard, Accessions, Genetic Variability, Heritability, Correlation

Introduction

Rapeseed-mustard is an important group of crop plants with great economic value world wide. *Brassica juncea* (Indian mustard) and *B. rapa* are the important oilseed crops in India. The *B. rapa* is divided into three ecotypes, *viz.*, toria, brown sarson and yellow sarson which are grown in India. Of these three ecotypes, yellow sarson is self compatible in breeding behavior and is one of the most important members among them. Yellow sarson is mainly grown in Assam, Bihar, Uttar Pradesh, Sikkim, Meghalaya and West Bengal, (Misra, 2008). It occupies an important position due to the presence of high oil content (up to 45%), high seed yield and early maturity (around 100 days) as compared to Indian mustard (130-150 days), furthermore, it's yellow seed coat colour has preference over brown seed colour. The oil is mainly used for edible purposes and in addition to this, the yellow sarson is most preferred choice as leafy vegetables among the entire cultivated oilseed brassicas in India (Chatterjee, 1992).

The improvement for yield and other traits not only depends on the amount of variability present in the breeding materials for the required traits but also on proper evaluation and further, utilization in the breeding programmes (Kumar *et al.*, 2004; Kumar and Misra, 2007). The present study was undertaken to find out variability for 15 agro-morphological traits in the yellow sarson germplasm. The estimation of extent and nature of variability in the germplasm accessions for yield and other economic traits is the pre-requisite for breeding programme. The effectiveness of selection for seed yield depends upon both, the genetic variability present in the population and the degree of association that exists between seed yield and its components traits. Therefore, the present investigation was undertaken to estimate the magnitude of genetic variability and correlation in the diverse germplasm of yellow sarson and selection of superior genotypes.

Materials and Methods

Sixty three accessions of yellow sarson (*B. rapa* L. var. *yellow sarson*) were evaluated during *rabi* season 2006-07 in an augmented complete block design with four checks (NDYS 2, Pusa gold, Ragani and YST 151) at the National Research Centre on Rapeseed–Mustard, Bharatpur, Rajasthan. These indigenously collected accessions of yellow sarson were acquired from National Bureau of Plant Genetic Resources, New Delhi (India). The collections were made in various exploration trips in the states of Bihar, Chattisgarh, Jharkand, Uttar Pradesh and West Bengal. Each genotype was sown in paired rows of 3 m length with 30 x 10 cm spacing. Recommended standard agronomic package of practices and plant protection measures were adopted. Randomly tagged five plants were selected at appropriate growth stage to record observations on morphological traits, namely, initiation of flowering, 50% flowering, maturity, plant height, primary branches and secondary branches per plant, main shoot length, siliquae on main shoot, siliqua length, and seeds per siliqua. Post-harvest observations include seed yield per plant, 1000-seed weight, harvest index and quality traits such as oil and protein content. The mean values of five plants for each character were considered for computation, except for days to flower initiation, 50%

* *Author for Correspondence: E-mail: akmisra@yahoo.com*

J. Plant Genet. Resour. 20(3): 216-220 (2007)

flowering and days to maturity (which was recorded on whole plot basis). 1000-seeds were counted by electronic seed counter (Contador, Germany) and weighed by electronic balance. Further, oil and protein content were analyzed by Near Infrared Reflectance Spectroscopy, (Dickey-John, Instalab 600). The mean data were subjected to analysis of variance, the data analyzed by using software Statistical Package for Augmented Design (SPAD) of IASRI, New Delhi. Phenotypic (PCV) and genotypic coefficient of variance (GCV) were calculated using formula suggested by Burton (1952), heritability (h^2) in broad sense and expected genetic advance as per cent of mean at 5% intensity of selection differential were calculated for each character as suggested by Johnson *et al.* (1955) and correlation coefficients were calculated according to the procedure of Singh and Chaudhary (1977).

Results and Discussion

Analysis of variance (Table 1) for seed yield and its related components showed that there was significant variability among accessions for initial flowering, 50% flowering, plant height, primary and secondary branches per plant, main shoot length, siliquae on main shoot, seeds per siliqua, 1000-seed weight, siliqua length, harvest index, oil content and seed yield per plant, suggesting that the material has adequate variability to support the breeding programme for improving the seed yield. The blocks show the intermingling relationship of significant and non-significant for the traits indicating lack of homogeneity among the blocks. The check versus genotype interaction showed highly significant for initial flowering, plant height, siliqua on main shoot and seeds per siliqua. This indicates difference between check as a group and genotype as another group.

The range, mean, genotypic and phenotypic coefficient of variation (GCV and PCV), heritability in broad sense and genetic advance expressed as percentage of mean value for different characters are presented in Table 2. The PCV was greater than GCV for all the characters indicating the influence of the environment in the expression of these traits. The maximum PCV was observed in seed yield per plant (44.8%) and followed by seeds per siliqua (25.2%), secondary branches per plant (24.8%) and harvest index (23.9%). The PCV varied from 2.9% (oil content) to 44.8% (seed yield per plant). The maximum GCV was found in seed yield per plant (35.0%) followed by harvest index (20.2%), seeds per siliqua (19.9%) and siliquae on main shoot (16.9%). The rest of the characters showed low PCV and GCV. High PCV and GCV for seed yield per plant, secondary branches per plant, seed per siliqua and harvest index were reported in oilseed brassicas (Mondal and Khajuria, 2000; Sikarwal *et al.*, 2000; Mahala *et al.*, 2003; Meena *et al.*, 2006)

Heritability is important selection parameter, since it is estimated from additive genetic variance, it plays important role in the selection of genotypes (Nadarajan and Gunasekaran, 2005). High heritability (broad sense value >60) values were observed for initial flowering, 50% flowering, plant height, siliqua length, harvest index, 1000-seed weight, seeds per siliqua and seed yield per plant. High genetic advance is another parameter to access the expected improvement in a character by hybridization and selection. High values for genetic advance were recorded for plant height, siliquae on main shoot, seeds

Table 1. Analysis of variance for different agro-morphological traits in yellow sarson

S.No.	Characters	Mean sum of square due to			
		Blocks	Checks	Entries	Checks vs entries
	Degree of freedom	4	3	68	1
1	Initial flowering (days)	29.1	149.4*	39.3**	128.9*
2	50% flowering (days)	41.3	132.9*	31.0**	57.1
3	Plant height (cm)	9995.4**	563.7	309.5**	4556.7**
4	Primary branches per plant	0.25	10.9*	1.1*	14.5
5	Secondary branches per plant	0.33	0.31	0.56*	3.9
6	Main shoot length (cm)	9.7	163.4	44.6*	2.0
7	Siliquae on main shoot	18.1	11.4	28.0**	103.6*
8	Siliqua length (cm)	0.08	0.78*	0.22**	2.2
9	Seeds per siliqua	29.2	102.1	57.1**	381.6*
10	1000-seed weight (g)	1.1*	1.27*	0.39**	1.2
11	Harvest index (%)	54.8*	69.7	32.6**	37.2
12	Maturity (days)	452.6*	28.8	58.0	29.3
13	Protein content (%)	0.18	0.83	0.4	4.7
14	Oil content (%)	2.41	1.9	1.5**	13.5
15	Seed yield per plant (g)	2.3	11.5	16.7**	4.0

*, ** Significant at 5% and 1% level, respectively

Table 2. Mean, range, genotypic and phenotypic coefficient of variation, heritability and genetic advance for different traits in yellow sarson

Characters	Mean	Range	GCV %	PCV %	Broad sense heritability (%)	Genetic advance (%)
Initial flowering (days)	47.0	35.0-53.0	11.1	13.3	69.7	19.2
50% flowering (days)	53.7	33.0-64.0	8.6	10.4	68.1	14.5
Plant height (cm)	100.3	69.4-152.3	14.0	17.5	64.1	23.2
Primary branches per plant	4.5	2.6-6.8	15.0	23.3	41.8	20.0
Secondary branches per plant	3.0	1.9-5.6	15.5	24.8	39.3	20.1
Main shoot length (cm)	44.5	36.9-72.2	10.2	15.0	46.2	14.3
Siliquae on main shoot	24.0	18.3-45.3	16.9	22.0	58.6	26.6
Siliqua length (cm)	3.8	2.8-4.9	10.1	12.2	68.2	17.2
Seeds per siliqua	29.6	15.9-45.9	19.9	25.5	60.8	32.0
1000-seed weight (g)	3.2	8.9-31.5	15.5	19.7	61.5	25.0
Harvest index (%)	23.9	8.2-32.6	20.2	23.9	71.8	35.3
Maturity (days)	117.0	102.0-135.0	4.2	6.5	42.4	5.7
Protein content (%)	20.1	17.9-22.9	2.4	3.1	57.5	3.7
Oil content (%)	42.7	39.6-45.6	2.2	2.9	58.7	3.5
Seed yield per plant (g)	9.1	5.3-25.3	35.0	44.8	61.1	56.3

per siliqua, 1000-seed weight, seed yield per plant and harvest index. In the present study, high heritability coupled with high genetic advance was observed for plant height, seeds per siliqua, 1000-seed weight, seed yield per plant and harvest index. Similar trends have also been reported by various other workers in *Brassica* spp. (Uddin *et al.,* 1995; Pant and Singh, 2001; Pandey and Singh, 2002; Mahala *et al.,* 2003).

Correlation estimates between seed yield and other morphological traits are useful in selection of desirable plant type in designing an effective breeding programme. Seed yield is a complex phenomenon which is encompassing the interactions between many yield contributing traits. Therefore, selection should be based on these traits and their correlation with seed yield (Grafius, 1964). The correlation coefficients with seed yield *vis-a-vis* other yield contributing traits and their all possible interrelationships are given in Table 3. The seed yield per plant was positively and significantly correlated with main shoot length, siliquae on main shoot, primary branches per plant, oil content, 1000-seed weight, harvest index and days to maturity, while remaining characters observed non-significant correlations except for two characters in seeds per siliqua and protein content, which showed negative but significant correlations with this trait. Seeds per siliqua showed positive and significant correlations with initiation of flowering, 50% flowering and siliqua length. There was significant positive correlations of harvest index with 1000-seed weight and oil content. Similarly, significant positive correlation was recorded in siliquae on main shoot with main shoot length and plant height; oil content with 1000-seed weight; plant

Table 3. Estimates of phenotypic correlation coefficient in different traits in yellow sarson

Characters	#IF	FF	PH	PB	SB	MSL	SMS	SL	SPS	SW	PC	OC	HI	DM
FF	0.866**													
PH	0.297*	0.325**												
PB	-0.004	-0.064	0.404**											
SB	0.021	0.037	0.244*	0.456**										
MSL	0.136	0.124	0.302**	0.148	0.099									
SMS	0.117	0.117	0.388**	0.128	0.189	0.683**								
SL	0.017	0.080	0.272*	-0.049	-0.074	-0.102	-0.047							
SPS	0.407**	0.428**	0.026	-0.132	-0.130	-0.201	-0.199	0.282*						
SW	-0.163	-0.177	-0.618**	-0.373**	-0.227	0.153	-0.021	-0.139	-0.143					
PC	0.085	0.086	0.192	0.015	0.198	-0.005	0.154	-0.271*	0.150	-0.290*				
OC	-0.135	-0.111	-0.547**	-0.260*	-0.278*	-0.021	-0.186	0.076	-0.184	0.676**	-0.606**			
HI	-0.142	-0.141	-0.275*	0.104	0.110	0.223	0.150	-0.014	-0.202	0.496**	-0.287*	0.632**		
DM	-0.174	-0.180	-0.665**	-0.360**	-0.199	0.266*	0.089	-0.290*	-0.288*	0.830**	-0.302**	0.609**	0.493**	
SYP	0.061	0.057	0.097	0.267*	0.166	0.514**	0.379**	0.006	-0.327**	0.308**	-0.329**	0.376**	0.610**	0.315**

*, ** Significant at 5% and 1% level, respectively

#IF: Initiation of flowering, FF: 50% flowering, PB: Primary branches per plant, SB: Secondary branches per plant, MSL: Main shoot length, PH: Plant height, SMS: Siliquae on main shoot, DM: Maturity duration, SL: Siliqua length, SYP: Seed yield per plant (g), SPS: Seeds per siliqua, HI: Harvest index, SW: Seed weight, PC: Protein content and OC: Oil content

Table 4. Promising accessions of yellow sarson

Characters	Promising Accessions
Initial flowering (days)	< 47: IC331817, IC342766, IC361510, IC361512
50% flowering (days)	< 53: IC331817, IC334291
Plant height (cm)	> 118: IC447818, IC447822, IC520757, IC521379
Primary branches per plant	> 5.4: IC361512, IC447818, IC520748, IC520749
Secondary branches per plant	> 3.5: IC355391, IC355397, IC361512, IC520748
Main shoot length (cm)	> 50.5: IC334290, IC336456, IC342762, IC342768
Siliquae on main shoot	> 28.0: IC336456, IC342760, IC342762, IC361506
Siliqua length (cm)	> 4.1: IC342766, IC355365, IC520755, IC520771
Seeds per siliqua	> 39.0: IC447740, IC447824, IC520748
1000-seed weight (g)	> 3.04: IC355412, IC355368, IC355382, IC361508
Seed yield per plant (g)	> 17.7: IC336456, IC355419, IC520771
Harvest index (%)	> 25.1: IC334200, IC334290, IC355365, IC361512
Oil content (%)	> 42.7: IC342283, IC355307, IC355312, IC355368, IC355378, IC355382

height with initiation of flowering and 50% flowering; siliqua length with plant height and primary branches per plant with plant height. Hence, selection for the higher values of these traits will be desirable for increase seed yield. The associations between the yield related attributes reveal the mutual relationship between two or more characters; therefore, it is an important parameter for taking a decision regarding the selection and its further utilization in improvement in the crop. This is in conformant of some of the earlier reports on *Brassica* (Yadav *et al.*, 2001; Kumar *et al.*, 2001; Patel and Patel, 2005; Misra *et al.,* 2007a, b).

Promising donors were identified for various seed yield contributing traits which are to be useful donors in the variety development programme. Accession IC361512 was identified as a useful donor for early flowering, high harvest index, more number in primary branches and secondary branches per plant (Table 4). The accessions IC342762 and IC334290 were recorded for more number of siliquae on main shoot and long main shoot length. IC355382 accession had high oil content and 1000-seed weight, and IC520748 showed more seeds per siliqua and primary branches per plant. Besides this accession IC355365 had long siliqua and high harvest index and IC447818 recorded for short plant height and high number of primary branches per plant. The highest seed yield per plant (21.9 g), 1000-seed weight (5.1 g) and number of seeds per siliqua (48.9) were recorded in accessions IC336456, IC361508 and IC447740, respectively.

On the basis of different variability parameters and correlation, the present investigation revealed that there is an adequate variability for siliquae on main shoot, main shoot length, 1000-seed weight, seeds per siliqua and harvest index in the indigenously collected germplasm of *Brassica rapa* var. *yellow sarson*. The promising accessions can be used directly for hybridization and other breeding strategy related to genetic enhancement of yellow sarson. It may be concluded that characters such as seeds per siliqua, siliquae on main shoot, oil content, harvest index, 1000-seed weight and seed yield per plant will help in improving the seed yield directly and indirectly. Therefore, these characters should be considered for seed yield improvement in yellow sarson breeding programmes.

References

Burton GW (1952) Quantitative inheritance of grasses. *Proc. of 6th Inl. Grassland. Cong.* **1:** 277-283.

Chatterjee SD (1992) Yellow sarson (*Brassica rapa* (L.) var. *yellow sarson*) the prospective oleiferous *Brassica* of India In: D Kumar and M Rai (eds) *Advance Oilseeds Research.* Scientific Publisher, Jodhpur, pp 315-327.

Grafius JE (1964) A geometry for plant breeding. *Crop Sci.* **4:** 242-248.

Johnson HW, HF Robinson and RE Comstock (1955) Estimates of genetic and environmental variability in soybeans. *Agron. J.* **47:** 314-318.

Kumar A, YS Chauhan, K Kumar and KN Maurya (2001) Genetic variability for seed yield and components traits in newly collected germplasm of yellow sarson (*Brassica rapa* var *yellow sarson*). *Indian J. Plant Genet. Resour.* **14:** 396-397.

Kumar PR, R Singh and AK Misra (2004) Rapeseed-mustard. In: BS Dhillon, RK Tyagi, S Saxena and A Agrawal (eds) *Plant Genetic Resources: Oilseeds and Cash Crops* Narosa Publishing House, New Delhi pp 20-44.

Kumar A and AK Misra (2007) Rapeseed-mustard biodiversity management and utilization In: S Kannaiyan and A Gopalam (eds) *Agrobiodiversity: Crop Genetic Resources and Conversation* Asso. Publ. Co. New Delhi, pp 122-128.

Misra AK (2008) Taxonomy and botany of rapeseed-mustard. In: A Kumar, JS Chauhan and C Chattopadhyay (eds) *Sustainable Production of Oilseeds.* Agrotech. Publ. Academy, Udaipur, pp 60-74.

Misra AK, A Kumar, PR Kumar and SS Manohar (2007a) Evaluation and characterization of elite germplasm of Indian mustard. *J. Oilseeds Res.* **24:** 27-30.

Misra AK, SS Manohar and A Kumar (2007b) Characterization of indigenously collected germplasm of *B rapa* L. var. *yellow sarson* for yield contributing traits. In: *Proceeding 12th International Rapeseed Congress,* March 26-30 2007, Wuhan, China, Vol I Science Press, USA, pp 280-283.

Meena ML, M Singh, JS Chauhan and A Kumar (2006) Genetic variability and character association of yield and related traits in advance breeding lines of Indian mustard (*Brassica juncea*). *Indian J. Plant Genet. Resour.* **19:** 61-65.

Mahla HR, SJ Jambhulkar, DK Yadav and R Sharma (2003) Genetic variability correlation and path analysis in Indian mustard (*Brassica juncea*). *Indian J. Genet.* **63:** 171-172.

Mondal SK and MR Khajuria (2000) Genetic analysis for attributes in mustard. *Environment Economy* **18:** 1-5.

Nadarajan N and M Gunasekaran (2005) *Quantitative Genetics and Biometrical Techniques in Plant Breeding,* Kalyani Publication, Ludhiana, 258 p.

Pandey S and B Singh (2002) Variability, heritability and genetic advance in Indian mustard. *Indian J. Plant Genet. Resour.* **15:** 286-287.

Pant SC and P Singh (2001) Genetic variability in Indian mustard. *Agri. Sci. Dig.* **21:** 28-30.

Patel AR, and KM Patel (2005) Genetic variability in Rapeseed (*Brassica rapa* L. var. *yellow* and *brown sarson*). *Brassica* **7:** 71-72.

Singh RK and BD Chaudhary (1977) *Biometrical Methods in Quantitative Genetic Analysis,* Kalyani Publ, New Delhi, 288 p.

Sikarwar RS, SS Dixit and CD Hirve (2000) Genetic association path analysis, heritability and genetic advance studies in mustard (*Brassica juncea*). *J. Oilseeds Res.* **17:** 11-16.

Uddin MJ, MAZ Choudhary and MFU Mia (1995) Character association and path analysis in Indian mustard. *Annals Bangladesh Agri.* **5:** 51-54.

Yadav SK, AK Shukla, JS Chauhan, AK Singh and PR Kumar (2001) Comparative analysis of variability in two ecotypes of Indian rapeseed (*Brassica rapa* L. var. *yellow* and *brown sarson*). *Indian J. Plant Genet. Resour.* **14:** 65-69.