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Study of floral biology and standardization of soft wood cutting propagation technique in Bhatkal jasmine (*Jasminum sambac var* Bhatkal Jasmine)

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Abstract
In the present investigation, morphological differences among the two jasmine ecotypes *viz*., Bhatkal Jasmine and Udupi Jasmine cultivated commercially in coastal districts of Karnataka *viz*., Uttara Kannada and Udupi were recorded. The phenotypic studies of the two ecotypes clearly show that there are less morphological and genetic variations between Bhatkal jasmine and Udupi jasmine. In propagation studies among the treatment combinations the three node semi hardwood stem cutting showed increased percentage of survival by showing good root and leaf growth compared to that of single, two and four node cuttings. Among different concentration of IBA at 2000 ppm was found to be most effective for improving rooting of Bhatkal jasmine cuttings.

Keywords: Jasmine, ecotype, nodes, auxin, morphological traits

Introduction
Jasmine belongs to the 'Oleaceae' family. The genus Jasminum comprises of around 200 species which are native to tropical and warm temperate regions of Europe, Asia and Africa. India is one of the centers of origin of Jasmine. Among the different jasmine ecotypes cultivated in coastal Karnataka *viz*., Bhatkal jasmine cultivated in Uttar Kannada district and Udupi jasmine in Udupi district. Bhatkal jasmine and Udupi jasmine have found favor among the users on account of its silent features and fragrance. Jasmine that grown in and around Bhatkal have not only found favor among the locals but have also touched the shores abroad. People flock markets to buy jasmines and pay a hefty price. On festive occasions growers fail to meet the demand as people from all religious rush to get their favorite fragrant flowers, despite sky-rocketing prices. The jasmine growers do not cultivate this as a commercial crop but rely on organic farming and use a limited area of their agricultural land for better yield. The jasmine crop fetches the growers high income with little investment. Understanding of floral biology of Bhatkal and Udupi jasmine useful in commercial floriculture, crop improvements and to standardize pruning period. Being a high income generating crop, flowers are needed to be produced in large quantity continuously for a longer period of the year to get high net income. To achieve large quantity of production it is necessary to go for horizontal expansion of the area under this crop. Further the area expansion needs good quality planting materials which have got ability to better field establishment and high yielding in short period of time. Production of good quality planting materials in large quantity with low cost needs standardization of propagation techniques. Keeping this point in view, the investigation on floral biology of Bhatkal jasmine, its propagation technique and standardization for quick and cost effective mass multiplication was carried out.

Materials and Methods
To contribute to the crop improvement and asexual propagation in different Bhatkal Jasminum species, the study was conducted in Bhatkal, Karnataka state. The morphological traits with respect to both qualitative and quantitative traits were evaluated from the Bhatkal and Udupi area jasmine plants. Plant growth type, growth habit, season of flowering, flowering type, mature flower bud colour, open flower colour, pistil type, calyx type, stigma tip and ovary type were recorded as per the DUS character of Jasmine given by the PPV&FRA of Jasmine (Anon. 2015) [1] and quantitative traits *viz*., flower diameter (cm), corolla tube length (cm), number of pistils, number of whorls of corolla, number of petals per flower, number of stamens, length of stamen (cm) were also recorded.

To standardize propagation technique the experiment was laid out in Factorial randomized block design with three replications and sixteen treatments and two factors: semi hardwood cutting with different number of nodes and Auxins. The first factor comprised of four treatments *viz*., semi hard wood cuttings with single node, two nodes, three nodes and four nodes and second factor contains 4 treatments *viz*., distilled water (T1), IBA 1000 ppm (T2), IBA 2000 ppm (T3), IBA 3000 ppm (T4). The stem cuttings were taken from healthy mother plants (5 years old) in the field of Bhatkal. The past season growth of immature semi hardwood cuttings with different nodes without leaves were taken. A slant cut was given at the basal end and a transverse cut at the top of each cutting. The cut ends were treated with 0.5% copper oxy-chloride solution for 15 minutes followed by growth regulator solutions by quick dip method. Then, the treated cuttings were planted vertically in polyethylene bags (15 cm diameter x 20 cm height) filled with media containing FYM, sand and top soil in 3:1:1 ratio. All cuttings were maintained under low cost polytunnel and watered regularly. During investigation micro-environment provided to the cuttings with 25-30 ^{0}C temperature and 80-90% relative humidity. Further observations were recorded on various shoot and root parameters such as days taken for sprouting, number of buds sprouted, root length (cm), number of leaves formed on cuttings and survival percentage (%). Data pertaining to various shoot and root parameters were tabulated and statistically analyzed using Factorial Completely Randomized Design (FCRD). The inference was drawn at 5% (P= 0.05) and 1% (P= 0.01) level of significance.

Result and Discussion

The two ecotypes namely Bhatkal jasmine and Udupi jasmine expressed similarity with respect to plant growth type, growth habit, season of flowering, flowering type, mature flower bud colour, open flower colour, pistil type, calyx type, stigma tip, ovary type, number of whorls, number of pistils, stamens in flowers and variations with respect to the flower diameter, corolla tube length, stamens length and number of petals. The two ecotypes recorded intermediate plant growth habit with shrub type growth. Shrub type is the most desirable growth habit for home gardening, landscaping and commercial cultivation (Safeena *et al*. 2017) [4]. The flowers are borne solitary on the ends of branchlets in both the ecotypes. Bilocular superior ovary, distinctly bifid stigma tip, inserted type pistil, well developed calyx, white color mature flower bud and open flower were observed in both Bhatkal jasmine and Udupi jasmine.

Table 1: Comparison between Udupi Jasmine and Bhatkal Jasmine for qualitative traits

Si. No.	Character	Udupi Jasmine	Bhatkal Jasmine
1	Mature flower bud color	White	White
2	Open flower color	White	Whitish green
3	Calyx	Well developed	Well developed
4	Pistil type	Inserted	Inserted
5	Stigma tip	Distinctly Bifid	Distinctly Bifid
6	Ovary type	Bilocular, Superior ovary	Bilocular, Superior ovary
7	Plant growth type	Shrub	Shrub
8	Plant growth habit	Intermediate	Intermediate
9	Season of flowering	Throughout the season	Throughout the season
10	Flower type	Single	Single

Number of petals influences the size and shape of the bud which in turn affects the quantum of filling in flowers (Nirmala and Champa, 2018) [8]. Number of petals recorded was highest in Udupi jasmine (7.0) than Bhatkal Jasmine (6.60). Udupi jasmine recorded maximum corolla tube length and flower diameter (2.56 cm and 2.70 cm respectively). The stamen length was recorded maximum in the case of Bhatkal jasmine (0.72 cm) compared to Udupi Jasmine (0.64 cm). Both the ecotypes of jasmine recorded a single whorl of corolla with similar number of stamens (02) and pistils (01). However there was no significant difference was observed for most of the quantitative floral traits studied except flower diameter, corolla tube length and stamen length. Malik *et al*., (2013) [5]; Shekar *et al*., (2013) and Nirmala *et al*., (2017) [7] reported differences for quantitative traits among the genotypes of jasmine grown under different ago-climatic situations.

Table 2: Comparison between Udupi Jasmine and Bhatkal Jasmine for quantitative floral traits

Ecotype	Flower diameter (cm)	Corolla tube length (cm)	Number of petals	No. stamen	Stamen length (cm)	No. of whorls of corolla	No. of pistil
Udupi Jasmine	2.70	2.56	07	02	0.64	1	1
Bhatkal Jasmine	2.08	2.05	6.60	02	0.72	1	1
Level of significance	**	**	NS	NS	**	NS	NS

Udupi and Bhatkal jasmine were compared for qualitative and quantitative characters. The study on these two jasmine ecotypes reveals that Udupi and Bhatkal jasmine are same without any morphological differences. These results are conformity with the findings of Chaitanya *et al*. (2020) [2].

In the present study, different concentration of IBA growth regulator resulted non significant influence while number of nodes on cuttings and interaction effects showed significant influence on days taken for sprouting and number of buds sprouted (Table 3). Cuttings with four nodes took least number of days (13.1 days) for sprouting while single node cuttings took more number of days (18.9 days). Treatment with growth regulator IBA@ 2000 ppm concentration induced sprouting early (15.40 days) and these result are in conformity with findings of Netam *et al*. (2016) [6] in jasmine. Among interaction effect four node cuttings with IBA 2000 ppm performed better (12.50 days). More number of sprouted buds observed in four node cuttings. Again four node cuttings with IBA 2000 ppm interaction resulted maximum sprouted buds (4.00). It might be due to more amount of stored

carbohydrates in four node cuttings followed by root inducing IBA treatment which help to induce early sprouting and more number of buds.

In this experiment, the maximum root length (10.70 cm) and more number of leaves per cutting (13.70) were resulted in three node cuttings (Plate - 2). Treatment with growth regulator IBA@ 2000 ppm recorded highest root length (10.30 cm) and number of leaves (13.40). Netam *et al*. (2016) [6] also reported that the maximum length of longest root per cutting was recorded under 1500 ppm NAA (6.06 cm) which was found significantly at par with IBA 2000 ppm. Chowdhuri *et al*. (2017) [3] reported maximum root length in semi hard wood cape jasmine cutting with 3-4 nodes treated with IBA@ 2000 ppm.

There was significant differences observed between number of nodes, auxin concentration and their combinations for root length and leaves number per cutting (Table 3). Under interaction effect, the combination of three node cuttings + IBA 1000 ppm resulted maximum root length (13.25 cm) and number leaves per cutting (15.75). The increased root length might be due to early production of callus, differentiation of cells, greater cell elongation and differentiation of vascular tissue, which in turn favoured the root growth (Kumaresan *et al.* 2019) [10]. Shenoy, 1992 [9] in *Rosa damascena* reported that the increase in root length over control may be due to the enhanced hydrolysis of carbohydrates, metabolites accumulation and cell division induced by Auxin.

Significant differences were observed between different node cuttings, auxin concentrations and their interactions for survival percentage (Table 3). The per cent survivability was found to be maximum in three node cuttings (75.00). In growth regulator treatments IBA growth regulator at 2000 ppm resulted 57.90 survivability. Among interactions three node cuttings with 2000 ppm IBA combination resulted highest survival per cent (82%). Initiation of more roots and leaves may be responsible for higher percentage of survivability in three node cutting+ Auxin 2000 ppm combination. Chowdhuri *et al*. (2017) [3] revealed that 88 per cent of 3-4 node semi hard wood cutting survivability treated with IBA 2000 ppm in cape jasmine.

Table 3: Effect of semi hard wood cutting with different nodes and IBA on days taken for sprouting, number of buds sprouted, root length (cm), number of leaves and survival percentage in *Jasminum sambac var* Bhatkal Jasmine

Treatment	Days taken for sprouting			Number of buds sprouted			Maximum root length (cm)			No. of leaves on cutting			Survival percentage		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
Factor A: Nodes N1:Single node	18.80	18.90	18.90	2.10	2.80	2.40	3.30	4.30	3.80	6.50	7.10	6.80	18.80	24.30	21.50
N2:Two node	16.30	15.70	16.00	3.10	3.40	3.20	6.90	9.50	8.20	11.30	12.40	11.90	38.30	44.30	41.30
N3:Three node	15.80	16.10	16.00	3.30	3.80	3.50	10.30	11.50	10.90	13.60	14.00	13.70	72.00	78.00	75.00
N4:Four node	13.30	12.90	13.10	3.60	3.90	3.70	7.80	9.90	8.90	12.50	13.20	12.80	66.80	70.50	68.60
CD	0.61	0.64	0.58	0.18	0.25	0.22	0.53	0.70	0.66	0.93	1.01	0.99	2.37	2.51	2.49
Level of Significance	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Factor: IBA G1: Distilled water	16.83	16.20	16.50	2.70	3.20	3.00	4.10	5.90	5.00	5.70	6.60	6.20	42.00	44.30	43.10
G2: IBA 1000 ppm	16.00	15.58	15.80	3.00	3.70	3.40	8.30	11.30	9.80	12.20	13.70	13.00	50.30	58.30	54.30
G3: IBA 2000 ppm	15.35	15.50	15.40	3.00	3.80	3.40	9.10	11.60	10.30	13.20	13.80	13.40	56.50	59.30	57.90
G4: IBA 3000 ppm	16.03	16.55	16.30	3.40	3.10	3.20	6.70	6.50	6.60	12.70	12.60	12.60	47.00	55.30	51.10
CD	-	-	-	-	-	-	0.89	0.98	0.95	1.56	1.78	1.67	2.56	2.86	2.79
Level of Significance	NS	NS	NS	NS	NS	NS	*	*	*	*	*	*	*	*	*
Interaction															
N1G1:	19.50	18.90	19.20	1.80	2.70	2.30	2.80	3.60	3.30	4.30	4.80	4.56	18.00	20.00	19.00
N1G2:	19.20	18.70	18.95	2.00	3.10	2.60	4.40	6.40	5.40	8.00	9.30	8.65	22.00	28.00	25.00
N1G3:	18.30	18.80	18.55	2.00	3.20	2.60	5.50	7.30	6.40	9.10	10.80	9.95	28.00	32.00	30.00
N1G4:	18.20	19.40	18.80	2.70	2.00	2.40	3.10	3.30	3.20	8.70	8.10	8.40	25.00	37.00	31.00
N2G1:	17.10	16.00	16.55	2.70	3.20	3.00	3.50	7.80	5.65	6.20	8.60	7.40	39.00	31.00	35.00
N2G2:	16.00	15.50	15.75	3.10	3.70	3.40	7.80	10.60	9.20	12.30	13.90	13.10	38.00	49.00	43.50
N2G3:	15.60	15.20	15.40	3.00	3.80	3.40	8.60	14.90	11.75	13.70	13.90	13.80	44.00	46.00	45.00
N2G4:	16.50	16.20	16.35	3.40	3.00	3.20	7.70	4.80	6.25	13.10	13.30	13.20	32.00	51.00	41.50
N3G1:	106.5	16.80	16.65	3.00	3.50	3.30	8.20	9.20	8.70	8.60	9.00	8.80	68.00	76.00	72.00
N3G2:	15.60	15.60	15.60	3.30	3.90	3.60	11.30	15.20	13.25	15.00	16.50	15.75	72.00	82.00	77.00
N3G3:	15.00	15.50	15.25	3.20	4.00	3.60	12.20	11.30	11.75	15.10	15.60	15.35	80.00	84.00	82.00
N3G4:	16.20	16.80	16.50	3.70	3.70	3.70	9.30	10.30	9.80	14.70	14.90	14.80	68.00	70.00	69.00
N4G1:	14.20	13.10	13.65	3.20	3.50	3.40	4.70	6.50	5.60	8.00	8.90	8.45	61.00	70.00	65.50
N4G2:	13.20	12.50	12.85	3.50	4.20	3.90	9.70	12.90	11.30	13.60	15.20	14.40	69.00	74.00	71.50
N4G3:	12.50	12.50	12.50	3.70	4.30	4.00	10.20	12.70	11.45	14.20	14.80	14.50	74.00	75.00	74.50
N4G4:	13.20	13.80	13.50	3.90	3.50	3.70	6.50	7.60	7.05	14.00	13.90	13.95	63.00	63.00	63.00
CD	0.96	0.81	0.92	0.26	0.31	0.29	1.45	1.81	1.71	2.89	3.21	3.18	2.93	3.31	3.19
Level of Significance	**	**	**	**	**	**	**	**	**	**	**	**	*	*	*

IBA 1000 ppm IBA 2000 ppm IBA 3000 ppm

Plate 1: Root and shoot characters in Two node Jasmine cuttings under different IBA concentrations

IBA 1000 ppm IBA 2000 ppm IBA 3000 ppm

Plate 2: Root and shoot characters in Three node Jasmine cuttings under different IBA concentrations

IBA 1000 ppm IBA 2000 ppm IBA 3000 ppm

Plate 3: Root and shoot characters in Four node Jasmine cuttings under different IBA concentrations

Conclusion

The present study concludes that, the three node semi hardwood stem cutting showed increased percentage of survival by showing good root and shoot growth compared to that of single, two and four node cuttings. Among different concentration of IBA at 2000 ppm was found to be most effective for improving rooting of cuttings.

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