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Kumaresan M
Department of floriculture and landscaping, Horticultural college and research institute, Tamil Nadu Agricultural University, Coimbatore -03, Tamil Nadu, India

KR Rajadurai
Department of floriculture and landscaping, Horticultural college and research institute, Tamil Nadu Agricultural University, Coimbatore -03, Tamil Nadu, India

M Ganga
Department of floriculture and landscaping, Horticultural college and research institute, Tamil Nadu Agricultural University, Coimbatore -03, Tamil Nadu, India

R Sivakumar
Department of crop physiology, Agricultural college and research institute, Tamil Nadu Agricultural University, Coimbatore -03, Tamil Nadu, India

Correspondence
Kumaresan M
Department of floriculture and landscaping, Horticultural college and research institute, Tamil Nadu Agricultural University, Coimbatore -03, Tamil Nadu, India

Effect of pruning and Paclobutrazol application on physiological and flowering characters of jasmine (*Jasminum sambac* L.) During off Season

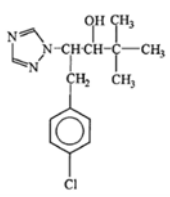
Kumaresan M, KR Rajadurai, M Ganga and R Sivakumar

Abstract
A field experiment was conducted at the Department of Floriculture and Landscaping, Tamil Nadu Agricultural University, Coimbatore during 2015 – 2016 to study the effect of pruning and paclobutrazol application on physiological and flowering characters of *Jasminum sambac* during off season (Oct.–Feb.). The experiment was laid out in Randomized Block Design (RBD) with 10 treatment combinations. Among the treatment combinations the plants treated with soil drenching of paclobutrazol at 300ppm as significantly increased physiological parameters *viz*., chlorophyll a (0.77 mg g^{-1}), chlorophyll b (0.49 mg g^{-1}) and total chlorophyll (1.33 mg g^{-1}), total phenol content (4.65 mg g^{-1}), IAA oxidase activity (12.35µg of unoxidised auxing^{-1} h^{-1}), soluble protein (16.05 mg g^{-1}), specific leaf weight (0.0114 mg cm^{2}) and flowering parameters *viz*., diameter of the flower buds (7.98 mm), corolla tube length (11.08 cm) and weight of hundred flower buds (20.96 g) (Feb.) in *Jasminum sambac*.

Keywords: Pruning, Paclobutrazol, Physiology and Flowering

Introduction
Jasmine (*Jasminum sambac* L.) is one of the oldest fragrant loose flowers which belong to the family Oleaceae and known to be the native of subtropical regions (David, 1990) [1]. It was highly esteemed for its attractive, white colour and fragrant flower. It has a pride of place in the heart of every south Indian woman. Jasmine flowers are widely used in aromatherapy since jasmine fragrance is effective in treating depression, nervous exhaustion and stress. Jasmine oil has a wide range of medicinal applications and is used in perfumery, soaps, flavouring and cosmetic industry. Jasmine require temperature of 27–32°C during day time and 21–27°C at night is ideal for good flowering. In off season temperature between 15 and 17°C during night shuts the flowering for a week (Leonhardt and Teves, 2002) [2]. Low winter temperature caused ultra-structural cellular changes in single whorled cultivars of *Jasminum sambac* and reduction in quality of flower (Su and Wang, 2001) [3]. Pruning is a cultural operations being followed in jasmine. It is a useful method since antique times for restarting growth of plants (Parsons, 1956) [4]. As a result of pruning, number of new shoots get increased which resulted in increased flower quality by activation of physiological activity. Plant growth and differentiation are regulated by phytohormones that presumably exert their influence on particular metabolic reactions in the target tissue *via* receptor molecules. Besides the natural phytohormones, the group of bioregulators / growth regulators that modify a plant in its growth and developmental behaviour without inducing phytotoxic or malformative effects includes synthetic substances such as the growth retardants.

Paclobutrazol: Paclobutrazol ([2RS, 3RS]-1-[4-chlorophenyl]-4, 4-dimethyl-2-[1, 2, 4-triazol-1-yl] pentan - 3-ol) is an important plant growth retardant that reduces plant growth and increases the commercial and aesthetic value of many floriculture and ornamental crops.



It is a triazole type of plant growth retardant and it is used to reduce vegetative growth of many plants such as potted flowering plants, indoor plants, annuals garden plants and ornamental trees (Reed *et al*., 1989) [5]. Paclobutrazol is antagonistic to gibberellins and auxins, reducing cell elongation and cell division by inhibiting gibberellin biosynthesis. Paclobutrazol are synthetic chemicals used to reduce unwanted longitudinal shoot growth (plant size) in many agronomic and horticultural crops (Davis *et al.,* 1988) [6]. It is labeled for use in chrysanthemums, hibiscus, geranium, poinsettia and many other potted ornamentals (Nelson, 1998) [7]. During off season, pruning and application of paclobutrazol alter the physiology of plants and enhance the production of quality flowers, but farmers are not aware of its benefits during off season production. Hence, an investigation was undertaken to find out the effects of pruning and paclobutrazol application on physiological and flowering characters of *Jasminum sambac* during off season.

Materials and Methods

The experiment was laid out in Randomized Block design with three replications and 10 treatments. Pruning was done to a height of 45 cm above the ground level. The plants were pruned in a month of September. After pruning, fertilizers were applied at the rate of 2.5 kg farmyard manure (FYM) and 60:120:120g NPK plant^{-1} in 2 splits (1/2 N+ full P: K at pruning and remaining $^{1}/_{2}$ N was applied after first flush of flowering). Crop was irrigated depending upon the soil moisture status at an interval of 10 days. The pruning operation was done in two years old plants manually with pruning shears. Pruning is done in the last week of September, 2015. The plants were cutoff at the level of 45 cm from the ground level. Pruning along with paclobutrazol (100, 200 and 300 ppm) were applied as soil drenching, (25, 50 and 75 ppm) where applied as foliar spraying and (25 + 10, 50 +15, 75+20 ppm) were applied as soil drenching + foliar spraying and control (pruning + without paclobutrazol). Drenching and spraying was done in 20th day after pruning, when the plant attain sufficient number of fresh leaves and the freshly prepared paclobutrazol were drenched at 10 cm from the nearby areas at different concentration and for spraying plants were sprayed using a hand sprayer on upper and lower surface of leaves as per the treatments. The treated plants were observed for physiological parameters *viz*., chlorophyll content, Phenol content, soluble protein, IAA oxidase activity, specific leaf weight and flowering parameters *viz*., diameter of the flower buds (mm), corolla tube length (cm) and weight of hundred flower buds (g) were taken at monthly intervals. The data were subjected to analysis of variance (ANOVA), and the mean values were compared using duncan's multiple range test at P=0.05 level.

Results and discussion

Physiological parameters

The results indicated that, pruning + paclobutrazol @ 300 ppm applied as soil drenching recorded maximum chlorophyll a (0.59, 0.65, 0.67, 0.71 and 0.77 mg g $^{-1}$), chlorophyll b (0.29, 0.37, 0.38, 0.43 and 0.49 mg g $^{-1}$) total chlorophyll content (0.94, 1.16, 1.20, 1.26 and 1.33 mg g $^{-1}$) in Oct., Nov., Dec. and Jan. (Table: 1 and 2). The increase in chlorophyll content might be due to increase in the cytokinin level in the leaves as a result of application of paclobutrazol. The cytokinin retards chlorophyll degradation, preserves it and increases its synthesis. Application of paclobutrazol showed a significant inverse relationship between leaf area and chlorophyll content of the leaf. These results were in line with the findings of Selim (1985) [8] in Bougainvillea, Selim (1990) [9] in *Pelargonium zonale*, Youssef (2004) [10] in *Strelitzia reginae,* Saker (2004) [11] in *Hibiscus rosa sinensis* and *Tabernaemontana coronaria* shrubs, El-Malt *et al*. (2006) [12] in *Hippeastrum vittatum,* Still *et al.* (2004) [13] in barley seedlings and Sebastian *et al*. (2002) [14] in Chrysanthemum.

Drenching of paclobutrazol alter the total phenol content of leaves. The phenol content was increased with increasing concentration of paclobutrazol. The phenol content was maximum in treatment with pruning + paclobutrazol @ 300 ppm as soil drenching (1.12, 2.42, 4.35, 4.45 and 4.65 mg g $^{-1}$) (Table: 2). The paclobutrazol-induced increase in phenol content may not have direct effect on phenol biosynthesis, but rather through its effects on phytohormone mediated increase in phenol content of leaves. Anti gibberellic nature of growth retardant might have promoted the enhanced level of total phenols in leaves (Banerjee *et al*., 2012) [15]. This is in accordance with the findings of Sheng and Zeng, 1993 [16] in Black locust (*Robinia pseudoacacia*) seedlings and Palanichamy *et al*. (2012) [17] and Patil *et al*. (1992) [18] in mango. Pruning + paclobutrazol @ 300 ppm as soil drenching showed increased level (13.58, 14.09, 14.30, 15.30 and 16.05 mg g $^{-1}$) (Table: 3) of soluble protein in the leaves when compared to untreated plants. Wanas (2007) [19] who indicated that application of paclobutrazol considerably increased the soluble protein content in leaves of faba bean plants compared with those of untreated plants. The results of the present study obtained were in agreement with those of Shokoofeh *et al.* (2013) [20] in *Stevia rebaudiana*, Amira (2007) [21] in Bean, Sankhla *et al.* (1985) [22] in soybean and Parvin *et al*. (2015) [23] in strawberry. Specific leaf weight was found to increase was in plants treated with pruning + paclobutrazol @ 300 ppm as soil drenching (Table: 4). This might due to increase in the palisade mesophyll cell density of treated plants which causes thickening of leaf and thereby leads to increases in specific leaf weight. Similar observation have also been earlier reported by Intrieri *et al.* (1986) [24], Clingeleffer (1985) [25] in grapes, Bailey (2016) [26] in Hydrangeas, Tekalign (2005) [27] in potato and David (1990) [28] in grape vines.

The increased IAA oxidase activity in the present study was recorded in plants treated with pruning + paclobutrazol @ 300 ppm as soil drenching (Table 3). The application of paclobutrazol might have enhanced the endogenous cytokinin level due to the reduction of other determined phytohormones (gibberellins and auxin), which in turn leads to increase the IAA oxidase activity that is clearly emancipated by the alterations of all physiological characteristics. Bekheka *et al.*

(2003) [29] reported that all triazole compounds and then derivatives act as anti-gibberellin compounds interfere with biosynthesis of endogenous gibberellin by preventing the oxidation of ent-kauren to ent-kaureonic acid. These components reduce the endogenous content of auxin (IAA) but lead to increase in endogenous content of Abscisic acid (ABA) in the paclobutrazol treated plants. This is in accordance with the findings of Hedden and Graebe (1985) [30] in *Cucurbita maxima* and *Malus pumila*, Abou (1993) [31] in *Epipremnum aureum* and Youssef (2004) [32] in *Sterilitizia reginae*.

Flowering parameters

The flowering and quality parameter is a very important character for flower cultivation which desired the market value of the flowers. The increase in quality parameters viz., diameter of the flower buds (10.36, 8.95, 7.01, 6.93 and 7.98 (mm)), corolla tube length (11.23, 11.05, 9.35, 9.3 and 9.31 cm)) and weight of hundred flower buds (11.08 , 20.01, 16.10, 17.53 and 19.03 (g)) in Oct., Nov., Dec. and Jan. (Table: 4 and 5) was higher in plants treated with pruning + paclobutrazol @ 300 ppm as soil drenching as they improve overall vegetative growth through modification in phytohormones characters which resulted in improved flower quality. It has also been reported that paclobutrazol application independently can increase the quality of flower buds. It's due to amount of cytokinin formed and allocation of photosynthates utilization. The transport of cytokinin stimulates the diameter and weight of buds (Gardner *et al*., 1991) [33]. Similar results were reported by Karaguzel and Ortacesme (2002) [34] in *Bougainvillea glabra*

Conclusion

The studies on effect of pruning and paclobutrazol application on physiological and flowering characters of jasmine (*Jasminum sambac* L.) during off season indicated that pruning was done in last week of September along with application of paclobutrazol @ 300 ppm as soil drenching recorded enhanced physiological and flower quality of *Jasminum sambac* during the off season (Oct., Nov., Dec. and Jan.).

Table 1: Effect of pruning and paclobutrazol application on chlorophyll a and chlorophyll b of *Jasminum sambac* L. during off season

Treatments	Chlorophyll a (mg g $^{-1}$)					Chlorophyll b (mg g $^{-1}$)				
	Oct. (2015)	Nov. (2015)	Dec. (2015)	Jan. (2016)	Feb. (2016)	Oct. (2015)	Nov. (2015)	Dec. (2015)	Jan. (2016)	Feb. (2016)
T_1	0.56	0.61	0.63	0.67	0.69	0.25	0.29	0.33	0.37	0.45
T_2	0.57	0.63	0.65	0.69	0.71	0.28	0.31	0.34	0.39	0.46
T_3	0.59	0.65	0.67	0.71	0.77	0.29	0.37	0.38	0.43	0.49
T_4	0.38	0.51	0.53	0.56	0.58	0.23	0.26	0.28	0.33	0.34
T_5	0.42	0.54	0.55	0.57	0.59	0.24	0.27	0.29	0.35	0.35
T_6	0.45	0.56	0.58	0.59	0.62	0.26	0.28	0.32	0.36	0.38
T_7	0.43	0.55	0.60	0.59	0.62	0.21	0.27	0.31	0.34	0.37
T_8	0.45	0.56	0.61	0.62	0.65	0.25	0.32	0.33	0.35	0.38
T_9	0.48	0.57	0.62	0.63	0.68	0.27	0.33	0.35	0.36	0.39
T_{10}	0.31	0.42	0.45	0.53	0.57	0.22	0.24	0.27	0.29	0.30
SEd	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
CD @ 5%	0.04	0.04	0.05	0.05	0.05	0.02	0.02	0.02	0.03	0.03

S. No.	Treatment details
T_1	Pruning + Paclobutrazol @100 ppm soil drenching
T_2	Pruning + Paclobutrazol @ 200 ppm soil drenching
T_3	Pruning + Paclobutrazol @ 300 ppm soil drenching
T_4	Pruning + Paclobutrazol @ 25 ppm foliar spraying
T_5	Pruning + Paclobutrazol @ 50 ppm foliar spraying
T_6	Pruning + Paclobutrazol @ 75 ppm foliar spraying
T_7	Pruning + Paclobutrazol @ 25 + 10 ppm (soil drenching + foliar spraying)
T_8	Pruning + Paclobutrazol @ 50 + 15 ppm (soil drenching + foliar spraying)
T_9	Pruning + Paclobutrazol @ 75 + 20ppm (soil drenching + foliar spraying)
T_{10}	Control (pruning + without paclobutrazol)

Table 2: Effect of pruning and paclobutrazol application on total chlorophyll and total phenol content of *Jasminum sambac* L. during off season

Treatments	Total Chlorophyll (mg g $^{-1}$)					Total phenol content (mg g^{-1})				
	Oct. (2015)	Nov. (2015)	Dec. (2015)	Jan. (2016)	Feb. (2016)	Oct. (2015)	Nov. (2015)	Dec. (2015)	Jan. (2016)	Feb. (2016)
T_1	0.87	0.98	1.02	1.23	1.25	1.22	2.36	4.15	4.34	4.62
T_2	0.89	1.09	1.15	1.25	1.26	1.22	2.37	4.16	4.35	4.62
T_3	0.94	1.16	1.20	1.26	1.33	1.12	2.42	4.35	4.45	4.65
T_4	0.55	0.73	0.75	0.92	1.03	1.38	1.75	2.75	3.75	3.88
T_5	0.63	0.75	0.78	1.01	1.06	1.43	1.82	2.76	3.85	3.92
T_6	0.64	0.79	0.80	1.02	1.08	1.55	1.85	2.98	3.84	3.96
T_7	0.63	0.83	0.91	0.98	1.07	1.45	2.25	2.57	3.51	3.61
T_8	0.65	0.85	0.95	1.03	1.10	1.45	2.25	2.59	3.66	3.71
T_9	0.76	0.89	0.98	1.06	1.11	1.35	2.34	2.65	3.75	3.92
T_{10}	0.53	0.63	0.75	0.83	0.88	1.06	1.25	1.25	1.85	1.98
SEd	0.02	0.03	0.03	0.04	0.04	0.05	0.08	0.13	0.15	0.16
CD @ 5%	0.06	0.07	0.08	0.09	0.09	0.11	0.18	0.28	0.34	0.35

Table 3: Effect of pruning and paclobutrazol application on IAA oxidase activity and soluble protein content of *Jasminum sambac* L. during off season

Treatments	IAA oxidase activity (µg of unoxidised auxin g^{-1} h^{-1})					Soluble protein content (mg g^{-1})				
	Oct. (2015)	Nov. (2015)	Dec. (2015)	Jan. (2016)	Feb. (2016)	Oct. (2015)	Nov. (2015)	Dec. (2015)	Jan. (2016)	Feb. (2016)
T_1	17.15	14.34	12.34	12.04	12.15	12.33	13.56	14.05	14.56	15.21
T_2	17.24	14.68	12.42	12.15	12.24	12.86	13.98	14.22	14.85	15.36
T_3	17.34	15.03	12.65	12.21	12.35	13.58	14.09	14.30	15.30	16.05
T_4	15.25	15.40	13.20	12.32	11.86	11.98	12.31	13.86	14.05	14.65
T_5	16.12	15.42	13.31	12.35	12.00	12.21	12.46	14.01	14.28	14.86
T_6	16.24	15.54	13.45	12.45	12.05	12.30	12.56	14.08	14.53	15.05
T_7	16.24	15.56	13.42	12.22	12.05	12.55	12.63	13.25	13.96	14.08
T_8	16.31	15.76	13.47	12.24	12.09	12.67	12.71	13.42	14.02	14.26
T_9	16.34	15.84	13.54	12.31	12.14	12.74	12.80	13.64	14.21	14.57
T_{10}	14.56	13.87	12.05	11.24	10.68	10.55	10.97	11.36	11.86	12.08
SEd	0.68	0.63	0.55	0.52	0.51	0.51	0.52	0.56	0.58	0.60
CD @ 5%	1.46	1.36	1.18	1.11	1.10	1.09	1.13	1.21	1.25	1.30

Table 4: Effect of pruning and paclobutrazol application on specific leaf and diameter of the flower bud of *Jasminum sambac* L. during off season

Treatments	Specific leaf weight (mg cm^{-2})			Diameter of the flower bud (mm)				
	Oct. (2015)	Dec. (2015)	Feb. (2016)	Oct. (2015)	Nov. (2015)	Dec. (2015)	Jan. (2016)	Feb. (2016)
T_1	0.0110	0.0131	0.0104	8.83	8.76	6.75	6.35	7.25
T_2	0.0101	0.0146	0.0104	9.41	8.84	6.88	6.48	7.93
T_3	0.0101	0.0149	0.0114	10.36	8.95	7.01	6.93	7.98
T_4	0.0085	0.0095	0.0086	8.54	8.32	6.25	6.22	7.22
T_5	0.0086	0.0102	0.0088	8.49	8.33	6.08	5.66	7.55
T_6	0.0092	0.0108	0.0094	8.51	8.33	6.03	5.34	7.71
T_7	0.0092	0.0112	0.0088	7.77	7.77	5.99	6.01	6.54
T_8	0.0104	0.0112	0.0097	8.44	8.01	6.15	5.55	7.68
T_9	0.0108	0.0128	0.0113	8.87	8.33	6.23	6.14	7.74
T_{10}	0.0084	0.0093	0.0081	7.66	6.33	6.35	5.22	6.32
SEd	0.0004	0.0005	0.0004	0.46	0.44	0.33	0.31	0.39
CD @ 5%	0.0009	0.0011	0.0009	0.99	0.94	0.69	0.68	0.85

Table 5: Effect of pruning and paclobutrazol application on corolla tube length and weight of hundred flower buds plant^{-1} of *Jasminum sambac* L. during off season

Treatments	Corolla tube length (mm)					Weight of hundred flower buds plant^{-1} (g)				
	Oct. (2015)	Nov. (2015)	Dec. (2015)	Jan. (2016)	Feb. (2016)	Oct. (2015)	Nov. (2015)	Dec. (2015)	Jan. (2016)	Feb. (2016)
T_1	10.22	10.88	9.15	9.11	9.33	20.85	19.21	15.78	16.61	18.28
T_2	11.22	10.54	9.32	9.26	10.11	20.85	19.30	15.85	16.85	18.35
T_3	11.23	11.05	9.35	9.31	11.08	20.96	20.01	16.10	17.53	19.03
T_4	10.66	10.22	8.52	8.42	10.08	18.94	17.23	14.95	15.05	17.15
T_5	10.77	10.55	8.54	8.51	10.01	19.77	17.98	15.83	15.47	17.38
T_6	10.81	10.88	8.71	8.67	10.22	19.98	18.06	15.88	16.01	17.85
T_7	10.01	9.15	8.39	8.01	8.55	19.44	18.73	15.57	16.33	18.15
T_8	10.15	9.66	8.45	8.33	8.46	20.56	18.91	15.61	15.85	18.21
T_9	10.33	9.66	8.55	8.42	9.18	20.64	19.02	15.74	15.93	18.38
T_{10}	9.76	9.03	7.83	7.51	8.15	20.88	17.03	14.64	14.91	16.21
SEd	0.56	0.54	0.46	0.45	0.51	1.07	0.98	0.82	0.84	0.94
CD @ 5%	1.18	1.16	1.01	0.98	1.09	2.14	1.84	1.64	1.68	1.82

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