Journal of Applied Horticulture, 27(3): 483-488, 2025

https://doi.org/10.37855/jah.2025.v27i03.88

Journal of Applied Horticulture

ISSN: 0972-1045

Studies on floral biology of jasmine (*Jasminum* spp.) under northern dry zone of Karnataka

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Abstract

Jasmine (*Jasminum* spp., family Oleaceae) is a commercially important flower crop valued for its aromatic blooms. Despite the wide genetic diversity present among jasmine genotypes, relatively few cultivars have been developed to date. Floral biology studies play a crucial role in identifying genotypes with favourable traits for breeding and crop improvement. However, such studies in jasmine are limited. So, the present investigation was conducted during 2019-2020 at the University of Horticultural Sciences, College of Horticulture, Bagalkot, Karnataka, to evaluate floral morphological and biological traits across 12 jasmine genotypes. Significant variation was observed in floral traits, including flower type, anthesis timing, anther dehiscence, stigma receptivity, and pollen sterility. The flowers were predominantly protandrous, with anther dehiscence occurring prior to anthesis. Anther dehiscence typically began at 4:00 PM and concluded by 7:00 PM, while anthesis commenced at 6:00 PM, peaking between 7:00 and 8:00 PM. Peak stigma receptivity was observed at anthesis and up to 12 hours post-anthesis. Most genotypes exhibited circular pollen grains, except *J. multiflorum*, which showed triangular pollen. Viable pollen diameter ranged from 42.57 to 79.53 µm, whereas non-viable pollen ranged from 24.93 to 45.40 µm. Pollen sterility percentages varied from 24.28% to 78.91%. This study provides essential insights into floral biology that can guide the selection of suitable parental genotypes for hybridization, helping to improve jasmine yield and quality. The observed variability in reproductive traits offers valuable information for breeders aiming to develop superior cultivars and can support strategic breeding and conservation programs in commercial jasmine cultivation.

Key words: Jasmine, floral biology, anthesis, anther dehiscence, stigma receptivity, pollen sterility

Introduction

Commercial floriculture in India encompasses of both modern and traditional flowers. Among the traditional flowers, Jasmine (*Jasminum* spp.) stands out as one of the most significant, cherished for its cultural, religious, and economic value. Jasmine, a member of the Oleaceae family and the Oleales order, is native to India (Usha *et al.,* 2022). The name "Jasmine" is derived from the Old Persian word "Yasmyn," which means "fragrance" (Jayamma *et al.,* 2014). The genus *Jasminum* consists of around 300 species, of which 42 species are native to India and widely distributed in regions such as parts of eastern and northeastern states and other notable areas include the Malabar Coast, the Western Ghats, the Nilgiri and Palani Hills, Coonoor, and the tropical forests of South Andaman (Kalaiyarasi *et al.*, 2019).

Jasmine, a tropical and subtropical plant, is widely cultivated in India, with Tamil Nadu, Karnataka and Andhra Pradesh leading in both area and production (Usha *et al.*, 2022). This perennial evergreen shrub is widely cultivated for loose flower production and ornamental purposes. It can be grown as a climber, potted plant, or used in shrubbery. Beyond its beauty, jasmine is highly valued for its essential oil, which is among the most expensive in the world. This oil is widely used in cosmetics, pharmaceuticals, perfumes, aromatherapy, and products like candles, soaps, and lotions. It also offers several therapeutic benefits, including pain relief, mood improvement, anti-inflammatory and antiseptic properties, muscle relaxation, and stimulation of various bodily functions (Sahu *et al.*, 2022). Owing to its diverse economic and cultural significance, Jasmine cultivation in India has seen a remarkable growth of 161.54% over the last decade, with the area under cultivation expanding from 9.1 thousand hectares to 23.8 thousand hectares (Kumar *et al.*, 2024). To further support this upward trend, there is an urgent need to enhance Jasmine cultivation by improving both quality and yield through targeted crop improvement programs.

Jasmine is a perennial heterozygous clonally propagated crop. The various crop improvement methods in jasmine include open-pollinated seedling selection, clonal selection, hybridization, mutation and ploidy breeding (Ganga *et al.*, 2020). To date, most of the jasmine varieties released are derived from clonal selections and mutants, with only a limited number developed through hybridization. Therefore, it is crucial to develop hybrid varieties by utilizing both commercially cultivated and underutilized species through planned crop improvement programme.

Before initiating any crop improvement program, a comprehensive understanding of floral morphology and reproductive biology is a critical prerequisite. Since, these traits are governed by genetic factors at the same time highly influenced by environmental conditions. Even though Karnataka leads in jasmine cultivation after Tamil Nadu, floral biology studies on this crop is very meager hardly one study have been conducted (Pavithra *et al.*, 2018). Thus, the present study was undertaken to investigate and document key floral morphological and biological parameters, including anthesis time, anther dehiscence, duration of stigma receptivity and percentage of pollen sterility in both commercially cultivated and underutilized *Jasminum* species in order to find out parents with desirable characters. Information on floral morphological traits among the genotypes would be helpful for selecting parents with desirable characteristics. Floral biological traits such as time of anthesis, anther dehiscence, stigma receptivity, and pollen viability serve as reliable references for planned crop improvement programs. Genotypes exhibiting the longest duration of stigma receptivity can be chosen as seed parents, while those with the highest pollen viability are ideal as pollen parents to ensure effective fertilization (Ganga *et al.*, 2020).

Materials and methods

The present study was conducted on the farms of the Department of Floriculture and Landscape Architecture at the College of Horticulture, Bagalkot, during the 2019-2020 period. The study site is situated at 16.18º N latitude and 75.07º E longitude, with an elevation of 533 meters above mean sea level, within the northern dry zone of Karnataka. The soil of the experimental field was classified as sandy loam with a pH ranging from 6.5 to 7.0. During the experimental period, the maximum and minimum temperatures ranged from 23.9°C to 40.5°C, with relative humidity levels fluctuating between 65% and 75.7%. Various genotypes of jasmine were collected for the study from the University of Horticultural Sciences, Bagalkote and Tamil Nadu Agricultural University. The genotypes examined, along with their sources of collection, are detailed below.

Table 1. List of Jasmine genotypes and their sources used to characterize morphological and floral traits

Genotypes	Source of collection
Jasminum calophyllum	TNAU, Coimbatore
Jasminum sambac cv. Ramananthapuram gundumalli	TNAU, Coimbatore
Jasminum nitidum	TNAU, Coimbatore
Jasminum multiflorum cv. Bagalkote local	Bagalkote, Karnataka
Jasminum auriculatum cv. Bagalkote local	Bagalkote, Karnataka
Jasminum sambac cv. Mysore mallige	Bagalkote, Karnataka
Jasminum primulinum	TNAU, Coimbatore
Jasminum grandiflorum cv. CO.1 Pitchi	TNAU, Coimbatore
Jasminum multiflorum	TNAU, Coimbatore
Jasminum multiflorum Pink	TNAU, Coimbatore
Jasminum primulinum cv. Bagalkote local	Bagalkote, Karnataka
Jasminum rigidum	TNAU, Coimbatore

During March, the pits of 45 cm^3sizes were digged out and each pit was filled with topsoil mixed with 15 kg Farm yard manure (FYM) and uniform size one year old rooted cuttings were planted during June at a spacing of 1.8 x 1.8m in Randomized Complete Block Design (RCBD) with three replications. Standard cultural practices were followed throughout the experiment. Observations on morphological traits were recorded by following the descriptors for Jasmine provided by the Protection of Plant Varieties and Farmers' Rights Authority (PPV-FRA). Quantitative data were analyzed using Analysis of Variance (ANOVA) based on a Randomized Complete Block Design, as outlined by Gomez and Gomez (1983), with results evaluated at the 1% significance level using an F-test in OPstat statistical software. Floral biological traits such as, anthesis and anther dehiscence time, time and duration of stigma receptivity, pollen size, pollen shape and pollen sterility percentage were recorded according to (Pavithra *et al.*, 2018).

Time of anthesis and anther dehiscence: Ten mature flower buds from each genotype were randomly tagged in the evening to record both anther dehiscence and anthesis. The time of anther dehiscence was observed by examining the tagged buds at 15-minute intervals from 4 PM using a hand magnifying lens, while the time of anthesis was noted when the tagged buds opened.

Time and duration of stigma receptivity: Stigma receptivity was assessed using the hydrogen peroxide (H_2O_2) test as described by (Thorat *et al.,* 2020), with slight modifications. Flowers from all genotypes were collected at three developmental stages: pre-anthesis, anthesis, and post-anthesis. Stigmas from each stage were carefully excised and placed on a cavity slide. A drop of 6% hydrogen peroxide solution was applied directly onto the surface of each stigma, and the slides were left undisturbed for 3 minutes. Following this, the stigmas were examined under a stereomicroscope at 10× magnification. Stigma receptivity was determined based on the presence and intensity of bubbling (effervescence), indicative of peroxidase activity. Receptive stigmas exhibited visible foam or bubbling due to the enzymatic breakdown of hydrogen peroxide. The time and duration of effervescence were recorded at different time intervals to evaluate the period of stigma receptivity. The degree of receptivity was categorized based on the density of bubbles formed as follows: −: none, +: low, ++: moderate and +++: high.

Pollen shape and diameter (µm): Pollen shape and diameter were recorded using a Trinocular Compound Photo Microscope (Model BM-3200T) with ISC capture (ISC) software. Freshly dehisced pollen was collected on a cavity slide with acetocarmine stain and observed after two minutes to ensure uniform staining. Ten randomly selected stained pollen grains were analyzed for shape, categorized as spherical or triangular, while size measurements were obtained using IS Capture software.

Pollen sterility (%): Pollen grain sterility was assessed using the acetocarmine staining method. Freshly dehisced pollen grains were placed on a cavity slide with one to two drops of acetocarmine stain, followed by the application of a cover slip. The slide was left for two to three minutes to allow for proper staining and examined under microscope (Alexander, 1969). The pollen grains that were stained and round and deep purplish-pink were considered viable, while those that were shriveled or unstained were classified as sterile or non-viable.

$$\text{Pollen sterility (\%)} = \frac{\text{No. of unstained pollen grains}}{\text{Total no. of pollen grains}} \times 100$$

Results and discussion

Understanding the floral biology of *Jasminum* species is essential for developing effective crop management and improvement strategies. All floral morphological traits exhibited highly significant variations across the different genotypes of jasmine

Table 2. Floral morphological characters recorded in different species of Jasmine

Plant character	*J. calophyllum*	*J. sambac*	*J. nitidum* cv. Co-1 Star Jasmine	*J. multiflorum* cv. Bagalkote local	*J. auriculatum*	*J. sambac* cv. Mysore mallige	*J. primulinum* (TNAU)	*J. grandiflorum*	*J. multiflorum* (TNAU)	*J. multiflorum* Pink	*J. primulinum* cv. Bagalkote local	*J. rigidum*
Plant growth type	C	S	S	S	S	S	S	S	S	S	S	C
Plant growth habit	SS	I	SU	SU	SU	I	SS	S	SU	I	SS	SS
Plant height at flowering	T	M	M	M	T	T	T	T	M	M	T	T
Leaf arrangement	O	O	O	O	O	O	O	O	O	O	O	O
Leaf marigin	E	ON	E	E	ON	ON	ON	ON	ON	ON	ON	E
Leaf tip	SH	M	SH	BL	SH	M	SH	M	M	SH	M	SH
Intensity of green colour	D	L	M	M	M	M	D	D	D	D	D	D
Flower bearing habit	CC	FC	CC	CC	MFC	FC	SC	MFC	CC	CC	SC	CC
Flower bud shape	PL	RS	PL	PL	PL	RS	RS	PL	PL	PL	RS	PL
Flower bud length	L	S	L	L	L	M	M	L	L	L	M	M
Corolla length	M	S	L	M	M	M	M	L	L	L	M	L
Corolla tube length	M	M	L	L	L	S	S	L	L	L	L	M
Fragrance at flower opening	A	P	A	A	P	P	A	P	A	A	A	P
Style type	E	I	E	E	I	I	E	E	I	I	E	E
Stigma tip	D	D	UD	UD	D	D	D	D	UD	D	UD	UD
Seed setting	P	A	A	A	P	A	A	P	A	P	A	P
Flower type	S	S	S	S	S	S	SD	S	S	S	S	S
Shape of Pollen grains	SP	SP	SP	T	SP	SP	SP	SP	T	T	SP	SP
Tinge on flower bud	A	A	P	A	A	A	P	P	A	P	P	P
Flower colour on opening	W	W	PW	W	GW	W	VY	PW	GW	W	VY	PW

Note: S=shrub, C=climber; SS=Strongly spreading, I=Intermediate, SU=Semi upright, S=Spreading, T=Tall, M=Medium, O=Opposite, E=Entire, ON=Ondulate, SH=Sharp, M=Medium, BL=Blunt, D=Dark, L=Light, M=Medium, Cc=Clustered cyme, FC=Forked cyme, MFC=Many flowered cyme, Sc=Solitary cyme, PL= Pointed and long, RS=Round and short; M=medium, A=Absent, *P*=Present; L=Long, S=Short, M=Medium; E=Exerted, I=Inserted, D= Divided, UD=Undivided, S=Single, SD=Semi double, S*P*=Spherical, T=Triangle, W=White, PW=Pinkish white, GW=Greenish white, VY=Vivid yelow

presented in Table 2. Among the genotypes studied, the predominant growth habit was shrub-like, which is considered most suitable for home gardening, landscaping, and commercial cultivation (Safeena et al., 2017; Nirmala and Champa, 2018). In contrast, J. calophyllum and J. rigidum were climbers, and growth habit across the genotypes ranged from semi-upright and intermediate to spreading and strongly spreading. Plant height at flowering was medium (45-100cm) to tall (≥ 100cm). Among the leaf characters, there was no observed variation in leaf arrangement across all genotypes, with all having opposite leaves. Leaf margin characteristics varied from entire to undulate, while leaf tip shapes ranged from sharp to medium and blunt. The intensity of green coloration on mature leaves exhibited differences, appearing as dark, light, or medium green. The leaf traits documented in this study are vital for breeding plants with aesthetically pleasing foliage, suitable for various landscaping applications (Nirmala and Champa, 2018). The flower-bearing habit varied, encompassing clustered cymes, 3–5 forked cymes, many-flowered cymes, and solitary cymes (Table 2). These observations are consistent with the findings of (Kalaiyarasi *et al.*, 2018), who reported that many-flowered cymes, both terminal and axillary, were observed in *J. auriculatum* and *J. grandiflorum*. In contrast, terminally clustered flowers were noted in J. *multiflorum* (IIHR JM-1 and IIHR JM-2), *J. calophyllum*, *J. flexil*e, and *J. malabaricum*. Similarly, Arumugam *et al.* (2002) reported that *J. sambac* produced three-forked cymes.

The size and shape of the flower bud are regarded as two key traits in many commercial jasmine genotypes (Muthuswamy, 1975). The character with respect to flower bud shape was pointed and long, round and short across the studied genotypes. Nirmala and Champa (2018) noted that in jasmine flowers, pointed and long flower buds are desirable for making flower strings, whereas round and short flower buds are suitable for making garlands, as they create a filler, more attractive, and visually appealing appearance. Key economic traits in the jasmine flower trade, including the length and diameter of the flower bud, the size of the flower diameter, and the length of the stalk, are critical, as studies indicate that larger flower buds with greater diameters and longer stalks are preferred by consumers due to their association with higher quality and aesthetic appeal (Kalaiyarasi *et al.*, 2018). In the current study, variations were observed among the genotypes regarding bud length, corolla length and corolla tube length, which were categorized as long, medium and short.

All the genotypes exhibited single flower form except *J. primulinum* TNAU, which displayed a semi-double form (Fig.1). While some genotypes showed a tinge on the flower buds, the color changed to white or pinkish-white as they bloomed, except in the yellow-flowering *J. primulinum* species. The flower quality parameter *viz.*, fragrance at flower opening was assessed based on olfactory perception and recorded as either present or absent. The style type varied from inserted to exerted, with minor variation observed in the stigma tip, which was categorized as divided or undivided. Notable differences were recorded with regard to stamen and style length by Kalaiyarasi *et al.* (2019 and Lakshmi and Ganga (2017). Seed setting was recorded as present or absent. Species exhibiting seed-setting potential can be effectively utilized as female parents in hybridization programs (Usha *et al.*, 2022).

The jasmine flower generally possesses two yellow, bithecous anthers that undergo longitudinal dehiscence from tip to base.

Fig. 1. Floral morphological characters in different genotypes of Jasmine. A. *J. calophyllum* (TNAU); B. *J. sambac* cv. Ramananthapuram gundumalli; C. *J. nitidum* (TNAU); D. *J. multiflorum* cv. Bagalkote local; E. *J. auriculatum* cv. Bagalkote local; F. *J. sambac* cv. Mysore mallige; G. *J. primulinum* (TNAU); H. *J. grandiflorum* cv. CO.1 Pitchi; I. *J. multiflorum* (TNAU); J. *J. multiflorum*

An exception to this pattern was observed in the *J. multiflorum* cv. Bagalkote local where the anthers dehisced from the base to upward (Fig. 2b). All the genotypes studied exhibited protandry, with anther dehiscence occurred one to two hours before anthesis, as summarized in Table 3. The timing of anther dehiscence varied among genotypes, typically commencing at 4:00 PM and concluding by 7:00 PM. Notably, earlier anther dehiscence was recorded during the months of April and May compared to other periods. This phenomenon could be attributed to the higher temperatures prevailing during these months, which likely promoted earlier dehiscence. Variations in the timing of anthesis were observed among the jasmine genotypes, as detailed in Table 3. Anthesis occurred consistently one to two hours following anther dehiscence across all genotypes. The onset of anthesis began at 5:00 PM and continued until 10:00 PM, with a peak period observed between 7:00 and 8:00 PM. Similar observations were reported by Pavitra *et al.* (2018) in jasmine, indicating that the anthesis and anther dehiscence time is not only influenced by genetic makeup but also significantly affected by environmental conditions. Elevated temperatures accelerate anther dehiscence, potentially leading to reduced pollen viability or asynchrony with stigma receptivity. Similarly, low RH can cause premature drying of anthers, affecting pollen release and dispersal (Shivanna and Rangaswamy, 1992).

Stigma receptivity represents a critical stage in flower maturation that significantly influences pollination success. Understanding the timing and duration of stigma receptivity is essential for optimizing hybridization programs. A considerable variation in stigma receptivity was observed among the genotypes studied. In most genotypes, receptivity began within 12 hours prior to anthesis and continued for up to 12 hours after anthesis. Peak receptivity was recorded at the time of anthesis (flower opening stage), followed by a secondary peak 12 hours post-anthesis. The stigma receptivity duration was highest in genotypes *J. nitidum* cv.CO-1 star jasmine, *J. auriculatum* cv. Bagalkote local and *J. rigidum* TNAU, while, slightly shorter duration was observed *in J. grandiflorum* cv. Co-1 Pitchi. Conversely, the shortest duration of stigma receptivity was found in *J. primulinum*-TNAU, *J. sambac* cv. Ramananthapuram gundumalli and *J. multiflorum* cv. Bagalkote local. These findings align with those of Ling *et al.* (2011), who reported that in *J. mesnyi*, stigma receptivity was higher at the bud stage, peaked at anthesis, and declined gradually thereafter. Similarly, Pavithra *et al.* (2018) reported that stigma receptivity varies across *Jasminum* species and is influenced by factors such as temperature and relative humidity.

Information on pollen morphology is significant in fields such as taxonomy, phylogeny, and paleobotany (Shivanna and Rangaswamy, 1992). In this study, notable variation in pollen shape was observed among the genotypes, with two distinct shapes identified across the 12 genotypes evaluated. These variations in pollen morphology not only aid in species and cultivar identification but also provide insights into evolutionary relationships within the genus *Jasminum* (Erdtman 1969). Morphological markers like pollen shape can also serve as supplementary tools in

Table 3. Time of anther dehiscence and anthesis in different species of Jasmine

Genotypes	Time of anther dehiscence					Time of anthesis					Metrological data	
	February (pm)	March (pm)	April (pm)	May (pm)	June (pm)	February (pm)	March (pm)	April (pm)	May (pm)	June (pm)	Average temp	Relative humidity
J. calophyllum	5.30	5.35	5.20	5.15	5.20	7.15	7.0	6.20	6.35	7.00	32.4	32.8
J. sambac cv. Ramananthapuram gundumalli	NF	6.30	6.00	6.15	6.25	NF	7.0	6.45	6.50	7.15	32.5	38.5
J. nitidum	6.25	6.30	6.10	6.20	6.40	8.30	8.20	7.45	7.30	8.00	29.1	59.6
J. multiflorum cv. Bagalkote local	4.30	4.45	4.15	4.05	4.20	8.30	8.45	8.20	8.15	8.30	27.0	70.1
J. auriculatum cv. Bagalkote local	4.15	4.10	4.00	4.05	4.25	6.15	6.00	5.20	5.30	6.20	26.3	69.7
J. sambac cv. Mysore mallige	NF	5.45	5.30	5.35	5.40	NF	6.45	6.50	7.00	7.15	26.6	70.0
J. primulinum	5.30	5.35	5.15	5.20	5.35	8.00	8.15	7.35	7.40	8.05	26.1	75.7
J. grandiflorum cv. CO.1 Pitchi	4.30	4.25	4.00	4.15	4.20	7.15	7.30	7.00	7.05	7.25	25.2	65.3
J. multiflorum	6.00	6.15	5.45	5.40	5.30	8.45	8.50	8.20	8.35	8.50	23.9	70.3
J. multiflorum Pink	6.40	6.35	6.00	6.15	6.45	9.15	9.00	8.45	8.30	9.05	24.4	55.1
J. primulinum cv. Bagalkote local	5.30	5.25	5.00	5.15	5.20	8.00	7.45	7.30	7.25	8.05	25.8	45.8
J. rigidum	5.45	6.00	5.30	5.35	5.30	7.25	7.30	7.00	7.15	7.35	27.4	28.7

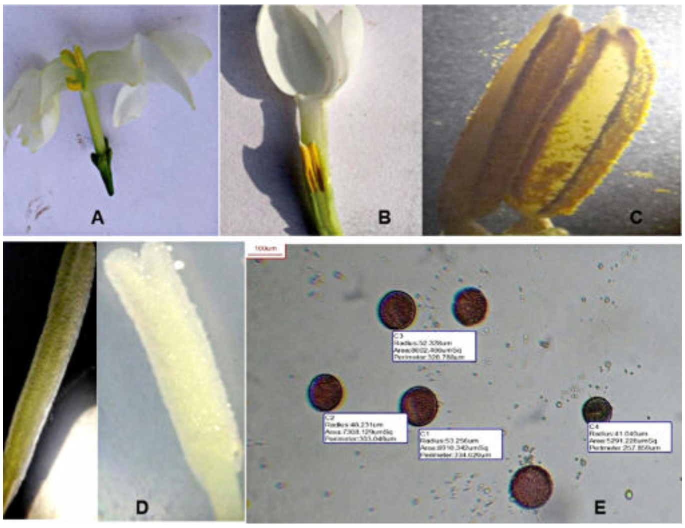

Fig. 2. Number of anthers per flower, anther dehiscence and stigma receptivity in different genotypes of Jasmine. A and B Anther dehiscence from bottom to tip in *J. multiflorum* cv. Bagalkote local; C. Microscopic view of anther dehiscence in *J. multiflorum* pink; D. Stigma receptivity before anthesis (Left) and at the time of anthesis (Right) in *J. grandiflorum* cv. CO.1 Pitchi E. Pollen diameter of Viable (Dark red) colour and non-viable (Black) pollen.

varietal authentication, which is crucial for maintaining genetic purity in commercial propagation. In this study, triangle-shaped pollen grains were found in *J. multiflorum* cv. Bagalkote local, *J. multiflorum* Pink, and *J. multiflorum*-TNAU, whereas the remaining genotypes exhibited spherical pollen grains. These findings align with the results of Kalaiyarasi *et al.* (2018), who reported three types of pollen shapes-spherical, triangular, and tricolpate in jasmine. Similar results were obtained by Raman *et al.* (1970), who observed spherical pollen grains in *J. grandiflorum* and spheroidal or slightly square-shaped pollen grains in *J. auriculatum***.**

Selection of viable pollen through estimating pollen diameter is one of the ways for successful pollination. Significant variation was observed among the genotypes in the diameter of viable and non-viable pollen grains. The diameter of viable pollen ranged from 42.57 to 79.53 µm, while non-viable pollen measured between 24.93 and 45.40 µm. Viable pollen grains were consistently larger than non-viable ones, likely due to the loss of moisture in non-viable pollen, leading to shriveling and decreased diameter. These findings are consistent with studies by Pavithra *et al.* (2018) and Kalaiyarasi *et al.* (2018), who reported that the selection of viable, mature pollen directly influences fertilization outcomes in jasmine. Among the genotypes, *J. multiflorum* Pink exhibited the largest viable pollen diameter, followed by *J. nitidum* cv. Co-1 star jasmine, while the smallest viable pollen diameter was found in *J. calophyllum.* Similarly, the largest non-viable pollen diameter was observed in *J. multiflorum* Pink, comparable to *J. multiflorum*, with the smallest diameter recorded in *J. calophyllum*. These results indicate that *J. multiflorum* Pink has the largest pollen grains, while *J. calophyllum*-TNAU has the smallest among the twelve jasmine genotypes studied (Table 4). The observed differences in pollen size may be attributed to the genetic makeup and morphological characteristics of the pollen (Shivanna and Rangaswamy, 1992).

Table 5. Viable and non-viable pollen diameter and pollen sterility % in different species of Jasmine

Genotype	Viable pollen diameter (µm)	Non-viable pollen diameter (µm)	Number of viable pollen	Number of non-viable pollen	Pollen sterility (%)
J. calophyllum	42.57	24.93	18.53	69.33	78.91
J. sambac cv. Ramananthapuram gundumalli	53.33	28.66	26.00	69.00	72.64
J. nitidum	60.60	39.26	129.93	68.67	34.58
J. multiflorum cv. Bagalkote local	51.80	37.40	76.47	41.87	35.38
J. auriculatum cv. Bagalkote local	53.97	25.46	102.33	32.80	24.28
J. sambac cv. Mysore mallige	51.00	35.66	33.20	66.60	66.8
J. primulinum	53.33	31.53	74.40	63.87	46.2
J. grandiflorum cv. CO.1 Pitchi	58.33	38.60	119.00	52.47	30.61
J. multiflorum	55.60	43.40	118.87	87.67	42.5
J. multiflorum Pink	79.53	45.40	60.60	92.93	60.53
J. primulinum cv. Bagalkote local	53.13	29.26	69.87	62.40	47.18
J. rigidum	49.33	32.33	100.47	61.33	37.91
S. Em **(±)**	1.41	0.91	1.90	1.18	0.68
C.D. (*P*=0.01)	5.65	3.64	7.60	4.73	2.70
CV (%)	4.44	4.61	4.26	3.21	2.29

Pollen sterility is a key determinant of reproductive success, and its variation among genotypes may arise from both genetic factors and environmental influences such as temperature extremes, humidity, light intensity, and water stress (Shivanna and Tandon, 2014). Significant differences were observed among the genotypes with respect to pollen sterility percentage. The least pollen sterility percentage was found in *J. auriculatum*

Table 4. Time and duration of stigma receptivity in different species of Jasmine

Genotype	30 h before anthesis	24 h before anthesis	12 h before anthesis	At the time of anthesis	12 h after anthesis	24 h after anthesis	30 h after anthesis
J. calophyllum	-	+	+ +	+ + +	+ +	+	-
J. sambac cv. Ramananthapuram gundumalli	-	-	+	+ + +	+ +	+	-
J. nitidum	-	+ +	+ + +	+ + +	+ + +	+ +	-
J. multiflorum cv. Bagalkote local	-	-	+	+ +	+ + +	+	-
J. auriculatum cv. Bagalkote local	-	+ +	+ +	+ + +	+ +	+ +	-
J. sambac cv. Mysore mallige	-	+	+ +	+ + +	+ +	+	-
J. primulinum	-	-	+ +	+ + +	+ +	-	-
J. grandiflorum cv. CO.1 Pitchi	-	+	+ +	+ + +	++	+ +	-
J. multiflorum	-	-	+ +	+ + +	+ +	+	+
J. multiflorum Pink	-	-	+	+ + +	+ +	+	-
J. primulinum cv. Bagalkote local	-	-	+	+ + +	+ +	+	-
J. rigidum	-	+ +	+ +	+ + +	+ +	+	+

Note: Note: -, none; +, less; ++, moderate; and +++, high cv. Bagalkote local followed by *J. grandiflorum* cv. Co-1 pitchi and *J. nitidum* cv. Co-1 star jasmine and the highest sterility percentage was observed in *J. calophyllum* followed by *J. sambac* cv. Ramananthapuram gundumalli (Table 5). From the above results, it can be concluded that the genotypes having lowest pollen sterility percentage could be used as pollen donor parents for effective fertilization. Similar research has been conducted by Pavithra *et al.* (2018) in Jasmine and Hemanta *et al.* (2017) in tuberose.

This study highlights that not only the commercially important jasmine species such as *J. sambac*, *J. auriculatum,* and *J. grandiflorum*, but also the relatively underutilized and recently released species *J. nitidum*, demonstrate comparable performance in terms of key floral morphological traits such as year-round flowering habit, long and sharp flower buds, many clustered inflorescence. Notably, *J. nitidum* was found to be on par with *J. grandiflorum* in floral biology characteristics including stigma receptivity, pollen viability, and pollen shape. These findings suggest that *J. nitidum* holds significant promise for inclusion in future breeding programs and crop improvement strategies aimed at enhancing jasmine productivity and diversity.

The success of any controlled hybridization program is significantly enhanced by the careful selection of parent plants that exhibit high cross-compatibility in addition to desirable horticultural traits. A comprehensive understanding of floral biology is critical in this context, as it facilitates the identification of suitable male and female parents. Based on the findings of the present investigation, there exists considerable scope to exploit the existing variability among genotypes with respect to plant architecture, shoot morphology, leaf characteristics, and floral attributes, thereby contributing to the enhancement of genetic diversity within the crop. Detailed studies on key floral biology traits such as timing of anthesis, anther dehiscence, stigma receptivity, and pollen viability provide valuable insights that can guide the strategic selection of parents for effective hybridization and sustained crop improvement.

While environmental factors play a critical role in influencing floral biology traits under field conditions, future research should also focus on comprehensive cytological analyses and genetic characterization of jasmine genotypes. Such studies will provide deeper insights into the underlying genetic diversity and relationships among genotypes, thereby facilitating the identification of desirable male and female parents for targeted hybridization. Additionally, this approach can help in recognizing pre- and post-fertilization barriers affecting fruit and seed set, which are essential for improving breeding efficiency. Furthermore, understanding the genetic makeup of jasmine species will contribute to the development of effective conservation strategies aimed at preserving genetic resources and enhancing the sustainability of jasmine cultivation.

Acknowledgements

Authors would like to extend profound gratitude to PG lab of Department of Floriculture and Landscaping College of Horticulture, University of Horticultural Sciences, Bagalkote, Karnataka**,** for providing lab facility and Indian council of Agricultural research for granting JRF fellowship for successful completion of research work.

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Received: April, 2025 ; Revised: May, 2025 ; Accepted: June, 2025