Journal of Horticultural Sciences
ISSN: 0973-354X
subbaraman.Sriram@icar.gov.in
Society for Promotion of Horticulture
India

Palynological investigations in Jasminum spp.

Ganga, M.; Lakshmi, J.; Manivannan, N.; Rajamani, K.
Palynological investigations in Jasminum spp.
Journal of Horticultural Sciences, vol. 15, núm. 2, 2020
Society for Promotion of Horticulture, India
Disponible en: https://www.redalyc.org/articulo.oa?id=577074696009
DOI: https://doi.org/10.24154/JHS.2020.v15i02.010

Original Research Papers

Palynological investigations in Jasminum spp.

M. Ganga gangasivakumar@yahoo.com
Agricultural University, India
J. Lakshmi
Agricultural University, India
N. Manivannan
Agricultural University, India
K. Rajamani
Agricultural University, India

Journal of Horticultural Sciences, vol. 15, núm. 2, 2020

Society for Promotion of Horticulture, India

Recepción: 07 Diciembre 2020
Aprobación: 28 Diciembre 2020

DOI: https://doi.org/10.24154/JHS.2020.v15i02.010

Redalyc: https://www.redalyc.org/articulo.oa?id=577074696009

Abstract: **The present investigation was carried out at the Department of Floriculture and Landscape Architecture, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during 2017-2019. The study involved nine jasmine genotypes, four falling under the commercially cultivated types and five belonging to underutilized species or 'lesser-known species'. The study was undertaken to investigate and document the palynological parameters of jasmines which could serve as a reliable reference for future jasmine breeding programmes. The palynological investigations were carried out using by Scanning Electron Microscopy (SEM), haemocytometry, acetocarmine test and i*n vitro* pollen germination. The pollen morphology analysis indicated wide variation among the species for shape of pollen grain, ranging from tricolpate to prolate; the exine ornamentation was reticulate in all the genotypes. Pollen output was the highest in *J. rigidum* (28,660 pollen/flower) and the lowest in (625 pollen/ flower) in *J. sambac* cv. Ramanathapuram Gundumalli. The maximum pollen germination rate and pollen tube length was recorded in *J. rigidum.***

Keywords: *Jasminum* spp, Palynology, Pollen morphology, Pollen germination.

INTRODUCTION

Jasmine (*Jasminum* sp.) belonging to family Oleaceae is one of the most important and popular traditional flowers of India. It is native to South and Southeast Asia. A large number of species of *Jasminum* are centered around the regions comprising India, China and Malaysia (Nirmala *et al.*, 2017). The area coverage under flower crops in India is 3,07,000 ha with a production of18,05,000 MT of loose flowers and 7,04,000 MT of cut flowers (2017-18) (www.indiastat.com). In India, Tamil Nadu is the leading producer of jasmine in the country with an annual production of 1,36,901 tonnes from an area of 13,246 ha with a productivity of 11.21 t/ha (Anonymous , 2019). The genus *Jasminum*consists of more than 200 species and is mostly tropical in distribution (Dickey, 1969).

Though there are a large number of species and varieties of jasmine, commercial cultivation is confined to only a very few species. Besides the three commercial jasmine species namely, *J. sambac, J. grandiflorum* and

J. auriculatum which have attained importance in commercial cultivation (Rimando, 2003; Green and Miller, 2009) and the less exploited, *J. multiflorum* (Syn: *J. pubescens*) which is cultivated to some extent in Karnataka, three lesser known species namely, *J. nitidum, J. calophyllum* and *J. flexile* possess economic importance since they produce flowers which are suitable for use as loose flower, besides being ideal garden plants. These three species have the added merit of flowering throughout the year (Ganga et al., 2015), unlike the three popular commercial species namely, *J. sambac, J. grandiflorum* and *J. auriculatum* which undergo 'off-season' during the cooler months. The species *J. rigidum* also possesses year-round flowering potential, though the flowers have shorter shelf life.

Since the demand for jasmine flowers is growing day by day owing to its wide range of uses, there arises a pressing need for improving its production and productivity, besides exploring newer strategies to evolve improved genotypes. Flowers of the three commercially important jasmine species are unavailable in the market during the 'off-season' coinciding with the cooler months (November to March). The above mentioned lesser-known species possess year-round flowering potential but produce flowers with milder fragrance. Interspecific hybridization can enable introgression of desirable genes within the species. Interspecific hybridization in jasmine has been attempted earlier (Anon., 1974; Veluswamy, 1981) but was not successful, the predominant reason being failure of seed germination owing to hybrid unviability and a possible endosperm antagonism in operation (Veluswamy, 1981).

Palynological data are essential pre-requisites of any plant breeding programme. Domez and Isik (2008) and Hanif *et al.* (2013) emphasized the association of palynological aspects with the cytological status of plant species. The present study was undertaken to investigate and document the palynological parameters of commercial and lesser-known species of *Jasminum* which would serve as a reliable reference for future jasmine breeding programmes.

MATERIALS AND METHODS

(i) Plant materials

Plant materials were collected from the jasmine germplasm of the Department of Floriculture and Landscape Architecture, TNAU, Coimbatore located at 11°02' N latitude and 76°57' E longitude at an altitude of 426.72 m above MSL. The weather condition at Coimbatore during the study was moderately warm with hot early summer months during March-May. In open field conditions, the maximum temperature fluctuated between 25°C and 35°C with a mean of 30°C. The minimum temperature ranged between 17°C and 23.5°C with a mean of 20°C. The annual rainfall was 750 mm and relative humidity ranged between 60 and 90 per cent with a mean of 75 per cent.

The study involved nine genotypes of jasmine belonging to eight Jasminum species. The commercial species category included four genotypes namely, J. sambac cv. Ramanathapuram Gundumalli, J. auriculatum cv. CO.1 Mullai, J. grandiflorum cv. CO.1 Pitchi and J. grandiflorum (White). The lesser known (underutilized) species category included five genotypes namely, J. calophyllum, J. flexile, J. multiflorum (Pink flowered type), J. nitidum and J. rigidum.

(ii) Methods adopted

The methods adopted to study the palynological aspects of the above listed Jasminum species are briefly discussed below.

Pollen morphology

For assessing the morphological characteristics of pollen, flower buds at mature bud stage were involved. In the laboratory, anthers were isolated from the flower buds in petri-dishes and were maintained for 24-48 hours at room temperature (24°C) to facilitate release of pollen. Then the petri- dishes with pollen were transferred to a desiccator, where they were kept until analysis. Preparation of pollen for analysis was performed by mounting two-layer transparent tape on the object carrier on the microscope and applying pollen with a brush. The prepared samples were observed under a Scanning Electron Microscope (SEM) at a magnification of 2000X (whole grain) to15,000X (exine pattern). The pollen size was measured and the range was recorded for a sample of 30 pollen grains from each of the nine genotypes of jasmine.

Pollen output

Pollen production per flower was estimated using Haemocytometer as suggested by Sathiamoorthy (1973). Three samples of anthers from each Jasminum species were collected just prior to dehiscence. The anthers were crushed with a small glass rod in a vial containing 2.5 ml of distilled water and a drop of teepol for obtaining a good suspension of pollen grains in water. The contents were thoroughly shaken and two drops of it were pipetted out and placed on each of the two counting chambers of a Spencer bright line Haemocytometer. The number of pollen grains in each of the eight "corner squares" was recorded. This was repeated five times for each sample and was designated as sub samples. The average number of pollen grains per square multiplied by 2500 gave the quantity of pollens per anther.

Pollen viability

The pollen viability and fertility were assessed by the following two methods.

(a) Acetocarmine test

Freshly dehisced pollen grains were collected from each of the Jasminum species in sterilized petri-dishes. The pollen grains were dusted on the cavity slide and a drop of Acetocarmine stain was placed on the pollen grains. Deeply stained, normal and plump pollen grains were considered viable while shriveled, deformed and weakly stained pollen grains were considered as sterile ones. Pollen viability was assessed for three days viz., first day, second day and third day of anther dehiscence and expressed in percentage.

(b) In vitro pollen germination

Pollen from freshly dehisced anthers were collected and tested for germination on the day of anther dehiscence. Pollen was dusted in cavity slide in which 10 per cent of sucrose and 10 ppm of boric acid solution were dropped over gently with a pointed dropper and pollen grains were mixed thoroughly in the solution with the help of a needle. The cavity slides were kept in petri dishes over small glass rods containing moist filter paper at the bottom and closed properly. These were then incubated at ambient room temperature (25oC) for optimum germination. The slides were examined under microscope after one hour, two hours and three hours. Germinated and non-germinated pollen grains were counted separately in several random fields containing a total of 100 pollen grains and the length of the pollen tube was measured in micrometer (µm).

RESULTS AND DISCUSSION

Pollen morphology

The details of pollen morphology of the nine genotypes of jasmine are furnished in Table 1 Scanning Electron Microscope (SEM) images of the Jasminum genotypes indicated wide variations in shape of pollen among the genotypes.

Pollen size

The pollen size ranged between 36.2 µm and 57.9 µmin J. sambac cv. Ramanathapuram Gundumalli, 33.0µm and 42.9 µm in J. auriculatum cv. CO. 1 Mullai,32.32 µm and 41.22 µm in J. grandiflorum cv. CO.1 Pitchi, 33.0 µm and 46.2 µm in J. grandiflorum(White), 53.5 µm and 68.4 µm in J. calophyllum,30.2 µm and 53.2 µm in J. flexile, 30.5 µm and 53.5µm in J. multiflorum (Pink), 33.0 µm and 52.8 µm inJ. nitidum and 39.6 µm and 49.5 µm in J. rigidum (Table 1).

Table 1
Pollen morphology, pollen size (µm) and pollen output in Jasminum species

Sl. No.	*Jasminum* genotype	Pollen shape	Morphological characters Exine ornamentation	Aperture	Pollen size range (µm)	Pollen output
1.	*J. sambac* cv. Ramanathapuram Gundumalli	Tricolpate	Reticulate	Poorly defined	36.2-57.9	625
2.	*J. auriculatum* cv. CO.1 Mullai	Late obovatus	Reticulate	Sunken	33.0-42.9	14,175
3.	*J. grandiflorum* cv. CO.1 Pitchi	Prolate	Reticulate, granular	Prominent	32.32-41.22	17,920
4.	*J. grandiflorum* (White)	Spheroidal	Coarsely Reticulate	Poorly defined	33.0-46.2	23,816
5.	*J. calophyllum*	Obtuse-angular	Reticulate	Prominent	53.5-68.4	8,769
6.	*J. flexile*	Circular	Reticulate and smooth	Poorly defined	30.2-53.2	13,778
7.	*J. multiflorum* | (Pink)	Prolate	Distinctly reticulate	Poorly defined	30.5-53.5	17,002
8.	*J. nitidum*	Circular	Coarse	Sunken	33.0-52.8	21,056
9.	*J. rigidum*	Prolate	Reticulate, conspicuous furrows	Prominent	39.6-49.5	28,660

Pollen output

Pollen output (average number of pollen produced/ flower) for the Jasminum species ranged between 625 and 28,660. The pollen output was 28,660 in J. rigidum which was the highest among the nine genotypes and 625 in J. sambac cv. Ramanathapuram Gundumalli which was the least among the genotypes. The pollen output was 14,175 in J. auriculatum cv. CO.1 Mullai, 17,920 in J. grandiflorum cv. CO.1 Pitchi, 23,816 J. grandiflorum cv. White, 8,769 in J. calophyllum, 13,778 in J. flexile, 17,002 in J. multiflorum (Pink) and 21,056 in J. nitidum and (Table 1).

Makde (1982) opined that in Jasminum species, a majority of pollen grains were characterized by large scale vacuolation and scanty cytoplasm resulting in degeneration of pollen grains prior to dehiscence, leading to low pollen output.

Pollen viability

Data on pollen viability are furnished in Tables 2 and 3 and pictorial details are furnished in Fig. 1 to 3. The percentage of fertile pollen in J. sambac cv. Ramanathapuram Gundumalli was 5.67 per cent on the day of dehiscence and it gradually decreased to 0 per cent on the third day. The percentage of fertile pollen in J. auriculatum cv. CO.1 Mullai was 94.87 per cent on the day of dehiscence and it gradually decreased to 43.33 per cent on the third day. The percentage of viable pollen in J. grandiflorum cv. CO.1 Pitchi was 77.17 per cent on the day of dehiscence and gradually decreased to 18.67 per cent on the third day. The percentage of viable

pollen in J. grandiflorum cv. White was 95.50 per cent on the day of dehiscence and it gradually decreased to 18.67 per cent on the third day. (Table 2).

In J. flexile, the percentage of viable pollen was 90.67 per cent on the day of dehiscence and it gradually decreased to 22.33 per cent on the third da y. The percentage of viable pollen in J. calophyllum was 77.17 per cent on the day of dehiscence and it gradually decreased to 18.67 percent on the third day. The percentage of viablepollen in J. multiflorum (Pink) was 54.67 per centon the day of dehiscence and gradually decreasedto 17.33 per cent on the third day. The percentageof fertile pollen in J. nitidum was 53.33 per centon the day of dehiscence and it gradually decreasedto 18.33 per cent on the third day. The percentageof fertile pollen in J. rigidum was 95.33 per centon the day of dehiscence and it gradually decreasedto 27.67 per cent on the third day (Table 3).

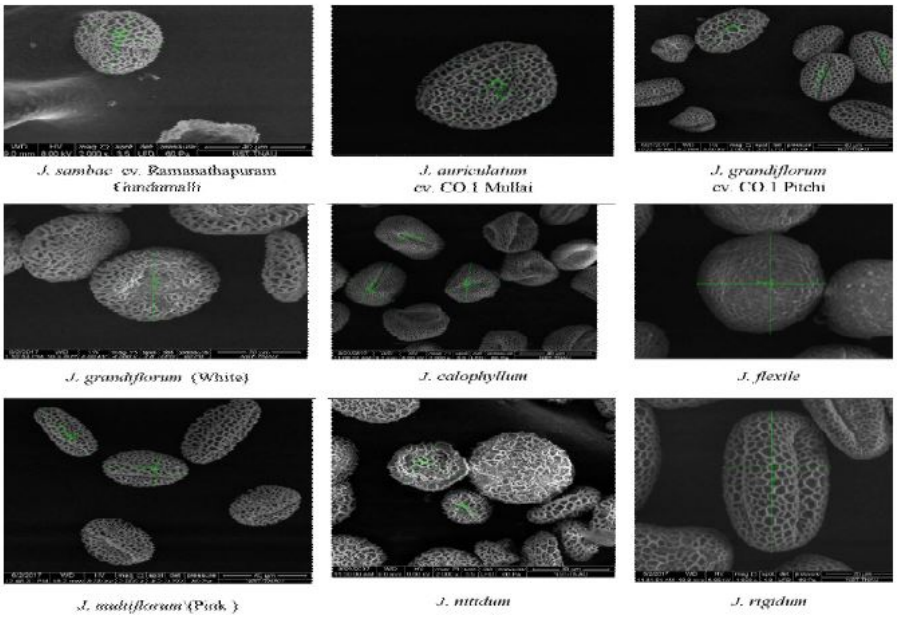

Fig. 1
Pollen morphology Jasminum species visualized under SEM

Pollen germination rate

The mean germination percentage in Jasminum species ranged between 0 per cent and 94.34 per cent, with the highest in J. rigidum. No germination was observed in J. sambac cv. Ramanathapuram Gundumalli. The mean germination percentage was 42.56 per cent in J. auriculatum cv. CO.1 Mullai, 25.3 % in J. grandiflorum cv. CO. 1 Pitchi, 59.9 % in J. grandiflorum cv. White, 31.72 % in J. flexile, 24.0 % in J. calophyllum, 1.39 % in J. multiflorum (Pink) and 8.86 % in J. nitidum (Table 4).

Pollen tube growth

In the present study, pollen tube growth as measured in terms of the length of pollen tube in the Jasminum species ranged between 0 µm and 1917.10 µm. The maximum pollen tube length of 1917.10 µm was recorded in J. rigidum. The mean length of pollen tube was 447.81 µm in J. auriculatum cv. CO. 1 Mullai, 552.61 µm in J. grandiflorum cv. CO. 1 Pitchi, 449.82 µm in J. grandiflorum cv. White, 222.15 µm in J. flexile, 641.15 µm in J. calophyllum, 884.27 µm in J. nitidum. Pollen tube was not conspicuous in J. multiflorum (Pink).

Pollen viability is an important factor, since the probability of fertilization usually declines when pollen grains with low viability are deposited on the stigma (Wilcock and Neiland, 2002; Zhao et al., 2004; Teng et al., 2012). Lai (1995) and Deng et al. (2014) attributed low pollen fertility and Deng et al. (2016) attributed low pollen viability for poor fertilization injasmine. Deng et al. (2016) also reported that among15% of anthers, tetrads formed pollen mass insteadof free microspores, and only one tube grew normallyfrom the tetrad pollen.

Table 2
Pollen of commercial jasmine genotypes

Age of pollen grains	No. of. pollen grains tested	*J. sambac* cv. Ramanthapuram Gundumalli		*J. auriculatum* cv. CO. 1 Mullai		*J. grandiflorum* cv. CO. 1 Pitchi		*J. grandiflorum* (White)	
		Fertile pollen (%)	Sterile pollen (%)	Fertile pollen (%)	Sterile pollen (%)	Fertile pollen (%)	Sterile pollen (%)	Fertile pollen (%)	Sterile pollen (%)
1st day of dehiscence	100	5.67	94.33	94.87	5.13	77.17	22.83	95.50	4.50
2nd day of dehiscence	100	3	97	78.33	21.67	56.00	44.00	62.67	37.33
3rd day of dehiscence	100	0	100	43.33	56.66	18.67	81.33	18.67	81.33

Table 3
Pollen viability of underutilized jasmine genotypes

		Fertile pollen (%)	Sterile pollen (%)	Fertile pollen (%)	Sterile pollen (%)	Fertile pollen (%)	Sterile pollen (%)	Fertile pollen (%)	Sterile pollen (%)	Fertile pollen (%)	Sterile pollen (%)
1st day of dehiscence	100	53.33	46.67	83.33	16.67	54.67	45.33	90.67	9.33	95.33	4.67
2nd day of dehiscence	100	44.33	55.67	75.33	24.67	45.33	54.67	69.33	30.67	78.00	22.00
3rd day of dehiscence	100	18.33	81.67	25.67	74.33	17.33	82.67	22.33	77.67	27.67	72.33

Table 4
In vitro pollen germination in Jasminum species (after 3 hr incubation)

Species	Germination %	Length of pollen tube (µm)
J. sambac cv. Ramanathapuram Gundumalli	0.00	-
J. auriculatum cv. CO. 1 Mullai	42.56	447.81
J. grandiflorum cv. CO. 1 Pitchi	25.3	552.61
J. grandiflorum (White)	59.9	449.82
J. flexile	31.72	222.15
J. calophyllum	24.0	641.15
J. multiflorum (Pink)	1.39	-
J. nitidum	8.86	884.27
J. rigidum	94.34	1917.10

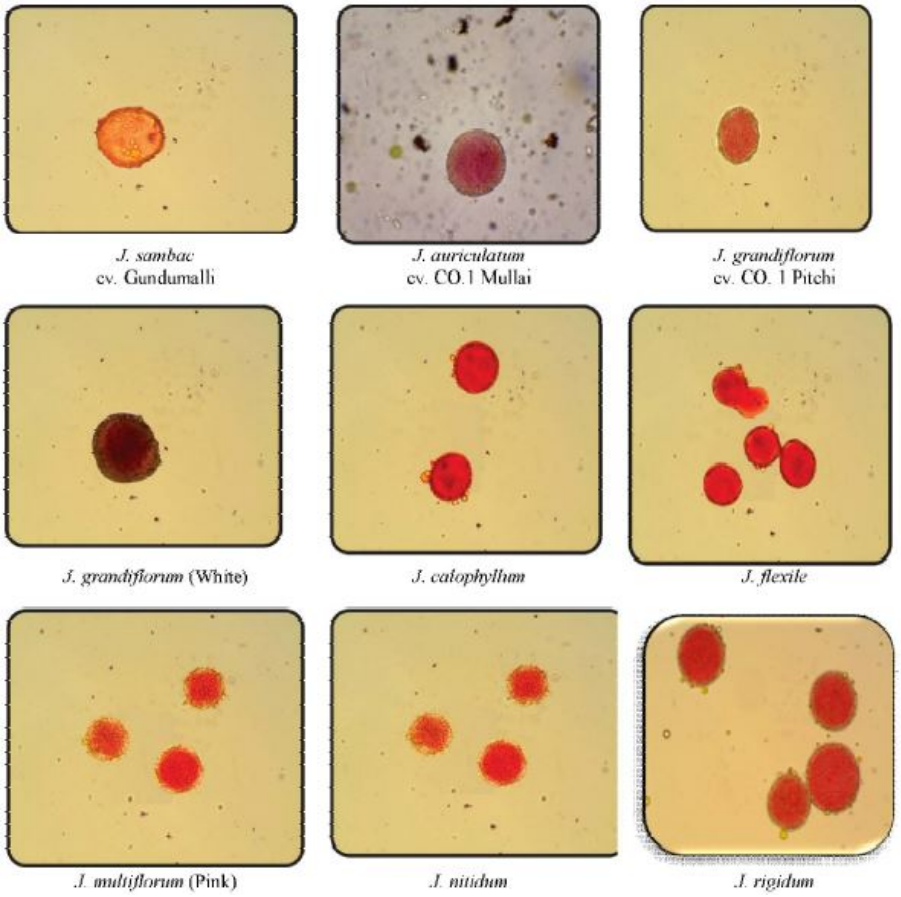

Fig. 2
Pollen stainability in Jasminum genotypes

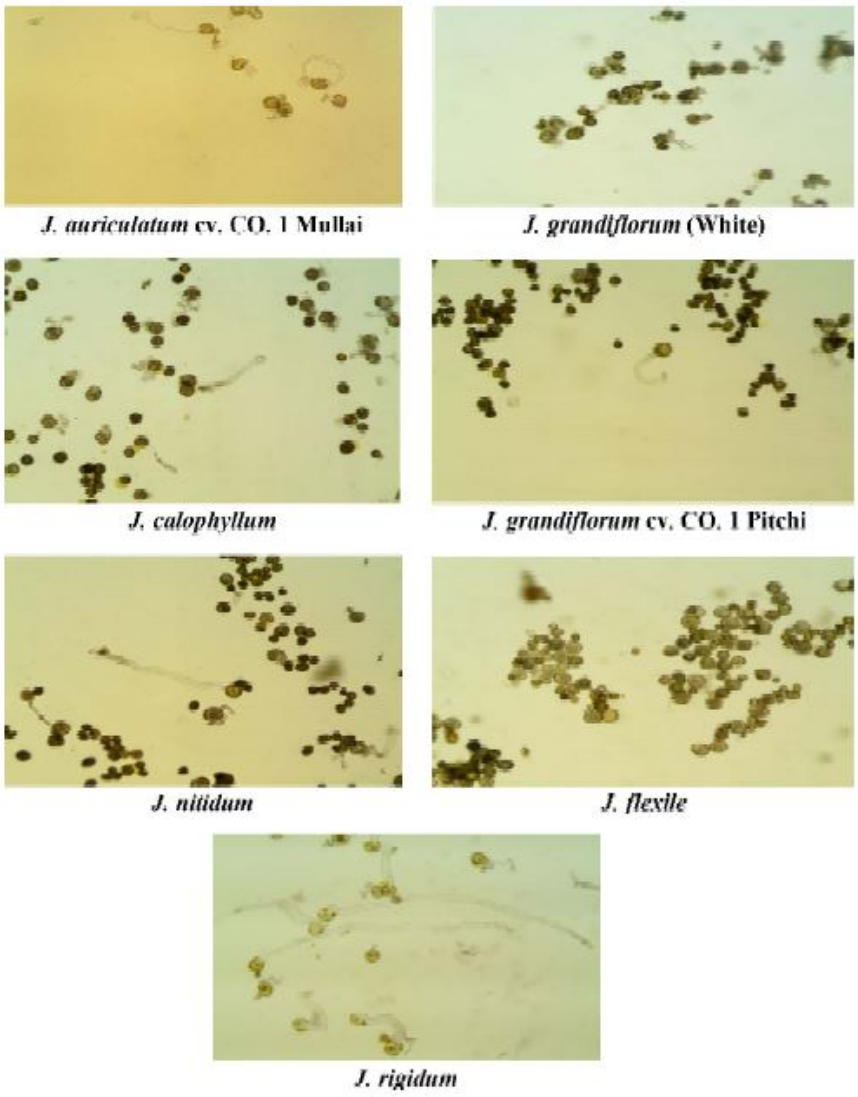

Fig. 3
In vitro pollen germination in Jasminum genotypes

The differential pollen viability of the jasmine species recorded in the present study is attributable to the varied ploidy levels and chromosomal forms. In J. sambac cv. Ramanathapuram Gundumalli, higher pollen sterility is attributed to its triploid status which leads to meiotic abnormalities. These observations are supported by the earlier reports of Raman (1955) and Deng et al. (2017) in Jasminum species.

In the various jasmine species studied, pollen germination percentage was low to moderate (Plate 2). This might be associated with the irregular meiosis leading to defective pollen and egg cells, ultimately resulting in sterility. Datta et al. (1960) elucidated that structural changes lead to loss of genes as expressed in the suppression of the female reproductive development in J. grandiflorum.

CONCLUSION

The inferences from the present study are (i) there is wide variation among the nine genotypes with respect to shape of pollen grain while exine ornamentation was reticulate in all the genotypes, (ii) J. auriculatum cv. CO. 1 Mullai, J. grandiflorum cv. White, J. flexile and J. rigidum had high pollen viability. Pollen output (average number of pollen produced/ flower) was the highest in J. rigidum (28,660) and the least (625) in J. sambac cv. Ramanathapuram Gundumalli; (iii) The highest rate of pollen germination (94.34%) and length of pollen tube (1917.10 μm) was recorded in J. rigidum.

REFERENCES

Anon, 1974. In: 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.

Datta, M. 1960. Cytogenetical Studies on Some Ornamental Jasmines. *Caryologia*, **13**(3): 713-748.

Deng, Y. M., X. Q. Ye, X. P. Jia and L. J. Liang. 2014. Pollen germination *in vitro* and pollen tube growth of *Jasminum sambac Aiton. Acta Agri Boreali Sin*, **29**: 172-178.

Deng Yanming, Xinping Jia, Lijian Liang, Chunsun Gu and Xiaobo Sun. 2016. Morphological anatomy, sporogenesis and gametogenesis in flowering process of jasmine (*Jasminum sambac* Aiton). *Scientia Horticulturae*, **198**: 257–266.

Deng, Y., X. Sun, C. Gu, X. Jia, L. Liang and J. Su, (2017). Identification of pre-fertilization reproductive barriers and the underlying cytological mechanism in crosses among three petal-types of *Jasminum sambac* and their relevance to phylogenetic relationships. *PLoS ONE*, **12**(4), e0176026.

Domez, E.O., and Isik, S. 2008. Pollen morphology of Turkish *Amaryllidaceae, Ixioliriaceae* and *Iridaceae. Grana* **47**(1): 15-38.

Ganga, M., P. Madhumalar, M. Jawaharlal and P. Ranchana. 2015. Assessment of the horticultural significance of lesser known jasmine (*Jasminum* spp.) wealth. *J. Orn. Hort*., **18** (1&2): 17-24.

Green, P. and Miller, D. 2009. The genus *Jasminum* in cultivation. Kew Publishing, Royal Botanic Gardens, Kew.

Hanif, U., Mazhar, M., and Sardar, A.A. 2013. Palyno-morphological studies of some ornamental plants of Mall Road, Lahore. *Biologia*, **59**(1), 147-156.

Makde, K. H. 1982. Tapetal dimorphism in *Jasminum grandiflorum* Linn. *Curr. Sci.* **51**(3): 661-662.

Raman, V.S. 1955. Cytogenetics of Indian Jasmine, the somatic chromosomes. *Cytologia*, **20**: 19-31.

Rimando, T. J. 2003. Sampaguita production. In. Orn. Hort.: A little giant in the tropics. SEAMEO SEARCA and UPLB, College, Los Banos, Laguna, Philippines, pp: 333.

Sathiyamoorthy, S. 1973. Preliminary investigations on breeding potential of some banana clones. M.Sc. (Hort.) Thesis, submitted to Tamil Nadu Agricultural University, Coimbatore.

Teng, N. J., Y. L.Wang, C. Q. Sun, W. M. Fang and F. D. Chen. 2012. Factors influencing fecundity in experimental crosses of water lotus (*Nelumbo nucifera* Gaertn.) cultivars. *BMC Pl. Biol*., **12**: 82.

Velusamy, P. 1981. Genetic studies in *Jasminum auriculatum* . Vahl. and *Jasminum grandiflorum* L. Ph.D. Thesis, submitted to Tamil Nadu Agricultural Universit y, Coimbatore.

Wilcock, C and R. Neiland. 2002. Pollination failure in plants: why it happens and when it matters. *Trends Pl. Sci.,* .: 270–277.

Zhao, L. M., H. Sun, M. Huang, S. M. Wang and Y. Q. Wang. 2004. The relationship between seed setting rate and pollen sterility rate for soybean. *Soybean Sci*., **23**: 250–252.