UDC 575.827; 633.75
Original scientific paper

GENETIC STUDIES AND THEIR IMPLICATION TO BREED DESIRED PLANT TYPE IN OPIUM POPPY (*PAPAVER SOMNIFERUM* L.)

S.P. SINGH, S. SHUKLA, and H.K. YADAV

Division of Genetics and Plant Breeding, National Botanical Research Institute (CSIR), Lucknow-226001, India

Singh S.P., S. Shukla, and H.K. Yadav (2004). *Genetic studies and their implication to breed desired plant type in opium poppy (Papaver somniferum L.)*. – Genetika, Vol. 36, No. 1, 69-81.

The extent of genetic variability, heritability, correlation coefficient and path analysis were analyzed for opium yield, seed yield and eight component traits in a group of 101 germplasm lines of different ecogeographical origin. Heritability was high for all the characters except capsules/plant. High heritability coupled with high genetic advance and coefficient of variability was noticed for capsule weight/plant, capsule area, husk yield/plant, seed yield/plant, opium yield/plant and leaves/plant. Opium yield, seed yield, husk yield and capsule weight exhibited positively significant correlation among themselves and these four characters had also positive significant genotypic correlation with plant height, branches/plant, capsules/plant, capsule area and leaves/plant. Path coefficient analysis indicated that capsule weight/plant had highest direct path towards opium yield (2.267) followed by capsules/plant (0.291), capsule area (0.203), plant height (0.155) and leaves/plant (0.101). Considering the direct and indirect selection of major contributors, a plant type in opium poppy (*Papaver somniferum* L.) based on multiple selection index has been discussed to enhance opium yield on one hand and dual purpose varieties (opium and seed yield) on the other hand.

Key words: opium poppy, heritability, correlation, path analysis, plant type, opium

---

Corresponding author: S.P. Singh, National Botanical Research Institute, Rana Pratap Marg, Lucknow – 226001, India
Tel: 91-522-2205842; Fax: 91-522-2205836; e-mail: s.p.singh@nbri.res.in

INTRODUCTION

The opium poppy is an important medicinal plant of pharmacopoel uses (SINGH *et al.*, 1995; 1999; PUSHPANGADAN, 2001; HUSAIN and SHARMA, 1983). The present tend is to breed the variety for specific alkaloids on one hand and develop dual-purpose variety i.e. opium and seed yield on the other hand to meet the position of country in international market. Availability of magnitude of variation in available germplasms, inter-dependence of quantitative characters with yield, extent of environmental influence on these factors, heritability and genetic gain are the pre requisite in formulating proper breeding program and selection of suitable genotypes in desired direction. Studies on genetic variability and indirect association however reported by several workers based on limited genetic materials (SHARMA *et al.*, 1981; SHUKLA and KHANNA, 1987; SINGH and KHANNA, 1993; SINGH *et al.*, 2003) but such study based on large germplasm of diverse geographical and genetical origin in rare. In present paper are reported the extended result of earlier report of an experiment based on 101 opium poppy *(Papaver somniferum* L.) germplasm of different origin.

MATERIALS AND METHODS

The present material comprised of 101 genetic stock of opium poppy including Indian land races (SINGH *et al.*, 1997) and genetic stock developed through inter and intraspecific hybridization (KHANNA and SHUKLA, 1989; SINGH *et al.*, 1999). These genotypes were evaluated in randomized block design with 3 replication during 2000-2001 at experimental plot of Genetics and Plant Breeding division, National Botanical Research Institute; Lucknow, India situated between 26°40'N latitude and 80°45' E longitudes and at an altitude of 129 m above sea level. Each replication consisted of 101 blocks with two rows/plot. The rows were Sm long. The spacing was 30cm between rows and 10 cm within rows, respectively. The nonexperimental rows were planted to check border effects and normal cultural practices were followed through out the season to get good crop. Ten randomly selected plants per treatment per replication were tagged before flowering to record the detail observations. The observations were recorded on days to flower, plant height (cm), branches/plant, capsules/plant, capsule area (cm2), leaves/plant, capsule weight/plant (g), husk yield/plant (g), seed yield/plant (g) and opium yield/plant (g).

Statistical analysis. - The plot means per replication was used for statistical analysis (PANSE and SUKHATME, 1967). The coefficients of variability, heritability and genetic advance as well as correlation coefficient were estiiriated according to JOHNSON *et al.,* (1955a,b). Path coefficient analysis was estimated by partitioning the genotypic correlation into direct and 'indirect effect according to DEWEY and LU, 1959.

RESULTS AND DISCUSSION

The analysis of variances (Table 1) revealed significant differences among treatment for all the characters. This showed the presence of much variability in germplasm lines and further genetic studies are warranted.

Genetic variability and heritability. - Genetic variability helps a great deal in detecting the range of genetic diversity for various traits in population. In present study a wider range of variability among genotypes was noticed for opium yield, seed yield and other component traits (Table 1). The opium yield was variable between 0.140 g to 0.300 g with arithmetic mean of 0.200+ 0.04 while seed yield and husk yield ranged from 3.50 g to 10.25 g and 2.5 g to 11.50 g with their population mean of 6.67+1.29 g and 5.4 + 1.05 g, respectively. Capsule weight/plant was variable between 6.0 to 20.0 g with arithmetic mean 12.07 +2.08 g. Range of capsule area (cm^2) was noticed between 8.3 to 22.3 cm2 with the average mean of 16.05 +1.34. The range of variability for days of flowering was very short in opium poppy. It ranged from 90.6 to 101.5 days after sowing with mean of 95.6 +0.09. This showed that in opium poppy whole population flowers within 10 days. However, SINGH *et al.*, (1999) reported that Indian landraces manifested high degree of infra population variation. These observations were also based on much wider germplasm. They detected two early types viz. Ornamental Red' and `Aphuri' having 80-83 days flowering period compared to 95-110 days of commercial varieties.

In order to assess the heritable portion of total variability, phenotypic variance (σ^2p) was partitioned into genotypic (σ^2g) and error variance (σ^2e) (Table 1). The magnitude of genotypic variance was much higher for all the traits. However, the influence of environmental variance was noticed maximum for capsules/plant. The higher genotypic and phenotypic coefficients of variabilities were noticed for branches/plant followed by capsules/plant, husk yield/plant, capsule weight/plant, opium yield and seed yield. While days to flower had low magnitude of variabilities (2.45%, 2.71 %). The genotypic and phenotypic coefficient of variabilities are quite comparable in present study except capsules/plant indicating that these characters possess greater scope of improvement. However, variability alone is not much helpful in determining the heritable: portion of variation. Amount of advance to be expected from selection can be obtained by the estimates of coefficient of variability along with heritability. Heritability in broad sense ranged from 56.41 to 82.51 percent, the maximum being in plant height (82.51%) followed by capsule size (82.43%), days to flower (82.14%) and capsule weight/plant (80.70%). The heritability for husk yield/plant (73.33%), seed yield/plant (74.30%) and leaves/plant (73.59%) were also high and magnitude was quite comparable. The high heritability for above traits indicates that the characters are under genotypic control. However, low heritability for capsules/plant revealed the role of environment, which confirms the conclusion drawn from components of variances. Estimates of heritability (Broad sense) would not be of much practical importance in selection based on phenotypic performance unless it is considered in combination of genetic advance (JOHNSON *et al.*, *1955a).* Heritability in combination with

Table 1. Genetic variability and heritability in opium poppy

Characters	F values	Mean ± SE	Component of variance			Coefficient of variability		Herittability	Genetic
			σ^2p	σ^2g	σ^2e	GCV	PCV	(%)	advance (%)
Days to Flower	10.13**	95.61±0.09	6.72	5.52	1.20	2.45	2.71	82.14	4.58
Plant height (cm)	5.72**	115.89±4.66	62.38	51.48	10.99	6.19	6.81	82.51	11.65
Branches/plant	1.93*	2.67±0.85	0.70	0.49	0.29	26.22	31.34	70.00	45.9
Capsules/plant	2.15*	2.06±0.60	0.39	0.22	0.18	22.77	30.32	56.41	34.97
Capsule area (cm^2)	5.70**	16.05±1.34	5.18	4.27	0.95	12.87	14.18	82.43	23.95
Leaves/plant	2.82* *	16.33±1.41	2.84	2.09	0.75	8.86	10.32	*73.59*	15.73
Capsule weight/plant (g)	3.94**	12.07±2.08	8.55	6.90	1.56	21.76	24.23	80.70	40.42
Husk yield/plant (g)	4.65**	5.40±1.05	2.23	1.68	0.55	24.00	27.65	75.33	42.73
Seed yield/plant (g)	2.97**	6.67±1.29	2.51	1.87	0.64	20.50	23.75	74.30	36.21
Opium yield/plant (g)	3.22**	0.20±0.04	0.0024	0.0017	0.007	20.70	24.62	70.83	35.48

*p = 0.05, ** p = 0.01. σ^2p = phenotypic variance, σ^2g = Genotypic variance, σ^2e = error variance, GCV = Genotypic coefficient of Variability, PCV = Phenotypic coefficient of variability, SE = Standard error

intensity of selection and amount of variability present in population influences the gains to be obtained from selection. Genetic gain in a character is a product of heritability and selection differential expressed in unit of standard deviation, has an added edge over heritability as guiding factor to breeders in selection programme (SINGH and SINGH, 1981). The direct genetic gain ranged from 4.58 to 45.9 percent. The maximum genetic gain was noticed for branches/plant (45.90%) followed by husk yield/plant (42.73%), capsule weight/plant (40.42%), seed yield/plant (36.21%), opium yield/plant (35.48%) and capsules/plant (34.97%). The high heritability coupled with high genetic advance and GCV was noticed for capsule weight/plant, capsule area, husk yield/plant, seed yield/plant and opium yield/plant indicating the control of additive gene action. In such cases simple selection model will be good enough to do needful because no additional gain is achieved by using more sophisticated models (SINGH *et al.*, 2003). Low heritability coupled with high genetic gain and GCV was noticed for capsules/plant and contrary to this was noticed for plant height and days to flower indicating that these characters are governed by non-additive gene action. For leaves /plant high heritability and moderate genetic gain and GCV indicated the equal importance of additive and non-additive gene action. High heritability and genetic advance noticed is in agreement of SINGH and KHANNA, 1993; SINGH *et al.*, 2003. However, contrary to this BHANDARI *et al*., (1997) noticed low heritability for seed yield and latex yield.

Correlation analysis. - Genotypic and phenotypic correlation coefficients were worked out in all possible combination for 10 characters including seed yield and opium yield (Table 2). Higher magnitude of genotypic correlation than phenotypic correlation was noticed for almost characters combinations indicating inherent association between characters which might be due to masking or modifying effect of envirornnent (SHUKLA and KHANNA, 1987; SINGH and KHANNA, 1993; SINGH *et al.*, 2003).

Days to flower exhibited negatively significant correlation with all characters except husk yield (-0.109) and plant height (0.025) suggested early flowering and maturity is not appropriate component trait to breed for increased opium yield in opium poppy. The negative association of days to flowering with seed yield, opium yield and plant height was also reported by SINGH and KHANNA, (1993). Opium yield had positive significant genotypic correlation with seed yield/plant (0.665), husk yield (0.634), capsule weight/plant (0.669), capsule area (0.474), capsules/plant (0.463), leaves/plant (0.396) and branches/plant (0.414). Opium yield had negative association with days to flowering (-0.246) as reported earlier by SHARMA *et al.*, (1981). Positive association of opium yield with capsules/plant, capsule area and seed yield was in agreement with SAINI and KAICKER, (1982), SHUKLA and KHANNA, (1987), SINGH and KHANNA (1993). Thus an increase in opium yield is possible if the plants with more capsules of larger area and more leaves/plant are selected. The capsule weight/plant positively and significantly associated with capsules/plant (0.931), branches/plant (0.885), capsule area (0.527), seed yield/plant (0.969), opium yield/plant (0.669), leaves/plant (0.356)

Table 1. Genetic variability and heritability in opium poppy

Characters	F values	Mean ± SE	Component of variance			Coefficient of variability		Herittability	Genetic
			σ^2p	σ^2g	σ^2e	GCV	PCV	(%)	advance (%)
Days to Flower	10.13**	95.61±0.09	6.72	5.52	1.20	2.45	2.71	82.14	4.58
Plant height (cm)	5.72**	115.89±4.66	62.38	51.48	10.99	6.19	6.81	82.51	11.65
Branches/plant	1.93*	2.67±0.85	0.70	0.49	0.29	26.22	31.34	70.00	45.9
Capsules/plant	2.15*	2.06±0.60	0.39	0.22	0.18	22.77	30.32	56.41	34.97
Capsule area (cm^2)	5.70**	16.05±1.34	5.18	4.27	0.95	12.87	14.18	82.43	23.95
Leaves/plant	2.82* *	16.33±1.41	2.84	2.09	0.75	8.86	10.32	*73.59*	15.73
Capsule weight/plant (g)	3.94**	12.07±2.08	8.55	6.90	1.56	21.76	24.23	80.70	40.42
Husk yield/plant (g)	4.65**	5.40±1.05	2.23	1.68	0.55	24.00	27.65	75.33	42.73
Seed yield/plant (g)	2.97**	6.67±1.29	2.51	1.87	0.64	20.50	23.75	74.30	36.21
Opium yield/plant (g)	3.22**	0.20±0.04	0.0024	0.0017	0.007	20.70	24.62	70.83	35.48

*p = 0.05, ** p = 0.01. σ^2p = phenotypic variance, σ^2g = Genotypic variance, σ^2e = error variance, GCV = Genotypic coefficient of Variability, PCV = Phenotypic coefficient of variability, SE = Standard error

and husk yield/plant (0.972). The above findings are in confirmity of SINGH *et. al.* (2003). Seed yield and husk yield - a component of capsule weight, were positively associated with each other (0.884) and both had also significant positive genotypic correlation with plant height, branches/plant, capsules/plant, capsule area and capsule weight/plant. Leaves/plant also exhibited significant positive association with these traits except husk yield/plant (positive non significant) and days to flower (negative significant). Positive association of seed yield/plant with capsule weight/plant, capsule area, branches/plant and capsules/plant was also reported by SAINI and KAICKER, (1982), SINGH and KHANNA, (1993) and SINGH *et al.*, (2003).

A significant positive association of seed yield/plant with husk yield and opium yield/plant indicates that higher capsule weight/plant is proportionately related with increase in seed yield, husk yield and opium yield. However, for proportional increase in opium yield/plant, a condusive climate during lancing is necessary as oozing of latex from laticifers of capsules is very much erratic to prevailing weather i.e. wind, fluctuation of temperature, cloudy weather, hail storms etc. The significant positive association of capsule area, capsules/plant, seed yield/plant, husk yield/plant, opium yield/plant and branches/plant among themselves in general and with opium yield in particular suggest that selection of components jointly or individually may enhance the productivity of opium yield/plant. A positive correlation between capsule size and capsules/plant was also noticed by SAINI and KAICKER, (1982), SHUKLA and KHANNA, (1987) and SINGH *et al.*, (2003), while negative correlation was reported by SHARMA *et al.*, (1981) and SINGH and KHANNA, (1993) in different sets of populations. The magnitude of genotypic correlation between capsules/plant and seed yield/plant was more than unity indicating the dependence of seed yield/plant of capsules bearings/plant, which is in agreement of SINGH and KHANNA, (1993). The genotypic correlation more than unity was probably due to low estimates of variances and high covariances. Such results may also be arised due to sampling errors (KHANNA and SINGH, 1975; SINGH and SINGH, 1979).

The significant genotypic correlation of leaves/plant with plant height (0.470), capsule area (0.268), capsule weight/plant (0.527) and their significant positive association with opium yield/plant indicated that since leaves are responsible for photosynthetic activity, the selection of medium plant height with more leaves of bigger size may increase the production of opium latex with increased capsule area as a locale of opium accumulation. Similar conclusion was also drawn by SINGH and KHANNA, (1993). However, in contrary SHARMA *et al.*, (1981) speculated about a plant type having dwarf stature, early flowering and many capsules of bigger size. Since in present study negative correlation of days to flower with all traits including opium yield/plant were noticed, plant type speculation by SHARMA *et al.*, (1981) may not be taken as selection criteria for high yield.

Path coefficient analysis. - Correlation coefficient measure the mutual association between two variables but not permit the cause and effect relationship of traits contributing directly or indirectly towards the economic yield, whereas

Table 2. Correlation coefficients among different traits in opium poppy

Characters		Plant height	Branches /plant	Capsules /plant	Capsule area	Leaves /plant	Capsule weight /plant	Husk yield /plant	Seed yield /plant	Opium yield /plant
Days to Flower	rg	0.025	-0.396**	-0.425**	-0.215*	-0.451**	-0.213*	-0.109	-0.309*	-0.246*
	rp	0.043	-0.233	-0.262	-0.156	-0.267	-0.166	-0.089	-0.222	-0.156
Plantheight	rg		0.123	0.186	0.407**	0.470**	0.485**	0.371**	0.565**	0.453**
	rp		0.077	0.102	0.322	0.310	0.289	0.225	0.310	0.269
Branches/plant	rg			0.930**	0.401**	0.238*	0.885**	0.745**	0.999**	0.414**
	rp			0.892	0.174	0.166	0.580	0.519	0.564	0.161
Capsule/plant	rg				0.292**	0.317**	0.931**	0.786**	1.057**	0.463**
	rp				0.128	0.208	0.606	0.527	0.603	0.193
Capsule area	rg					0.268**	0.527**	0.462**	0.566**	0.474**
	rp					0.157	0.337	0.274	0.352	0.284
Leaves/plant	rg						0.356**	0.187	0.482**	0.396**
	rp						0.196	0.104	0.251	0.269
Capsule weight/plant	rg							0.972**	0.969**	0.669**
	rp							0.929	0.939	0.321
Husk yield/plant	rg								0.884**	0.634**
	rp								0.748	0.286
Seed yieldlplant	rg									0.665**
	rp									0.307

*p = 0.05, ** p = 0.01 probability level; rg – genotypic correlation, rp – phenotypic correlation

path coefficient is partially standardized regression coefficient and as such measure the direct influence of one variable upon another and specifies the causes and measure their relative importance.

The capsule weight/plant, which had highest positive significant genotypic correlation with opium yield, also exhibited maximum direct path (2.267) (Table 3, Fig. 1). It also indirectly contributed to opium yield via capsule area (0.107), leaves/plant (0.036), plant height (0.075) and days to flower (0.028). Capsules/plant showed next highest (0.291) direct path followed by capsule area (0.203). These component traits indirectly contributed towards opium yield via each other and also through capsule weight/plant, leaves/plant, plant height and days to flower. This indicates that more capsules with bigger size produce more opium, which is in consonance of SINGH and KHANNA, (1993). In general all the main components contributing directly towards opium yield are also contributing indirectly through each others.

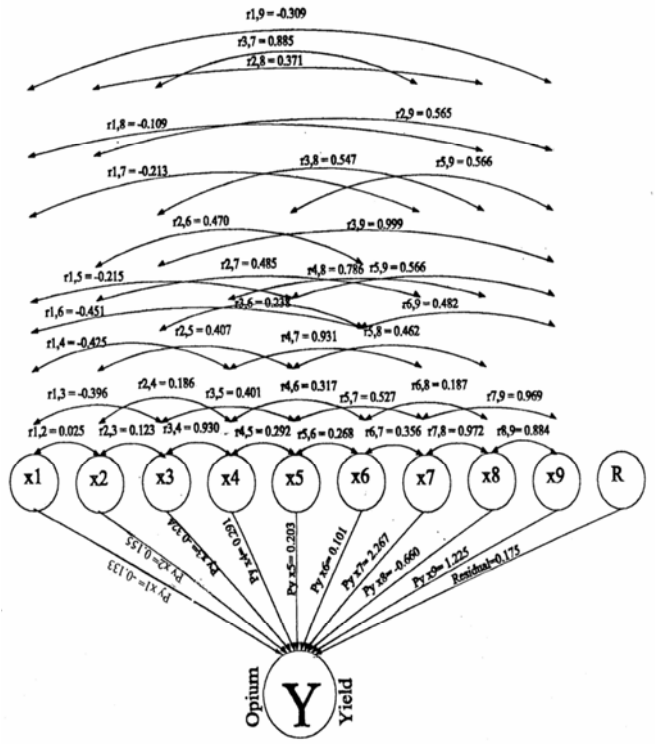

Fig. 1. Path diagram and coefficient factors influencing opium yield in opium poppy (1 – days to flower; 2 – plant height; 3 – branches / plant; 4 – capsules / plant; 5 – capsule size; 6 – leaves / plant; 7 – capsules weight / plant; 8 – husk yield / plant; 9 – seed yield / plant)

Fig. 2. Model plant type of opium poppy (*Papaver somniferum* L.) for high latex and seed yield

Days to flower, which had negative genotypic correlation also exhibited negative direct path towards opium yield (-0.133). The negative direct path and correlation are also well supported by negative indirect effect of capsule weight (-0.483), capsules/plant (-0.124), capsule area (-0.044) and leaves/plant (-0.045). Hence the selection for early plant types may not be beneficial for opium yield. However, days to flower has substantial support to opium yield via positive indirect effect of seed yield/plant, husk yield/plant and plant height. The positive direct effect of plant height (0.155) and leaves/plant (0.101) for opium yield and positive

indirect effect via each other and other component traits indicates that plant model with medium height and maturity with more leaves/plant would be desirable for opium yield. Simultaneous increase of leaves/plant is more essential as production of opium is end product of biochemical activity (SINGH and KHANNA, 1993). This result also confirmed the findings of correlation coefficient.

The seed yield and husk yield, which had high significant positive genotypic correlation exhibited negative direct path. However, negative direct effects are counterbalanced through positive indirect effect of capsule weight/plant, capsule area, capsules/plat, plant height, leaves/plant as well as their highly significant genotypic association with opium yield. The negative direct path of seed yield towards opium yield of present findings is in agreement of KAICKER *et al.*, (1975) and SAINI and KAICKER, (1982). Whereas contrary to this positive direct effect was noticed by SHUKLA and KHANNA, (1987) and SINGH *et al.*, (2003).

From overall genetic studies it is emphasized that in any selection and breeding programme, characters least affected by the environment and characters working together mus be considered (SINGH and SINGH, 1979). In present investigation capsules weight/plant, capsule area, plant height, leaves/plant, seed yield/plant, husk yield/plant and opium yield/plant were least influenced by environment with high selection gain as evidenced by high heritability and genetic advance and also had appreciable influence directly and indirectly towards opium yield due to positive significant association among themselves indicating that the selection of any of these characters or simultaneous selection for more than one characters would improve yield. To maintain balance in plant growth, to derive a multiple selection index and to develop a model plant type for increased opium in opium poppy, desirable characters would be medium plant height and maturity, more capsules of larger size and an increased number of leaves/plant (Fig. 2). Although seed yield is a by product of opium poppy cultivation, breeding for above component traits and selection of genotypes combining these traits may also increase seed yield in addition to opium yield and thus a dual purpose variety may be developed (SINGH and KHANNA, 1993).

Acknowledgement. Authors thank, Director, NBRI, Lucknow for providing facilities and Ministry of Finance, Dept. of Revenue, Govt. of India, CCF Office, New Delhi for financial support.

Received April 29th, 2004
Accepted May 28th, 2004

REFERENCES

BHANDARI M.M., R. GUPTA, P.P. SHARMA, and A. JOSHI (1997): Path analysis in opium poppy *(Papaver somniferum L.).* Indian Journal of Genetics & Plant Breeding, *57 (1),* 14-18.

DEWEY D.R. and K.H. LU (1959): A correlation and path coefficient analysis of components of crested wheat grass production. Agron J., *51*, 515.

HUSAIN A. and J.R SHARMA (1983): Opium poppy. CIMAP. Lucknow Publishing House, Lucknow.

JOHNSON H.W., H.F. ROBINSON, and R.E. COMSTOCK (1955a): Estimate of genetic and environmental variability in soyabeans. Agron. J., *47*, 314-318.

JOHNSON H.W., H.F. ROBINSON, and R.E. COMSTOCK (1955b): Genotypic and phenotypic correlation in soybean and their implication in selection. Agron. J., *47*, *477-485.*

KAICKER U.S., B. SINGH, K.A. BALKRISHANAN, H.P. SINGH, and B. SINGH (1975): Correlations and path coeffcaent of opium poppy. Genetic Agraria, *29*, 357.

KHANNA K.R. and U.P. SINGH (1975): Correlation studies in P. *somniferum* and their bearing on yield improvement. Planta Medica., *28, 92-96.*

KHANNA K.R. and S. SHUKLA (1989): Genetic studies and economic potential of interspecific crosses in opium poppy (P. *somniferum L.*). *In*: *Prospectives in Plant Sciences in India,* Eds. Bir and Sagoo, Today & Tomorrow Publishers, 81-92.

PANSE V.G. and P.V. SUKHATME (1967): *Statistical methods for Agricultural workers.* Indian Council of Agricultural Research. New Delhi, India.

PUSHPANGADAN P. and S.P. SINGH (2001). POPPY. *In*: *A Hand book Of Herbs and Spices* (ed. K.V.Peter) Woodhead Publisher London, U.K. P: 262-268.

SAINI H.C. and U.S. KAICKER (1982): Model plant architecture through association and path coefficient analysis in opium poppy. Indian J. Agric. Sci., *52*, 744.

SHARMA J.R., H.O. MISRA, R.V. NAIR, R.K. SRIVASTAVA, O.P. SINGH, and D.P. SRIVASTAVA (1981): Phenological distribution of latex yield and plant type concept in opium poppy *(Papaver somniferum L.)* Indian Drug. *19*, 70.

SHUKLA S. and K.R. KHANNA (1987): Genetic association in opium poppy (P. *somniferum* L.). Indian J. Agric. Sci., *57* (3), 147-151.

SINGH S.P. and K.R. KHANNA (1993): Path coefficient analysis for opium and seed yield in opium poppy *(Papaver somniferum L.).* Genetika, 25 (2), 119-128.

SINGH S.P., S. SHUKLA, and K.R. KHANNA (1995): The Opium Poppy. *In*: *Advances in Horticulture: Medicinal and Aromatic Plants* (Eds K. L. Chadha and Rajendra Gupta). Vol. 11: 535-574. Malhotra Publication house New Delhi.

SINGH S.P., S. SHUKLA, and K.R. KHANNA (1997): Characterization of Indian landraces and improved varieties of opium poppy *(Papaver somniferum* L.). JMAPS., *19* (2)*,* 369-386.

SINGH S.P., S. SHUKLA, and K.R. KHANNA (1999): Breeding strategy in opium poppy (*Papaver somniferum* L.) at National Botanical Research Institute Lucknow. Appl. Bot. Abst., *l9*, 121-139.

SINGH S.P. and H.N. SINGH (1979): Path coefficient analysis for yield component in Okra. Indian J. Agric. Sci., *49*, 401-403.

SINGH S.P. and H.N. SINGH (1981): Gene system involved and their implication in breeding of lablab bean *(Dolichos lablab).* Plant Breeding, *87,* 240-247.

SINGH S.P., H.K. YADAV, S. SHUKLA, and A. CHATTERJEE (2003): Studies on different selection parameters in opium poppy *(Papaver somniferum L.)* J. Med. and Arom. Plant Sci., *25*, 8-12.

GENETIČKA ISPITIVANJA I NJIHOVA IMPLIKACIJA U OPLENJIVANJU OPIUMSKOG MAKA (*PAPAVER SOMIVIFERUM* L.) NA ŽELJENI TIP BILJKE

S.P. SINGH, S. SHUKLA, and H.K. YADAV

Odelenje za genetiku i oplemenjivanje, Nacionalni botanički istraživački Institut (CSIR), Lucknow-226001, Indija

I z v o d

Vršena su ispitivanja genetičke varijabilnosti, naslednosti, koeficijenta korelacije i pat analiza prinosa opiuma, prinosa semena i devet komponenata prinosa, u grupi koja se sastojala od sto jednog (101) genotipa različitog ekogeografskog porekla. Utvrđen je visok stepen naslednosti za sve ispitivane osobine izuzev broja kapsula po biljci. Visok stepen naslednosti, ukopčan sa visokim stepenom genetičkog poboljšanja i koeficijentom variranja je utvrđen za težinu kapsule po biljci, površinu kapsule, prinos ljuske po biljci, prinos po biljci, prinos opijuma po biljci i broju listova po biljci. Utvrđen je visok stepen kako međusobne korelacije između prinosa opijuma, prinosa semena, prinosa ljuske i težine kapsule tako i pozitivna značajna korelacija ovih osobina sa visinom biljke, brojem grančica po biljci, brojem kapsula po biljci, površinom kapsule i brojem listova po biljci. Pat koeficijen analiza ukazuje da težina kapsule ima direktan uticaj na prinosu opijuma (2.267) a zatim slede broj kapsula po biljci (0.291), površina kapsule (0.203), visina biljke (0.155) i broj listova po biljci (0.101). Obzirom na direktnu ili indirektnu selekciju na glavne osobine, tip biljke opijumskog maka (*Papaver somniferum* L.) zasnovan na multiplom selekcionom indeksu je diskutovan u cilju povećanja prinosa opijuma s jedne strane i dobijanja sorata sa dvostrukom namenom (visok prinos sa visokim sadržajem opijuma.

Primljeno 29. IV 2004.
Odobreno 28. V 2004.