Mysore J. Agric. Sci., 51 (4) : 822-831, 2017

Morphological Diversity of Jasmine Cultivars and Wild Species in Karnataka

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Abstract

Jasmines (*Jasminum* sp.) are commercially important flower crop cultivated for their attractive fragrant flowers in India. Karnataka is known for cultivation of jasmines due to its versatile utility as fresh flowers. Essential oil extracted from the fragrant flowers has great demand in the international market for perfumery industry. In this study, an attempt was made to collect both cultivated and wild species of jasmines through survey. The genotypes were assessed for thirty-nine qualitative and twenty quantitative morphological traits including vegetative and floral characters. Using the PHYLIP version 3.5, dendrogram was generated for qualitative characters. ANOVA was performed on quantitative characters to assess the morphological diversity. Based on the dendrogram, forty eighty genoptyes were grouped into three clusters. A wild species J. *rottlerianum*, distinct from all other genotypes constituted Cluster I. Another wild species *J. ritchiei* formed Cluster 2. Cluster 3 consisted two sub clusters. Sub cluster 3.1consisted of variants of cultivated species *J. sambac,* two variants each of *J. multiflorum* and *J. grandiflorum* and one of the *J. auriculatum* along with seven species grown in home gardens (*J. angustifolium, J. rigidum, J. officinale, J. flexile, J. calophyllum, J. humile* and *J. primulinum* and four wild species. *(J. communis, J. cuspidatum, J. sp. 2 and J. sp. 7*). Sub cluster 3.2 consisted of another three wild species (*J. sp. 1, J. sp. 3 and J. sp. 4*). The variation in morphological characters is reflected in the clustering pattern as the cultivated and wild genotypes are found interspersed among one another. The ANOVA indicated that 48 genotypes had a coefficient of variance of 42 per cent representing very high degree of variation among the genotypes. The morphological diversity that exists in *Jasminum* species have potential applications crop improvement programme.

Keywords : *Jasminum,* morphological, diversity, species, cultivars

Jasmines (*Jasminum* sp.) are commercially important flower crop cultivated for its attractive and fragrant flowers in the Southern and Eastern parts of India. A native of tropical and subtropical region, jasmine is esteemed for its attractive fragrant flowers and is highly valued for the essential oil. Indo-Malayan region being the center of origin, the diversity existing in jasmine is enormous in India. The distribution of *Jasminum* genus is pan-tropical but a large number of species are centered around India, China and Malaya (Annon, 1959). Belonging to family Oleaceae, genus *Jasminum* comprises of more than 200 species (Dickey,1970) of which many are synonyms and 90 are true in existence (Muthukrishna and Pappiah, 1980). Jasmines are commercially cultivated for their flowers in the Southern and Eastern parts of India. Major jasmine producing states in India are Tamil Nadu and Karnataka. Karnataka, is known for cultivation of jasmines due to its versatile utility as fresh flowers in ceremonies, religious offerings, perfuming the hair oils, etc. In Karnataka jasmine is grown in area of 6,360 hectares with a production of 43,600 tonnes of flowers (Annon, 2014). Jasmine flowers produced in Tamil Nadu and Karnataka are exported to the neighboring countries *viz.,* Sri Lanka, Singapore, Malaysia and Middle East countries (https://www.nabard.org/english/plant_jasmine.aspx) apart from being sold in local and distant markets. About 15,000 kg of loose flowers are sold every day in big cities *viz.,* Calcutta, Bombay, Delhi, Madras and Bangalore. They are also used in extraction of essential oil which is a highly lucrative business. The distribution of *Jasminum* genus is pan-tropical but a large number of species are centered around India, China and Malaya (Annon, 1959).

India may be one of the principal centers of origin because as many as 72 species are distributed in India, Malaysia and China out of 90 species. *J. sambac, J. auriculatum* and *J. grandiflorum* are commercially cultivated in India.

Essential oil is extracted from the fragrant flowers of jasmine that has great demand in the international market for perfumery industry. The natural oils of jasmine are used in high-grade perfume and invariably most of the superior perfumes contain at least a small quantity of jasmine oil. The odour of jasmine flowers cannot be imitated by any known synthetic aromatic chemical or natural isolates thus giving it a unique status in the perfume world. Among Indian jasmines, scented species such as *J. grandiflorum, J. auriculatum, J. sambac, J. angustifolium, J. officinale, J. humile* and *J. pubescense* were found useful. The Indian *J. grandiflorum* is compared favourably with that of Spanish jasmine both in yield and quality of oil (Bose *et al*., 2003).

Availability of reliable genetic resource is a pre-requisite for any crop improvement programme. Perusal of the literature reveals that crop improvement in jasmine is not given much priority. Present varieties are mainly improved clones of *Jasminum grandiflorum, J. auriculatum* and *J. sambac* and *J. multiflorum*. Crop improvement work in jasmine carried out by Tamil Nadu Agricultural University, Coimbatore has resulted in high yielding varieties such as Mullai and Parimullai of (*J. auriculatum*), Co-1 Pitchi (*J. grandiflorum*). *J. grandiflorum viz.,* 'Arka Surabhi' which is also a high yielding strain, and a promising selection of *J. auriculatum*, IIHR-JA-13 with high concrete yield was developed at Indian Institute of Horticultural Research, Hessarghatta, Bangalore (Srivastava and Kumar, 2004).

Although jasmine is under cultivation from centuries, identification of species, varieties and common types is enigmatic, as this has been done mainly based on morphological characters. The classification is inadequate and misleading due to existence of large number of varieties and cultivars with synonyms. Though Dickey (1970) has stated that *Jasminum* is a genus of more than 200 species, many of these species are however synonyms and 90 species are considered to be true in existence (Muthukrishna and Pappiah, 1980). Hitherto, systematic studies have not been taken up to classify the available species / varieties / genotypes under different groups. Collection of jasmine germplasm and its morphological evaluation will provide an idea about the diversity and relatedness among the genotypes. This will further assist planned breeding programme of the crop.

Material and Methods

In the present study, 48 genotypes of species and cultivars belonging to the genus *Jasminum* were collected from State universities / research stations and farmers' field. The wild species were collected from their natural habitats from Hassan, Shimoga and Chikkamagalur districts of Karnataka during 2008-2012 and maintained at College of Agriculture, Hassan.

Each genotype was identified and assigned to its classification by the utilization of taxonomic literature (World Floras, Regional Floras etc.) and the material in herbaria. The genotypes which could not be identified were given vernacular descriptions. All the above jasmine genotypes were serially numbered from 1-48 and used as respective accession numbers. The morphological observations were recorded on various quantitative and qualitative parameters *in situ* by collecting 10 samples from each representative genotype. The details of the 48 genotypes used and their respective accession numbers in the study are presented in Table I.

Table I

List of genotypes used for morphological characterization

Genotype names	Region	Wild/Cultivated
J. sambac 1	Tamilnadu	Cultivated (Commercial)
J. sambac 2	Tamilnadu	Cultivated (Commercial)
J. sambac 3	Karnataka	Cultivated (Home garden)
J. officinale	Karnataka	Wild
J. sambac 4	Karnataka	Cultivated (Home garden)
J. sp1,Bangalore	Karnataka	Wild
J. sambac 5	Karnataka	Cultivated (Commercial)
J. grandiflorum1	Tamilnadu	Cultivated(Commercial)
J. sambac 6	Karnataka	Cultivated (Home garden)
J. flexile	Karnataka	Cultivated (Home garden)
J. grandiflorum2	Tamilnadu	Cultivated(Commercial)
J. sambac 7	Karnataka	Cultivated (Home garden)
J. sp2, Bangalore	Karnataka	Wild
J. cuspidatum	Karnataka	Wild
J. multiflorum1	Karnataka	Cultivated (Commercial)

Genotype names	Region	Wild/Cultivated
J. auriculatum1	Tamilnadu	Cultivated (Commercial)
J. mesni	Karnataka	Cultivated (Home garden)
J. rigidum	Karnataka	Cultivated (Home garden)
J. sambac8	Karnataka	Cultivated (Commercial)
J. sambac9	Karnataka	Cultivated (Commercial)
J. sambac10	Karnataka	Cultivated (Home garden)
J. sambac11	Karnataka	Cultivated (home garden)
J. sambac 12	Karnataka	Cultivated (Commercial)
J. sp3Lalbagh	Karnataka	Wild
J. primulinum	Karnataka	Cultivated (Home garden)
J. dichotomum	Karnataka	Wild
J. angustifolium	Karnataka	Cultivated (Commercial)
J. communis	Karnataka	Wild
J. sp 4 Lalbagh	Karnataka	Wild
J. sp 5 Lalbagh	Karnataka	Wild
J. sp 6 Lalbagh	Karnataka	Wild
J. auriculatum2	Karnataka	Cultivated (Commercial)
J. roxburghianum	Karnataka	Wild
J. sp 7 Shimoga	Karnataka	Wild
J. sp 8 Puttur	Karnataka	Wild
J. sambac 13	Karnataka	Cultivated (Home garden)
J. malabaricum 1	Karnataka	Wild
J. malabaricum 2	Karnataka	Wild
J. malabaricum 3	Karnataka	Wild
J. multiflorum 2	Karnataka	Cultivated (Commercial)
J. calophyllum	Karnataka	Cultivated (Home garden)
J. multiflorum3	Karnataka	Cultivated (Commercial)
J. multiflorum 4	Karnataka	Cultivated (Commercial)
J.multiflorum 5	Karnataka	Cultivated (Commercial)
J. multiflorum6	Karnataka	Cultivated (Commercial)
J. rottlerianum	Karnataka	Wild
J. sambac 14	Karnataka	Cultivated (Home garden)
J. ritchiei	Karnataka	Wild

Morphological characteristics were recorded by selecting the current season shoots called primary lateral shoots. Observations were recorded on Plant habit (bushy, spreading or climbing), leaf character (leaf type -simple or compound, leaf texture -pubescent or glabrous, phyllotaxy of the leaves, leaf shape, length / breadth of the leaf and petiole length, leaf colour and shape of the leaf base, floral characters of the fully matured buds in peak season of flowering, shape of the flower bud (ovate to acute or ovate to elliptic or round etc.), length and breadth of the bud, pedicel length, number of calyx teeth, calyx length, length of the corolla tube, number of whorls, number of petals, petal size, flower diameter, number and nature of stamen, the colour, number and the nature of the stamens (whether petaloid or not) length of the anther and filament; length of the style and stigma, type of the stigma (simple or bifid). The length of leaf and flower parts were recorded and expressed in centimeter. In addition, observations were also made on fruit set, fragrance of the flower, flower colour and Season of flowering (Table II and III).

TABLE II

Qualitative phenotypic characters recorded on 48 genotypes of jasmine

Sl. No.	Phenotypic traits (Qualitative)	Sl. No.	Phenotypic traits (Qualitative)
A.	**Plant Type**	**F.**	**Leaf Base**
1.	Bush	21.	Even
2.	Climber	22.	Uneven
3.	Creeper	G	Bud shape
B.	**Leaf Type**	23.	Conical pointed
4.	Simple	24.	Conical round
5.	Compound	25.	Ovate
C.	**Leaf shape**	26.	Round
6.	Acuminate	**H.**	**Type of Stigma**
7.	Ovate	27.	Simple
8.	Lanceolate	28.	Bifid
9.	Cordate	29.	Peteloid
10.	Obovate	30.	Arrow
11.	Others	31.	Hooded
D.	**Leaf Colour**	**I.**	**Flower colour**
12.	Dark green	32.	white
13.	Green	33.	cream
14.	Light green	34.	yellow
E.	**Leaf Texture**	35.	Pink underneath
15.	Rough	**J**	**Season of flowering**
16.	Smooth	36.	Seasonal
17.	Pubescent	37.	Throughout the year
18.	Glabrous	**K**	**Fruit set**
19.	Leathery	38.	Yes
20.	Velvety	39.	No

TABLE III

Quantitative phenotypic characters recorded on 48 genotypes of jasmine

Sl. No.	Qualitative character	Sl. No.	Qualitative character
1.	Petiole Length (cm)	11.	No. of Whorls
2.	Leaf Length (cm)	12.	No. of Petals
3.	Leaf Breadth (cm)	13.	Petal Length (cm)
4.	Bud Length (cm)	14.	Petal Breadth (cm)
5.	Bud Breadth (cm)	15.	No. of Stamens
6.	Flower Diameter (cm)	16.	Filament length (cm)
7.	Flower Stalk length (cm)	17.	Anther length (cm)
8.	Calyx Length (cm)	18.	Stigma+Style Length (cm)
9.	No. of Calyx Teeth	19.	Aroma
10.	Corolla tube length	20.	Number of staminodes

Statistical analysis

Based on thirty nine qualitative morphological traits clustering of the genotypes was performed using the software PHYLIP version 3.5. Estimates of similarity among the genotypes were calculated according to Nei's genetic distance (Nei, 1978). The Neighbour-joining method was applied to cluster the genotypes from the distance matrix. The data collected on 20 quantitative traits (Table III) of 48 genotypes was subjected to ANOVA to analyze the morphological diversity.

RESULTS AND DISCUSSION

The 48 genotypes collected from different regions were categorized into species under cultivation or grown in home gardens and those found in wild (Table IV). Twenty five species were found to be under cultivation and in home gardens while, twenty three species were grouped as those found in wild. The floral morphological diversity in the cultivated and wild species of jasmine are shown in Fig. 1.

TABLE IV

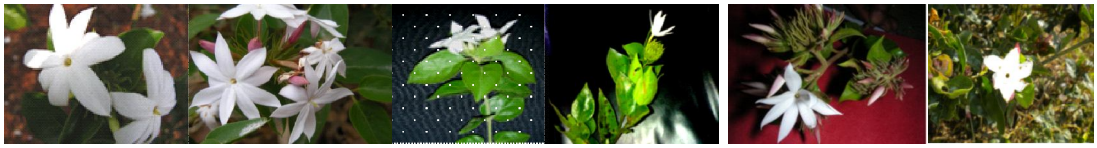
Germplasm collection under cultivated and wild species

Cultivated species	No. of collections	Wild species	No. of collections
Jasminum sambac, (Linn) Ait	14	*Jasminum dichotomum*	1
Jasminum multiflorum, Burm.f. Andr .*J. pubescens*, Willd	3	*Jasminum malabaricum* Wight	3
Jasminum auriculatum, Vahl.	1	*Jasminum primulinum* Hemsl. / *Jasminum mesni*, Hance.	1
Jasminum grandiflorum, Linn.	2	*Jasminum officinale* Linn	1
Jasminum angustifolium Vahl.	1	*Jasminum auriculatum* Vahl.	1
Jasminum humile Linn.	1	*Jasminum communis*	1
Jasminum calophyllum, Wall.	1	*Jasminum rottlerianum* Wall	1
Jasminum flexile, Vahl	1	*Jasminum multiflorum* Burm.f. Andr / *Jasminum pubiscens* Willd	3
Jasminum rigidum, Zenker.	1	*Jasminum cuspidatum* Rottler	1
Total	25	*Jasminum roxburghianum* Wall	1
		Jasminum ritchiei C. B. Clarke	1
		Jasminum species (Wild)	8
		Total	23

J. sambac

J. grandiflorum

J. auriculatum



J. multiflorum

J. flexile *J. cuspidatum* *J. mesni* *J. rigidum* *J. primulinum* *J. dichotomum* *J. angustifolium*

J. Communis *J. officinale* *J malabaricum* *J. calophyllum* *J. rottlerianum* *J. ritchiei*

Fig.1 Floral morphological diversity in cultivated and wild species of jasmines

Morphological diversity

The dendrogram of 48 genotypes clustered into 3 major groups (Fig. 2). A wild species *J. rottlerianum* collected from the forests of Hassan (Karnataka), was distinct from all other genotypes forming a separate cluster (Cluster 1). Another wild species (*J. ritchiei*) formed cluster 2. Cluster 3 consisted of many sub clusters. In this sub cluster, four of the six *J. multiflorum* genotypes, consisting of one cultivated (*J. multiflorum* 3) and three wild (*J. multiflorum* 4, 5 and 6) grouped nearby but were distinct from each other. Similarly the three variants of *J. malabaricum* (1, 2 and 3) also clustered next to one another. Five of the genotypes belonging to wild species (*J. roxburghianum, J. auriculatum* 2 , *J.* sp. *5, J.* sp. 6 and *J.* sp. 8) were placed nearby. Further, there was formation of two sub clusters - 3.1 and 3.2. Cluster 3.1 consisted of the cultivated species *J. sambac* (all the variants), *J. multiflorum* 1 and 2 (two local cultivated types), *J. grandiflorum* 1 and 2, *J. auriculatum* 1 (cultivated type) and those grown in home gardens (*J. angustifolium, J. rigidum, J. officinale, J. flexile, J. calophyllum, J. humile* and *J. primulinum* along with wild species *(J. communis, J. cuspidatum, J.* sp. 2 and *J.* sp. 7). Another sub cluster 3.2 consisted of three wild species (*J.* sp. 1, 3, and 4).

Cluster 3.1 again formed two more clusters. Cluster 3.1.1 mainly consisted of all the variants *J. sambac*. The cluster 3.1.2 consisted of variants of *J. grandiflorum and J. auriculatum* 1. All the three species are under cultivation (Fig. 2).

The clustering pattern of 48 genotypes based on morphological characters indicate wide variation in the genetic diversity among different species in jasmine (Fig. 2). Among the cultivated species, the fragrant varieties *J. sambac, J. grandiflorum* and *J. auriculatum* clustered separately. The genotypes of *J. sambac* fell into two different sub clusters. Among the non fragrant species *J. multiflorum,* the cultivated

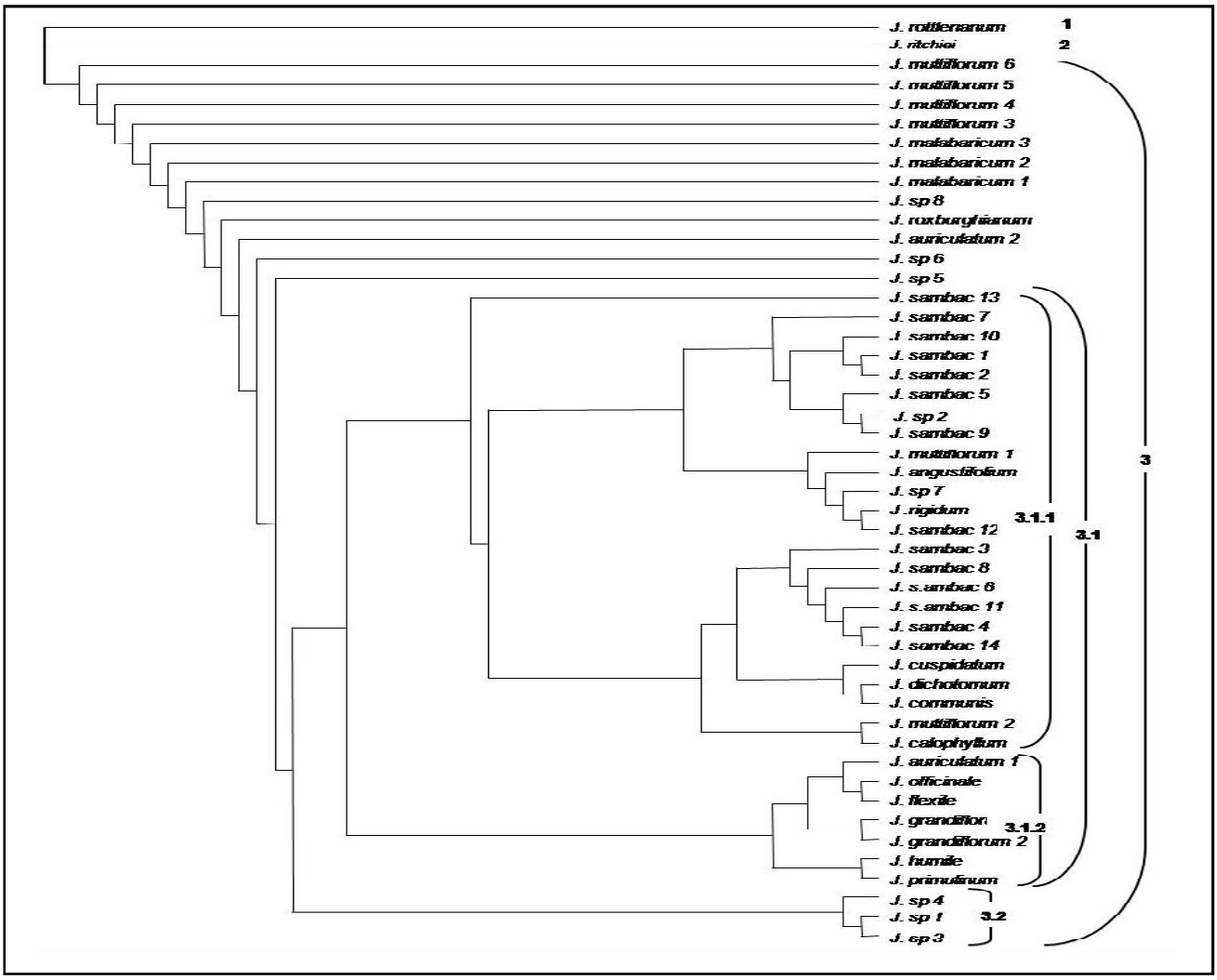


Fig. 2. Dendrogram of jasmine genotypes based on morphological data.

variety (*J. multiflorum* 3) and wild variants *(J. multiflorum* 4, 5 and 6) were found among the wild species of jasmine while the cultivated local varieties (*J. multiflorum* 1 and 2) were found in the different cluster 3.1.1 indicating morphological variation among the cultivated types.

The ANOVA indicated that 48 genotypes under the study had a coefficient of variance of 42 per cent (Table V) which represents very high degree of variation among the genotypes in their phenotypic characters.

The genotype *Jasminum rigidum* was significantly dissimilar with the genotype *J. primulinum* in morphological characters such as petiole length, leaf breadth, bud length, bud breadth, flower diameter, number of calyx teeth, corolla tube length, number of petals, petal length, number of stamens, filament length and aroma. Similarly, it differed from *J. dichotomum* with respect to petiole length, leaf length, leaf breadth, flower diameter, corolla tube length, number of petals, petal length and aroma. It differed significantly from *J. malabaricum* 3 with respect to leaf length, flower diameter, corolla tube length, petal length and aroma. A significant difference in leaf length, flower diameter, corolla tube length, petal length, and aroma between *J. primulinum* and *J. dichotomum* were observed.

J. primulinum differed significantly from *J. malabaricum* 3 in petiole length, leaf length, Leaf breadth, bud breadth, number of calyx teeth, number of petals, number of stamens and aroma. The genotypes *J. dichotomum* and *J. malabaricum* 3

TABLE V

Analysis of variance for quantitative morphological characters (genotype G1-G24)

Character / Genotype	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	G14	G15	G16	G17	G18	G19	G20	G21	G22	G23	G24
Petiole Length	1.20	1.26	1.13	1.15	1.15	1.10	1.21	1.64	1.25	1.68	1.64	1.17	1.21	1.17	1.25	1.17	1.67	1.13	1.20	1.17	1.15	1.32	1.22	1.16
Leaf Length	2.89	2.86	2.38	2.36	2.72	1.70	2.84	3.00	3.23	2.82	2.78	2.82	2.88	2.38	2.30	2.51	3.09	2.37	2.99	2.85	2.71	3.19	2.95	2.24
Leaf Breadth	2.33	2.31	2.21	1.92	2.03	1.44	2.06	2.46	2.51	3.31	2.38	2.38	2.06	1.78	2.16	2.02	3.12	1.86	2.11	1.89	2.11	2.46	2.04	1.92
Bud Length	1.41	1.79	1.00	1.34	1.47	1.25	1.50	1.64	1.34	1.39	1.49	1.72	1.19	1.50	1.65	1.34	1.28	1.09	1.35	1.16	1.43	1.40	1.52	1.30
Bud Breadth	1.33	1.26	1.00	1.21	1.80	1.22	1.17	1.22	1.16	1.22	1.21	1.36	1.15	1.17	1.24	1.22	1.17	1.02	1.14	1.13	1.31	1.42	1.22	1.18
Flower Diameter	1.93	1.96	1.00	1.80	1.86	1.76	2.03	2.22	1.48	1.92	2.29	2.09	1.78	2.27	2.39	1.78	1.57	1.79	1.86	2.15	2.28	1.79	2.15	1.54
Flower Stalk length	1.29	1.24	1.00	1.15	1.31	1.16	1.17	1.32	1.14	1.10	1.79	1.50	1.14	1.77	1.07	1.16	1.21	1.12	1.16	1.18	1.26	1.32	1.29	1.13
Calyx Length	1.42	1.44	1.00	1.20	1.42	1.40	1.43	1.34	1.19	1.16	1.56	1.33	1.37	1.25	1.50	1.12	1.15	1.22	1.40	1.49	1.49	1.33	1.41	1.14
No. of Calyx Teeth	2.95	3.14	1.00	2.47	2.91	2.88	2.81	2.34	1.98	2.49	2.30	2.79	2.72	2.66	2.62	2.59	1.95	2.10	2.88	2.82	2.77	2.56	2.83	2.20
Corolla Tube Length	1.50	1.52	1.00	1.62	1.47	1.45	1.63	1.85	1.25	1.75	1.83	1.66	1.54	1.62	1.71	1.61	1.49	1.69	1.38	1.57	1.61	1.47	1.61	1.47
No. of Whorls	1.41	1.41	1.00	1.41	1.76	1.41	1.41	1.41	1.50	1.41	1.41	1.95	1.41	1.41	1.41	1.41	1.29	1.37	1.41	1.57	1.73	2.02	1.41	1.33
No. of Petals	3.01	3.03	1.29	2.90	4.03	3.42	2.81	2.39	2.94	2.93	2.39	4.80	2.77	3.06	2.90	2.79	2.01	2.43	2.81	3.17	3.86	4.50	1.41	1.33
Petal Length	1.46	1.52	1.05	1.42	1.46	1.41	1.55	1.68	1.25	1.49	1.74	2.03	1.41	1.70	1.79	1.40	1.30	1.52	1.46	1.64	1.70	1.41	1.63	1.28
Petal Breadth	1.38	1.32	1.00	1.22	1.26	1.10	1.23	1.41	1.17	1.24	1.43	1.32	1.18	1.21	1.32	1.21	1.21	1.20	1.19	1.25	1.32	1.27	1.23	1.15
No. of Stamens	1.73	1.73	1.00	1.73	1.04	1.73	1.73	1.73	1.16	1.76	1.73	1.52	1.73	1.73	1.73	1.73	1.51	1.66	1.73	1.79	1.73	1.07	1.73	1.59
Filament length	1.36	1.26	1.00	1.45	1.14	1.24	1.46	1.66	1.16	1.58	1.34	1.61	1.34	1.34	1.32	1.46	1.44	1.37	1.55	1.48	1.40	1.05	1.41	1.26
Anther length	1.15	1.13	1.00	1.17	1.06	1.10	1.14	1.20	1.07	1.15	1.24	1.23	1.10	1.14	1.21	1.16	1.16	1.07	1.16	1.19	1.17	1.03	1.17	1.09
Stigma + Style Length	1.29	1.59	1.00	1.25	1.30	1.36	1.31	1.85	1.09	1.72	1.84	1.29	1.34	1.62	1.71	1.26	1.26	1.22	1.33	1.40	1.29	1.05	1.30	1.42
Aroma	2.45	2.24	1.00	2.24	2.45	2.24	2.45	2.45	1.72	2.24	2.24	1.68	2.24	2.00	1.41	2.45	1.29	1.37	2.45	2.45	2.24	2.16	2.24	1.99
No. of staminodes	1.00	1.00	1.00	1.00	1.70	1.00	1.00	1.00	1.23	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.07	1.00	1.00
F test	*																							
S.Em	0.09																							
C.D	0.24																							
C.V	0.42																							

TABLE V (contd.)

Analysis of variance for quantitative morphological characters (G25-48)

Character / Genotype	G25	G26	G27	G28	G29	G30	G31	G32	G33	G34	G37	G38	G39	G40	G41	G42	G43	G44	G45	G46	G47	G48
Petiole Length	1.20	1.26	1.13	1.15	1.15	1.10	1.21	1.64	1.25	1.68	1.64	1.17	1.21	1.17	1.25	1.17	1.67	1.13	1.20	1.17	1.15	1.32
Petiole Length	1.51	1.38	1.49	1.23	1.07	1.08	1.17	1.10	1.09	1.25	1.35	1.42	1.50	1.30	1.21	1.14	1.17	1.14	1.22	1.26	1.16	1.16
Leaf Length	2.61	2.74	3.23	3.07	2.06	1.91	2.50	2.20	1.91	2.95	3.04	2.97	3.02	2.27	2.73	2.34	2.56	2.34	2.72	3.00	2.25	2.47
Leaf Breadth	2.93	2.44	2.41	1.95	1.70	1.49	1.66	1.72	1.64	1.93	2.43	2.83	2.22	1.77	2.01	1.93	2.18	1.93	2.06	2.22	1.87	2.04
Bud Length	1.41	1.11	1.52	1.61	1.17	1.33	1.38	1.26	1.07	1.68	1.47	1.43	1.11	1.43	1.60	1.53	1.82	1.25	1.68	1.43	1.04	1.20
Bud Breadth	1.67	1.07	1.25	1.21	1.08	1.12	1.14	1.15	1.02	1.23	1.17	1.20	1.04	1.14	1.20	1.29	1.20	1.14	1.19	1.17	1.07	1.06
Flower Diameter	1.34	1.35	2.35	2.19	1.38	1.84	1.68	1.63	1.34	2.24	1.93	1.60	1.10	2.04	2.21	2.08	2.00	1.54	2.21	1.93	1.11	1.40
Flower Stalk length	1.09	1.10	1.11	1.31	1.05	1.35	1.12	1.11	1.08	1.63	1.20	1.11	1.02	1.11	1.67	1.11	1.80	1.05	1.16	1.08	1.03	1.20
Calyx Length	1.12	1.15	1.69	1.34	1.07	1.13	1.15	1.19	1.12	1.52	1.37	1.22	1.22	1.45	1.45	1.38	1.69	1.19	1.50	1.42	1.04	1.15
No. of Calyx Teeth	1.49	1.95	2.53	2.66	1.87	2.28	2.41	2.39	1.81	2.74	2.55	2.45	2.39	2.51	2.65	2.75	2.64	1.88	2.77	2.49	1.23	1.85
Corolla Tube Length	1.12	1.22	1.90	1.73	1.28	1.36	1.62	1.42	1.10	1.63	1.58	1.53	1.28	1.45	1.70	1.58	1.71	1.29	1.70	1.87	1.05	1.20
No. of Whorls	1.16	1.41	1.41	1.41	1.25	1.37	1.41	1.41	1.25	1.41	1.41	1.41	1.17	1.37	1.41	1.41	1.41	1.21	1.41	1.41	1.18	1.25
No. of Petals	1.59	1.56	2.70	3.39	2.20	2.61	2.66	2.86	2.08	3.29	2.96	2.43	1.78	2.71	3.40	3.01	2.96	2.00	2.91	2.91	1.69	1.99
Petal Length	1.17	1.19	1.89	1.66	1.19	1.46	1.35	1.32	1.17	1.71	1.49	1.32	1.24	1.60	1.72	1.63	1.60	1.32	1.67	1.49	1.05	1.20
Petal Breadth	1.14	1.06	1.34	1.15	1.08	1.15	1.14	1.14	1.08	1.18	1.16	1.12	1.08	1.23	1.19	1.41	1.26	1.21	1.26	1.22	1.03	1.06
No. of Stamens	1.19	1.73	1.73	1.73	1.44	1.66	1.73	1.73	1.44	1.73	1.73	1.73	1.26	1.66	1.73	1.73	1.73	1.37	1.73	1.73	1.18	1.44
Filament length	1.07	1.17	1.55	1.47	1.23	1.27	1.44	1.44	1.21	1.46	1.37	1.28	1.18	1.26	1.26	1.24	1.14	1.12	1.29	1.75	1.05	1.13
Anther length	1.08	1.07	1.31	1.21	1.08	1.12	1.16	1.16	1.06	1.21	1.14	1.10	1.09	1.10	1.21	1.20	1.24	1.10	1.20	1.16	1.01	1.13
Stigma + Style Length	1.12	1.25	1.26	1.75	1.19	1.56	1.63	1.26	1.28	1.74	1.70	1.47	1.33	1.67	1.73	1.63	1.25	1.32	1.50	1.98	1.03	1.14
Aroma	1.00	2.24	1.41	2.24	1.74	2.11	2.24	2.24	1.74	2.00	2.45	2.24	1.17	1.37	1.73	1.41	1.73	1.37	1.41	2.24	1.14	1.25
No. of staminodes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
F test	*																					
S.Em	0.09																					
C.D	0.24																					
C.V	0.42																					

differed in petiole length, leaf length, leaf breadth, number of whorls, number of stamens and aroma.

Jasmines are perennial in nature and hence the natural population is heterozygous. Seedling selections from the open pollinated progeny will help in exploiting the variation available in that crop. Variability in three commercially important cultivars *viz., J. auriculatum. J. grandiflorum* and *J. sambac* has been catalogued by various workers (Raman, 1955; Alikhan *et al.,* 1970 and Veluswamy *et al.,* 1973). Studies on morphological variability of 15 varieties of *J. sambac* Ait. were conducted by Alikhan *et al.* (1970). Variability in nine important attributes of flowers in seedling population of two clones of *J. auriculatum* Vahl. was reported by Muthuswamy *et al.* (1972). Veluswamy *et al.* (1973) reported appreciable morphological variation in six clones of *J. grandiflorum* with respect to foliar, flower buds and floral characters.

The distribution of genus *Jasminum* is pan-tropical but a large number of species are centered around India, China and Malaysia (Anon., 1959). This comprises of diploids, triploids and tetraploids with n=13. Diploids (2n=26) are generally common in this genus. It is reported that this genus comprises of more than 200 species (Rendle, 1925; Bailey, 1958 and Dickey, 1970) of which many are synonyms and 90 species are considered to be true in existence (Veluswamy *et al.* 1975) as indicated by Baker (1877), Cooke (1905) and Duthie (1911). Ambiguity exists regarding the occurrence of true number of species and genetic relationship because of synonyms in jasmine germplasm. This has led to difficulty in utilization of resources and breeding new varieties.

Genetic improvement in jasmine through hybridization is limited due to non-fruit setting in most of the species. Among the cultivated jasmines, only *J. sambac* cv. Soojimalli and *J. auriculatum* set fruits. Also, due to small flower size, emasculation and pollination are difficult processes (Srivastava, 1995). Further, non-seed setting is a major problem in jasmines. Interspecific hybridization involving species such as *J. auriculatum*, *J. grandiflorum*, *J. flexile, J. calophyllum* and *J. sambac* resulted in low success rate (Annon, 1974). Crosses between tetraploid female *J. auriculatum* and *J. grandiflorum, J. angustifolium, J. flexile* and *J. calophyllum, J. rigidum, J. arborescens* or *J. paniculatum* as male parents did not show encouraging results. Though Veluswamy (1981) reported a good fruit set in crosses involving *J. auriculatum* with *J. flexile* and *J. grandiflorum; J. grandiflorum* with *J. auriculatum; J. calophyllum* and *J. flexile* and *J. sambac* with *J. grandiflorum,* the seeds failed to germinate. Intraspecific hybridization in *J. grandiflorum* and *J. auriculatum* (Short Round x short Point, Parimullai x Short point and an induced tetraploid x diploid of *J. auriculatum* showed partial success (Muthuswami and Abdul Khader, 1986). Further, attempts made by Veluswamy (1981) on selfing *J. grandiflorum* were not successful as there was no fruit set, but open pollination yielded 18 to 52 per cent fruit set. Progeny evaluation studies with open pollinated *J. auriculatum* seedlings have resulted in identification of superior morphological characters over commonly cultivated Parimullai (Muthuswami *et al*., 1972, Thangaraj, 1977).

In the present study, morphological variations were noticed both in vegetative as well as reproductive characters. Vegetative characters included growth habit, leaf size and shape, and petiole length. Reproductive characters included bud length, bud breadth, flower diameter, flower stalk length, calyx length, no. of calyx teeth, corolla tube length, number of whorls, number of petals, petal length, petal breadth, number of stamens, filament length, anther length, stigma + style length, aroma, staminodes. These variations in vegetative and floral characters were noticed both in cultivated as well as wild species. Such morphological variations can form the basis for selection of parents for breeding programme in jasmine for development of elite varieties.

References

Alikhan, M. W., Muthuswami, S. and Raman, K. R.,1970, *South Indian Horticulture*, **18** : 25-32.

Anonymous, 1959, *The Wealth of India*, Council of Scientific and Industrial Research, New Delhi.

Anonymous, 1974, *Second Annual Progress Report. Scheme for intensification of research on the development of rose and jasmine varieties with high essential oil content*, ICAR, Tamil Nadu Agricultural University, Coimbatore.

ANONYMOUS, 2014, Indian Horticulture database - 2014. Ministry of Agriculture, Government of India.

BAILEY, L. H., 1958, Manual of cultivated plants. Macmillan Co., New York.

BAKER, J. G., 1877, Flora of Mauritius and the Scychilles. Reeve & Co., London.

BOSE, T. K., YADAV, L. P., PARTHASARATHY, V. A. AND DAS, P., 2003, Commercial flowers, Vol.II., Naya Udyog, Kolkata, pp : 455-494.

COOKE, T., 1905, The flora of Presidency of Bombay, Taylor and Francis, London.

DICKEY, R. D., 1970, In: Flowering vines of the world, E. A. Menninger (ed.). Heart side Press Inc., New York.

DUTHIE, J. F., 1911, Flora of Upper Gangetic plain and of the adjacent Siewalik and sub Himalayan tract. Supdt., Govt. Printing, Calcutta, India.

https://www.nabard.org/english/plant_jasmine.aspx

MUTHUKRISHNAN, C. R. AND PAPPIAH, C. M.,1980, *Nat. Seminar Prodn. Tech. Comm. Flower Crops,* Tamil Nadu Agricultural University, Coimbatore, India, pp. 1-3.

MUTHUSWAMI, S. AND ABDUL KHADER MD, J. B. M., 1986, Jasmine. In : Chadha, K.L. and Choudhury, B. (Eds.) Ornamental Horticulture in India. Pp. 113-126. ICAR, New Delhi.

MUTHUSWAMI, S., THANGARAJ, T. AND PAPPIAH, C. M., 1972, Variation in flower characters of *J. auriculatum* Vahl. seedling . S. *Indian Hort*., **20** : 87-92.

NEI, M., 1978, Estimation of average heterozygosity and genetic distance from a small number of individuals. *Genetics*, **89**(3) : 583-590.

RAMAN, V. S., 1955, Cytogenetics of the Indian jasmines I. Morphological and taxonomical. *Bot. Mag. Tokyo,* **68** : 253-259.

RENDLE, A. S., 1925, The classification of flowering plants, Vol. II. Cambridge Univ. press, Oxford, England.

SRIVASTAV, H.C., 1995, French Jasmine. In: Advances in Horticulture Vol. VII, (Eds). Chanda, K.D and Gupta, R., Malhotra Publishing House, New Delhi, pp. 805-583.

SRIVASTAVA, H. C. AND KUMAR, T. V., 2004, IIHR-JA-13 a promising selection of *Jasminum auriculatum* for high yield of concrete. *J. Medicinal and Aromatic Pl. Sci.*, **26**(1) : 2-4.

THANGARAJ, T, 1977, Studies on the variability and genetic improvement of jasmine (*Jasminum auriculatum* Vahl.) from open pollinated progenies. *M.Sc. (Agri.) Thesis* submitted to TNAU, Coimbatore.

VELUSWAMY, P., 1981, Genetic studies in *J. auriculatum* Vahl. and *J. grandiflorum* L. *M.Sc.(Agri) Thesis* submitted to TNAU, Coimbatore.

VELUSWAMY, P., MUTHUSWAMI, S. AND THANGARAJ, T.,1973, Origin and distribution of jasmine. *Indian J. Orn. Hort*., **4**: 45-55.

VELUSWAMY, P., MUTHUSWAMI, S. AND THANGARAJ, T. , 1975, A study on germination of seeds of some *Jasminum* species and clones. *S. Indian Hort*., **23**: 71-72.

(*Received :* August, 2017 *Accepted :* Nov., 2017)