



ISSN: 0975-833X

Available online at <http://www.journalcra.com>

INTERNATIONAL JOURNAL
OF CURRENT RESEARCH

International Journal of Current Research
Vol. 13, Issue, 12, pp.19972-19978, December, 2021

DOI: <https://doi.org/10.24941/ijcr.42650.12.2021>

RESEARCH ARTICLE

INDUCTION OF OFF SEASON FLOWERS IN JASMINE (*JASMINUM SAMBAC* AIT.) CV. GUNDUMALLI

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ARTICLE INFO

Article History:

Received 17th September, 2021
Received in revised form
28th October, 2021
Accepted 10th November, 2021
Published online 29th December, 2021

Keywords:

Jasmine-*Jasminum sambac*- off
Season Flowering,
Pruning-Chemical,
Flower Yield.

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ABSTRACT

An experiment was laid out at Krishi Vigyan Kendra, Madurai during 2019-21. The aim of this study is to induce off season flowering (Nov- Feb) in *Jasminum sambac* Ait. cv. Gundu malli through pruning, chemical manipulation and to find out the suitable chemical for induction of off season flowering in *Jasminum sambac* Ait. cv. Gundu malli. The following treatments were imposed. The main plot treatments viz., The Pruning was done during the month of August (M₁), September (M₂) and last week of November (control). The sub plot treatments viz., 0.6 g a.i /m² of Paclobutrazol (S₁), 150 ppm of Mepiquat chloride (S₂), 1.0 % of Nitrobenzene (S₃), 1.0% of Thio urea (S₄) and 1000 ppm and 4% of Cycocel + Humic acid respectively (S₅). It was laid out in split plot design with three replications and the results were statically analyzed. Morphological, physiological and yield parameters could be recorded during 2019-21. Among the different pruning and chemical treatments, Among the different pruning and chemical treatments, September pruning (M₂) + Thio urea (1.0%) (S₄) recorded maximum Plant height (59.50 cm), No. of productive shoots/plant (45.50 Nos.), Duration of flowering (110.50 Days), Chlorophyll “a” (0.58 mg g-1), Chlorophyll “b” content (0.48 mg g-1), Total phenol content (4.62 µg/g), Corolla tube length (1.21cm), Length of flower bud (2.51cm), Diameter of the flower bud (6.25 mm), Number of flower buds per cyme (8.30 Nos.), Number of cymes per plant (92.50 Nos.), Number of flower buds per plant (230.21 Nos.), Estimated flower yield/plant (55.15 g/plant), flower yield (0.82 kg/plot), estimated flower yield (0.39 t/ha) and shelf life (12.55 days). Whereas, Days taken to initiate flowering i.e. bud initiation (30.50 Days) and Days taken for peak flowering (88.50 Days) were recorded September pruning (M₂) + Paclobutrazol (0.6 g a.i /m²) (S₁) However, September pruning (M₂) + Nitrobenzene (1.0 %) (S₃) recorded maximum number of flower bud (8.30 nos.) and weight of hundred flower buds (24.54 g) during 2019-20. During 2020-21 Among the different pruning and chemical treatments, September pruning (M₂) + Cycocel + Humic acid (S₅) recorded maximum Plant height (46.50 cm), No. of productive shoots/plant (25.50 Nos.), Duration of flowering (69.50 Days), Chlorophyll “a” (0.59 mg g-1), Chlorophyll “b” content (0.46 mg g-1), Total phenol content (3.62 µg/g), Corolla tube length (1.17 cm), Length of flower bud (2.24 cm), Diameter of the flower bud (6.50 mm), Number of flower buds per cyme (8.50 Nos.), Number of cymes per plant (65.50 Nos.), Number of flower buds per plant (195.50 Nos.), flower yield /plant and flower yield per plot were recorded 0.76 kg 5.75 kg respectively.

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Citation: Palanikumar, M. and Chelvi Rameesh. “Induction of off season flowers in Jasmine (*Jasminum sambac* Ait.) cv. Gundumalli”, 2021. International Journal of Current Research, 13, (12), 19972-19978.

INTRODUCTION

Jasmine (*Jasminum sambac* Ait.) belongs to family Oleaceae and is of about 200 species which are mainly shrubs and climbers (Taj & Naik, 2013). The term jasmine is probably derived from the Persian name “Yasmyn” and Arabic word “*Jessamine*” meaning “fragrance” (Bailey, 1947).

Among the large number of species existing, only three species (*J. sambac*, *J. grandiflorum* and *J. auriculatum*) have attained importance in commercial cultivation (Rimando, 2003). India is one of the centers of origin of jasmine. A critical analysis of these species, has revealed that, number of true species to be only 89, of which 40 inhabited the Indian sub-continent. The best known species of *Jasminum sambac* Ait. and several varieties of this species viz., Arabian jasmine or Tuscan

jasmine, Grand Duke of Tuscassy, Motia, Moghra, Mallige, Kodai Mullai are commercially cultivated. Jasmine is cultivated commercially for its fresh flowers and it is used for various purposes viz., making bouquet, decorating hair by women, religious offerings etc. It is also used for extraction of Jasmine concrete which is used in cosmetics and perfumery industries. In China, *Jasminum sambac* flowers are used for flavoring. Tamil Nadu ranks first in loose flower cultivation with an area around 30.89 thousand hectare and production with 426.66 thousand metric tonnes. Jasmine flowers produced from Tamil Nadu are being air lifted to other cities such as Mumbai, Kolkatta, Bengaluru, Delhi, etc. apart from internal trade, fresh flowers of jasmine are exported to Malaysia, Singapore, Gulf countries, Sri Lanka and USA. The major jasmine producing districts of Tamil Nadu are Madurai, Erode, Coimbatore, Dindigul, Salem, Tirunelveli, Virudhunagar and Trichy of which Madurai and Erode are predominant districts. With its heady fragrance, exclusive size and shape, the "Madurai Malli"s uniqueness has a distinct reputation universally bringing special fame to the temple city of Madurai. Madurai Malli is being grown on 1,250 hectares by 4,000-odd farmers in the district. It has been reported that the demand for jasmine is increasing due to its unique fragrance but there is a huge demand-supply gap of fresh flowers during off season. The annual demand is estimated to be 10,500 tonnes while the district produces only 9,500 tonnes. During regular season, the cost of flower is between Rs. 40-120/kg. The rainy and followed by winter season (Nov, Dec and Jan) are the off season for Jasmine production. During the off season the cost of flower is between Rs. 1250-3000/kg. This results in scarcity during the lean season and glut during the peak season creating a wide fluctuation in price. The present research on induction of off season flowering in Gundumalli through physical and chemical interventions i.e, pruning and application of chemicals helps in improving the economic status of jasmine growers and will meet the increased demand of flowers during the auspicious occasions in South India. The present study was attempted with single pruning during September and October followed by applications of various chemicals like paclobutrazol, methanol and nitrobenzene at fixed concentrations for induction of flowering during off season.

MATERIALS AND METHODS

An experiment was laid out at Krishi Vigyan Kendra, Madurai during 2019-21. The aim of this study is to induce off season flowering (Nov- Feb) in *Jasminum sambac* Ait. cv. Gundu malli through pruning, chemical manipulation and to find out the suitable chemical for induction of off season flowering in *Jasminum sambac* Ait. cv. Gundu malli. The following treatments were imposed. The main plot treatments viz., The Pruning is done during August (M₁), September (M₂) and last week of November (control). The sub plot treatments viz., 0.6 g a.i /m² of Paclobutrazol (S₁), 150 ppm of Mepiquat chloride (S₂), 1.0 % of Nitrobenzene (S₃), 1.0% of Thio urea (S₄) and 1000 ppm and 4% of Cycocel + Humic acid respectively (S₄). It was laid out in split plot design with three replications and the results were statically analyzed.

RESULTS AND DISCUSSION

2019-20: The pruning treatments viz., August (M₁), September (M₂), November (M₃) (Control) and chemical treatments viz.,

S₁.Paclobutrazol (0.6 g a.i /m²), S₂.Mepiquat chloride (150 ppm) , S₃.Nitrobenzene (1.0 %) , S₄.Thio urea (1.0%) , S₅.Cycocel + Humic acid (1000 ppm and 4% respectively) and S₆.Control were imposed. Among the different pruning and chemical treatments, September pruning (M₂) + Thio urea (1.0%) (S₄) recorded maximum Plant height (59.50 cm), No. of productive shoots/plant (45.50 Nos.), Duration of flowering (110.50 Days), Chlorophyll "a" (0.58 mg g⁻¹), Chlorophyll "b" content (0.48 mg g⁻¹), Total phenol content (4.62 µg/g), Corolla tube length (1.21cm), Length of flower bud (2.51cm), Diameter of the flower bud (6.25 mm), Number of flower buds per cyme (8.30 Nos.), Number of cymes per plant (92.50 Nos.), Number of flower buds per plant (230.21 Nos.), Estimated flower yield/plant (55.15 g/plant), flower yield (0.82 kg/plot), estimated flower yield (0.39 t/ha) and shelf life (12.55 days) compared to September pruning (M₂) + control (S₅) recorded minimum Plant height (37.10 cm), No. of productive shoots/plant (36.50 Nos.), Duration of flowering (75.45 Days), Chlorophyll "a" (0.42 mg g⁻¹), Chlorophyll "b" content (0.36 mg g⁻¹), Total phenol content (2.75 µg/g), Corolla tube length (1.16cm), Length of flower bud (2.35cm), Diameter of the flower bud (5.10 mm), Number of cymes per plant (48.50 Nos.), Number of flower buds per plant (139.25 Nos.), Estimated flower yield/plant (28.32 g/plant), flower yield (0.42 kg/plot), estimated flower yield (0.19 t/ha) and shelf life (8.56 days). Whereas, Days taken to initiate flowering i.e. bud initiation (30.50 Days) and Days taken for peak flowering (88.50 Days) were recorded September pruning (M₂) +Paclobutrazol (0.6 g a.i /m²)(S₁) compared to September pruning (M₂) + control (S₅) recorded Days taken to initiate flowering i.e. bud initiation (21.25 Days) and Days taken for peak flowering (59.50 Days). However, September pruning (M₂) + Nitrobenzene (1.0 %) (S₃) recorded maximum number of flower bud (8.30 nos.) and weight of hundred flower buds (24.54 g) compared to September pruning (M₂) + control (S₅) recorded minimum number of flower bud (4.95 nos.) and weight of hundred flower buds (22.32 g) (Table 1 -7). Both pruning and foliar spray of growth retardants showed significant effect but their interaction was not significant for the flower quality parameters viz., length of flower bud, corolla tube length and diameter of flower bud. The results are in confirmaity with findings of Rajesh (1195) in calendula, Sainath (2009) in annual chrysanthemum and Kalicharan (2012) in moringa. This might be due to their inhibitory role on cell division and cell elongation of apical meristematic cells as an anti gibberellins compound. Mepiquat chloride can restrict vegetative growth, including the plant to direct more carbohydrates to the reproductive organs. Hence, the vegetative growth was restricted which favours stored carbohydrates and other nutrients to play their role on flowering.

2020-21: The pruning treatments viz., August (M₁), September (M₂), November (M₃) (Control) and chemical treatments viz., S₁.Paclobutrazol (0.6 g a.i /m²), S₂.Mepiquat chloride (150 ppm) , S₃.Nitrobenzene (1.0 %) , S₄.Thio urea (1.0%) , S₅.Cycocel + Humic acid (1000 ppm and 4% respectively) and S₆.Control were imposed. Among the different pruning and chemical treatments, September pruning (M₂) + Cycocel + Humic acid (S₅) recorded maximum Plant height (46.50 cm), No. of productive shoots/plant (25.50 Nos.), Duration of flowering (69.50Days), Chlorophyll "a" (0.59 mg g⁻¹), Chlorophyll "b" content (0.46 mg g⁻¹), Total phenol content (3.62µg/g), Corolla tube length (1.17cm), Length of flower bud (2.24cm), Diameter of the flower bud (6.50 mm), Number

Table 1. Plant height (cm) and No. of productive shoots/plant (Nos.) and Days taken to initiate flowering i.e. bud initiation (Days) during 2019-20

Treatments	Plant height (cm)			No. of productive shoots/plant (Nos.)			Days taken to initiate flowering i.e. bud initiation (Days)		
	Aug 2020 (M1)	Sept 2020 (M2)	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)	Nov 2020 (Control)	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)
S ₁ .Paclobutrazol (0.6 g a.i /m ²)	26.35	44.50	36.25	27.12	32.45	26.45	25.52	30.50	27.45
S ₂ .Mepiquat chloride (150 ppm)	28.50	38.15	32.45	26.45	38.15	32.54	19.45	26.45	22.65
S ₃ .Nitrobenzene (1.0 %)	25.14	42.15	34.50	21.50	36.10	31.50	18.52	24.54	21.15
S ₄ .Thio urea (1.0%)	36.16	59.50	47.15	32.50	45.50	39.50	17.28	22.25	18.56
S ₅ .Cycocel + Humic acid (1000 ppm and 4% respectively)	31.50	42.50	34.25	20.45	33.50	27.50	16.35	23.45	19.42
S ₆ .Control	26.50	37.10	31.50	21.13	36.50	29.50	14.12	21.25	18.50
Mean	29.03	43.98	36.02	24.86	37.03	31.17	18.54	24.74	21.29
SEd	0.61	0.70	0.64	1.20	1.60	1.40	0.36	0.42	0.38
CD (0.05)	1.14	1.46	1.32	2.91	3.21	2.94	1.02	1.15	1.09

Table 2. Days taken for peak flowering (Days), Duration of flowering (Days) and Chlorophyll “a” content during 2019-20

Treatments	Days taken for peak flowering (Days)			Duration of flowering (Days)			Chlorophyll “a” content		
	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)
S ₁ .Paclobutrazol (0.6 g a.i /m ²)	71.50	88.50	81.50	88.21	98.45	92.45	0.47	0.56	0.51
S ₂ .Mepiquat chloride (150 ppm)	67.52	85.45	75.45	79.15	92.50	85.41	0.41	0.48	0.45
S ₃ .Nitrobenzene (1.0 %)	61.42	78.45	67.15	71.12	84.26	76.25	0.45	0.51	0.48
S ₄ .Thio urea (1.0%)	59.45	76.41	66.41	88.24	110.50	94.21	0.51	0.58	0.55
S ₅ .Cycocel + Humic acid (1000 ppm and 4% respectively)	48.41	67.48	56.25	68.65	82.25	75.65	0.39	0.46	0.42
S ₆ .Control	41.52	59.50	48.45	61.24	75.45	68.42	0.36	0.42	0.39
Mean	58.30	75.97	65.87	76.10	90.57	82.07	0.43	0.50	0.47
SEd	0.68	0.88	0.76	1.61	1.85	1.74	0.01	0.06	0.04
CD (0.05)	1.76	1.86	1.81	3.10	3.94	3.25	0.04	0.09	0.06

Table 3. Chlorophyll “b” , Total phenol content (µg/g) and Corolla tube length (cm) during 2019-20

Treatments	Chlorophyll “b” content			Total phenol content (µg/g)			Corolla tube length (cm)		
	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)
S ₁ .Paclobutrazol (0.6 g a.i /m ²)	0.38	0.46	0.40	3.50	4.12	3.52	1.15	1.20	1.17
S ₂ .Mepiquat chloride (150 ppm)	0.31	0.41	0.34	2.94	3.50	3.12	1.14	1.17	1.04
S ₃ .Nitrobenzene (1.0 %)	0.34	0.42	0.39	2.82	3.10	2.86	1.13	1.18	1.06
S ₄ .Thio urea (1.0%)	0.36	0.48	0.41	4.41	4.62	4.45	1.17	1.21	1.19
S ₅ .Cycocel + Humic acid (1000 ppm and 4% respectively)	0.29	0.39	0.32	2.51	2.90	2.54	1.08	1.15	1.02
S ₆ .Control	0.28	0.36	0.31	1.94	2.75	2.20	1.10	1.16	1.11
Mean	0.33	0.42	0.36	3.02	3.50	3.12	1.13	1.18	1.10
SEd	0.01	0.01	0.01	0.12	0.18	0.15	0.04	0.01	0.01
CD (0.05)	0.02	0.03	0.02	0.24	0.32	0.28	0.08	0.19	0.12

Table 4. Length of flower bud (cm), Diameter of the flower bud (mm) and Number of flower buds per cyme (Nos.) during 2019-20

Treatments	Length of flower bud (cm)			Diameter of the flower bud (mm)			Number of flower buds per cyme (Nos.)		
	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)
S ₁ Paclobutrazol (0.6 g a.i /m ²)	2.36	2.42	2.33	5.65	6.20	5.72	7.15	7.62	7.60
S ₂ Mepiquat chloride (150 ppm)	2.31	2.33	2.26	5.15	5.80	5.35	6.75	7.18	7.00
S ₃ Nitrobenzene (1.0 %)	2.30	2.36	2.28	4.98	5.65	5.15	7.75	8.30	8.10
S ₄ Thio urea (1.0%)	2.40	2.51	2.39	5.75	6.25	5.95	7.20	7.51	7.40
S ₅ Cycocel + Humic acid (1000 ppm and 4% respectively)	2.12	2.20	2.07	5.15	5.96	5.50	5.82	7.42	6.20
S ₆ Control	2.25	2.35	2.24	4.75	5.10	4.98	4.00	4.95	4.10
Mean	2.29	2.36	2.26	5.24	5.83	5.44	6.45	7.16	6.73
SEd	0.06	0.04	0.03	0.31	0.35	0.33	0.12	0.13	0.13
CD (0.05)	0.13	0.08	0.08	0.75	0.85	0.80	0.21	0.34	0.25

Table 5. Number of cymes per plant (Nos.), Number of flower buds per plant (Nos.) and Estimated flower yield/plant (kg) during 2019-20

Treatments	Number of cymes per plant (Nos.)			Number of flower buds per plant (Nos.)			Estimated flower yield/plant (kg)		
	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)
S ₁ Paclobutrazol (0.6 g a.i /m ²)	26.91	39.43	35.48	188.35	193.15	192.25	41.45	46.15	44.75
S ₂ Mepiquat chloride (150 ppm)	52.38	53.84	52.12	161.02	167.25	165.43	35.25	38.55	37.43
S ₃ Nitrobenzene (1.0 %)	55.11	85.76	64.25	141.24	153.12	143.76	28.12	32.22	31.25
S ₄ Thio urea (1.0%)	61.25	92.50	82.52	218.15	230.21	225.12	47.45	55.15	53.12
S ₅ Cycocel + Humic acid (1000 ppm and 4% respectively)	23.55	36.55	31.72	129.17	129.38	130.15	15.42	19.52	18.15
S ₆ Control	37.12	48.50	43.58	133.21	139.25	137.17	23.50	28.32	25.72
Mean	42.72	59.43	51.61	161.86	168.73	165.65	31.87	36.65	35.07
SEd	1.63	2.34	2.14	2.76	2.76	2.79	2.11	2.29	1.38
CD (0.05)	3.48	4.92	4.55	5.72	5.87	5.76	4.51	4.87	3.12

Table 6. Flower yield (Kg/plot) and Estimated flower yield (t/ha) during 2019-20

Treatments	Flower yield (Kg/plot)			Estimated flower yield (t/ha)		
	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)
S ₁ Paclobutrazol (0.6 g a.i /m ²)	0.62	0.71	0.65	0.29	0.38	0.35
S ₂ Mepiquat chloride (150 ppm)	0.53	0.58	0.55	0.31	0.31	0.28
S ₃ Nitrobenzene (1.0 %)	0.41	0.49	0.43	0.22	0.28	0.26
S ₄ Thio urea (1.0%)	0.73	0.82	0.78	0.32	0.39	0.36
S ₅ Cycocel + Humic acid (1000 ppm and 4% respectively)	0.26	0.35	0.28	0.13	0.12	0.15
S ₆ Control	0.32	0.42	0.36	0.15	0.19	0.17
Mean	0.48	0.56	0.51	0.24	0.28	0.26
SEd	0.02	0.03	0.02	2.25	3.65	2.26
CD (0.05)	0.04	0.07	0.05	4.73	7.82	4.75

Table 7. Weight of hundred flower buds (g) and Shelf life at refrigerated condition (without vent) (Days) during 2019-20

Treatments	Weight of hundred flower buds (g)			Shelf life at refrigerated condition (without vent) (Days)		
	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)	Aug 2020 (M1)	Sept 2020 (M2)	Nov 2020 (Control)
S ₁ Paclobutrazol (0.6 g a.i /m ²)	23.31	23.48	23.33	10.25	11.52	11.50
S ₂ Mepiquat chloride (150 ppm)	20.00	20.58	20.12	7.21	7.55	7.51
S ₃ Nitrobenzene (1.0 %)	23.76	24.54	24.02	11.41	11.53	11.48
S ₄ Thio urea (1.0%)	21.38	21.53	21.41	12.49	12.55	12.51
S ₅ Cycocel + Humic acid (1000 ppm and 4% respectively)	18.00	18.67	18.12	7.95	8.15	8.10
S ₆ Control	22.10	22.32	22.11	8.45	8.56	8.51
Mean	21.43	21.85	21.52	9.63	9.98	9.94
SEd	1.17	1.26	1.62	0.11	0.13	0.12
CD (0.05)	2.49	2.71	3.51	0.22	0.26	0.24

Table 8. Plant height (cm) and No. of productive shoots/plant (Nos.) and Days taken to initiate flowering i.e. bud initiation (Days) during 2020-21

Treatments	Plant height (cm)			No. of productive shoots/plant (Nos.)			Days taken to initiate flowering i.e. bud initiation (Days)		
	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)
S ₁ Paclobutrazol (0.6 g a.i /m ²)	28.50	38.50	26.50	28.50	21.50	29.25	15.50	21.50	18.50
S ₂ Mepiquat chloride (150 ppm)	26.50	36.50	27.50	28.00	22.50	29.50	13.50	19.50	15.50
S ₃ Nitrobenzene (1.0 %)	27.50	39.50	26.00	29.00	23.00	30.50	17.50	21.00	18.00
S ₄ Thio urea (1.0%)	30.50	41.50	25.00	27.50	21.00	32.50	19.50	23.50	20.50
S ₅ Cycocel + Humic acid (1000 ppm and 4% respectively)	32.50	46.50	22.50	25.50	18.00	35.50	20.50	25.50	21.50
S ₆ Control	21.50	30.50	28.50	18.00	21.25	26.50	16.50	20.50	18.50
Mean	27.83	38.83	26.00	26.08	21.21	30.63	17.17	21.92	18.75
SEd	0.59	0.67	0.32	0.31	0.43	0.61	1.19	1.58	1.36
CD (0.05)	11.12	11.42	3.13	3.12	3.21	11.29	12.82	13.11	12.75

Table 9. Days taken for peak flowering (Days), Duration of flowering (Days) and Chlorophyll "a" content during 2020-21

Treatments	Days taken for peak flowering (Days)			Duration of flowering (Days)			Chlorophyll "a" content		
	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)
S ₁ Paclobutrazol (0.6 g a.i /m ²)	65.50	55.50	71.50	55.50	64.50	48.50	0.43	0.58	0.43
S ₂ Mepiquat chloride (150 ppm)	68.50	58.50	78.50	51.00	64.00	46.50	0.46	0.51	0.47
S ₃ Nitrobenzene (1.0 %)	57.00	56.50	65.50	58.00	59.00	45.50	0.48	0.54	0.44
S ₄ Thio urea (1.0%)	59.50	53.50	67.50	59.50	65.00	49.50	0.51	0.58	0.49
S ₅ Cycocel + Humic acid (1000 ppm and 4% respectively)	55.00	49.50	66.50	61.00	69.50	51.00	0.55	0.59	0.51
S ₆ Control	62.50	64.50	51.50	48.50	51.00	49.00	0.38	0.44	0.42
Mean	61.33	56.33	66.83	55.58	62.17	48.33	0.47	0.54	0.46
SEd	0.67	0.86	0.76	1.64	1.65	1.76	0.03	0.04	0.06
CD (0.05)	1.75	1.88	1.74	3.25	3.91	3.21	0.08	0.08	0.09

Table 10. Chlorophyll "b", Total phenol content ($\mu\text{g/g}$) and Corolla tube length (cm) during 2020-21

Treatments	Chlorophyll "b" content			Total phenol content ($\mu\text{g/g}$)			Corolla tube length (cm)		
	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)
S ₁ Paclobutrazol (0.6 g a.i /m ²)	0.34	0.44	0.38	1.94	2.50	2.12	1.12	1.22	1.14
S ₂ Mepiquat chloride (150 ppm)	0.33	0.43	0.31	1.51	1.90	1.54	1.11	1.14	1.15
S ₃ Nitrobenzene (1.0 %)	0.31	0.44	0.32	1.82	2.10	1.86	1.14	1.16	1.17
S ₄ Thio urea (1.0%)	0.30	0.35	0.29	2.50	3.12	2.52	1.18	1.23	1.19
S ₅ Cycocel + Humic acid (1000 ppm and 4% respectively)	0.37	0.46	0.39	3.41	3.62	3.45	1.07	1.17	1.12
S ₆ Control	0.25	0.31	0.28	0.94	1.75	1.20	1.12	1.18	1.13
Mean	0.32	0.41	0.33	2.02	2.50	2.12	1.12	1.18	1.15
SEd	0.03	0.03	0.02	0.16	0.16	0.18	0.08	0.05	0.05
CD (0.05)	0.08	0.07	0.08	0.28	0.38	0.26	0.15	1.23	1.19

Table 11. Length of flower bud (cm), Diameter of the flower bud (mm) and Number of flower buds per cyme (Nos.) during 2020-21

Treatments	Length of flower bud (cm)			Diameter of the flower bud (mm)			Number of flower buds per cyme (Nos.)		
	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)
S ₁ Paclobutrazol (0.6 g a.i /m ²)	2.32	2.38	2.31	4.50	5.60	5.25	6.80	7.55	7.25
S ₂ Mepiquat chloride (150 ppm)	2.29	2.36	2.24	5.00	5.70	5.50	6.50	7.50	7.50
S ₃ Nitrobenzene (1.0 %)	2.33	2.34	2.24	4.75	5.55	5.45	7.25	7.25	7.20
S ₄ Thio urea (1.0%)	2.38	2.48	2.35	5.65	5.80	5.65	5.75	7.50	6.35
S ₅ Cycocel + Humic acid (1000 ppm and 4% respectively)	2.16	2.24	2.17	5.80	6.50	5.75	7.50	8.50	8.00
S ₆ Control	2.21	2.31	2.28	4.60	5.00	4.75	4.25	4.50	4.20
Mean	2.28	2.35	2.27	5.05	5.69	5.39	6.34	7.13	6.75
SEd	0.09	0.08	0.05	0.35	0.38	0.36	0.15	0.18	0.15
CD (0.05)	0.19	0.12	0.13	0.71	0.81	0.84	0.27	0.37	0.28

Table 12. Number of cymes per plant (Nos.), Number of flower buds per plant (Nos.) and Estimated flower yield/plant (kg) during 2020-21

Treatments	Number of cymes per plant (Nos.)			Number of flower buds per plant (Nos.)			Estimated flower yield/plant (kg)		
	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)
S ₁ Paclobutrazol (0.6 g a.i /m ²)	27.50	38.50	34.50	155.00	185.50	165.50	0.65	0.75	0.61
S ₂ Mepiquat chloride (150 ppm)	35.50	47.50	43.50	155.50	175.50	162.50	0.61	0.68	0.65
S ₃ Nitrobenzene (1.0 %)	42.50	49.50	45.50	140.00	156.50	145.50	0.72	0.65	0.68
S ₄ Thio urea (1.0%)	28.50	35.50	31.50	135.50	132.50	128.50	0.55	0.55	0.61
S ₅ Cycocel + Humic acid (1000 ppm and 4% respectively)	53.50	65.50	52.50	175.50	195.50	184.50	0.85	0.76	0.74
S ₆ Control	25.50	31.50	28.50	120.50	130.50	115.50	0.81	0.71	0.65
Mean	35.50	44.67	39.33	147.00	162.67	150.33	0.70	0.68	0.66
SEd	1.66	2.31	2.17	2.71	2.72	2.71	2.18	2.32	1.36
CD (0.05)	2.41	3.98	3.51	4.76	4.85	4.79	3.56	3.82	2.14

Table 13. Flower yield (Kg/plot) and Estimated flower yield (t/ha) during 2020-21

Treatments	Flower yield (Kg/plot)			Estimated flower yield (t/ha)		
	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)
S ₁ .Paclobutrazol (0.6 g a.i /m ²)	3.25	4.25	3.75	5.30	7.50	7.25
S ₂ .Mepiquat chloride (150 ppm)	3.75	4.10	3.85	5.60	6.10	6.25
S ₃ .Nitrobenzene (1.0 %)	4.10	4.25	4.10	5.20	6.50	6.40
S ₄ .Thio urea (1.0%)	4.50	4.25	5.15	5.70	6.20	6.30
S ₅ .Cycocel + Humic acid (1000 ppm and 4% respectively)	5.10	5.75	5.25	5.80	7.80	7.40
S ₆ .Control	4.75	4.15	5.10	5.15	6.25	5.80
Mean	4.24	4.46	4.53	5.46	6.73	6.57
SEd	0.15	0.08	0.06	2.25	3.65	2.26
CD (0.05)	0.16	0.15	0.19	4.73	7.82	4.75

Table 14. Weight of hundred flower buds (g) and Shelf life at refrigerated condition (without vent) (Days) during 2020-21

Treatments	Weight of hundred flower buds (g)			Shelf life at refrigerated condition (without vent) (Days)		
	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)	Aug 2021 (M1)	Sept 2021 (M2)	Nov 2021 (Control)
S ₁ .Paclobutrazol (0.6 g a.i /m ²)	33.50	65.50	62.50	10.50	11.25	11.75
S ₂ .Mepiquat chloride (150 ppm)	25.50	72.50	69.50	7.50	7.50	7.55
S ₃ .Nitrobenzene (1.0 %)	24.75	68.25	62.50	10.50	11.50	11.40
S ₄ .Thio urea (1.0%)	20.50	72.50	68.00	8.50	8.50	8.15
S ₅ .Cycocel + Humic acid (1000 ppm and 4% respectively)	28.50	85.50	72.50	12.00	12.50	12.50
S ₆ .Control	21.50	55.50	52.50	7.10	8.50	8.50
Mean	25.71	69.96	64.58	9.35	9.96	9.98
SEd	1.12	1.24	1.65	0.13	0.16	0.14
CD (0.05)	2.47	2.76	3.56	0.26	0.22	0.26

of flower buds per cyme (8.50 Nos.), Number of cymes per plant (65.50 Nos.), Number of flower buds per plant (195.50 Nos.), flower yield /plant and flower yield per plot were recorded 0.76 kg 5.75 kg respectively (Table 7-14). The highest level of chlorophyll, total phenol content and soluble protein content observed in the plants pruned during last week of September might be due to the improved photosynthetic efficiency which ultimately resulted in improved flower quality and yield potential. Similar results were obtained by Kumaresean, 2016 in jasmine.

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