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Heritability and genetic advance for effective selection in opium poppy (*Papaver somniferum*)

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ABSTRACT

A study was conducted during 2003–08 to examine the genetic gain and heritability for 5 quantitative traits in different generations of opium poppy (*Papaver somniferum* L.). For the formulation of effective selection strategy in opium poppy (*P. somniferum* L.), cyclical process of testing selections, discarding inferior genotypes and retesting the superior selections, i e multistage testing is an essential step for its evaluation. The progenies of randomly selected individuals from 14 promising hybrids were evaluated over F_2 to F_6 generations for opium and seed yield and their contributing traits, viz capsules/plant, capsule size (cm^2), seed yield/plant (g), opium yield/plant (mg) and morphine content. In general heritability and genetic gain declined from generation to generation. A cross between 'MOP 541' × 'BR 241' showed similar pattern for genetic gain in all the traits. The values of broad sense heritability decreased from F_2 to F_6 generation for most of the traits.

Key words: Genetic gain, Heritability, Multistage testing, *Papaver somniferum*

Multistage testing of strains (lines, hybrids, clones etc.) is an essential aspect in plant breeding programmes. Multistage testing, here refers to many generations of crop evaluation (the cyclical process of testing selection, discarding inferior genotypes and retesting the superior selections) until it reaches to stability with desirable characteristics and high level of productivity. Periodic evaluation of genetic improvement is essential for understanding yield-limiting factors, illustrating the importance of plant breeding to the public and identifying the traits that might require increased efforts by breeders (Evans 1993). Apart from this, genetic gain and heritability (in broad sense) at each generation must be examined so that selection may be intensified at a particular generation and the inefficient generation can be discarded (Ahmed *et al*. 2006). This programme is quite expensive from the economic point of view for the breeders and farmers. Very few researchers attempted a comprehensive examination of multistage system of test in Opium poppy (*Papaver somniferum* L.). Since Opium poppy is one of the most important medicinal plant due to its valuable alkaloids, especially for morphine in latex. Poppy seed is also in demand as it possesses high content of protein (24%) with large amount of edible oil (up to 50%) rich in linoleic acid (70%) which lowers the cholesterol level in the blood of human system (Singh *et al.* 1995). For the last few decades, a number of high-yielding varieties have been developed (Shukla and Singh 2004). However, development of new high-yielding varieties is a continuous process of plant breeding. Hybridization is often used to generate sufficient level of genetic variability, other desirable characteristics and to obtain segregating population with high productivity (Ceolin *et al.* 2007). Generally, in the segregating population of opium poppy the probability of obtaining individuals with all the favourable alleles through subsequent generations is reduced. Opium yield is the most important trait in selective process and it can be enhanced through indirect selection of agronomic traits that are positively correlated with productivity (Cruz and Carneiro 2003). Prior to the release of a variety for commercial cultivation, it must be tested for several generations. The objective of the present study was to examine genetic gain and heritability for 5 quantitative traits in different generations of opium poppy and to determine ways to increase the overall gain, if possible.

MATERIALS AND METHODS

The experimental material consisted of 14 promising crosses which were evaluated from F_2 to F_6 generations in randomized block design with 3 replications each with 2 rows of 3 m length at the field of National Botanical Research Institute, Lucknow located at 26.5°N, 80.5°E and 120 m

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Table 1 Mean data of promising crosses over generations for different traits in *P. somniferum*

Crosses	Capsule number/plant					Capsule size (cm^2)					Seed yield (g)				
	F_2	F_3	F_4	F_5	F_6	F_2	F_3	F_4	F_5	F_6	F_2	F_3	F_4	F_5	F_6
'Gz'×'BR 230'	2.967	2.443	1.997	1.890	1.667	15.593	14.653	13.113	12.850	11.767	9.000	8.500	6.667	4.400	2.920
'NB 1'×'BR 241'	3.133	2.443	1.993	1.887	1.567	14.957	14.897	13.883	12.063	11.263	8.400	7.000	5.800	3.600	3.266
'ND 5'×'ND 1002'	2.633	2.223	2.110	1.343	1.167	13.770	13.187	12.587	10.093	9.477	8.933	6.623	3.600	3.400	1.576
'NB 5'×'BR 241'	3.267	2.553	1.667	1.443	1.333	14.337	13.420	13.820	13.680	10.273	9.874	6.670	6.000	5.333	1.299
'MOP 541'×'BR 241'	2.600	1.667	1.443	1.447	1.200	12.840	12.753	11.267	10.433	9.930	10.600	5.400	3.867	2.267	1.585
'MOP 541'×'NB 11'	1.357	1.443	1.540	1.667	1.753	11.678	13.670	14.510	15.297	16.310	6.867	7.167	7.000	8.133	8.328
'UO 601'×'BR 231'	3.667	2.820	2.550	2.110	1.877	15.963	14.727	13.440	12.600	11.260	10.867	6.217	6.067	3.733	3.034
'UO 601'×'BR 234'	2.133	2.220	1.660	2.000	3.150	11.697	14.813	15.640	16.387	16.737	6.300	6.500	6.333	7.493	8.067
'ND 1002'×'BR 234'	1.327	1.500	1.210	2.110	3.867	11.290	13.827	13.847	14.517	15.597	6.267	7.300	7.200	8.133	8.267
'ND 1001'×'NB 11'	1.233	1.557	1.997	2.333	3.717	11.477	12.790	12.940	10.790	11.420	4.330	4.980	4.733	5.133	6.333
'ND 1001'×'IS 13'	2.667	1.447	1.330	1.220	1.150	12.970	11.427	10.867	9.377	8.587	8.600	3.500	2.800	1.667	1.304
'ND 1001'×'UO 1285'	2.933	2.033	2.220	1.390	1.200	15.913	16.390	14.907	12.723	12.557	8.200	5.340	5.133	2.400	1.785
'BR 226'×'UO 1285'	3.167	2.000	1.777	1.600	1.267	16.517	14.503	13.580	12.463	11.680	10.400	6.223	4.133	3.200	2.855
'BR 230'×'IS 16'	3.300	1.890	1.440	1.333	1.917	13.567	13.443	12.150	10.580	9.983	9.467	5.700	3.800	2.467	2.307
Mean±SE	2.599	2.017	1.781	1.698	1.916	13.755	13.893	13.325	12.418	11.917	8.436	6.223	5.224	4.383	3.780
	±0.21	±0.12	±0.10	±0.09	±0.25	±0.49	±0.32	±0.35	±0.55	±0.68	±0.50	±0.32	±0.37	±0.58	±0.72

Crosses	Opium yield/plant (mg)					Morphine (%)				
	F_2	F_3	F_4	F_5	F_6	F_2	F_3	F_4	F_5	F_6
'Gz'×'BR 230'	263.000	254.333	237.000	188.333	112.000	11.803	14.956	15.567	16.400	16.267
'NB 1'×'BR 241'	262.000	168.000	110.333	100.000	77.333	14.290	14.100	16.200	16.600	17.300
'ND 5'×'ND 1002'	237.330	169.000	148.333	107.333	93.667	13.897	13.255	14.600	15.267	15.133
'NB 5'×'BR 241'	281.667	166.000	132.000	124.000	70.333	13.453	13.321	14.467	13.300	16.100
'MOP 541'×'BR 241'	280.000	123.000	112.000	89.000	84.000	12.817	13.248	15.200	16.300	18.673
'MOP 541'×'NB 11'	107.200	112.333	122.333	127.000	144.000	17.033	16.231	16.167	15.900	12.633
'UO 601'×'BR 231'	284.667	191.000	145.333	96.667	48.333	14.263	15.264	16.233	16.467	19.527
'UO 601'×'BR 234'	57.330	114.000	128.333	130.333	154.000	17.673	15.478	14.300	13.533	12.333
'ND 1002'×'BR 234'	63.677	118.333	120.000	122.000	125.333	17.507	16.589	15.800	14.267	13.600
'ND 1001'×'NB 11'	66.330	102.000	112.333	161.333	201.000	17.003	16.548	16.433	16.300	13.867
'ND 1001'×'IS 13'	264.667	139.333	109.667	104.000	77.333	13.100	14.987	15.600	16.483	17.437
'ND 1001'×'UO 1285'	269.668	168.333	157.333	154.667	65.333	14.410	17.564	17.467	17.867	18.600
'BR 226'×'UO 1285'	266.000	186.000	184.000	123.000	128.667	13.270	14.359	15.800	16.500	16.367
'BR 230'×'IS 16'	174.330	164.000	106.000	97.667	88.333	15.360	16.954	17.600	18.567	16.800
Mean±SE	205.562	155.405	137.500	123.238	104.976	14.706	15.204	15.817	15.982	16.045
	±14.70	±10.94	±9.69	±7.57	±11.13	±0.50	±0.38	±0.26	±0.39	±0.60

above sea level. The plant-to-plant spacing was 10 cm and row-to-row was 30 cm. During the field experimentation 10–15 tonnes/ha farmyard manure and inorganic fertilizers @ 90 kg N + 60 kg P_2O_5 + 60 kg K_2O/ha was applied. Half of the nitrogen and full phosphorus and potassium fertilizers were used as basal dressing at the time of last ploughing. Remaining half of the nitrogenous fertilizer was applied as top-dressing in 2 splits after second and fourth irrigation. Ten irrigations were given during the crop season depending upon the soil moisture conditions. Two to three times prophylactic sprays of Dithane M-45 (0.2%) were given for protection of the crop due to disease (Yadav *et al.* 2006). The study is based on 14 F_2 crosses and their subsequent generation which were advanced following selfing of randomly selected plants. The crosses were selfed to produce F_3 and subsequent generations. In F_3 and subsequent generations each cross was grown in first week of November with 3 replications during 2004–05 to 2007–08. Ten plants/replication were selected individually in each cross and selfed. The selfed seeds of 10 plants were pooled to obtain the next generation. The data for capsules/plant, capsule size (cm^2), seed yield/plant (g), opium yield/plant (mg) and morphine percentage were recorded on 10 randomly selected plants of each replication in all the generation under study. Opium latex was collected from fully grown green capsules and subsequently seeds were harvested from the dried capsules. Morphine percentage in opium was determined following the method of Pride and Stern (1954). The mean values of data for all the 5 traits were used for the analysis. Genetic gain was calculated by using broad sense heritability as described by St. Martin and Futi (2000). Expected genetic gain over F_2 base population was obtained by the expression

$$GG= (Xs – Xo).H^2$$

$$GG\%=(GG/Xo).100$$

The broad sense heritability (H^2) or the degree of genetic control was calculated for each trait using formula

$$H^2= s^2_g/s^2_{g} + s^2_e$$

RESULTS AND DISCUSSION

The mean data of promising 14 crosses for different traits over F_2 to F_6 generations are presented in Table 1. The analysis of variance for each trait indicated that genotypic mean squares for all the traits were highly significant which suggested significant amount of phenotypic variability among

Table 2 ANOVA for 5 traits over 6 generations (F_2 to F_6) in opium poppy

Crosses/sources	Generations	Treatments (df 13)	Replication (df 2)	Error (df 26)	s^2g	s^2ps	ó^{2}e	Heritability
			MSS					
Capsule number /plant	F_2	1.018**	0.006	0.012	0.335	0.348	0.012	0.963
	F_3	0.702**	0.108	0.277	0.141	0.234	0.094	0.604
	F_4	0.303**	0.015	0.148	0.051	0.200	0.148	0.258
	F_5	0.731**	0.003	0.123	0.202	0.325	0.123	0.622
	F_6	2.017**	0.113	0.499	0.506	1.005	0.499	0.503
Capsule size(cm^2)	F_2	2.163**	0.193	0.200	0.654	0.854	0.200	0.765
	F_3	5.662**	0.980	2.013	1.216	1.887	0.671	0.644
	F_4	5.925**	1.443	2.185	1.246	3.432	2.185	0.363
	F_5	9.674**	0.128	0.651	3.007	3.659	0.651	0.821
	F_6	11.202**	1.342	2.108	3.031	3.631	2.108	0.589
Seed yield/plant(g)	F_2	4.014**	0.245	0.472	1.180	1.653	0.472	0.714
	F_3	4.412**	0.133	1.116	1.098	1.470	0.372	0.747
	F_4	4.974**	0.298	2.023	0.983	3.006	2.023	0.327
	F_5	6.245**	2.263	0.713	1.843	2.557	0.714	0.720
	F_6	7.194**	0.212	1.850	1.781	3.631	1.850	0.490
Opium yield/plant (mg)	F_2	4746.663**	68.839	68.78	1559.294	1628.074	68.780	0.957
	F_3	3010.246**	202.169	362.185	882.687	1003.415	120.728	0.879
	F_4	5421.472**	1969.118	836.712	1528.253	2364.966	836.712	0.646
	F_5	3560.731**	94.365	609.623	983.702	1593.326	609.623	0.617
	F_6	8155.633**	1405.698	1530.465	2208.389	3738.855	1530.465	0.590
Morphine (%)	F_2	3.072**	0.015	0.023	1.016	1.039	0.023	0.977
	F_3	3.016**	0.004	0.047	0.989	1.005	0.015	0.984
	F_4	2.498**	0.204	0.979	0.506	1.485	0.979	0.340
	F_5	6.356**	1.565	1.247	1.703	2.950	1.247	0.577
	F_6	17.831	3.574	11.867	1.988	13.855	11.867	0.143

*P=0.05; *P=0.01

s^2g, Genotypic variances; s^2p, phenotypic variances; s^2e, environmental variances

Table 3 Genetic gain (%) of subsequent generation over base population (F_2) in opium poppy

Crosses	Capsule number/plant				Capsule size (cm^2)				Seed yield (g)			
	F_3	F_4	F_5	F_6	F_3	F_4	F_5	F_6	F_3	F_4	F_5	F_6
'Gz' × 'BR 230'	–10.66	–8.44	–22.58	–7.92	17.36	6.30	1.68	–3.86	–4.15	–8.48	–36.80	–33.10
'NB 1' × 'BR 241'	–13.30	–9.39	–24.74	–9.09	15.65	5.85	0.73	–3.42	–12.45	–10.12	–41.14	–29.95
'ND 5' × 'ND 1002'	–15.15	–8.26	56.26	63.67	8.63	5.06	–14.27	–13.21	–19.31	–19.52	–41.91	–2.05
'NB 5' × 'BR 241'	–13.19	–12.64	–34.72	–29.77	10.87	3.58	8.94	–9.85	–24.24	–12.83	–33.11	–42.55
'MOP 541' × 'BR 241'	–21.68	–11.48	–19.62	–5.87	0.07	2.45	8.76	–11.45	–36.65	–20.77	–56.60	–0.11
'MOP 541' × 'NB 11'	–13.71	–4.52	–6.67	–3.06	10.99	1.55	6.69	3.19	–34.26	–19.18	–54.68	–3.69
'UO 601' × 'BR 231'	–30.42	–14.89	–43.37	–24.56	8.76	9.74	23.03	18.01	–31.97	–14.44	–47.26	1.88
'UO 601' × 'BR 234'	–25.85	–5.72	–3.88	23.98	17.16	7.06	–4.52	–6.85	–23.83	–12.31	–58.58	–1.08
'ND 1002' × 'BR 234'	–36.37	–15.16	–17.45	16.01	14.47	8.22	4.07	–0.14	–8.74	–6.86	–53.42	1.71
'ND 1001' × 'NB 11'	–23.28	–5.46	–4.90	23.51	7.37	4.63	–4.91	–0.29	–29.81	–14.23	–32.27	–2.64
'ND 1001' × 'IS 13'	–27.64	–12.93	–33.75	–23.58	2.68	–0.34	–11.92	–12.80	–44.30	–22.05	–60.84	–0.52
'ND 1001' × 'UO 1285'	–36.37	–15.07	–32.72	–10.80	18.80	9.12	0.99	3.18	–26.05	–12.23	–50.93	–0.63
'BR 226' × 'UO 1285'	–22.26	–11.33	–26.19	–4.82	7.33	0.99	–7.84	–7.45	–30.00	–19.70	–49.85	–3.43
'BR 230' × 'IS 16'	–25.81	–14.54	–32.86	–21.09	5.00	–1.20	–12.98	–12.11	–29.72	–19.57	–55.78	–37.06

	Opium yield/plant (mg)				Morphine (%)			
	F_3	F_4	F_5	F_6	F_3	F_4	F_5	F_6
'Gz' × 'BR 230'	8.05	–7.58	–11.83	–30.64	–10.21	–4.27	–11.03	–3.11
'NB 1' × 'BR 241'	–31.54	–37.40	–38.15	–41.59	–4.02	–3.89	–8.49	–3.90
'ND 5' × 'ND 1002'	–40.36	–25.31	–24.22	–33.80	–35.71	–7.20	–6.26	–17.08
'NB 5' × 'BR 241'	–36.10	–34.33	–34.54	–44.27	–0.74	–3.22	–13.73	–2.75
'MOP 541' × 'BR 241'	–32.43	–49.29	–38.76	–42.09	–31.75	–13.43	–6.54	–7.72
'MOP 541' × 'NB 11'	–37.98	–38.89	–31.30	–33.02	–40.36	1.14	0.73	–3.84
'UO 601' × 'BR 231'	–35.32	–28.92	–31.62	–40.75	–48.98	–11.39	–4.65	–8.23
'UO 601' × 'BR 234'	–30.68	–40.99	–32.38	–36.84	–8.41	–12.22	–6.49	–8.07
'ND 1002' × 'BR 234'	–22.01	–35.12	–35.20	–41.50	–19.02	–5.16	–3.32	3.60
'ND 1001' × 'NB 11'	–11.19	–29.15	–37.35	–24.32	–14.47	–2.63	–1.14	–2.39
'ND 1001' × 'IS 13'	–37.77	–41.63	–37.83	–37.46	–41.76	–6.05	–6.57	–6.22
'ND 1001' × 'UO 1285'	–38.33	–33.03	–26.91	–26.31	–44.71	–4.52	–7.28	–11.11
'BR 226' × 'UO 1285'	–29.27	–26.44	–19.91	–36.34	–30.46	12.63	–0.98	–2.73
'BR 230' × 'IS 16'	–5.21	–37.05	–43.89	–26.96	–6.80	–6.28	–9.81	–2.27

all the crosses (Table 2). The heritability varied from 71.4 to 97.7% in F_2, 60.4 to 98.4% in F_3, 25.8 to 64.6% in F_4, 57.7 to 82.1% in F_5 and 14.3 to 59.0% in F_6 generation which indicated significant genetic variation for yield components among crosses. The knowledge of heritable variability is crucial for proper breeding programme and selection of suitable genotypes in desired direction. Broad sense heritability provides an indication of the importance of genetic variance in relation to total variance. (Goncalves *et al.* 2008). The values of broad sense heritability decreased from F_2 to F_4 for all the traits and suddenly increased in F_5 generation for all the traits and finally decreased in F_6 generation. Low heritability was also reported earlier by Bhandari *et al.* (1997) for seed yield, opium yield and morphine content. The continuous decreasing heritability from F_2 to F_6 generation showed a clearcut trend of increasing homozygosity for all the traits in the crosses. It might be due to selection of desirable plants, followed by selfing of selected plants. The sudden enhancement in heritability for all the traits in F_5 generation was might be due to highly favourable environmental effects as our present crop opium poppy is highly environment-sensitive crop and can easily be affected by the favourable environmental conditions (Shukla *et al.* 2004). Generally, heritability estimates are influenced by experimental error as it is a part of denominator used in estimation of heritability. The degree of uniformity in test environment influences the experimental error. Moreover, multilocation testing will also provide more reliable estimates of heritability than testing at one location. Hence, heritability estimates in F_5 generation might be validated.

The estimates of predicted genetic gain in different generations for all the traits are shown in Table 3. Genetic advance is the product of heritability and selection differential expressed in terms of unit of standard deviation and thus provides an added edge over heritability in selection programme. In the present study, genetic gain was expressed as a percentage of mean for F_3, F_4, F_5 and F_6 generations over F_2 generation. The results based on overall analysis of

Table 4 Distribution of promising selected crosses in different groups for different traits

Group	Capsules/plant	Capsule size (cm^2)	Seed yield (g)	Opium yield (mg)	Morphine (%)
I		'Gz'×'BR 230', 'NBRI 1'× 'BR 241', 'UO 601'×'BR 234', 'ND 1002'× 'BR 234', 'ND 1001'×'IS 13'	'NBRI-5'×'BR241', 'Gz'× 'BR230', 'NB-5'× 'ND1002'	'UO 601'×'BR 231', 'GZ'× 'BR 230', 'NB 1'× 'BR 241', 'NBRI 5'× 'BR 241', 'MOP 541'× 'NBRI 11', 'ND 1002'× 'BR 234', 'BR 230'× 'IS 16'	'ND 1001'×'NB 11', 'NB 5'×'R 241', 'ND 1001' ×'UO 1285', 'BR 230'× 'IS 16'
II		'NBRI 5'×'ND 1002', 'ND 1001'× 'NBRI 11', 'ND 1001'×'UO 1285', 'BR 226'×'UO 1285', 'BR 230'×'IS 16'			'MOP 541'×'NBRI 11'
III		'MOP 541'×'BR 241', 'UO 601'× 'BR 231', 'NB 5'×'BR 241', 'MOP 541' ×'NB 11'			
IV				'ND1001'×'NBRI 11'	'ND 1001'×'IS 13'
V	'NBRI 5'×'BR 241', 'Gz'×'BR 230', 'NB1'×'BR 231', 'MOP 541'×'BR 241', 'UO 601'×'BR 231', 'ND 1002'× 'BR 234', 'ND 1001'×'IS 13', 'ND 1001' ×'UO 1285', 'BR 226'× 'UO 1285', 'BR 230'×'IS 16'		'MOP 541'× 'NB 11', 'NBRI 1'× 'BR 241', 'UO 601'×'BR 231', 'UO 601'×'BR 234', 'ND 1002'× 'BR 234', 'ND 1001'× 'NB 11', 'ND 1001'×'IS 13', 'ND 1001'× 'UO 1285', 'BR 226'× 'UO 1285', 'BR 230'×'IS 16'	'NBRI 5'×'ND 1002', 'MOP 541'×'BR 241', 'UO 601'×'BR 234', 'BR 226'×'UO 1285'	'Gz'×'BR 230', 'NBRI 1'× 'BR 241', 'NBRI 5'×'ND 1002', 'MOP 541' ×'BR 241', 'UO 601'× 'BR 231', 'UO 601'× 'BR 234', 'BR 230'×'IS 16'
VI			'MOP 541'×'BR 241'		
VII				'ND 1001'×'IS 13', 'ND 1001'×'UO 1285'	'ND 1002'×'BR 234'
VIII	'NBRI 5'×'ND 1002', 'UO 601'× 'BR 234', 'ND 1001'×'NBRI 11'				

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pattern of genetic gain for each trait showed different trends for different traits. Hence, for convenience to interpret the results to reach on fruitful conclusion, the crosses showing similar pattern over different traits in each generation were grouped accordingly. So, 14 crosses were grouped into 8 distinct groups (Table 4).

The promising selected crosses for different traits were distributed in different groups and presented in Table 4. The promising crosses for different traits in group I showed decline in genetic gain from F_3 to F_6 generation. Similarly, different crosses of group II had increasing pattern of genetic gain in F_3 and decline in F_4 and F_5 and then increase in F_6. Group III showed increasing pattern of genetic gain from F_3 to F_5 generation and finally decreased in F_6 generation, group IV showed decreasing trend in genetic gain up to F_4, followed by increasing trend from F_5 to F_6 generation, group V had crosses having decreased genetic gain from F_3 to F_5 which finally increased in F_6 generation, group VI had single cross showed decline in genetic gain from F_3 to F_6 except in F_5 generation, group VII had declined in genetic gain in F_3 and F_6 generation and increase in F_4 ands F_5 and finally the last group VIII showed increasing pattern in genetic gain from F_3 to F_6 generation. The groups I, II, IV, V, VI and VII had crosses which showed reduction in genetic gain from generation to generation due to accumulation of favourable genes and attaining the homozygosity that is governed through dominance gene actions but discrepancies that occurred among the continuous pattern might be due to environmental effects or manual sampling error. Similarly groups III and VIII had crosses which showed increasing pattern in genetic gain from generation to generation and accumulation of favourable alleles. However, some discrepancies in particular patterns might again be due to environmental effects or manual sampling error.

Based on overall analysis, the cross 'MOP541' × 'BR241' for 4 traits and cross 'Gz' × 'BR230' for 3 traits followed similar pattern of genetic gain. These crosses can easily be utilized in composite breeding programme. It was also noticed from the present study that capsule numbers, capsule size, seed yield and opium yield were positively associated with each other and negatively with morphine which suggested that increase in one is directly associated with increase in other, while for morphine it is *vice versa*, as also reported earlier by Yadav *et al.* (2006). Based on this study it is suggested that selection process for isolation of promising lines/crosses would be more powerful if it is based on genetically and phenotypically correlated traits instead of selection based on single trait. Multiple correlated trait breeding seems to be an important tool for enhancing the selection response instead of individual trait selection procedure which can bias the results, as the lines remaining one to be considered for a second trait do not represent a random sample of the entire parental population (Bauer and Leon 2008). In general, seed and opium yield are the most important traits in selective process of crosses/genotypes and can easily be increased by using multiple correlated trait selection method. Simultaneously, multiple stage testing would be beneficial during selection process to avoid undesirable and inefficient stages of selections. Another very important aspect in selection is that the characters chosen for selection criteria must be least affected by the environment and directly or indirectly affect each other. Anbessa *et al.* (2006) illustrated that knowledge of relative contribution of genetic components and environmental effects in controlling the variation for different traits is important for the successful breeding programme. Opium poppy is a self-pollinated crop having high degree of cross pollination varying from 7 to 40% (Bhandari 1990). Hence, the crop shows inbreeding depression in the subsequent generations after selfing, so to maintain crop vigour sibbing (intermating) would be more preferable instead of selfing in the later generations after following effective selection strategies, as suggested earlier by Shukla *et al.* (1999).

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