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Selection parameter analysis for F_1 and F_2 generations in yellow sarson (*Brassica rapa* L. var. yellow sarson)

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Abstract
High heritability were observed for 1000-seed weight (89.39 g) and oil content (52.67%) in F_1 generation and for harvest index (30.97%) in F_2 generation. Among all the characters, the highest values were recorded for 1000-seed weight (89.39 g) and harvest index (30.97%) in F_1 and F_2 generations, respectively. High genetic advance were observed for leaf area index (76.45) and 1000-seed weight (36.60) in F_1 generations and for leaf area index (67.64) and 1000-seed weight (51.59) in F_2 generations. Among parents + F_1s, seed yield per plant showed positive and significant association with leaf area index (cm/m^2), number of secondary branches per plant, number of seeds per siliqua, harvest index (%), oil content (%) and protein content (%) at both phenotypic and genotypic level. Among parents + F_2s, seed yield per plant showed positive and significant association with number of primary branches per plant, number of secondary branches per plant, number of siliquae per plant, number of seeds per siliqua, 1000-seed weight (g), harvest index (%), biological yield per plant (g), oil content (%) and protein content (%) at both phenotypic and genotypic level. Number of siliquae per plant (0.1611), followed by 1000-seed weight (0.1358), oil content (0.1324), number of seeds per siliqua (0.1191), number of secondary branches per plant (0.1182), plant height (0.0947) and Number of siliquae per plant (0.0613), followed by plant height (0.0714), number of secondary branches per plant (0.808), oil content (0.1806) and harvest index (0.2305) exerted very high and positive direct effect on seed yield per plant at both phenotypic and genotypic level among parents + F_1s, respectively. Plant height (0.0016), followed by harvest index (0.0660), leaf area index (0.0726), 1000-seed weight (0.0759), number of siliquae per plant (0.0953), length of main raceme (o.1271), number of seeds per siliqua (0.1340), number of secondary branches per plant (0.1787) and protein content (0.2745) and Number of seeds per siliqua (2.1773), followed by length of main raceme (1.0040), protein content (0.1964), leaf area index (0.3026) and plant height (0.4316) exerted very high and positive direct effect on seed yield per plant at both phenotypic and genotypic level among parents + F_2s, respectively.

Keywords: Correlation, genetic advance, heritability and path coefficient

1. Introduction
India is a leading oilseed producing county of the world with around 7 per cent contribution in the global production. *Brassica* (Rapeseed & mustard) is the second most important edible oil crop in India after groundnut and accounts for nearly 30 per cent of the total oilseeds produced in the country (IIOR/DOR, Hyderabad, A.P.). Yellow sarson *[Brassica campestris* (L.) var. yellow sarson] is the most important oilseed crop among the Rapeseed-mustard group. It is cultivated in *Rabi* (Post-rainy) season mainly in North-West India. The estimated area, production and productivity of rapeseed-mustard in the world was 31.68 million ha, 59.07 million tones and 1864 kg/ha, respectively. In India the estimated area, production and productivity of rapeseed-mustard is 8.02 million has, 63.62 million tones and kg/ha, respectively. It is mainly cultivated in Rajasthan, Uttar Pradesh, Madhya Pradesh, Gujarat, Haryana, West Bengal, Assam, Bihar and Punjab. In Uttar Pradesh rapeseed-mustard are cultivated with an area, production and productivity of 6.62 million ha., 8.36 million tones and 1263 kg/ha., respectively (Anonymous, 2016). Rapeseed mustard group of crops play a vital role in human nutrition and oilseed economy of the country. Mustard oil contains vitamins, minerals, proteins and carbohydrate. It has been reported that 100g of mustard oil produce a sizeable amount of erucic acid (52.2%) and linolenic acid (12.4%). The protein content in mustard ranges between 24-30% on the whole seed basis and between 34-40% on meal basis (Annual Progress Report, 2016).

2. Materials & Methods
The materials comprised 25 lines namely, YSC-63, YSC-41, B-09, YSK-71, YSKM-11-02, YSC-76, YSKM-10-1, YSKM-11-1, YSC-75, YSKM-10-02, YSK-9-01, YSC-80, K-88, YSC-

15, Type-42, YSC-18, YSK-03, YSC-21, YSC-92, YSC-45, YSC-30, YSC-95, YSC-40, YSC-46 and YSC-46 used as female and 4 testers namely, NRCYS-05-02, YSH-401, YST-151 and Pitambari (check) used as male of yellow sarson [*Brassica campestris* (L.) var. yellow sarson] selected on the basis of variability for days to maturity, plant height and other agronomic characters from the Oilseeds Section, Department of Genetics and Plant Breeding, Chandra Shakher Azad University of Agriculture and Technology, Kanpur. Observation were recorded on fifteen characters viz., days to 50% flowering, days to maturity, plant height (cm), length of main raceme (cm), leaf area index (cm/m^2), number of primary branches per plant, number of secondary branches per plant, number of siliquae per plant, number of seeds per siliqua, biological yield per plant (g), 1000-seed weight (g), harvest index (%), oil content (%), protein content (%) and seed yield per plant (g). All the Twenty five females were crossed with each of four males in line x tester mating deigns to produce sufficient amount of F_0 seeds of 100 crosses during the *Rabi* season 2011-12 to raise the F_1s. The F_1s were selfed in order to obtain F_2s seeds during the *Rabi* season 2012-13. 229 treatments (29 Parents + 100 F_1s and 100 F_2s) were sown at oil seed research farm, Kalyanpur, Kanpur in R. B. D. with three replication. Recommended agronomic package and practices were followed to raise good crop. The parents were also maintained through selfing. The heritability in narrow sense (h^2) was calculated as suggested by Kempthorne and Curnow (1961). Genetic advance was calculated using the following formula suggested by Allard (1960) [1]. The formula of calculation of the genotypic and phenotypic coefficients of correlation were used as suggested by AL. Jibouri *et al.* (1958). The estimates of direct and indirect effects were calculated by path coefficient analysis as suggested by Wright (1921) [4] and elaborated by Dewey and Lu (1959) [2].

3. Results and Discussion

Table-1 revealed that High heritability were observed for 1000-seed weight (89.39g) and oil content (52.67%) in F_1 generation and for harvest index (30.97%) in F_2 generation. Among all the characters, the highest values were recorded for 1000-seed weight (89.39g) and harvest index (30.97%) in F_1 and F_2 generations, respectively. These finding were also similar to Chauhan *et al*. (2000, 2011) [6], Dharmendra and Sinha (2001) [16] and Dholu *et al*. (2013) [8]. High genetic advance were observed for leaf area index (76.45) and 1000-seed weight (36.60) in F_1 generations and for leaf area index (67.64) and 1000-seed weight (51.59) in F_2 generations. Table-2 and 3 revealed that Among parents + F_1s, seed yield per plant showed positive and significant association with leaf area index (cm/m^2), number of secondary branches per plant, number of seeds per siliqua, harvest index (%), oil content (%) and protein content (%) at both phenotypic and genotypic level. Among parents + F_2s, seed yield per plant showed positive and significant association with number of primary branches per plant, number of secondary branches per plant, number of siliquae per plant, number of seeds per siliqua, 1000-seed weight (g), harvest index (%), biological yield per plant (g), oil content (%) and protein content (%) at both phenotypic and genotypic level.

Table-4, 5, 6 and 7 revealed that Number of siliquae per plant (0.1611), followed by 1000-seed weight (0.1358), oil content (0.1324), number of seeds per siliqua (0.1191), number of secondary branches per plant (0.1182), plant height (0.0947) and Number of siliquae per plant (0.0613), followed by plant height (0.0714), number of secondary branches per plant (0.808), oil content (0.1806) and harvest index (0.2305) exerted very high and positive direct effect on seed yield per plant at both phenotypic and genotypic level among parents + F_1s, respectively.

Plant height (0.0016), followed by harvest index (0.0660), leaf area index (0.0726), 1000-seed weight (0.0759), number of siliquae per plant (0.0953), length of main raceme (o.1271), number of seeds per siliqua (0.1340), number of secondary branches per plant (0.1787) and protein content (0.2745) and Number of seeds per siliqua (2.1773), followed by length of main raceme (1.0040), protein content (0.1964), leaf area index (0.3026) and plant height (0.4316) exerted very high and positive direct effect on seed yield per plant at both phenotypic and genotypic level among parents + F_2s, respectively. These findings were also similar to Gautam *et al*. (2010) [15], Prajapati *et al*. (2013) [14], Patel *et al*. (2010) [14], Katiyar *et al*. (2010) and Ghose *et al*. (2000).

Table 1: Grand mean, heritability (narrow sense), genetic advance and genetic advance in per cent over mean for 15 characters in F_1 and F_2 generations of yellow sarson (*Brassica campestris* var. yellow sarson)

Characters	Grand mean		Heritability (%)		Genetic advance		Genetic advance in percent over mean	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
Days to 50% flowering	54.10	55.33	9.01	-2.87	5.94	3.48	10.98	6.29
Days to maturity	120.20	123.03	11.88	3.00	4.08	1.11	3.39	0.91
Plant height (cm)	146.43	148.64	11.40	2.46	6.26	3.73	4.28	2.51
Length of main raceme (cm)	54.55	53.02	7.57	2.86	3.52	1.59	6.45	3.00
Leaf area index (cm/m^2)	2.72	2.72	6.95	10.60	2.08	1.85	76.45	67.94
No. of primary branches per plant	5.24	4.80	-25.50	-21.10	-0.35	-0.63	-6.72	-13.23
No. of secondary branches per plant	11.76	12.67	13.66	0.95	0.97	1.68	8.21	13.26
No. of siliquae per plant	142.29	137.90	23.67	26.48	8.66	7.76	6.09	5.62
No. of seeds per siliqua	29.69	28.45	7.97	3.52	5.84	4.04	19.66	14.19
Biological yield per plant (g)	31.60	29.95	17.48	1.83	4.08	0.28	12.92	0.92
Harvest index (%)	33.64	33.71	29.07	30.97	2.16	2.43	6.41	7.21
1000-seed weight (g)	3.94	3.17	89.39	12.75	1.44	1.64	36.60	51.59
Oil content (%)	41.54	41.55	52.67	22.15	1.35	1.38	3.25	3.32
Protein content (%)	25.75	25.63	18.04	18.64	4.04	3.97	15.70	15.48
Seed yield per plant (g)	11.58	11.50	2.13	3.18	2.31	2.29	19.99	19.94

Table 2: Estimate of pehnotypic (rp) upper diagonal and genotypic (rg) lower diagonal correlation coefficient among 15 characters in P + F_1s in yellow sarson (*Brassica campestris* var. yellow sarson)

rg \ rp	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
A	1.00	0.39**	0.48**	-0.12*	-0.06	-0.24**	-0.17**	-0.28**	-0.50**	-0.17**	-0.17**	-0.29**	-0.18**	-0.47**	-0.51**
B	0.53	1.00	0.54**	-0.10*	-0.08	-0.21**	-0.19**	-0.50**	-0.51**	-0.21**	-0.18**	-0.42**	-0.25**	-0.48**	-0.49**
C	0.59	0.76	1.00	-0.14**	-0.06	-0.26 **	-0.33**	-0.59**	-0.65**	-0.21**	-0.25**	-0.57**	-0.29**	-0.58**	-0.47**
D	-0.19	-0.13	-0.24	1.00	-0.03	0.16 **	0.16**	0.14**	0.12*	0.05	0.28**	0.21**	0.21**	0.03	0.09
E	-0.06	-0.10	-0.08	-0.04	1.00	0.05	-0.01**	0.22**	0.14**	0.07	-0.12*	0.06	0.20**	0.11*	0.05
F	-0.76	-0.77	-0.80	0.58	0.19	1.00	0.07	0.23**	0.19**	0.11*	0.16**	0.20**	0.09	0.22**	0.18**
G	-0.42	-0.59	-0.70	0.39	-0.05	0.86	1.00	0.25**	0.16**	0.11*	0.07	0.25**	0.29**	0.22**	0.26**
H	-0.38	-0.70	-0.65	0.19	0.24	0.68	0.44	1.00	0.58**	0.40**	0.28**	0.59**	0.47**	0.43**	0.44**
I	-0.65	-0.75	-0.83	0.20	0.18	0.85	0.47	0.76	1.00	0.40**	0.32**	0.46**	0.31**	0.62**	0.49**
J	-0.21	-0.30	-0.34	0.15	0.07	0.27	0.04	0.62	0.61	1.00	0.28**	0.26**	0.25**	0.30**	0.15**
K	-0.25	-0.31	-0.46	0.37	-0.17	0.32	0.48	0.43	0.54	0.49	1.00	0.42**	0.22**	0.23**	0.18**
L	-0.33	-0.55	-0.66	0.33	0.05	0.65	0.54	0.65	0.55	0.36	0.63	1.00	0.51**	0.27**	0.40**
M	-0.33	-0.53	-0.61	0.31	0.29	0.73	0.23	0.79	0.66	0.39	0.41	0.90	1.00	0.21**	0.24**
N	-0.52	-0.57	-0.66	0.03	0.10	0.69	0.42	0.47	0.75	0.38	0.30	0.29	0.31	1.00	0.46**
O	-0.56	-0.58	-0.52	0.12	0.05	0.57	0.50	0.48	0.58	0.19	0.27	0.41	0.39	0.46	1.00

*, ** significant at 5 and 1 per cent level, respectively.

Where,

A= Days to 50% flowering, B= Days to maturity, C = Plant height (cm), D = Length of main raceme (cm),

E = Leaf area index (cm/m^2), F = No. of primary branches per plant, G = No. of secondary branches per plant, H = No. of siliquae per plant, I = No. of seeds per per siliqua, J = Biological yield per plant,

K = Harvest index (%), L = 1000-seed weight, M = Oil content (%), N = Protein content and O = Seed yield per plant (g).

Table 3: Estimate of pehnotypic upper diagonal (rp) and genotypic lower diagonal (rg) correlation coefficient among 15 characters in P + F_2s in yellow sarson (*Brassica campestris* var. yellow sarson)

Rg \ Rp	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
A	1.00	-0.11*	0.27**	0.20**	-0.05	-0.06	-0.24 **	0.11 *	-0.35 **	0.08	-0.10*	0.10*	-0.04	-0.32 **	-0.33 **
B	-0.19	1.00	0.03	-0.00	0.04	-0.08	0.02	-0.18 **	0.05	0.12*	0.04	0.01	-0.01	0.05	-0.03
C	0.38	0.13	1.00	0.20**	-0.04	-0.01	-0.27 **	-0.06	-0.46 **	0.08	-0.23 **	-0.08	-0.17 **	-0.45 **	-0.30 **
D	0.24	-0.08	0.40	1.00	-0.11*	0.01	-0.04	-0.00	-0.23 **	-0.00	-0.05	-0.03	0.04	-0.18 **	-0.01
E	-0.07	0.09	-0.05	-0.21	1.00	-0.04	0.13 **	0.00	0.04	-0.00	0.05	0.00	-0.00	0.08	0.12*
F	-0.23	-0.17	-0.30	-0.03	-0.04	1.00	0.03	-0.01	0.05	-0.02	0.04	-0.04	0.09	0.03	0.04
G	-0.50	0.12	-0.54	-0.09	0.15	0.36	1.00	0.01	0.33 **	-0.10*	0.20 **	0.08	0.29 **	0.47 **	0.43 **
H	0.17	-0.37	-0.02	-0.00	-0.00	0.08	0.01	1.00	0.05	0.00	-0.05	0.08	0.06	-0.24 **	0.03
I	-0.49	0.04	-0.64	-0.48	0.08	0.26	0.81	0.06	1.00	0.12*	0.02	-0.26**	0.23**	0.57 **	0.35 **
J	0.32	0.38	0.25	0.08	0.00	0.24	0.13	0.11	0.04	1.00	-0.09	-0.09	0.02	0.01	-0.14**
K	-0.21	0.00	-0.37	-0.05	0.08	0.09	0.47	-0.09	0.29	-0.58	1.00	0.00	0.11*	0.11*	0.15**
L	0.14	0.01	-0.12	-0.07	-0.02	-0.04	0.08	0.09	-0.32	-0.31	0.01	1.00	-0.03	-0.14**	0.01
M	-0.22	-0.21	-0.41	-0.15	-0.04	0.10	0.71	0.14	0.65	0.09	0.13	-0.08	1.00	0.28**	0.17**
N	-0.42	0.08	-0.55	-0.33	0.08	0.09	0.74	-0.27	0.75	0.04	0.15	-0.15	0.45	1.00	0.44**
O	-0.45	-0.07	-0.36	-0.04	0.11	0.13	0.65	0.01	0.48	-0.53	0.20	-0.00	0.26	0.45	1.00

*, ** significant at 5 and 1 per cent level, respectively.

Where,

A= Days to 50% flowering, B= Days to maturity, C = Plant height (cm), D = Length of main raceme (cm),

E = Leaf area index (cm/m^2), F = No. of primary branches per plant, G = No. of secondary branches per plant, H = No. of siliquae per plant, I = No. of seeds per per siliqua, J = Biological yield per plant,

K = Harvest index (%), L = 1000-seed weight, M = Oil content (%), N = Protein content and O = Seed yield per plant (g).

Table 4: Estimate of direct and indirect effects of 15 different characters on seed yield/plant at phenotypic level in P + F_1s in yellow sarson (*Brassica campestris* var. yellow sarson)

Pg / Rg	A	B	C	D	E	F	G	H	I	J	K	L	M	N
A	-0.2893	-0.1155	-0.1390	0.0361	0.0174	0.0706	0.0510	0.0814	0.1458	0.0513	0.0516	0.0855	0.0530	0.1367
B	-0.0719	-0.1800	-0.0986	0.0186	0.0152	0.0379	0.0346	0.0911	0.0928	0.0386	0.0333	0.0774	0.0462	0.0872
C	0.0455	0.0519	0.0947	-0.0139	-0.0059	-0.0248	-0.0320	-0.0568	-0.0618	-0.0200	-0.0246	-0.0543	-0.0275	-0.0555
D	0.0034	0.0028	0.0040	-0.0273	0.0010	-0.0045	-0.0046	-0.0040	-0.0034	-0.0014	-0.0078	-0.0059	-0.0058	-0.0010
E	0.0020	0.0027	0.0020	0.0012	-0.0325	-0.0019	0.0006	-0.0073	-0.0048	-0.0025	0.0042	-0.0020	-0.0065	-0.0036
F	0.0014	0.0012	0.0015	-0.0009	-0.0003	-0.0057	-0.0004	-0.0014	-0.0011	-0.0006	-0.0009	-0.0012	-0.0006	-0.0013
G	-0.0209	-0.0228	-0.0400	0.0199	-0.0023	0.0086	0.1182	0.0301	0.0192	0.0136	0.0086	0.0296	0.0352	0.0264
H	-0.0453	-0.0815	-0.0966	0.0238	0.0364	0.0386	0.0410	0.1611	0.0945	0.0659	0.0466	0.0951	0.0768	0.0703
I	-0.0600	-0.0614	-0.0777	0.0147	0.0175	0.0234	0.0193	0.0699	0.1191	0.0482	0.0382	0.0549	0.0372	0.0741
J	0.0177	0.0214	0.0211	-0.0050	-0.0076	-0.0111	-0.0115	-0.0408	-0.0403	-0.0998	-0.0285	-0.0263	-0.0253	-0.0303
K	0.0024	0.0025	0.0035	-0.0038	0.0017	-0.0022	-0.0010	-0.0039	-0.0043	-0.0038	-0.0134	-0.0057	-0.0030	-0.0031
L	-0.0401	-0.0584	-0.0779	0.0295	0.0083	0.0277	0.0340	0.0801	0.0626	0.0358	0.0577	0.1358	0.0701	0.0380
M	0.0061	0.0086	0.0097	-0.0071	-0.0067	-0.0033	-0.0100	-0.0159	-0.0105	-0.0085	-0.0074	-0.0173	-0.0335	-0.0073
N	-0.0626	-0.0641	-0.0776	0.0050	0.0146	0.0299	0.0296	0.0577	0.0824	0.0402	0.0310	0.0371	0.0289	0.1324
O	-0.5115	-0.4926	-0.4707	0.0907	0.0567	0.1833	0.2690	0.4413	0.4902	0.1570	0.1884	0.4027	0.2453	0.4629

R Square = 0.4375
Residual Effect = 0.7500
Where,
A= Days to 50% flowering, B= Days to maturity, C = Plant height (cm), D = Length of main raceme (cm),
E = Leaf area index (cm/m^2), F = No. of primary branches per plant, G = No. of secondary branches per plant, H = No. of siliquae per plant, I = No. of seeds per per siliqua, J = Biological yield per plant,
K = Harvest index (%), L = 1000-seed weight, M = Oil content (%), N = Protein content and O = Seed yield per plant (g).

Table 5: Estimate of direct and indirect effects of 15 different characters on seed yield/plant at genotypic level in P + F_1s in yellow sarson (*Brassica campestris* var. yellow sarson)

Pg / Rg	A	B	C	D	E	F	G	H	I	J	K	L	M	N
A	-0.2223	-0.1186	-0.1319	0.0425	0.0137	-0.1709	0.0941	0.0859	0.1464	0.0485	0.0576	0.0736	0.0750	0.1174
B	-0.1246	-0.2335	-0.1797	0.0321	0.0251	-0.1806	0.1387	0.1653	0.1762	0.0715	0.0737	0.1303	0.1246	0.1340
C	0.0424	0.0550	0.0714	-0.0178	-0.0060	0.0573	-0.0502	-0.0469	-0.0599	-0.0246	-0.0330	-0.0473	-0.0441	-0.0477
D	0.0512	0.0368	0.0667	-0.2679	0.0129	0.1559	-0.1058	-0.0533	-0.0554	-0.0403	-0.1016	-0.0886	-0.0843	-0.0084
E	0.0032	0.0056	0.0044	0.0025	-0.0523	0.0103	0.0029	-0.0129	-0.0097	-0.0042	0.0091	-0.0031	-0.0156	-0.0057
F	-0.3359	-0.3378	-0.3505	0.2542	0.0858	-0.4368	0.3761	0.2992	0.3742	0.1202	0.1425	0.2874	0.3202	0.3054
G	-0.0342	-0.0480	-0.0568	0.0319	-0.0045	-0.0696	0.0808	0.0357	0.0388	0.0035	0.0388	0.0438	0.0193	0.0340
H	-0.0237	-0.0434	-0.0402	0.0122	0.0151	-0.0420	0.0271	0.0613	0.0467	0.0385	0.0264	0.0401	0.0490	0.0294
I	0.1226	0.1405	0.1561	-0.0385	-0.0344	0.1595	-0.0893	-0.1417	-0.1862	-0.1149	-0.1020	-0.1036	-0.1234	-0.1412
J	0.0025	0.0035	0.0039	-0.0017	-0.0009	0.0032	-0.0005	-0.0072	-0.0071	-0.0115	-0.0057	-0.0042	-0.0046	-0.0044
K	-0.0597	-0.0728	-0.1066	0.0874	-0.0399	-0.0752	0.1107	0.0993	0.1262	0.1142	0.2305	0.1453	0.0946	0.0693
L	0.0728	0.1226	0.1455	-0.0726	-0.0128	0.1445	-0.1191	-0.1437	-0.1222	-0.0811	-0.1385	-0.2197	-0.1981	-0.0652
M	-0.0609	-0.0963	-0.1114	0.0568	0.0538	-0.1324	0.0432	0.1444	0.1196	0.0721	0.0741	0.1628	0.1806	0.0568
N	0.0021	0.0022	0.0026	-0.0001	-0.0004	0.0027	-0.0016	-0.0019	-0.0030	-0.0015	-0.0012	-0.0012	-0.0012	-0.0039
O	-0.5646	-0.5842	-0.5266	0.1210	0.0551	-0.5740	0.5071	0.4835	0.5847	0.1904	0.2708	0.4159	0.3922	0.4697

R Square = 0.4394
Residual Effect = 0.7487
Where,
A= Days to 50% flowering, B= Days to maturity, C = Plant height (cm), D = Length of main raceme (cm),
E = Leaf area index (cm/m^2), F = No. of primary branches per plant, G = No. of secondary branches per plant, H = No. of siliquae per plant, I = No. of seeds per per siliqua, J = Biological yield per plant,
K = Harvest index (%), L = 1000-seed weight, M = Oil content (%), N = Protein content and O = Seed yield per plant (g).

Table 6: Estimate of direct and indirect effects of 15 different characters on seed yield/plant at phenotypic level in P + F_2s in yellow sarson (*Brassica campestris* var. yellow sarson)

	A	B	C	D	E	G	H	I	J	K	L	M	N
A	-0.1911	0.0225	-0.0523	-0.0394	0.0105	0.0459	-0.0214	0.0679	-0.0154	0.0196	-0.0204	0.0085	0.0612
B	0.0072	-0.0614	-0.0020	0.0006	-0.0029	-0.0017	0.0112	-0.0034	-0.0079	-0.0029	-0.0011	0.0008	-0.0035
C	0.0004	0.0001	0.0016	0.0003	-0.0001	-0.0004	-0.0001	-0.0008	0.0001	-0.0004	-0.0001	-0.0003	-0.0007
D	0.0262	-0.0012	0.0255	0.1271	-0.0147	-0.0057	-0.0005	-0.0301	-0.0011	-0.0066	-0.0050	0.0060	-0.0239
E	-0.0040	0.0034	-0.0034	-0.0084	0.0726	0.0099	0.0001	0.0036	-0.0007	0.0041	0.0000	-0.0006	0.0065
G	-0.0429	0.0048	-0.0485	-0.0080	0.0245	0.1787	0.0035	0.0592	-0.0187	0.0373	0.0154	0.0535	0.0849
H	0.0107	-0.0173	-0.0060	-0.0004	0.0001	0.0019	0.0953	0.0051	0.0004	-0.0051	0.0085	0.0060	-0.0233
I	-0.0476	0.0075	-0.0625	-0.0318	0.0066	0.0444	0.0072	0.1340	0.0171	0.0031	-0.0350	0.0311	0.0775
J	-0.0086	-0.0137	-0.0092	0.0009	0.0010	0.0112	-0.0004	-0.0137	-0.1069	0.0102	0.0097	-0.0030	-0.0019
K	-0.0068	0.0031	-0.0156	-0.0034	0.0037	0.0138	-0.0035	0.0015	-0.0063	0.0660	0.0006	0.0078	0.0077
L	0.0081	0.0013	-0.0066	-0.0030	0.0001	0.0066	0.0068	-0.0198	-0.0069	0.0006	0.0759	-0.0026	-0.0107
M	0.0005	0.0001	0.0018	-0.0005	0.0001	-0.0030	-0.0006	-0.0024	-0.0003	-0.0012	0.0003	-0.0101	-0.0029
N	-0.0878	0.0155	-0.1247	-0.0515	0.0245	0.1304	-0.0672	0.1588	0.0050	0.0321	-0.0387	0.0794	0.2745
O	-0.3357	-0.0354	-0.3019	-0.0173	0.1260	0.4320	0.0302	0.3599	-0.1416	0.1567	0.0103	0.1765	0.4452

*, ** significant at 5 and 1 per cent level, respectively.

R Square = 0.3477

Residual Effect = 0.8076

Where,

A= Days to 50% flowering, B= Days to maturity, C = Plant height (cm), D = Length of main raceme (cm),

E = Leaf area index (cm/m^2), G = No. of secondary branches per plant, H = No. of siliquae per plant,

I = No. of seeds per per siliqua, J = Biological yield per plant, K = Harvest index (%), L = 1000-seed weight, M = Oil content (%), N = Protein content and O = Seed yield per plant (g).

Table 7: Estimate of direct and indirect effects of 15 different characters on seed yield/plant at genotypic level in P + F_2s in yellow sarson (*Brassica campestris* var. yellow sarson)

	A	B	C	D	E	G	H	I	J	K	L	M	N
A	-0.2686	0.0526	-0.1029	-0.0666	0.0206	0.1362	-0.0457	0.1334	-0.0859	0.0577	-0.0391	0.0614	0.1152
B	0.0099	-0.0504	-0.0069	0.0043	-0.0048	-0.0064	0.0191	-0.0022	-0.0193	-0.0002	-0.0010	0.0110	-0.0043
C	0.1654	0.0591	0.4316	0.1746	-0.0225	-0.2371	-0.0095	-0.2781	0.1086	-0.1637	-0.0533	-0.1812	-0.2415
D	0.2490	-0.0855	0.4061	1.0040	-0.2119	-0.0950	-0.0073	-0.4857	0.0841	-0.0558	-0.0750	-0.1570	-0.3313
E	-0.0232	0.0287	-0.0158	-0.0639	0.3026	0.0473	-0.0018	0.0272	0.0026	0.0260	-0.0072	-0.0142	0.0262
G	0.5165	-0.1301	0.5597	0.0964	-0.1594	-1.0188	-0.0142	-0.8255	-0.1356	-0.4809	-0.0860	-0.7310	-0.7589
H	-0.0065	0.0144	0.0008	0.0003	0.0002	-0.0005	-0.0379	-0.0024	-0.0042	0.0037	-0.0034	-0.0054	0.0105
I	-1.0818	0.0943	-1.4027	-1.0532	0.1956	1.7642	0.1398	2.1773	0.1032	0.6398	-0.7165	1.4343	1.6537
J	-0.1038	-0.1241	-0.0816	-0.0272	-0.0028	-0.0432	-0.0361	-0.0154	-0.3243	0.1911	0.1010	-0.0296	-0.0139
K	0.0086	-0.0001	0.0151	0.0022	-0.0034	-0.0188	0.0039	-0.0117	0.0235	-0.0398	-0.0005	-0.0055	-0.0062
L	0.1310	0.0170	-0.1110	-0.0671	-0.0214	0.0758	0.0817	-0.2957	-0.2800	0.0109	0.8987	-0.0790	-0.1350
M	0.0292	0.0280	0.0537	0.0200	0.0060	-0.0917	-0.0183	-0.0842	-0.0117	-0.0175	0.0112	-0.1278	-0.0585
N	-0.0843	0.0166	-0.1099	-0.0648	0.0170	0.1463	-0.0542	0.1492	0.0084	0.0305	-0.0295	0.0898	0.1964
O	-0.4584	-0.0794	-0.3638	-0.0411	0.1158	0.6583	0.0194	0.4862	-0.5305	0.2016	-0.0004	0.2659	0.4524

*, ** significant at 5 and 1 per cent level, respectively.

R Square = 0.5696

Residual Effect = 0.6561

Where,

A= Days to 50% flowering, B= Days to maturity, C = Plant height (cm), D = Length of main raceme (cm),

E = Leaf area index (cm/m^2), G = No. of secondary branches per plant, H = No. of siliquae per plant,

I = No. of seeds per per siliqua, J = Biological yield per plant,K = Harvest index (%), L = 1000-seed weight, M = Oil content (%), N = Protein content and O = Seed yield per plant (g).

4. References

1. Allard RW Principles of plant breeding Jhon wiley and sons Inc. Publ. New York, 1960.
2. Dewey DR, Lu KH. A correlation and path coefficient analysis of components of crested wheat grass seed production Agron J. 1959; 51:515-518.
3. Kempthorne O. An Introduction to Genetical Statistics. John Wiley and Sons London, 1957.
4. Wright S. Correlation and causation J Agric Res. 1921; 20:557-558.
5. Chauhan JS, Meena ML, Kumar Arvind. Estimation of heterosis and inbreeding deepression for seed yield and its components Indian mustard [Brassica juncea (L.) Czern Coss] Journal of Maharashtra Agricultural Universities. 2011; 36(1):57-62.
6. Chauhan SS, Srivastava RK, Kumar K. Heterosis in single and three way crosses in Indian mustard (Brassica juncea (L.) Czern & Coss) Indian J Genet. 2000; 60(1):131-132.
7. Dharmendra Singh Mishra, VK Sinha. Genetic architecture of yield and its contributing characters in yellow sarson (Brassica compestris Linn var yellow sarson), Indian Journal of Agricultural Research. 2001; 35(4):263-266.
8. Dholu VK, Sasidharan N, Suthar K, Bhusan B, Patel JN. Heterosis and combining ability analysis in Indian mustard [*Brassica juncea* (L.) Czern Coss]. International Journal of Agricultural Sciences. 2013; 10(1):102-107.
9. Gautam KN, AD, Verma OP, Kumar K Singh, RB Maurya. Comparative studies on combining ability and heterosis for seed yield and its components in Yellow sarson (*Brassica compestris Linn* var yellow sarson) under normal and partially reclaimed soils *Research on Crops* 2001; 11(1):82-86.
10. Ghosh SK, Gulati SC, Rajani Raman. Combining ability and heterosis for seed yield and its components in Indian mustard. [Brassica juncea (L.) Czern & Coss] Indian J Genet. 2002; 62(1):29-33.
11. Gupta Priti, Chaudhary HB, Lal SK. Heterosis and combining ability analysis for yield and its components in Indian mustard [*Brassica juncea* (L.) Czern and Coss] Frontiers of Agriculture in China 2010; 4(3):299-307.
12. Katiyar RK, Chamola R, Chopra VL. Study of heterosis for seed yield in Indian mustard [*B Juncea* (L) Czern and Coss] *Cruciferae Newsletter* 2000; 22:41-42.
13. Patel KR, Patel MP, Patel KM, Patel CG. Genetic determination of yield in rapeseed (*Brassica compestris Linn* var yellow sarson), Indian Journal of Agricultural Research. 2010; 35(4):263-266.
14. Prajapati KK, Verma OP, Kumar K, Prakash Singh, Tiwari R. Estimates of some quantitative genetic characters in Brassica rapa var. yellow sarson under different environments, Journal of Oil seeds Research. 2013; 27(1):49-51.
15. Gautam AD, Verma OP, Kumar K, Singh RB, Maurya KN. Comparative studies on combining ability and heterosis for seed yield and its components in yellow sarson (Brassic rapa var yellow sarson) under normal and partially reclaimed soils Research on Crops 2010; 11(1):82-86.
16. Dharmendra Singh, Mishra VK, Sinha TS. Genetic architecture of yield and its contributing characters in yellow sarson (Brassica campestris Linn Yellow sarson Prain) Agricultural Sciences Digest 2001; 22(1):10-13.