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Genetic variability, heritability and correlation studies in *Hibiscus rosa-sinensis*

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Abstract
Hibiscus rosa-sinensis is an ornamental flowering shrub that have been found in all the households. The flowers have got ornamental, neutraceutical and ethical values in India. The flowers are rich in anthocyanin which can be used as a food colourant. High genotypic and phenotypic coefficient of variance was observed for characters like leaf area, petal width, style length, bud width, leaf length, flower diameter, single flower weight, anthocyanin content and flower yield. Flower yield was found to be positively related with floral parameters like petal length, petal width, style length and single flower weight.

Keywords: Hibiscus, flowers, variability, heritability, correlation

Introduction
Hibiscus rosa-sinensis is a common and highly preferred flowering shrub found in most of the households. *H. rosa-sinensis* have a good cultural value in India. *H. rosa-sinensis* is the major flower that is offered to the Goddess 'Kali' (Gupta, 1971) [6]. In the Indian literatures the glory of the rising sun is often compared to the resplendently beautiful flower. A famous poet in in his praise of the Sun God begins with `japaa kusuma sankaasam' where 'japaa' represents hibiscus flowers. The flowers of Hibiscus possess immense medicinal value. In a traditional folk medical system of Sagar taluk in Karnataka, the leaf paste of *H. rosa-sinensis* is mixed with cow's milk and given to women suffering from menstrual disorder (Rajakumar and Shivanna, 2010) [15]. The high flavonoid and terpenoid content of its flowers are responsible for the antioxidant and anticancer activities (Salem *et al*., 2014 [16]. The flowers contain the compounds like flavonol quercetin and anthocyanin cyanidin (Nakamura *et al*., 1990; [11] Puckhaber *et al*., 2002) [13]. The anthocyanin from different plant sources have the potential to be utilised in the food industry as a natural colourants (Ersus and Yurdagel (2007) [5] Loypimai *et al*. (2015) [8] and Díaz-García *et al*. (2015) [4] Selim *et al*. (2008) [18]. Petals of hibiscus are a rich source of anthocyanin. On accounting the phytochemical constituent in its flower petals it has the potential to be utilised as neutraceutical, food and textile colourant and a genetic improvement of the crop is needed. But, the genetic improvement of any crop depends upon the existence of variability among populations. Therefore the knowledge of variability, and the degree of direction of correlation among yield attributes is necessary while aiming at a rational genetic improvement in flower yield through selection approach in a population of diverse genotype. Keeping an eye on such requirement the study was undertaken to measure the genetic variability and correlation between flower yield components in *H. rosa-sinensis* and some possible information about selection criteria in *H. rosa-sinensis*.

Materials and Methods
The current study was carried out with 16 accessions of *Hibiscus rosa-sinensis* at Department of floriculture and Landscaping, Tamil Nadu Agricultural University, Coimbatore. The plants were collected from places in and around Kerala and Tamil Nadu. The plants were propagated through cuttings and 6 months old plantlets were planted in experimental filed with a spacing of 1.5m x 1.5m. Characters like plant height, number of primary branches, leaf length, leaf area, petal, petal width, style length, single flower weight, bud width, anthocyanin content was observed from two year old plants. Flower yield per plant were observed for a duration of one year and the average yield per plant was used for correlation studies. All the management practices were followed at regular intervals. The phenotypic coefficient of variation and genotypic coefficient of variation were calculated as suggested by Burton (1952) [3]. The heritability (h^2) in broad sense was calculated according to Lush (1940) [9] and expressed as percentage (%).Genetic advance for each character was computed according to the method suggested by Johnson *et al*. (1955) [7].

Result and Discussion

The hibiscus plants are mainly used as a flowering shrub for their showy flowers. Apart from that, they are utilized for their medicinal value and as a neutraceutical. Floral characters and flower yield play an important role on evaluating the accessions of hibiscus accessions for their ornamental and neutraceutical value. Among the genotypes significant differences was observed for all the characters under study. This variation reflected the diverse geographic origin and distribution of the genotypes. The mean and the range observed for the characters taken for the study are presented in table 1.

A high genotypic correlation coefficient was observed for characters like leaf area, petal width, style length, bud width, leaf length, flower diameter, single flower weight, anthocyanin content and flower yield. A medium genotypic coefficient of variance is observed for characters like plant height, primary branches per plant and petal length. The phenotypic coefficient of variance was found higher than that of the genotypic coefficient of variance in many of the characters (Table 2), indicating the influence of environment on the expression of these characters and thus selection based on phenotypic basis would not be effective for the genetic improvement of such traits. Similar findings have been reported by Aishwariya (2014) [1] in Jasminum sambac High heritability is observed in all the characters that are taken up for the study. Except for petal length. Similar result shave been reported by Naikwad *et al.* (2018) [10] in china aster. A high heritability coupled with high genetic advance have been observed in all the characters except petal length which showed a low heritability and low genetic advance. High heritability coupled with high genetic advance indicates the predominance of additive gene effect on such traits. Similar results have been reported by Raghava *et al.* (1992) [14], Sirohi and Behera (2000) [21], Singh and Kumar (2008) [10] and Naikwad *et al.* (2018) [10] in chrysanthemum, marigold and china aster respectively.

The correlation between the floral characters and the morphological characters were performed and presented in table 3. In the present study it was observed that the petal characters like petal length, petal width and style length were positively and significantly correlated with each other both phenotypically and genotypically. The petal characters like petal length and style length were negatively correlated with the bud diameter. The flower diameter showed a positive relation with the petal length and petal width. The petal width did not show any significant correlation with the bud diameter. The similar results have been reported by San Pascual *et al.* (2017) [17] in the hybrids of *Hibiscus rosa-sinensis.* It was observed that the plant growth parameter like plant height was significantly correlated with number of primary branches, leaf area, flower diameter, petal length, petal width, style length, single flower yield and flower yield. Similar results have been reported by Prakash *et al.* (2018) [12] in *Dendranthema grandiflora.*

A positive significant correlation was observed between leaf area and plant height, leaf length, flower yield and anthocyanin content. It didn't show any significant correlation with floral parameters like petal length, petal width, style length, flower diameter, bud diameter and single flower weight. Similar results have been reported by Swathi and Naik (2017) [22] in marigold and San Pascual *et al.* (2017) [17] in the hybrids of *Hibiscus rosa-sinensis.*

Flower yield was found to be positively related with floral parameters like petal length, petal width, style length and single flower weight. It shows the direct influence of floral characters on the flower yield. Flower yield showed a negative relation with number of branches per plant. Similar results were reported by Baskaran *et al.* (2016) [2] and Sewaniya (2009) [19] who observed a similar kind of relation with the morphological parameters and flower yield in chrysanthemum and hybrid tea roses. Anthocyanin content was found to be directly related with leaf area, bud width and single flower weight. Anthocyanin content did not show any significant relation with any other floral and morphological parameters. Similar results have been reported by Swathi *et al.* (2017) [22] who found a positive correlation between xanthophyll content and other plant characters in marigold.

Table 1: Mean, range and variance of 12 qualitative characters in *Hibiscus rosa-sinensis*

	Mean	Range	Variance	
			Phenotypic	Genotypic
Plant height (cm)	129.45	72 - 184	649.10	445.19
Primary branches per plant	9.98	7 - 15	5.63	3.65
Leaf length (cm)	7.42	4.40 - 9.50	3.14	2.78
Leaf area (cm^2)	28.25	6.30 - 57.30	138.82	118.11
Flower diameter (cm)	10.22	7.20 - 13.10	10.83	10.43
Petal length (cm)	5.64	3.00 - 7.50	9.42	0.66
Petal width (cm)	3.78	2.00 - 5.50	1.25	1.11
Style length (cm)	6.48	1.30 - 11.60	6.61	6.23
Bud width (mm)	10.34	6.04 - 20.90	16.91	16.67
Single flower weight (g)	8.10	2.40 - 11.60	5.66	5.41
Anthocyanin content (mg/l)	36.65	4.94 - 84.56	485.87	476.40
Flower yield (g/plant)	111.33	36.00 - 226.13	2692.30	2676.75

Table 2: Coefficient of variance, heritability, genetic advance and genetic advance % of mean in 12 quantitative characters in *Hibiscus rosa-sinensis*

Character	Coefficient of variance		Heritability (h^2)	Genetic advance % of mean
	Phenotypic	Genotypic		
Plant height (cm)	20.10	16.65	68.59	28.40
Primary branches per plant	24.55	19.77	64.85	32.79
Leaf length (cm)	22.66	21.33	88.61	41.37
Leaf area (cm^2)	42.24	38.96	85.08	74.02
Flower diameter (cm)	36.04	35.36	96.25	71.46
Petal length (cm)	51.47	13.64	7.02	7.44

Petal width (cm)	31.60	29.80	88.91	57.88
Style length (cm)	40.20	39.03	94.26	78.06
Bud width (mm)	40.82	40.54	98.62	82.93
Single flower weight (g)	29.79	29.12	95.57	58.64
Anthocyanin content (mg/l)	64.61	63.98	98.05	98.51
Flower yield (g/plant)	45.98	45.85	99.42	94.18

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Table 3: Correlation coefficient among the different characters in different accessions of *Hibiscus rosa-sinensis*

Character		PH	PB	LL	LA	FD	PL	PW	SL	BW	SFW	AC	FY
PH	P	1	0.3014*	0.2507^{ns}	0.6310**	0.4733**	0.3037*	0.4772**	0.3677*	0.2184^{ns}	0.2544^{ns}	0.6394**	0.1291^{ns}
PH	G	1	0.4161**	0.3798**	0.8566**	0.5736**	0.3682*	0.6185**	0.4410**	0.2841*	0.3475*	0.7806**	0.1307^{ns}
PB	P		1	-0.4800**	-0.3036*	0.3267*	-0.1386^{ns}	0.0611^{ns}	-0.0639^{ns}	-0.1321^{ns}	0.0562^{ns}	-0.4512**	0.0409^{ns}
PB	G		1	-0.5745**	-0.3736*	0.3846**	-0.2122^{ns}	0.1213^{ns}	-0.0748^{ns}	-0.1864^{ns}	0.0463^{ns}	-0.5812**	0.0519^{ns}
LL	P			1	0.5910**	-0.4408**	-0.1618^{ns}	-0.1964^{ns}	-0.0029^{ns}	0.1789^{ns}	-0.0573^{ns}	0.4111**	0.0075^{ns}
LL	G			1	0.6328**	-0.4637**	-0.2022^{ns}	-0.2193^{ns}	-0.0251^{ns}	0.1953^{ns}	-0.0587^{ns}	0.4349**	0.0231^{ns}
LA	P				1	0.2715^{ns}	-0.0097^{ns}	0.2701^{ns}	0.1127^{ns}	0.2696^{ns}	0.0842^{ns}	0.5492**	0.3502**
LA	G				1	0.3092*	0.0336^{ns}	0.3055*	0.1510^{ns}	0.2838*	0.1032^{ns}	0.5958**	0.3870**
FD	P					1	0.3126*	0.6447**	0.1843^{ns}	0.1401^{ns}	0.2867*	0.1697^{ns}	0.1384^{ns}
FD	G					1	0.3579*	0.7215**	0.1984^{ns}	0.1353^{ns}	0.2820^{ns}	0.1661^{ns}	0.1472^{ns}
PL	P						1	0.7187**	0.6968**	-0.3928**	0.6958**	0.5425**	-0.1499^{ns}
PL	G						1	0.8090**	0.7656**	-0.4382**	0.7874**	0.5988**	-0.1512^{ns}
PW	P							1	0.6827**	-0.2666^{ns}	0.7215**	0.5905**	0.0354^{ns}
PW	G							1	0.7519**	-0.2841*	0.7896**	0.6342**	0.0398^{ns}
SL	P								1	-0.6161**	0.8782**	0.6854**	-0.1763^{ns}
SL	G								1	-0.6382**	0.9334**	0.7091**	-0.1821^{ns}
BW	P									1	-0.7206**	-0.2442^{ns}	0.4890**
BW	G									1	-0.7522**	-0.2502^{ns}	0.5024**
SFW	P										1	0.6605**	-0.3698**
SFW	G										1	0.6692**	-0.3812**
AC	P											1	-0.2195^{ns}
AC	G											1	-0.2202^{ns}
FY	P												1
FY	G												1

Plant height (PH), Primary branches per plant (PB), Leaf length (LL), Leaf area (LA), Flower diameter (FD), Petal length (PL), Petal width (PW), Style length (SL), Bud width (BW), Single flower weight (SFW), Flower yield (FY), Anthocyanin content (AC), * - significant at 0.05%, **significant at 0.01%

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