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Genetic variability and correlation studies among different *Lilium* genotypes

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ABSTRACT

The present study was carried out for two years (2016-18) to estimate the genetic variability, heritability, genetic advance, genetic gain and correlation among 18 *Lilium* genotypes. Findings revealed characters such as number of bulblet/plant, number of leaves/plant and number of flowers/plant recorded high genotypic coefficient of variability (GCV). High heritability coupled with moderate genetic advance recorded for number of leaves/plant, plant height and stem length. Moderate heritability with highest genetic gain recorded for number of bulblets/plant followed by traits such as number of leaves per plant, leaf width, number of flowers/plant and weight of bulblet etc. Significant positive correlation of yield parameter (number of flowers per plant) recorded with plant height, number of leaves per plant, leaf length, stem length, stem diameter, duration of flowering, bulb diameter and weight of bulb etc. Maximum positive direct effect of days to flower bud formation, number of leaves per plant, bulb diameter, weight of bulb, leaf length, stem length etc. on number of flowers per plant revealed the true relationship between them and selection on the basis of these characters would be more effective for the improvement among *Lilium* genotypes.

Key words: Correlation, Genotypic variability, Heritability

Lilium is one of the popular and economically important ornamental bulbous plant. It belongs to the family Liliaceae and is native to Northern Hemisphere mainly Asia, North America and Europe. The genus *Lilium* comprises around 100 species and more than 9400 cultivars. They are available in wide range of colours, forms commercially used as cut flower, pot plant and in landscape. Some of the cultivars are highly fragrant and possess medicinal properties. *Lilium* occupy an important place in international flower market ranking 4th position among the top 10 cut flowers of the world (Anon 2018). The major production areas are located in hilly states of the country like Himachal Pradesh, Uttarakhand, J&K and recently, Haryana is emerging as a leading potential hub for *Lilium* cultivation (Anon 2016). Correlation studies determine as how far two variables are associated with each other. The yield component is the most important aspiration of plant and is expressed with function of many components traits and their interaction with the environment. Therefore, it is essential to study the genetic variability and mutual associations between various plant characters so that reliable selection criteria for genetic improvement of yield and other desirable traits can be performed.

MATERIALS AND METHODS

An experiment was conducted for two years (2016-18) in a Randomized Block Design with three replications at the experimental farm of Dr YSP UHF, Nauni, Himachal Pradesh under shade net house (50%) conditions. The experimental farm is located 1276 m amsl and is characterized by sub-temperate climate with mild summers and cool winters. 18 genotypes, viz. seven Asiatic hybrids (Navona, Prato, Tresor, Shiraj, Brunello, Pollyana and Elite), seven LA hybrids (Eyeliner, Ercolano, Ceb Dazzle, Best Seller, Pavia, Salmon Classic and Cilesta), two OT hybrids (Yelloween and Montego Bay) and two Oriental hybrids (Viviana and Sapporo) were selected and procured from ICAR-IARI, Regional Station, Katrain, Kullu (Himachal Pradesh). Freshly harvested healthy and uniform size (12/14) bulbs were stored at 4ºC in cool chamber for 9 weeks before planting. For second year planting, previous year planted crops were harvested and similar vernalization treatment was given to the bulbs. Subsequently, planting was done in growing medium comprised of soil, FYM, sand and vermicompost in the ratio of 2:1:1:1 (v/v), spread in raised (20 cm) beds of 60 cm × 60 cm. Basal dose of nitrogen (6.52 g/m^2), phosphorus (18.75 g/m^2) and potassium (5.0 g/m^2) was applied in the form of urea (3.9 g/0.6 m^2), single super phosphate (11.25 g/0.6 m^2) and muriate of potash (3.0 g/0.6 m^2). Bulbs were planted at a depth of 8-10 cm and after planting drenching were carried out with solution of Bavistin (0.1 %) and Dithane M-45 (0.2%). All the standard cultural practices were carried out throughout the growing period. Observations were recorded on ten randomly selected plants of each genotype in each replication for 21 quantitative parameters (Table 1 and Table 2).

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Table 1 Pooled estimates of mean, genotypic & phenotypic coefficient of variability, heritability, genetic advance and genetic gain among *Lilium* genotypes

Character	Mean ± Standard error	Range	Coefficients of variability (%)		Heritability (%)	Genetic advance (%)	Genetic gain (%)
			PCV	GCV			
Days taken for bulb sprout emergence	48.26 ± 0.86	33.50 – 66.89	20.37	20.25	98.86	20.02	41.49
Per cent bulb sprouting (%)	98.70 ±1.59	93.33 - 100.00	2.68	1.80	45.31	2.47	2.50
Plant height (cm)	71.07 ± 3.18	53.55 - 87.46	15.25	14.23	87.06	19.44	27.36
Number of leaves/plant	48.35 ±1.26	18.37 - 80.92	37.82	37.68	99.29	37.40	77.35
Leaf length (cm)	10.27 ± 0.26	6.55 - 13.81	20.14	19.90	97.62	4.16	40.51
Leaf width (cm)	2.11 ± 0.11	1.43 - 3.92	30.39	29.66	95.22	1.26	59.61
Stem length (cm)	50.99 ± 0.92	32.03 - 69.24	22.15	22.04	99.00	23.04	45.18
Days to flower bud formation	70.89 ± 0.35	54.02 – 87.12	11.63	11.62	99.73	16.94	23.90
Bud length (cm)	9.04 ± 0.25	6.13 - 12.32	16.28	15.93	95.79	2.90	32.12
Days to first flower	105.23 ± 0.38	82.23 – 119.29	9.26	9.25	99.77	20.03	19.04
Stem diameter (cm)	0.56 ± 0.03	0.40 - 0.72	18.12	16.83	86.21	0.18	32.18
Size of the flower (cm)	16.11 ± 0.46	13.29 - 20.43	11.26	10.70	90.27	3.37	20.93
Number of flowers/plant	4.06 ± 0.38	1.78 - 8.05	44.91	43.43	93.52	3.51	86.51
Tepal length (cm)	10.0 ± 0.29	7.48 - 12.45	13.47	13.00	93.18	2.61	25.86
Tepal width (cm)	3.21 ± 0.11	2.35 - 3.97	14.99	14.40	92.26	0.92	28.49
Duration of flowering (days)	13.95 ± 0.68	11.96 - 16.28	11.63	10.00	73.94	2.47	17.71
Bulb diameter (cm)	4.11 ± 0.28	3.16- 4.79	13.03	9.91	57.83	0.64	15.52
Weight of bulb (g)	25.56 ± 1.03	13.86 - 36.03	24.03	23.52	95.80	12.12	47.43
Number of bulblets/plant	0.96 ± 0.22	0.42 - 2.23	61.69	54.77	78.82	0.96	100.16
Weight of bulblet (g)	2.01 ± 0.33	0.62 - 3.10	35.41	29.22	68.07	1.00	49.66
Vase life (days)	6.74 ± 0.44	6.67 - 9.20	15.30	13.00	72.18	1.53	22.76

RESULTS AND DISCUSSION

Coefficients of variability: The variability observed in the characters may be attributed due to the interaction effects of genotype and prevailing environment conditions. Environmental variations are not fixable. In our study, high value of PCV (>30%) was recorded for number of bulblets/plant (61.69%), number of flowers per plant (44.91%), number of leaves/plant (37.82%), weight of bulblet (35.41%) and leaf width (30.39%) (Table 1). Similarly, Kumar (2013) in *Lilium*, Pratap and Rao (2006), Kumar *et al*. (2015) in gladiolus and Jhon *et al*. (2006) in tulip also reported higher PCV than GCV for most of the characters.

Moderate values of PCV (15-30%) for weight of bulb (24.03%), stem length (22.15%), days to sprouting (20.37%), leaf length (20.14%), stem diameter (18.12%), bud length (16.28 %), vase life (15.30 %) and plant height (15.25%).

High value of GCV (>30%) obtained for number of bulblets per plant (54.77 %) followed by number of flowers/plant (43.4%) number of leaves/plant (37.68%); moderate values of GCV (15-30%) for characters such as weight of bulblet (29.22%), weight of bulb (23.52%), stem length (22.04%), days to sprouting (20.25%), leaf length (19.90%), stem diameter (16.83%), bud length (15.93%) and low GCV values (<15%) were observed for per cent bulb sprouting (1.80%), plant height (14.23 %), days to flower bud formation (11.62%), days to first flower (9.25%), size of the flower (10.70%), tepal length (13.00%), tepal width (14.40%), duration of flowering (10.00%), vase life (13.00%) and bulb diameter (9.91%).

Coefficients of variability varied in magnitude from character to character indicating great diversity in the experimental material used. High GCV recorded for number of bulblets/plant, number of flowers/plant and number of leaves/plant indicating these traits were little influenced by environment and selection of these traits for improvement will be effective. These results are in conformity with Choudhary *et al*. (2012) and Kumar *et al.* (2010) in gladiolus.

Heritability: The estimates of heritability in broad sense give a measure of transmission of characters from one generation to another thus, giving an idea of heritable portion of variability and enabling the plant breeder in isolating the elite selection in the crop. High heritability (>80%) estimates were recorded for parameters like; days taken for bulb sprout emergence (98.86%), plant height (87.06%), number of leaves/plant (99.29%), leaf length (97.62%), leaf width (95.22%), stem length (99.00%), days

Table 2 Pooled analysis of coefficients of correlation at genotypic level (above diagonal) and phenotypic level (below diagonal) among different characters in *Lilium* genotypes

*C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	-	-0.03	0.24	-0.38**	-0.56**	0.74**	0.23	0.65**	0.52**	0.63**	-0.05	0.42**	-0.29*	0.38**	0.36**	-0.11	-0.81**	-0.48**	-0.22	0.28*	0.37**
2		-	0.31*	0.20	0.32*	0.10	0.32*	-0.07	0.14	-0.14	0.04	0.07	0.26	-0.02	-0.17	0.16	0.33*	-0.09	0.03	0.11	0.00
3			-	0.65**	0.48**	-0.12	1.01**	0.06	0.33*	0.17	-0.03	0.15	0.74**	0.16	-0.24	-0.37**	-0.05	0.23	-0.05	0.20	0.20
4				-	0.74**	-0.62**	0.60**	-0.51**	-0.24	-0.37**	0.15	-0.35**	0.90**	-0.30*	-0.50**	-0.05	0.41**	0.62**	0.34*	0.29*	0.03
5					-	-0.67**	0.49**	-0.64**	-0.06	-0.48**	0.24	-0.21	0.75**	-0.16	-0.24	-0.07	0.80**	0.58**	0.29*	0.00	-0.38**
6						-	-0.09	0.60**	0.49**	0.50**	0.03	0.63**	-0.44**	0.49**	0.56**	0.13	-0.65**	-0.48**	-0.29*	0.24	0.51**
7							-	0.05	0.32*	0.15	0.00	0.14	0.72**	0.18	-0.15	-0.41**	0.00	0.24	0.02	0.24	0.17
8								-	0.40**	0.94**	-0.58**	0.43**	-0.33*	0.42**	0.15	-0.04	-0.70**	-0.62**	-0.01	0.19	0.26
9									-	0.32*	0.21	0.89**	-0.07	0.93**	0.67**	0.31*	-0.26	-0.20	-0.30*	0.07	0.11
10										-	-0.63**	0.31*	-0.22	0.29*	0.02	-0.11	-0.62**	-0.46**	0.10	0.29*	0.24
11											-	0.14	0.17	0.28*	0.40**	0.20	0.37**	0.38**	-0.21	0.20	0.01
12												-	-0.15	0.89**	0.74**	0.39**	-0.31*	-0.32*	-0.35**	0.15	0.35*
13													-	-0.13	-0.39**	-0.15	0.36**	0.47**	0.33*	0.30*	0.05
14														-	0.73**	0.30*	-0.16	-0.15	-0.21	0.16	0.13
15															-	0.32*	-0.24	-0.14	-0.27	0.08	0.02
16																-	0.17	0.17	0.21	0.42**	0.11
17																	-	0.58**	0.13	0.1	-0.68**
18																			0.19	0.30*	-0.16
19																			-	0.34*	0.14
20																				-	0.31*
21																					-

*Significant at 5% level of significance; **Significant at 1% level of significance. *C: Characters=1: Days taken for bulb sprout emergence; 2: Per cent bulb sprouting (%); 3: Plant height (cm); 4: Number of leaves/plant; 5: Leaf length (cm); 6: Leaf width (cm); 7: Stem length (cm); 8: Days to flower bud formation ; 9: Bud length (cm); 10: Days to first flower; 11: Stem diameter (cm); 12: Size of the flower (cm); 13: Number of flowers/plant; 14: Tepal length (cm); 15: Tepal width (cm); 16: Duration of flowering (days); 17: Bulb diameter (cm); 18: Weight of bulb (g); 19: Number of bulblets/plant; 20: Weight of bulblet (g); 21: Vase life (days)

to flower bud formation (99.73%), bud length (95.79%), days to first flower (99.77%), stem diameter (86.21%), size of the flower (90.27%), number of flowers/plant (93.52%), tepal length (93.18%), tepal width (92.26%) and weight of bulb (95.80%) and moderate heritability estimates (50-80%) were observed for duration of flowering (73.94%), vase life (72.18%), bulb diameter (57.83%), number of bulblets/plant (78.82%) and weight of bulblet (68.07%).

High value of heritability indicates that there is a very good scope for the improvement for these traits. Low heritability values suggest the involvement of environmental component in the expression of character thereby direct selection of a particular character would be futile; hence indirect selection needs to be adopted. In present study, high estimates of heritability were obtained for all the characters except per cent bulb sprouting. These results are in agreement with the earlier findings of Jhon *et al*. (2006) in tulip and Dhiman *et al*. (2015) in *Lilium*.

Genetic advance and genetic gain: High heritability estimates along with high genetic advance (>50) as per cent of mean will be more useful than heritability alone to know the ultimate effect of selection. High heritability coupled with moderate genetic advance was observed for number of leaves/plant (37.40%) suggesting the involvement of dominant and epistatic gene action and these traits can be improved through hybridization. Kumar (2013) also reported high heritability with moderate genetic advance as per cent of mean for number of leaves/plant, flower diameter, bud diameter, petal breadth and bulb height among different Asiatic *Lilium* hybrids.

In the present study low genetic advance (<25%) reported for most of the parameters. High heritability along with low genetic advance observed in traits, viz. days taken for bulb sprout emergence (20.02%), leaf length (4.16%), leaf width (1.26%), stem length (23.04%), days to flower bud formation (16.94%), bud length (2.90%), days to first flower (20.03%), stem diameter (0.18%), size of the flower (3.37%), number of flowers/plant (3.51%), tepal length (2.61%), tepal width (0.92%) and weight of bulb (12.12%) indicating that high heritability of these characters is purely governed by favourable environmental conditions and selection of such traits may not be useful. High heritability along with low genetic advance for days to first flower has also been reported by Dhiman *et al*. (2015) in Asiatic hybrid lily and Bhatia *et al*. (2017) in tulip.

Moderate heritability with highest genetic gain (100.16%) recorded for number of bulblets/plant. Verty *et al*. (2017) and Naresh *et al*. (2015) also reported highest genetic gain for number of cormels/plant in gladiolus. High heritability along with high genetic gain observed for the traits like; number of leaves per plant (77.35%), leaf width (59.61%) and number of flowers/plant (86.51%) indicating the involvement of both additive and non-additive gene action signifying that simple selection will be helpful in selecting better genotypes. High heritability along with low genetic gain for traits such as days to flower bud formation (23.90%), days to first flower (19.04%) and size of the flower (20.93%) indicating that the selection for these characters would not be effective for improvement.

Coefficients of correlation: In floriculture industry, cut flowers are the most important component. Genotypes which possess the characteristic of high yield and wider climatic adaptability along with several other economic and social aspects are ideal. However not even a single species or variety of plant material will meet all of these criteria. Therefore, direct and indirect selection of various traits is carried out for crop improvement purposes. Positive correlations ensure simultaneous improvement in one or more variables and negative correlations bring out the need to obtain a compromise between the desirable traits.

Genotypic correlation coefficient: Estimates of coefficient of correlation worked out at genotypic level revealed the strong positive and significant correlation of number of flowers/plant with plant height (0.74), number of leaves/plant (0.90), leaf length (0.75), stem length (0.72), days to flower bud formation (0.43), bud length (0.89), days to first flower (0.31), bulb diameter (0.36), weight of bulb (0.47), number of bulblets/plant (0.33) and weight of bulblet (0.30). Balaram and Janakiram (2009) also reported positive correlation between number of leaves/plant and florets/spike in gladiolus. More photosynthates are made available through more number of leaves which in turn improved the number of flowers/plant.

Plant height which is an important aesthetic trait for cut flower had significant and positive correlation with per cent bulb sprouting (0.31), number of leaves/plant (0.65), leaf length (0.48), stem length (1.01), bud length (0.33) and number of flowers/plant (0.74) which could be improved with the improvement in any of these characters. These results are in close agreement with Dhiman *et al*. (2015) in *Lilium* and Bhatia *et al*. (2017) in tulip.

Significantly high positive correlation of size of the flower reported with days taken for bulb sprout emergence (0.42), leaf width (0.63), tepal length (0.89), tepal width (0.74), duration of flowering (0.39) and vase life (0.35).

Lilium hybrids are commercially propagated by bulbs. So there is a need to improve the multiplication potential either by selecting the genotypes with high bulb multiplication coefficient or via indirect improvement of traits associated with bulb size. In our study, bulb diameter recorded positive correlation with per cent bulb sprouting (0.33), number of leaves/plant (0.41), leaf length (0.80), stem diameter (0.37), number of flowers/plant (0.36) and weight of bulb (0.58). Likewise weight of bulb was positively correlated with number of leaves/plant (0.62), leaf length (0.58), stem diameter (0.38), number of flowers/plant (0.47), bulb diameter (0.58) and weight of bulblet (0.30) indicating improvement in size and weight of bulb could be achieved through selection of any of these traits. Similar results were also reported by Kumar (2013) in *Lilium*. Vase life is an important parameter which decides the overall present ability and acceptability of cut flower. Vase life recorded significant positive correlation with days taken for bulb sprout emergence (0.37), leaf width (0.51),

size of the flower (0.35) and weight of bulblet (0.31).

Hence it can be concluded that yield and other aesthetic traits in *Lilium* found to be positively correlated with number of leaves/plant, leaf length, stem length, weight of bulb and weight of bulblet and direct selection of such traits will be beneficial in further crop improvement.

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