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Assessment of genetic variability among lilium (*Lilium* spp.) genotypes for productivity and quality traits

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Abstract
An experiment was conducted with 30 genotypes of lilium to study the genotypic and phenotypic coefficients of variation, heritability and expected genetic advance. The data indicated that estimates of phenotypic coefficient of variation (PCV) is greater than those of genotypic coefficient of variation (GCV) for all the traits studied indicating apparent variation is not only due to genotypes but also due to the influence of environment. High heritability coupled with high genetic advance were observed for most of the traits indicating the presence of additive gene action. High estimates of GCV (>20%), PCV (>20%), heritability (>60%) and genetic advance over mean (>20%) were obtained for days to bulb sprouting, plant height at 60 days after planting, number of leaves, leaf area index, total chlorophyll, flowering duration, stalk length, stalk diameter, florets per stalk, stalks per square meter and bulbs per plant showing that selection of these characters may be relied upon for pure line selection for improvement.

Keywords: Lilium, genetic variability, heritability, productivity traits

1. Introduction
Lilium spp. which adds a touch of elegance to garden belongs to the family Liliaceae. Lily is one of the most beautiful and popular ornamental bulbous plant consists of about 80-100 species. In the language of flowers, lily is considered as the symbol of beauty and innocence and deserves to be called the "Aristocrat of the plant world". The appearance, beauty and color of the blooms are very attractive and popularity of this lilium species is increasing both as a cut flower, potted plant and in landscape. There is a tremendous scope for improvement especially with spike related traits through inter and intra specific hybridization programmes. A study on such traits will be essential for successful breeding programme. A systematic study of vegetative characters would facilitate the breeders to select suitable genotypes for planned breeding programme (Mahajan *et al.*, 2011) [9]. In lilium, like any other plant species, the phenotypic expression of a character is mainly governed by the genetic make-up of the plant, the environment in which it is grown and the interaction between the genotype and the environment. Further, the genotype of a plant is controlled by additive gene effect (heritable), non-additive gene effect or dominance (non-heritable) and epistasis (non-allelic interaction). Apportioning of phenotypic variability into its heritable and non-heritable components with suitable genetic parameters such as genotypic and phenotypic co-efficient of variation, heritability and genetic advance is necessary. Thus the present study was taken up to know the genetic variability in lilium which can be used in lilium improvement programme.

Material and Methods
The experiment was carried out at department of Floriculture and Landscape Architecture, Kittur Rani Channamma college of Horticulture, Arabhavi, which is situated in the northern dry zone (Zone III) of Karnataka. The experiment was laid out in complete randomized design with spacing of 30×15 cm, which was replicated twice with 30 genotypes in protected condition. The details of 30 genotypes used in the study are presented in the table 1. Recommended agro techniques were followed and observations were made on the vegetative and floral parameters. The data regarding parameters of variability like mean, range, phenotypic and genotypic coefficient of variation (Burton and Devane, 1953) [3], broad sense heritability and genetic advance (Johnson *et al.*, 1955) [8] were noted.

Results and discussion

The analysis of variance revealed highly significant differences among the genotypes for all traits studied (Table 2) indicating that genotypes used in the present study are genetically diverse and can be exploited through selection. Parameters like days taken to first flower bud initiation, days to first harvest and duration of flowering varied significantly among cultivars due to their genetic makeup which is in concurrence with the conclusions of Raghupathi *et al.* (2019) [13] in dahlia and Arulmani *et al.* (2016) [1] in gaillardia. The evaluated genotypes exhibited significant variation for various yield parameters like flowers per plant, stalks per meter square, bulb weight and number of bulbs per plant. Differences in yield among the genotypes was mostly due to genetic variation and effect of growing environment, which is supported by studies of Shukla *et al.* (2018) [16] and Manjula *et al.* (2017) [10] in dahlia.

Estimates of phenotypic coefficient of variance (PCV) was higher compared to genotypic coefficient of variance (GCV) for all the characters (Table 3), indicating the role of environmental factors for the expression of these traits. High estimates of GCV coupled with PCV were obtained for days to bulb sprouting (63.44%, 63.61%), plant height at 60 days after planting (23.38%, 23.77%), number of leaves (34.23%, 34.49%), leaf area index (40.10%, 40.41%), total chlorophyll (27.31%, 27.62%), flowering duration (24.72%, 25.17%), stalk length (24.12%, 24.12%), stalk diameter (29.50%, 29.85%), florets per stalk (44.33%, 44.56%), stalks per meter square (23.96% and 24.26 %), bulbs per plant (23.29%, 23.68%). The GCV and PCV are required to understand the effect of environment on various polygenic traits (Naresh *et al*., 2015) [11]. Similar results were obtained by Sangeeta Kumari (2019) [15] in lilium, Giri *et al.* (2019) [7] in marigold, Raghupathi *et al.* (2019) [13] in dahlia, Rai (2016) [14] in china aster, Ghimiray and Sarkar (2015) [6] in Gerbera. Hence these characters can be relied upon for further crop improvement.

In this study, high estimates of heritability coupled with high genetic advance over mean were obtained for all the characters except, Bulbs sprouting percentage and stalk weight. It indicates the presence of additive gene effects in these traits and their amicability for direct selection. These results are in agreement with the earlier findings of Sangeetha Kumari (2019) [15] and Dhiman *et al*. (2015) [5] in lilium, Naresh *et al*. (2015) [11], Pattanaik *et al*. (2015) [12], Bhujbal *et al*. (2013) [2], Choudhary *et al*. (2012) [4] and Sripada Shwetha *et al*. (2020) [17] in gladiolus, Arulmani *et al*. (2016) [1] in Gaillardia.

Table 1: Details of the lilium genotypes used in present study

Sl. No.	Genotype	Flower colour
1	ACC-1	Brilliant Greenish Yellow
2	ACC-2	Brilliant Greenish Yellow
3	Arbatax	Vivid Purplish Red
4	Arletta	White
5	Armandale	Vivid Red
6	Best Seller	Light Yellowish Pink
7	Cavalia Zanlacav	Brilliant Yellow Green
8	Celesta	Brilliant Orange
9	Cesare	Strong Orange
10	Couplet Zanlacoudn	Moderate Purplish Pink
11	Eyeliner	White
12	Indian Summer Set	Strong Purplish Pink
13	Largo	Vivid Purplish Red
14	Lexus Zanlorexus	Strong Purplish Pink
15	Litowin	White
16	Melconli	Greenish White
17	Meriva Zanlorva	White
18	Nashville	Brilliant Greenish Yellow
19	Navona	White
20	Original Love	Vivid Reddish Orange
21	Pavia	Brilliant Yellow
22	Ravena	Deep Purplish Pink
23	Rialto	White
24	Ripasso	Strong Reddish Purple
25	Salmon Classic	Brilliant Orange Yellow
26	Saloniki	Light Purple
27	Sedano Zanlorsed	White
28	Signum	White
29	Tresor	Strong Orange
30	Yelloween	Light Greenish Yellow

Table 2: Analysis of variance for productivity and quality traits in lilium

Sl. No.	Characters	Replication d.f=1	Genotypes (Df=29)	Error Df=29	SEm ±	CD @ 1%
1	Days to bulb sprouting	0.003	157.90**	0.44	0.46	1.83
2	Plant height	0.001	333.11**	5.56	1.64	6.50
3	Number of leaves	11.598	555.65**	4.15	1.42	5.62
4	Leaf area index	0.0002	0.11**	0.001	0.02	0.08
5	Total chlorophyll (mg/g)	0.073	16.70**	0.19	0.30	1.19

6	Days to flower bud initiation	31.36	152.42**	2.44	1.08	4.30
7	Days to first harvest	22.94	223.43**	3.57	1.31	5.20
8	Flowering duration (days)	0.56	24.08**	0.43	0.46	1.81
9	Stalk length (cm)	3.29	244.10**	2.60	1.12	4.44
10	Stalk diameter (mm)	0.071	9.16**	0.11	0.22	0.91
11	Stalk weight (g)	200.78	132.77**	8.14	1.98	7.86
12	Bud length (cm)	0.10	3.54**	0.11	0.23	0.93
13	Bud diameter (mm)	0.51	20.24**	0.80	0.62	2.47
14	Flower diameter (cm)	0.003	6.76**	0.54	0.51	2.03
15	Vase life with anthers	0.28	5.33**	0.11	0.23	0.91
16	Florets per stalk	0.013	4.63**	0.02	0.11	0.42
17	Stalks per meter square	11.79	47.87**	0.61	0.54	2.15
18	Bulbs per plant	0.005	0.14**	0.002	0.03	0.13
19	Diameter of bulb (cm)	0.075	1.86**	0.06	0.17	0.66
20	Weight of bulb (g)	38.24	102.42**	1.69	0.90	3.59

Table 3: Estimates of range, mean, components of variance, heritability and genetic advance for various parameters of lilium

Sl. No.	Characters	Range		Mean	Coefficient of variance		h^2 (%)	GAM (%)
		Min.	Max.		GCV (%)	PCV (%)		
1	Days to bulb sprouting (days)	2.42	30.16	13.98	63.44	63.61	99.40	130.31
2	Plant height (cm)	24.53	77.05	54.74	23.38	23.77	96.70	47.36
3	Number of leaves	17.05	77.10	48.50	34.23	34.49	98.50	69.99
4	Leaf area index	0.20	0.99	0.59	40.10	40.41	98.50	81.98
5	Total chlorophyll (mg/g)	3.74	16.65	10.52	27.31	27.62	97.77	55.63
6	Days to flower bud initiation	43.06	77.52	60.52	14.30	14.53	96.90	29.00
7	Days to first harvest	58.22	103.14	80.87	12.97	13.17	96.90	26.28
8	Flowering duration (days)	8.37	22.08	13.91	24.72	25.17	96.50	50.02
9	Stalk length (cm)	26.20	65.14	45.56	24.12	24.37	97.90	49.15
10	Stalk diameter (mm)	4.03	12.07	7.21	29.50	29.85	97.70	60.06
11	Stalk weight (g)	67.46	99.56	83.41	9.46	10.06	88.40	18.33
12	Bud length (cm)	7.19	12.82	9.12	14.35	14.81	93.80	28.62
13	Bud diameter (mm)	13.04	29.78	18.31	17.02	17.71	92.40	33.70
14	Flower diameter (cm)	10.64	20.18	14.69	11.99	13.00	85.10	22.79
15	Vase life with anthers	6.39	12.68	9.10	17.76	18.13	96.00	35.86
16	Florets per stalk	1.00	6.88	3.42	44.33	44.56	99.00	90.86
17	Stalks per meter square	15.83	43.16	20.29	23.96	24.26	97.50	48.73
18	Bulbs per plant	1.00	2.00	1.12	23.29	23.68	96.70	47.18
19	Diameter of bulb (cm)	3.52	7.86	5.55	17.09	17.63	94.00	34.13
20	Weight of bulb (g)	23.22	58.49	41.46	17.11	17.40	96.70	34.68

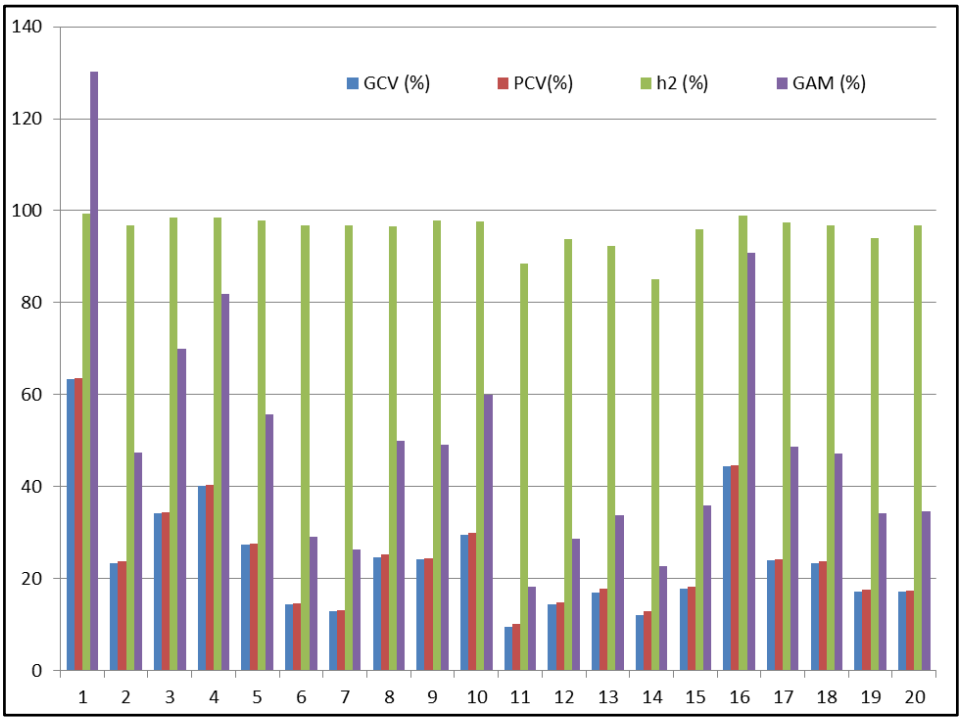

Fig 1: Estimates of components of variance, heritability and genetic advance over mean for various parameters of lilium

1	Days to bulb sprouting	6	Flower bud initiation (days)	11	Stalk weight (g)	16	Florets per stalk
2	Plant height (cm)	7	Days to first harvest	12	Bud length (cm)	17	Stalks/m2
3	Number of leaves	8	Flowering duration	13	Bud diameter (mm)	18	Bulbs per plant
4	Leaf area index	9	Stalk length (cm)	14	Flower diameter	19	Bulb diameter (cm)
5	Total chlorophyll	10	Stalk diameter (mm)	15	Vase life	20	Bulb weight (g)

Conclusion

In conclusion, there was a wide range of variability for various growth, flowering, quality and yield parameters in lilium. Most of the parameters included in the study exhibited high estimates of GCV coupled with PCV and high heritability coupled with high genetic advance as per cent of mean. For most of the traits, the difference between PCV and GCV was less indicating that these characters are not considerably influenced by environmental factors suggesting the presence of sufficient genetic variability, which can be exploited by practicing selection.

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