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Reproductive Biology Analyses in Jasmine (*Jasminum* spp.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Jasmine occupies predominant position among the flower crops in India in terms of area, production, productivity as well as economic and cultural significance. The demand for jasmine flowers is growing day by day owing to its wide range of uses and there is a pressing need for improving the crop by exploring strategies to evolve improved genotypes. The present study focuses on the floral morphology involved in the reproduction of *Jasminum* spp. Reproductive biology is the principle criterion considered in the evolution of hybrids. The aim of this study was to determine the floral traits and factors that influence successful reproduction in jasmine and assess the components that hinder fruit set. The results of the study indicated that *J. flexile* and *J. calophyllum* had superior traits in terms of pollen viability, pollen germination and stigma receptivity and also both the genotypes were well suited for all the possible pollination conditions. *J. sambac* recorded superior floral morphological traits but the overall response in terms of pollen viability, pollen germination and stigma receptivity were recorded the least. Assessment of breeding system that helps in analysis of pollination mechanism was also documented. *J. auriculatum* was found to be a potential species with maximum fruit set percentage. *J. sambac* recorded poor results indicating the prevalence of fertilization barriers that hinder hybridization.

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1. INTRODUCTION

Jasmine is the most revelled crop among the traditional loose flowers in India. The vast use of the flowers in various industries has solemnized its prime position in floriculture industry [1]. The flowers known for their unique and exotic fragrance are well used in perfumeries and cosmetic industries. The essential oil and concrete yielded from the flowers have wide application in aromatherapy that helps to relieve stress and heal various ailments and utilization of the jasmine crop is also employed in medical and pharmaceutical industries [2]. Commercialization apart, the crop has been extensively used in landscaping and a preferential household plant. Jasmine substantially occupies main position for production and consumption in India for its use in preparation of garlands, hair adornments and religious ceremonies. Profuse demand in the Middle East and European countries for the flowers gave rise to the export of stringed flowers of *J. sambac.* India is a major exporter of jasmine oil that totally contributes over 40 per cent of the export [3].

The genus *Jasminum* belongs to the family Oleaceae and is reported to constitute 200 species among which 40 species are native to India [4]. They are widely distributed along the tropical and sub-tropical parts of Sikkim, Himalayas, Deccan plateau region, Malabar Coast and Western Ghats and most of the species are cultivated in large scale in Southern parts of India. The commercially cultivated jasmine species in Tamil Nadu, Karnataka, Andhra Pradesh, Uttar Pradesh and some parts of Bihar and West Bengal are *J. sambac, J. grandiflorum, J. auriculatum and J. multiflorum*. Exclusive of these commercially important species, lesser known species namely, *J. nitidum, J. calophyllum* and *J. flexile* also acquire economic importance as they produce flowers which are suitable for use as loose flower, besides being ideal garden plants [5,6].

Reproduction plays a crucial role in evolutionary process of a plant. The study on reproductive biology allows one to understand the underlying mechanism in sexual or asexual reproduction in plants [7]. It also provides insight on different phenophases of plant development and the constraints that limit them. The fundamental basis for the crop improvement is through analysis of the process involved in the reproduction cycle of a plant and factors associated with it [8]. The present study focuses on the reproductive biology of various *Jasminum* spp and their associated mechanisms that aid successful fertilization and also may hinder pollination and fertilization.

2. MATERIALS AND METHODS

2.1 Plant Material

The study was carried out during 2019 to 2021 at the Department of Floriculture and Landscape Architecture, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. Ten year old plants of *J. auriculatum* cultivars CO.1 Mullai, CO.2 Mullai, Parimullai at 1.5x1.5m spacing and *J. grandiflorum* cultivars CO.1 Pitchi and CO.2 Pitchi, *J. sambac*, *J. multiflorum*, *J. nitidum*, *J. calophyllum* and *J. flexile* spaced at 2x1.5m were selected for the study.

2.2 Flowering Phenology and Floral Traits

This study was conducted during February–December where ten individual plants were randomly selected in each cultivar and observations were recorded for the number of flowers per inflorescence each day. Ten inflorescences in each of the *Jasminum* species were tagged at the time of appearance of flower bud for assessing the duration of the various phases in flower development. A series of developmental stages in *Jasminum* species was categorized as per [9]. For each cultivar, the dynamics of the flower opening, anthesis and anther dehiscence were recorded every day.

2.3 Stigma Receptivity

Stigma receptivity was assessed by conducting the oxidation test using 6 % hydrogen peroxide [10]. Pistils were collected at different stages: immediately after anthesis, 24 hours, 48 hours and 72 hours after anthesis. Then stigmas were placed in few drops of 6 % hydrogen peroxide and were observed under microscope. Bubbling at stigmatic surface indicates the active/ receptive stage of stigmas.

2.4 Pollen Viability

In the present study pollen viability tests were carried out with triphenyl tetrazolium chloride

(TTC) and iodine potassium iodide (IKI) techniques to assess the authenticity of the test and thereby attaining precise results. Pollen grains were collected from each parental genotype and tested for viability at different intervals: 0-1 hour (fresh pollen), 12 hours, 24 hours, 48 hours and 72 hours after anther dehiscence [11]. A small portion of pollen was taken into a cavity slide with the help of a needle and few drops of stain were added into it using micropipette. Slides were kept at least for 30 min before taking observations. Number of viable pollen was counted and the viability was expressed in terms of percentage.

2.5 Pollen Germination

The pollen was collected from freshly dehisced anthers and was stored under laboratory conditions. The tests were conducted at different time intervals: 0-1 hrs (fresh pollen), 12 hrs, 24 hrs, 48 hrs and 72 hrs after anther dehiscence. Standard [12] medium comprising of 20 % (w/v) sucrose, 100 ppm boric acid (H_3BO_3), 200 ppm calcium nitrate ($Ca(NO_3)_2.4H_2O$), 200 ppm magnesium sulphate ($MgSO_4$) and 100 ppm potassium nitrate was used as a nutrient matrix. Pollen grains were considered as germinated if the pollen tube length was equal or greater than the diameter of the pollen grain [13,14]. Number of pollen grains germinated was counted and expressed in percentage.

2.6 Pollen/Ovule (P/O) Ratio

The reproductive system is estimated by P/O ratio according to the standards set by [15]. At the full bloom stage, 10 fully bloomed flowers with intact pollen grains were randomly selected from each genotype. All the anthers of each single flower were taken and 1 $molL^{-1}$ HCl solution was used to remove anther wall. Using a micropipette, 1 µL of pollen suspension was placed onto a glass slide and the number of pollen grains was counted under the microscope. The total pollen number of each anther was calculated using the formula,

$$\text{Total pollen number/anther} = \text{pollen number}^{-}{}^{1\mu L} \times 10^4$$

The ovary was cut with a scalpel, and the number of ovules in each ovary was observed under stereomicroscope.

2.7 Outcrossing Index (OCI)

Fifty blooming flowers of each cultivar were randomly selected and their reproductive systems were assessed according to the standards established by [16].

The OCI value was calculated as the sum of the above three parameters.

2.8 Fruit Set

Fifty flowers from different individuals of each cultivar were randomly selected and assessed for fruit setting potential under open pollination condition. The fruit and seed setting rate of each cultivar was counted 4–20 weeks after pollination.

2.9 Statistical Analysis

Statistical analysis was carried out in triplicates and the values were expressed in Mean ± SD. The analysis of variance was done following completely randomized design as per the procedure suggested by [17].

Table 1. Assessment of breeding system

S.No.	Parameters	Range	Score
1.	Diameter of the corolla	<1 mm	0
		1-2 mm	1
		2-6 mm	2
		>6 mm	3
2.	Time period between the anther dehiscence and stigma-receptivity	Stigma matured first or anther and stigma matured simultaneously	0
		Anthers matured first	1
3.	Spatial position of stigma to anthers	Same position	0
		Spatial separation	1

3. RESULTS AND DISCUSSION

3.1 Flowering Phenology and Floral Traits

The detailed descriptions of the floral traits for the *Jasminum* genotypes are furnished in Table 3. *J. multiflorum* and *J. nitidum* exhibited bolder flowering traits while *J. flexile* comparatively expressed least values in terms of flower diameter (2.17 cm), filament length (0.75 cm) followed by *J. calophyllum*. *J. flexile* and *J. calophyllum* recorded floral traits that are favourable for pollination and aid in successful hybridization among other *Jasminum* spp. The flowering period in jasmine varied with the genotypes. The longest flowering phenophase was recorded in *J. sambac* (65 days from pruning) and the shortest period (38 days from pruning) was observed in *J. flexile* (Table 4). The developmental stages in *Jasminum* species was categorized (Fig. 1) as per [9]. The flowering period for various *Jasminum* spp. varied from late February to early December. Peak season of jasmine flowering was recorded from March-June in most of the genotypes. *J. multiflorum*, *J. nitidum*, *J. calophyllum* and *J. flexile* flowered year round and *J. multiflorum* flowered vigorously during the months of September-December. Early anthesis was expressed in *J. multiflorum* and *J. nitidum* and very late anthesis in *J. calophyllum*. Peak duration of anther dehiscence was observed earliest in *J. calophyllum* and late in *J. nitidum* (Table 2). The information generated on floral morphological traits in different genotypes will facilitate the crop improvement programmes in jasmine [18,19,20].

Table 2. Anthesis and anther dehiscence duration of selected *Jasminum* spp

Cultivars	Peak season of flowering	Peak duration of Anthesis	Peak duration of Anther Dehiscence
J. auriculatum CO.1 Mullai	May – June	6:00-7:00 pm	3:30-5:00 pm
J. auriculatum CO.2 Mullai	April – June	6:00-7:00 pm	3:30-5:00 pm
J. auriculatum Parimullai	April – June	6:00-7:00 pm	3:30-5:00 pm
J. grandiflorum CO.1 Pitchi	July – September	6:30-7:30 pm	3:30-4:30 pm
J. grandiflorum CO.2 Pitchi	July – September	6:30-7:30 pm	3:30-4:30 pm
J. sambac	February – May	6:30-8:00 pm	3:30-5:00 pm
J. calophyllum	April – July	7:00-8:00 pm	2:30-4:30 pm
J. flexile	February – March	6:00-7:30 pm	2:30-5:30 pm
J. multiflorum	September – December	5:30-7:30 pm	3:30-5:30 pm
J. nitidum	February – May	5:30-7:30 pm	4:30-5:30 pm

Fig. 1. Floral phenophase of *J. auriculatum* cv. Parimullai
a. Small green bud; b. Elongated bud; c. Enlarged bud; d. Bud break; e. Initial bloom; f. Full bloom; g. Final bloom; h. Withered stage

Table 3. Floral traits of selected *Jasminum spp*

Parameter	*J. auriculatum* CO.1 Mullai	*J. auriculatum* CO.2 Mullai	*J. auriculatum* Parimullai	*J. grandiflorum* CO.1 Pitchi	*J. grandiflorum* CO.2 Pitchi	*J. sambac*	*J. calophyllum*	*J. flexile*	*J. multiflorum*	*J. nitidum*
Flower diameter	2.64±0.005	2.59±0.02	2.68±1.23	3.65±0.09	3.89±1.36	2.52±0.05	2.27±0.72	2.17±0.16	3.52±0.08	4.24±0.41
Pedicel length	2.29±0.71	2.32±0.35	2.39±0.52	2.38±0.11	2.44±0.28	1.46±0.21	1.16±0.61	1.23±0.32	2.94±0.18	2.67±0.64
Petal length	1.65±0.02	1.65±0.47	1.64±1.54	3.14±1.06	3.48±0.87	1.93±1.13	2.13±0.32	2.43±0.54	3.09±0.06	4.17±1.23
Petal width	1.35±0.56	1.36±0.08	1.39±1.19	2.07±0.006	2.19±1.25	1.27±0.89	1.86±0.64	0.89±0.38	2.06±1.08	1.76±1.01
Anther length	0.57±1.29	0.57±1.35	0.57±0.05	1.27±1.08	1.24±0.07	0.69±0.37	0.62±0.29	0.66±0.04	0.78±1.29	0.65±0.65
Filament length	0.97±1.41	0.99±0.77	0.94±0.92	1.52±0.65	1.83±0.56	0.51±1.46	0.87±1.28	0.75±1.14	0.92±0.64	0.97±0.09
Stigma length	0.42±0.06	0.42±0.35	0.42±0.67	1.38±0.27	1.38±1.27	0.56±0.21	0.92±0.36	0.81±0.78	1.04±0.36	1.28±1.87
Stigma diameter	0.21±0.32	0.21±0.04	0.20±0.09	0.27±0.22	0.28±0.006	0.24±2.68	0.25±0.04	0.24±0.05	0.33±1.95	0.39±1.28
Style length	1.24±1.21	1.27±0.007	1.20±1.34	1.46±0.63	1.37±0.28	0.78±0.41	0.65±1.22	0.97±1.92	1.26±1.54	1.86±0.74
Ovary length	0.29±0.91	0.30±0.10	0.28±0.25	0.38±0.05	0.45±1.90	0.42±1.79	0.33±0.97	0.38±0.39	0.26±0.26	0.41±0.69
Ovary width	0.21±0.38	0.21±0.005	0.21±1.26	0.17±1.04	0.11±6.25	0.51±0.36	0.48±2.11	0.52±1.07	0.28±1.22	0.26±0.04
Stigma – Anther Distance	0.76±0.13	0.75±1.21	0.74±0.008	0.54±0.95	0.49±1.28	1.27±0.04	0.14±0.35	0.29±1.93	0.12±0.08	0.09±1.27

Table 4. Phenological observation of flowering phase in selected *Jasminum spp*

Character	*J. auriculatum* Co.1 Mullai	*J. auriculatum* Co.2 Mullai	*J. auriculatum* Parimullai	*J. grandiflorum* Co.1 Pitchi	*J. grandiflorum* Co.2 Pitchi	*J. sambac*	*J. calophyllum*	*J. flexile*	*J. multiflorum*	*J. nitidum*
Bud initiation (DAP*)	36.12±1.15	37.56±0.34	32.7±0.01	34.21±0.65	34.07±0.42	38.05±0.06	27.65±0.06	20.97±0.16	34.12±0.85	34.48±0.02
Small green bud	5.04±0.58	5.18±0.03	5.35±0.05	6.31±0.06	5.18±0.18	5.14±0.03	3.06±0.007	3.32±0.02	4.06±0.04	5.08±0.12
Enlarged bud	4.01±0.58	3.15±0.01	3.12±0.61	5.16±0.10	3.11±0.06	3.01±0.04	4.11±0.02	4.15±0.04	4.32±0.08	3.12±0.02
Elongated bud	2.32±0.03	3.28±0.01	2.01±0.01	2.32±0.05	2.04±0.01	8.65±0.08	4.68±0.09	3.06±0.007	3.46±0.01	3.29±0.11
Bud break	2.09±0.47	2.14±0.005	2.00±0.12	3.02±0.07	2.11±0.12	3.52±0.03	3.64±0.01	2.08±0.002	2.72±0.01	3.65±0.04
Initial bloom	1.00±0.08	1.61±0.12	1.05±0.001	2.13±0.09	2.04±0.02	2.08±0.05	2.07±0.04	2.03±0.01	2.31±0.03	2.54±0.005
Full bloom	0.97±0.32	1.01±0.01	1.13±0.01	2.07±0.12	1.09±0.01	1.67±0.02	1.35±0.01	1.64±0.03	1.28±0.02	1.15±0.04
Final bloom	1.32±0.58	1.32±0.02	1.08±0.020	1.24±0.04	1.65±0.01	1.25±0.008	1.09±0.008	1.28±0.08	1.21±0.002	1.27±0.26
Withered stage	3.48±0.06	3.28±0.27	4.39±0.10	2.15±0.02	2.57±0.04	3.01±0.02	2.39±0.008	2.23±0.02	3.08±0.01	3.25±0.07
Total Duration	56.35±1.08	57.94±0.38	52.18±0.04	58.61±0.75	53.86±0.56	66.38±0.03	50.04±0.15	40.76±0.18	56.56±0.76	57.83±0.08

***The above values for all the parameters are expressed in days*
**DAP- Days after Pruning*

3.2 Stigma Receptivity

The receptive stage of stigma was high during the time of anthesis and receded gradually over the time period for all the *Jasminum* specieas. *J. calophyllum* was found most receptive upto 72 hours of anthesis and *J. sambac* recorded the least receptive stigmatic surface that only lasted within 24 hours of anthesis (Table 5). Receptive stigmas are characterised by high enzymatic activity. Enzymes such as peroxidases, dehydrogenases and esterases coincide with the developmental stage that influences the stigma receptivity [21]. The receptive cells that are present in stigma recognise the pollen and germination is aided by suitable substrate [16]. The receptive cells are responsible for the acceptance or rejection of the pollen [22] and have the capability to differentiate among self and non-self pollen that may limit self-fertilization.

3.3 Pollen Viability and Pollen Germination

The data furnished in Table 6. signified that IKI provided better results in comparision with TTC stain. *J. flexile* observed maximum percentage of viable pollen under both the stains while *J. sambac* recorded minimum number of viable pollens (27.09%) for IKI stain and nil results for TTC stain. *J. calophyllum* pollen remained viable even after 48 hours of anthesis followed by *J. flexile* in comparision with *J. sambac* where pollen viability endured 24 hours of anthesis (Fig. 2). Pollen germination prevailed in all *Jasminum* genotypes under Brewbaker and Kwack medium as nutrient medium. Pollen germination was observed maximum during anthesis and decreased over period of time.

Pollen germination was very meagre in all the genotypes after 48 hours of anthesis (Fig. 3). *J. flexile* followed by *J. grandiflorum* CO.1 Pitchi recorded maximum germination and minimum was noticed in *J. sambac* (Table 6.). The stage of pollen collection has an impact on pollen viability and ability to germinate during hybridization. The pertinent time of anther collection reinforces the notion among the cultivars the highest and lowest percentages of germinated pollen grains occur during anthesis and post-anthesis respectively [23]. The increase in osmotic pressure and low cell wall resistance creates rapid influx of water in the pollen grain resulting in imbibition damage that bursts open the pollen [24]. The pollen viability is lowered by membrane dehydration and disorganized pollen metabolism [25].

Table 5. Stigma receptivity of selected *Jasminum* spp

Cultivars	Anthesis	24 h after anthesis	48 h after anthesis	72 h after anthesis
J. auriculatum CO.1 Mullai	+++	++	+	-
J. auriculatum CO.2 Mullai	+++	++	+	+
J. auriculatum Parimullai	+++	++	+	+
J. grandiflorum CO.1 Pitchi	+++	+	-	-
J. grandiflorum CO.2 Pitchi	+++	+	-	-
J. sambac	+++	-	-	-
J. calophyllum	+++	++	+	+
J. flexile	+++	++	+	-
J. multiflorum	+++	++	-	-
J. nitidum	+++	++	+	-

**+++: High; ++: Moderate; +: Low; -: Absent*

Table 6. Pollen viability and *in vitro* pollen germination of selected *Jasminum* spp

Cultivars	Pollen Viability No. of viable pollen (%)		Pollen germination	
	TTC stain	IKI stain	Germination percentage (%)	Pollen tube length (µm)
J. auriculatum CO.1 Mullai	63.21	74.27	42.28	445.61
J. auriculatum CO.2 Mullai	68.19	83.96	47.56	447.29
J. auriculatum Parimullai	68.28	90.11	52.36	461.43
J. grandiflorum CO.1 Pitchi	32.07	58.32	58.14	552.61
J. grandiflorum CO.2 Pitchi	44.34	65.27	61.03	549.32

Cultivars	Pollen Viability No. of viable pollen (%)		Pollen germination	
	TTC stain	IKI stain	Germination percentage (%)	Pollen tube length (µm)
J. sambac	-	27.09	7.03	4.06
J. calophyllum	67.91	75.04	35.27	641.15
J. flexile	92.25	95.29	62.57	745.12
J. multiflorum	58.35	76.38	13.57	154.32
J. nitidum	64.43	72.44	25.14	436.24

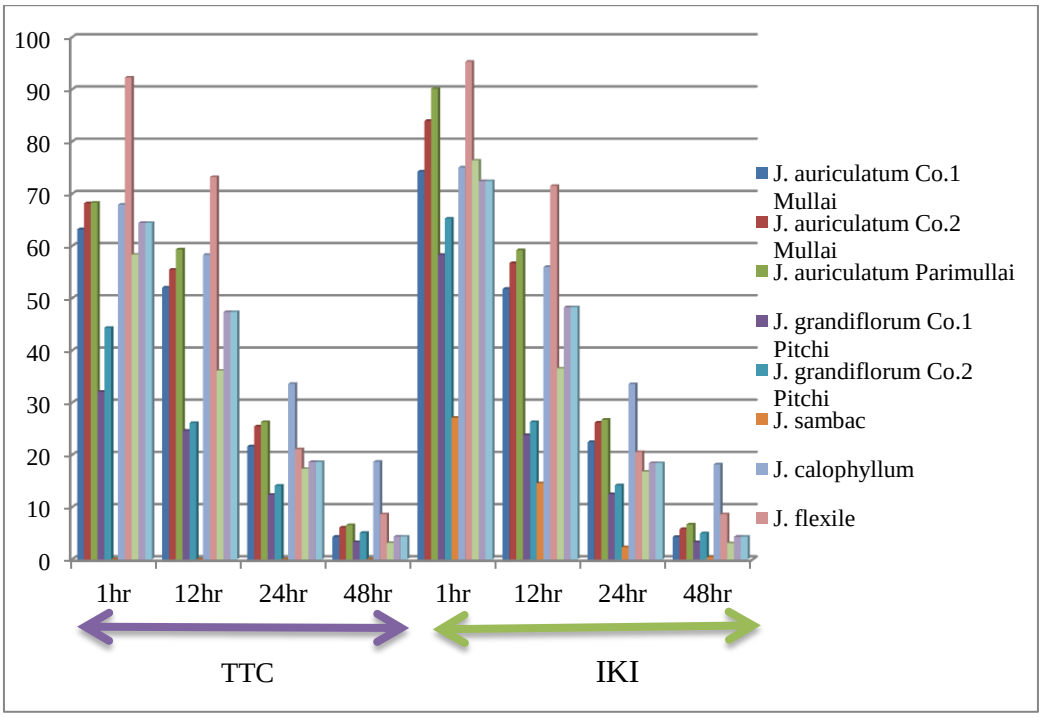

Fig. 2. Analysis of pollen viability of *Jasminum* genotypes at different time intervals

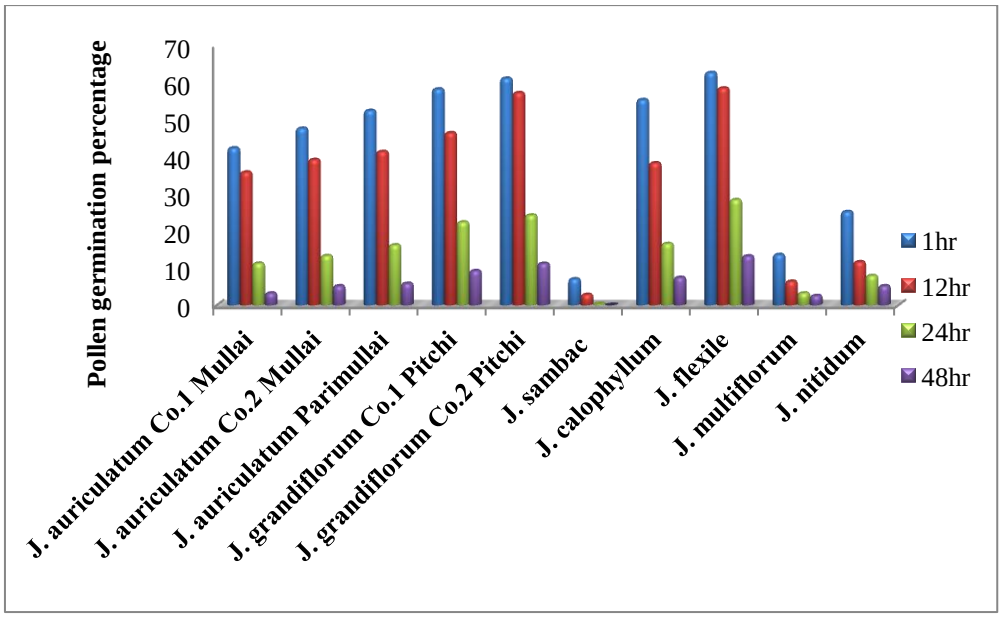

Fig. 3. Analysis of pollen germination of *Jasminum* genotypes at different time intervals

3.4 Pollen Ovule Ratio

J. sambac had the least pollen count and highest was recorded in J. grandiflorum cv. Co. 2 Pitchi. Most of the genotypes recorded only two ovules with the exception being J. grandiflorum, *J. calophyllum* and *J. flexile*. The reproductive system reflected with P/O ratio indicated that most of the *Jasminum* genotypes fall under obligate xenogamy conditions while *J. sambac* tended towards facultative autogamy or xenogamy conditions (Table 7). The correlation between pollen-ovule (P/O) ratio and breeding system has generally been analysed with respect to pollination efficiency. The P/O of the flower and the inflorescence belong to the same order of magnitude. The difference between P/O ratios for the inflorescence and the flower in a given species is due mainly to the ratio between male and female flowers in the inflorescence [26,27]. [11] determined the P/O in 80 different species, concluding that the greater the degree of autogamy, the lower the P/O. The results derived from all the *Jasminum* genotypes determine that P/O variability is also influenced by taxonomic position and pollination mechanism in this plant group. These results are in concurrent with the findings of [28] and [29].

3.5 Outcrossing Index

The sum of the results determined most of the *Jasminum* types were suited for mixed mating system while *J. grandiflorum* corresponded to strictly cross pollinated condition. *J. calophyllum* and *J. flexile* were categorised under self pollinated condition tending towards mixed mating condition (Table 8). The outcrossing index also revealed that *Jasminum* spp. were mostly partially self-compatible or self-incompatible and were pollinator assisted type. Variations among the population that are typically small will characterize the mating system of the species. Evolution of mating system diversity is analysed by substantial variation among the population. Assessment of multiple populations in mating system studies provides broad view regarding the distribution of the population and their outcrossing rate concerning the evolution of such variation [30,31,32].

3.6 Fruit Set

The natural fruit set under open pollinated conditions revealed that *Jasminum* spp. consists spherical to obovate shaped fruits that are green during immature stage turning purplish black on maturity (Fig. 4). Fruits of *J. calophyllum* and *J. flexile* showed no difference in colour upon maturity. The peak fruiting was observed in the months of June-December while *J. flexile* documented shortest peak during February-March. *J. sambac* revealed nil fruit set indicating prevailing barriers hindering fertilization. Sparse fruiting was recorded in *J. multiflorum* and *J. nitidum* whereas profuse fruit set was observed in *J. auriculatum*. The fruit size varied along the genotypes detailed in Table 9. *J. auriculatum* documented single seed per fruit while no seed set or deformities in fruit formation among *Jasminum* genotypes emphasized abrasions in post-fertilization process [9].

Table 7. Pollen/Ovule ratio of selected *Jasminum* spp

Cultivars	Pollen count	No of ovules	P/O ratio	Type of breeding system
J. auriculatum CO.1 Mullai	14,175	2	7,087.5	e*
J. auriculatum CO.2 Mullai	18,203	2	9101.5	e*
J. auriculatum Parimullai	23,657	2 – 4	11783.5	e*
J. grandiflorum CO.1 Pitchi	17,920	2 – 4	3584	e*
J. grandiflorum CO.2 Pitchi	23,816	2	11908	e*
J. sambac	530	2	265	c/d*
J. calophyllum	8,769	2 – 4	4384.5	e*
J. flexile	10,254	2 – 4	5127	e*
J. multiflorum	17,205	2	8602.5	e*
J. nitidum	21,056	2	10,528	e*

**a= Cleistogamy; b= Obligate autogamy; c= Facultative autogamy; d= Facultative xenogamy; e= Obligate xenogamy*

Table 8. Outcrossing Index of selected *Jasminum* spp

Cultivars	Corolla diameter	Overlapping time period between the anther dehiscence and stigma-receptivity	Spatial position of stigma to anthers	OCI
J. auriculatum CO.1 Mullai	3	0	1	4*
J. auriculatum CO.2 Mullai	3	0	1	4*
J. auriculatum Parimullai	3	0	1	4*
J. grandiflorum CO.1 Pitchi	3	1	1	5*
J. grandiflorum CO.2 Pitchi	3	1	1	5*
J. sambac	3	0	1	4*
J. calophyllum	3	0	0	3*
J. flexile	3	0	0	3*
J. multiflorum	3	0	1	4*
J. nitidum	3	0	1	4*

**0- Cleistogamy; 1- Obligate autogamy; 2- Facultative autogamy; 3- Self pollinated; 4- Mixed mating; 5- Cross pollinated*

Table 9. Natural fruit set in selected *Jasminum* spp

Cultivars	Fruit intensity	Season of fruit set	Fruit shape	Fruit colour	Fruit length (cm)	Fruit girth (cm)
J. auriculatum CO.1 Mullai	Moderately Profuse	June – December	Spherical	Medium green	1.09	1.31
J. auriculatum CO.2 Mullai	Profuse	June – December	Spherical	Light green	1.12	1.35
J. auriculatum Parimullai	Profuse	June – December	Spherical	Medium green	1.18	1.46
J. grandiflorum CO.1 Pitchi	Very Sparse	December – March	Conical	Yellow green	0.53	0.31
J. grandiflorum CO.2 Pitchi	Very Sparse	February – March	Conical	Yellow Green	0.51	0.46
J. sambac	NIL					
J. calophyllum	Profuse	February – November	Oblate	Dark green	0.89	0.66
J. flexile	Profuse	February – March	Obovate	Medium green	0.92	1.01
J. multiflorum	Sparse	September – October	Obovate	Medium green	1.29	1.15
J. nitidum	Sparse	September – December	Obovate	Light green	1.18	1.25

Open pollinated fruits of *J.auriculatum*
Change of colour is evident upon maturity

Open pollinated fruits of *J.calophyllum*
Colour remains constant upon maturity

Fig. 4. Fruit set in open pollinated (OP) genotypes of *J. auriculatum* and *J. calophyllum*

4. CONCLUSION

The results in the current study provide the detailed description of the floral traits of different Jasminum genotypes and the influence of these traits in successful pollination and fertilization of the species. The experiment also focuses on the pollination mechanism involved and the breeding system associated within. Among the Jasminum genotypes *J. flexile* exhibited favourable results vouching it as the best among all the genotypes that can be utilised in crop improvement to evolve superior and diverse progenies. Few of Jasminum spp. yielded low results and the said outcome could be influenced by reproductive barriers that limit hybridization. The assessment of reproductive traits in different genotypes will facilitate further crop improvement programmes in jasmine.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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