Indian J. Hort. 70(4), December 2013: 555-559

Genetic variability, heritability, correlation analysis for quantitative traits in Asiatic lilium

Rajiv Kumar*
Division of Horticulture, ICAR Research Complex for NEH region, Umiam 793 103, Meghalaya

ABSTRACT

In present investigation genetic studies were carried out with eight Asiatic lilium genotypes, *viz*., Avelino, Botticelli, Brunello, Detroit, Farfalla, Gironde, Navona and Vermeer on 19 quantitative traits so as to identify promising traits based on which selection can be made. The experiment carried out following randomized block design with three replications. Results indicated that high phenotypic and genotypic coefficient of variations were found for leaf length, leaf breadth, plant spread, number of flowers/plant, pedicel length, number of bulblets/ bulb, and scales/ bulb indicating high genetic variability in these traits. High heritability coupled with high genetic advance as per cent of mean was observed for plant height, leaf length, leaf breadth, plant spread, number of flowers/plant, bud length before opening, pedicel length, petal length, bulb weight, number of bulblets/bulb, scales/bulb and propagation coefficient, indicating the possible role of additive gene action. Flower diameter was positive and significantly associated with number of flowers/plant, bud diameter, bud diameter, petal length, petal breadth, bulb weight, bulb diameter, bulb height and propagation coefficient. To improve flower yield/ plant in Asiatic lilium, focus should be given on number of leaves per plant as it has positive correlation with number of flowers per plant.

Key words: Asiatic lilium, genetic variability, heritability, correlation co-efficient.

INTRODUCTION

The genus *Lilium* (family Liliaceae) includes about 100 species that are native to North America, Europe, and Asia (Beattie, 2). There is a large diversity in plant architecture, flower shapes, colours, sizes and fragrance, and bulb morphology. The cultivars that are currently popular are derived primarily from species originating from Japan and China. *Lilium* is mainly grown for cut flowers as well as for pot plant in landscape. In recent years, several new *Lilium* cultivars with wide range of colours have entered the flower business. Investigations have examined various *Lilium* flower traits using quantitative genetic approaches (Chitra and Rajamani, 4; Huang *et al*., 7).

Genetic variability forms the basis for crop improvement. Genotypic and phenotypic coefficients of variation are useful in detecting the amount of variability present in the available genotypes. The main purpose of estimating heritability and the genetic parameters that compose the heritability estimate is to compare the expected gains from selection based on alternative selection strategies (Holland *et al*., 6). Correlation analysis is a biometrical technique to find out the nature and degree of associations among various traits. Therefore, information on variability and heritability of plant characters and association among yield and quality characters are of vital importance in any breeding programme. The present study was undertaken to ascertain the magnitude and extent of genetic variability, heritability, genetic advance and the association of 19 characters in 8 Asiatic lilium genotypes.

MATERIALS AND METHODS

The present study was carried out at Research Farm of the Division of Horticulture, ICAR Research Complex for NEH Region, Umiam, Meghalaya during 2008-09. Umiam is situated at 25° 41' N latitude, 91° 55' E longitude and 1010 m above mean sea level. Experimental material consists of 8 genotypes of Asiatic *Lilium*, *viz.,* Avelino, Botticelli, Farfalla, Brunello, Detroit, Gironde, Navona and Vermeer. The experiment was laid out in randomized block design with three replications. The bulbs of 10/12 grade were planted on the raised beds of 1.5 m × 1.5 m with a spacing of 20 cm × 15 cm. The data were recorded on five plants from each genotype in each replication for 19 characters, *viz.*, plant height (cm), leaves/plant, leaf length (cm), leaf breadth (cm), plant spread (cm), plant girth at centre (mm), flower diameter (cm), number of flowers/plant, bud length before opening (cm), bud diameter (cm), pedicel length (cm), petal length (cm), petal breadth (cm), bulb weight (g), bulb diameter (cm), bulb height (cm), number of bulblets/ bulb, number of scales/bulb and propagation coefficient (%), which were analyzed statistically.

The phenotypic and genotypic co-efficient of variation were calculated using the procedure as

*Corresponding author's present address: Division of Ornamental Crops, Indian Institute of Horticultural Research, Hessaraghatta Lake Post, Bengaluru 560089; E-mail: flori_rajiv@yahoo.co.in

suggested (Singh and Chaudhary, 10). Heritability in broad sense and genetic advance expressed in per cent of mean were calculated (Burton, 3). Correlation coefficients of variations were calculated using the formula suggested (Johnson *et al*., 8).

RESULTS AND DISCUSSION

The analysis of variance for growth, flowering and bulb characters in Asiatic lilium has revealed wide variations for all the character studied indicating sufficient genetic variability to be exploited in a breeding programme (Table 1). In the present study, maximum values for genotypic (381.26) and phenotypic (409.90) variances were observed for propagation coefficient, whereas, bulb height showed least genotypic (0.12) and phenotypic (0.15) variances. Estimates of phenotypic variance and genotypic variance had only a narrow difference for leaf length, leaf breadth, plant spread, plant girth at centre, flower diameter, flowers/plant, bud length before opening, pedicel length, petal length, bulb height, bulblets/bulb indicating the fact that these characters are not much influenced by environmental factors. Phenotypic coefficient of variation was recorded higher than genotypic coefficient of variation for the characters studied which indicated greater genotype and environment interaction. Similar results were also reported in glory lily (Farooqi *et al*., 5) and in gladiolus (Prabhat Kumar, 9).

High (>20%) phenotypic and genotypic coefficient of variation were observed for leaf length, leaf breadth, plant spread, flowers/plant, pedicel length, bulblets/ bulb, scales/bulb indicating high genetic variability in these traits; it was moderate (10-20%) for plant height, leaves/plant, bud length before opening, petal length, bulb weight and propagation coefficient. However, plant girth at centre, flower diameter, bud diameter and bulb diameter showed low (<10%) phenotypic and genotypic coefficient of variation suggesting that these genotypes possessed less variability for these traits. Variability in plant height and flower diameter has also been reported in *Lilium martagon* (Balode, 1). Therefore, it appears that phenotypic variability may be a good measure of genotypic variability for all the characters. However, it is not possible to estimate the heritable variation with the help of GCV. GCV together with heritability estimates would give the best picture of the amount of advance to be expected by selection (Burton, 3). The heritable portion of variability was thus determined with the help of heritability estimates.

In the present study, heritability estimates ranged from 39.82% (plant girth at centre) to 96.14% (petal length). The magnitude of heritability in broad sense was high for most of the characters except plant girth at centre and bulb diameter. Such high heritability estimates have been found to be helpful in making selection of superior genotypes on the basis of phenotypic performance with respect to the quantitative characters. High heritability for most of the quantitative traits was also reported in glory lily (Farooqi *et al*., 5). However, high heritability associated with high genetic advance proves more useful for efficient improvement of a character through simple selection. In the present study, high heritability estimates with high genetic advance as per cent of mean was observed for plant height, leaf length, leaf breadth, plant spread, flowers/plant, bud length before opening, pedicel length, petal length, bulb weight, bulblet/ bulb, scales/bulb and propagation coefficient, indicated the possible role of additive gene action. High heritability with high genetic advance for plant height and weight of corm has been reported in gladiolus (Prabhat Kumar, 9). High heritability with medium genetic advance as per cent of mean was observed for number of leaves/ plant, flower diameter, bud diameter, petal breadth and bulb height indicating presence of dominant and epistatic gene effects inferring that these characters could be improved through hybridization. Plant girth at centre and bulb diameter observed low heritability and low genetic advance.

All possible phenotypic and genotypic correlation studies were carried out to know the nature of relationship existing between growth, flowering and bulb contributing characters. The correlation involving flower yield along with flower diameter, stalk length, stalk thickness, early flowering and vase life deserves special attention as these characters would be primary interest in lilium breeding. In the present investigation, the estimates of genotypic correlation were higher than the phenotypic correlations, indicating the presence of inherent association between various characters (Table 2). In all instance, however, more reliance may be placed on the genotypic correlation. Higher genotypic correlation coefficient than phenotypic correlation coefficient among the various traits has also been reported in glory lily (Chitra and Rajamani, 4). This may be due to effect of environment in modifying the effect of total expression of genotypes, thus altering the phenotypic expression. The correlation analysis revealed positive and significant correlation of plant height with leaves/plant, leaf length, leaf breadth, plant spread, flower diameter, bud diameter, pedicel length, petal breadth, bulb weight, bulb diameter, bulb height, bulblets/ bulb and propagation coefficient at both phenotypic and genotypic levels. Highly significant and positive correlation of plant height with weight and diameter of corm has also been reported in gladiolus (Kumar, 9).

Table 1. Mean, range, variances, genotypic and phenotypic coefficient of variation, heritability and genetic advance for 19 traits in Asiatic lilium.

Character	Mean ± SEm	Range	Genotypic variance	Phenotypic variance	Genotypic coefficient of variation (%)	Phenotypic coefficient of variation (%)	Heritability (%)	Genetic advance	Genetic advance as per cent of mean (%)
Plant height (cm)	41.82±1.46	33.86-52.86	46.41	49.63	16.28	16.84	93.51	13.12	31.37
No. of leaves/plant	91.47±4.20	76.26-104.53	109.37	135.82	11.43	12.74	80.53	17.35	18.96
Leaf length (cm)	5.85±0.34	3.68-8.64	2.95	3.10	29.37	30.08	95.35	3.38	57.77
Leaf breadth (cm)	0.98±0.20	0.54-1.74	0.31	0.19	36.85	44.79	67.68	0.50	51.02
Plant spread (cm)	12.54±0.50	8.96-17.13	7.40	7.78	21.68	22.23	95.11	5.33	42.50
Plant girth at centre (mm)	5.62±0.25	5.14-6.19	6.41	7.16	4.50	7.13	39.82	0.21	3.73
Flower diameter (cm)	15.45±0.46	13.2-17.36	1.82	2.08	8.74	9.34	87.43	2.43	15.74
No. of flowers/plant	3.51±0.26	1.73-4.93	1.25	1.36	31.86	33.17	92.25	2.13	60.68
Bud length before opening (cm)	8.45±0.56	7.08-10.07	0.94	1.04	11.47	12.07	90.38	1.81	20.42
Bud diameter (cm)	2.31±0.07	2.14-2.7	2.96	3.67	7.45	8.30	80.67	0.29	12.55
Pedicel length (cm)	6.00±0.33	4.7-7.84	1.58	1.75	20.96	22.02	90.62	2.35	39.16
Petal length (cm)	9.27±0.17	7.71-10.59	1.04	1.08	11.01	11.23	96.14	2.02	21.79
Petal breadth (cm)	4.53±0.18	3.62-5.12	0.18	0.23	9.58	10.77	79.20	0.71	15.67
Bulb weight (g)	48.66±2.33	37.66-56.66	41.51	49.72	13.23	14.48	83.49	11.08	22.77
Bulb diameter (cm)	5.00±0.17	4.67-5.4	4.20	8.53	4.09	5.84	49.26	0.21	4.20
Bulb height (cm)	3.84±0.14	3.33-4.43	0.12	0.15	9.23	10.25	81.13	0.59	15.36
No. of bulblets/ bulb	2.12±0.12	1.13-5.6	2.23	2.42	70.35	73.24	92.27	2.84	27.83
No. of scales/ bulb	45.00±2.48	31.66-63.66	111.10	120.34	23.37	24.33	92.32	20.05	44.55
Propagation coefficient (%)	138.86±4.32	105.71-161.88	381.26	409.90	14.06	14.58	93.01	37.41	26.94

Table 2. Estimates of phenotypic (r_p) and genotypic (r_g) correlation among different parameters in Asiatic lilium.

Character		X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19
X1	r_p	1.00	0.62*	0.47*	-0.28	0.67*	-0.09	0.51*	-0.16	0.40	0.63*	0.83*	0.55*	0.54*	0.58*	0.66*	0.55*	0.55*	0.23	0.59*
	r_g	1.00	0.76*	0.50*	-0.36	0.70*	-0.19	057*	-0.14	0.47*	0.71*	0.88*	0.59*	0.57*	0.66*	0.93*	0.67*	0.58*	0.27	0.64*
X2	r_p		1.00	-0.01	-0.58*	0.16	0.05	0.14	0.55*	0.12	0.16	0.62*	0.38	0.10	0.24	0.22	0.42	-0.01	0.48*	0.26
	r_g		1.00	0.01	-0.80*	0.18	0.10	0.17	0.49*	0.16	0.15	0.75*	0.42	0.09	0.30	0.38	0.42	0.01	0.57*	0.30
X3	r_p			1.00	0.05	0.80*	0.20	0.55*	-0.61*	0.78*	0.60*	0.17	0.58*	0.61*	0.50*	0.47*	0.40	0.83*	-0.28	0.46*
	r_g			1.00	0.05	0.85*	0.28	0.63*	-0.65*	0.83*	0.74*	0.21	0.62*	0.68*	0.55*	0.70*	0.47*	0.86*	-0.30	0.50*
X4	r_p				1.00	0.03	0.01	-0.08	-0.35	-0.04	0.10	-0.38	-0.26	0.22	-0.13	-0.05	-0.21	0.15	-0.72*	-0.14
	r_g				1.00	-0.05	-0.06	0.06	-0.45*	-0.10	0.21	-0.53*	-0.34	0.32	-0.11	-0.09	-0.35	0.19	-0.86*	-0.10
X5	r_p					1.00	0.16	0.80*	-0.70*	0.84	0.76*	0.30	0.78*	0.82*	0.78*	0.72*	0.61*	0.80*	-0.17	0.78*
	r_g					1.00	0.21	0.90*	-0.75*	0.89*	0.83*	0.32	0.80*	0.93*	0.90*	0.99*	0.70*	0.86*	-0.16	0.85*
X6	r_p						1.00	-0.01	-0.02	0.21	0.11	-0.35	0.07	0.20	0.05	-0.08	-0.23	0.28	-0.27	-0.11
	r_g						1.00	0.01	-0.08	0.47*	0.27	-0.58*	0.22	0.30	-0.05	-0.01	-0.25	0.31	-0.46	-0.01
X7	r_p							1.00	-0.60*	0.80*	0.52*	0.14	0.86*	0.74*	0.84*	0.57*	0.74*	0.44	-0.07	0.89*
	r_g							1.00	-0.64*	0.92*	0.57*	0.22	0.95*	0.94*	0.99*	0.98*	0.96*	0.50*	-0.08	0.98*
X8	r_p								1.00	-0.56*	-0.50*	0.14	-0.36	-0.61*	-0.54*	-0.54*	-0.24	-0.67*	0.41	-0.54*
	r_g								1.00	-0.60*	-0.62*	0.15	-0.39	-0.73*	-0.62*	-0.73*	-0.30	-0.72*	0.45*	-0.57*
X9	r_p									1.00	0.47*	0.03	0.89*	0.68*	0.71*	0.47*	0.70*	0.54*	-0.17	0.74*
	r_g									1.00	0.57*	0.05	0.93*	0.88*	0.87*	0.81*	0.76*	0.63*	-0.22	0.80*
X10	r_p										1.00	0.31	0.39	0.62*	0.39	0.47*	0.23	0.79*	-0.15	0.39
	r_g										1.00	0.35	0.42	0.78*	0.52*	0.94*	0.30	0.98*	-0.12	0.46*
X11	r_p											1.00	0.24	0.10	0.31	0.51*	0.41	0.23	0.46*	0.29
	r_g											1.00	0.26	0.13	0.33	0.57*	0.46*	0.26	0.50*	0.34
X12	r_p												1.00	0.38	0.80*	0.54*	0.86*	0.35	0.08	0.87*
	r_g												1.00	0.76*	0.94*	0.82*	0.95*	0.40	0.06	0.90*
X13	r_p													1.00	0.73*	0.66*	0.53*	0.66*	-0.42	0.77*
	r_g													1.00	0.91*	0.98*	0.66*	0.72*	-0.46*	0.86*
X14	r_p														1.00	0.76*	0.80*	0.43	-0.09	0.92*
	r_g														1.00	1.00*	0.90*	0.48*	-0.06	0.99*
X15	r_p															1.00	0.55*	0.61*	-0.40	0.70*
	r_g															1.00	0.78*	0.80*	-0.05	0.99*
X16	r_p																1.00	0.17	0.18	0.83*
	r_g																1.00	0.22	0.22	0.92*
X17	r_p																	1.00	-0.29	0.38
	r_g																	1.00	-0.32	0.42
X18	r_p																		1.00	-0.03
	r_g																		1.00	-0.05
X19	r_p																			1.00

*Significant at 5% level of probability

X1 = plant height (cm), X2 = leaves/plant, X3 = leaf length (cm), X4= leaf breadth (cm), X5 = plant spread (cm), X6 = plant girth at centre (mm), X7 = flower diameter (cm), X8 = number of flowers/plant, X9 = bud length before opening (cm), X10 = bud diameter (cm), X11 = pedicel length (cm), X12 = petal length (cm), X13 = petal breadth (cm), X14 = bulb weight (g), X15 = bulb diameter (cm), X16 = bulb height (cm), X17 = bulblets/bulb, X18 = scales/bulb, X19 = propagation coefficient (%).

Significant and positive correlation of number of leaves per plant with flower per plant, pedicel length, scales/bulb and propagation coefficient was recorded at both phenotypic and genotypic levels. Leaf length was positive and significantly correlated with plant spread, flower diameter, bud length before opening, bud diameter, petal length, petal breadth, bulb weight, bulb diameter, bulblets/ bulb and propagation coefficient, however, this was negatively correlated with number of flower/plant both at phenotypic and genotypic level. Leaf breadth was positive and significantly correlated with scales/bulb at both phenotypic and genotypic levels. This was negatively correlated with flowers/plant and pedicel length at genotypic level only. Plant spread was significant and positively correlated with flower diameter, bud length before opening, bud diameter, petal length, petal breadth, bulb weight, bulb diameter, bulb height, bulblets/ bulb and propagation coefficient.

Flower diameter was found significant and positively correlated with number of flowers/plant, bud length before opening, bud diameter, petal length before opening, bud diameter, petal length, petal breadth, bulb weight, bulb diameter, bulb height and propagation coefficient at both phenotypic and genotypic levels. Number of flowers per plant was negative and significantly correlated with bud length before opening, bud diameter, petal breadth, bulb weight, bulb diameter, bulblets/scale and propagation coefficient at both phenotypic and genotypic levels. Bud length was significant and positively correlated with bud diameter, petal length, petal breadth, bulb weight, bulb diameter, bulb height, bulblets/ bulb and propagation coefficient at both phenotypic and genotypic levels. Bud diameter was significant and positively correlated with petal breadth, bulb diameter and bulblets/ bulb both at phenotypic and genotypic levels. Pedicel length was significant and positively correlated with bulb diameter and scales/bulb at both phenotypic and genotypic levels. Petal length was significant and positively correlated with bulb weight, bulb diameter, bulb height and propagation coefficient at both phenotypic and genotypic levels. Petal breadth was significant and positively correlated with bulb weight, bulb diameter, bulb diameter, bulb height, bulblets/bulb and propagation coefficient at both phenotypic and genotypic levels.

Bulb weight exhibited significant positive correlation with bulb diameter, bulb weight and propagation coefficient at both phenotypic and genotypic levels. Bulb diameter was significant and positively correlated with bulb height, bulblets/bulb and propagation coefficient at both phenotypic and genotypic levels. Positive and significant correlation was observed between bulb height and propagation coefficient at both phenotypic and genotypic levels.

REFERENCES

1. Balode, A. 2007. Variability of wild martagon lily (*Lilium martagon* L.) in the region of Kurzeme. *Proc. 13th Int. Scientific Conf. "Research for Rural Development 2007",* Jelgava, Latvia, pp. 50-56.

2. Beattie, D.J. and White, J.W. 1993. Lilium - hybrids and species. *The Physiology of Flower Bulbs*. Elsevier Science Publ. Amsterdam, pp. 423-54.

3. Burton, G.W. 1952. Quantitative inheritance in grasses. *Proc. 5th International Grassland Congress*, **1**: 277-83.

4. Chitra, R. and Rajamani, K. 2010. Character association and path analysis in glory lily (*Gloriosa superb* L.). *Int. J. Faculty Agric. Biol.* **5**: 78-82.

5. Farooqi, A.A., Gowda, H.R. and Hegde, L.1999. Genetic variability correlation and path analysis in glory lily. *J. Med. Arom. Pl. Sci.* **21**: 316-19.

6. Holland, J.B., Nyquist, W.E. and Cervantes-Martinez, C.T. 2003. Estimating and interpreting heritability for plant breeding: An update. *Pl. Breed. Rev.* **22**: 109-12.

7. Huang, Yong-fang, Yang Mao-xun, Zhang Hao, Zhuang Xue-ying, Wu, Xue-hui and Xie Wan. 2009. Genetic diversity and genetic structure analysis of the natural populations of *Lilium brownii* from Guangdong, China. *Biochem. Genet.* **47**: 503-10.

8. Johnson, H.W., Robinson, H.F. and Comstock, R.E. 1955. Estimates of genetic and environmental variability in soybean. *Agron. J.* **47**: 314-18.

9. Prabhat Kumar, Maurya, R.K., Chakraborty, B., Rakesh, M. and Mishra, D.S. 2011. Genetic variability and correlation studies in *Gladiolus hybrida* L. under tarai condition. *Ann. Hort.* **4**: 140-46.

10. Singh, R.K. and Chaudhary, B.D. 1985. *Biometrical Methods in Quantitative Genetic Analysis*. Kalyani Publishers, New Delhi, 318 p.

Received : December, 2012; Revised : October, 2013; Accepted : November, 2013