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Augmentation of Growth and Flowering Characteristics for off-season Flower Production in Jasmine (*J. sambac* (L.) Aiton.) through Pruning and Growth Regulators

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Abstract

An experiment was conducted at the Department of Horticulture, UAS, GKVK, Bengaluru during 2022-23 to analyse the effect of pruning and growth regulators on 'off season' flower production in *Jasminum sambac* (L.) Aiton. Three pruning treatments were imposed, *viz.,* during the second fortnight of August (P_1), October (P_2) and December (control). Growth regulator treatment included GA_3 at 100 (G_1), 150 (G_2), and 200 ppm (G_3); Cycocel at 500 (G_4), 750 (G_5), and 1000 ppm (G_6) along with double distilled water (Control, G_7); there were sprayed at 15 days after pruning. The 21 treatments comprising of pruning schedule and growth regulators was laid out in Factorial Randomized Complete Block Design (FRCBD) with three replications. Among different vegetative characteristics, P_3G_3 (December pruning + GA_3 at 200 ppm) had recorded maximum plant height and plant spread in E-W and N-S directions at 30, 60 and 90 days after pruning, respectively. Number of primary branches per plant showed no significant difference among the treatments. Higher number of secondary branches per plant was recorded in P_3G_6 (December pruning + Cycocel at 1000 ppm). Flower characteristics *viz.,* days taken for bud initiation (35.00 days), first flowering (47.00 days) and 50 per cent flowering (71.00 days) were minimum in December pruning along with foliar application of Cycocel at 1000 ppm (P_3G_6) and significantly different from others. Total duration of flowering (250 days) was maximum in plants pruned during October month with application of Cycocel at 1000 ppm (P_2G_6) with significantly increased in off season flower yield (December to February) per plant (0.141 kg) and per ha (0.628 t).

Keywords : Jasmine, Off-season, Pruning, Growth regulators

Jasminum sambac (L.) Aiton commonly known as Arabian jasmine, Gundu mallige, Mallika, Mogra etc., is a climbing, trailing and erect flowering shrub that belonging to the family Oleaceae. Although more than 200 species are known, 40 species have been identified in India and four species namely *Jasminum grandiflorum, J. auriculatum, J. sambac* and *J. multiforum* are commercially cultivated in Karnataka.

Jasmine plants are of great economic value for the florist, landscaper as well as medical, pharmaceutical and fragrance industries. As a florist plant, jasmine is grown for loose flowers used for making veni and garlands. Jasmine has unique importance and popularity in the perfume industry due to its inimitable sweet fragrance that cannot be exactly imitated by any mixture of known synthetic aroma chemicals or natural isolates. As an important commercial flower

crop, it occupies larger area among the traditional flower crops in Karnataka and Tamil Nadu. As per the data on area and production by State Department of Horticulture during the last five year (2019-2022), there is reduction in area under cultivation and also production. The reasons being urbanization, high labour cost experienced for harvesting and for the preparation of garlands. Pest and disease incidence are also affecting the production resulting in the reduction of yield. Recently, a species of red spider mite, (*Tetranchus lombardinii*) is reported as potential threat for jasmine production (Pooja and Srinivasa, 2022 & Majeed *et al*., 2022). In study on morphological diversity of jasmine cultivars and wild species in Karnataka, seasonal flowering habit of jasmines is found to be another major limiting factor that affects the affecting the commercial production. (Nirmala *et al.,* 2017)

The discovery of growth regulators and their application in horticulture have significantly influenced the production in horticultural crops. Growth and flowering responses of flower crops to these chemical substances have been intensively studied with a view to have compact plants with higher flower yield and also to hasten or delay flowering as per to the needs of the market (Sridhar *et al.,* 2013). Regulation of flowering in jasmine has immense practical value as there are peak and lean productive seasons with consequent yield reduction which greatly the market. Limiting influences price the peak flowering season since it will help to fetch the highest price and also to enter the needs of the consumers to coincide with the time of greatest demand would confer great advantage to the growers. Keeping this in view, the present investigation was formulated to study the effect of pruning schedule and application of growth regulators at different concentrations on the growth and flowering of jasmine.

Material and Methods

The present study was conducted in the Department of Horticulture, UAS, GKVK, Bengaluru during 2022-23. The experimental field was located in Eastern dry zone (Zone-5) of Karnataka state at $13^{0}05"$ at North latitude and $77^{0}34"$ East longitude with an elevation of about 924 meters above mean sea level. The experiment included 21 treatments laid out in Factorial Randomized Complete Block Design (FRCBD) with three replications. Treatments were imposed to find out the suitable interaction effect of pruning and growth regulators for the induction of off season flowering. Pruning was done at 45cm above ground level during the second fortnight of August (P_1), October (P_2) and December (Regular pruning) and different concentration of plant growth regulators were sprayed on 15th day after the pruning. The growth regulator treatments included application of GA_3 at 100 ppm (G_1), GA_3 at 150 ppm (G_2), GA_3 at 200 ppm (G_3), Cycocel at 500 ppm (G_4), Cycocel at 750 ppm (G_5), Cycocel at 1000 ppm (G_6) and double distilled water (G_7-Control). Vegetative parameters recorded were plant height, plant spread in E-W direction, N-S direction, number of primary branches and number of secondary branches at 30, 60 and 90 days after pruning. The flowering parameters like days to bud initiation, days taken for first flowering, 50 per cent flowering and duration flowering and flower yield were also recorded. The data were analyzed using OPSTAT.

Results and Discussion

Influence of Pruning and Growth Regulators on Vegetative Growth of *J. sambac*

Among the three different pruning months, December pruning (P_3) *i.e.,* on-season pruning recorded significantly maximum growth parameters *viz.,* plant height (64.86, 72.24 and 75.23 cm), plant spread in East-West (55.48, 68.14 and 74.05 cm) and North-South (46.52, 49.19 and 54.33 cm) directions and produced higher number of secondary branches (7.67, 9.95 and 14.19) per plant which were on par with October pruning (P_2) at 30, 60 and 90 days after pruning (DAP), respectively.

Among the growth regulators, foliar application of GA_3 at 200 ppm recorded significantly higher plant height (68.44, 77.00 and 81.00 cm), plant spread in E-W direction (62.00, 73.11 and 77.56 cm) and N-S direction (50.44, 53.11 and 58.11cm), followed by GA_3 at 150 ppm at 30, 60 and 90 DAP. Whereas,

TABLE 1

Plant height influenced by pruning and plant growth regulators and their interaction in *Jasminum sambac* (L.)

Treatments	Plant Height (DAP)		
	30	60	90
Pruning months			
P_1 - August	56.86 c	67.14 b	72.14 b
P_2 - October	61.24 b	71.38 a	75.38 a
P_3 - December (Control)	64.86 a	72.24 a	75.23 a
S.Em±	0.490	0.524	0.409
CD @ 5%	0.993	1.062	0.829
Plant growth regulators			
G_1- GA_3 @100 ppm	62.67 bc	71.89 bc	75.89 c
G_2- GA_3 @ 150 ppm	64.67 b	74.56 ab	78.56 b
G_3- GA_3 @ 200 ppm	68.44 a	77.00 a	81.00 a
G_4-Cycocel @ 500 ppm	58.67 de	67.78 d	71.78 de
G_5-Cycocel @ 750 ppm	57.44 e	66.89 de	70.89 e
G_6- Cycocel @ 1000 ppm	54.00 f	64.22 e	68.22 f
G_7- Double distilled water (Control)	61.00 cd	69.44 cd	73.44 d
S.Em±	0.748	0.800	0.624
CD @ 5%	1.517	1.623	1.266
Interaction effect			
P_1G_1 - Aug. pruning + GA_3 @ 100 ppm	56.33 hi	69.33 fghi	74.33 fg
P_1G_2 - Aug. pruning + GA_3 @ 150 ppm	60.67 efg	72.67 bcde	77.67 cde
P_1G_3 - Aug. pruning + GA_3 @ 200 ppm	66.67 bc	75.67 ab	80.67 ab
P_1G_4 - Aug. pruning + Cycocel @ 500 ppm	54.33 ij	65.00 jk	70.00 ij
P_1G_5 - Aug. pruning + Cycocel @ 750 ppm	52.33 jk	63.33 k	68.33 j
P_1G_6 - Aug. pruning + Cycocel @ 1000 ppm	50.00 k	57.67 l	62.67 k
P_1G_7 - Aug. pruning + Control	57.67 h	66.33 ij	71.33 hi
P_2G_1 - Oct. pruning + GA_3 @ 100 ppm	64.00 cd	72.33 cdef	76.33 def
P_2G_2 - Oct. pruning + GA_3 @ 150 ppm	64.33 cd	75.33 abc	79.33 abc
P_2G_3 - Oct. pruning + GA_3 @ 200 ppm	69.00 ab	77.33 a	81.00 ab
P_2G_4 - Oct. pruning + Cycocel @ 500 ppm	58.33 fgh	68.33 ghi	72.33 ghi
P_2G_5 - Oct. pruning + Cycocel @ 750 ppm	58.00 gh	67.67 ghij	71.67 hi
P_2G_6 - Oct. pruning + Cycocel @ 1000 ppm	54.00 ij	67.00 hij	71.00 hi
P_2G_7 - Oct. pruning + Control	61.00 ef	71.67 def	75.67 ef
P_3G_1 - Dec. pruning + GA_3 @ 100 ppm	67.67 ab	74.00 bcd	77.00 cde
P_3G_2 - Dec. pruning + GA_3 @ 150 ppm	69.00 ab	75.67 ab	78.67 bcd
P_3G_3 - Dec. pruning + GA_3 @ 200 ppm	69.67 a	78.00 a	81.33 a
P_3G_4 - Dec. pruning + Cycocel @ 500 ppm	63.33 de	70.00 efgh	73.00 gh
P_3G_5 - Dec. pruning + Cycocel @ 750 ppm	62.00 de	69.67 efgh	72.67 gh
P_3G_6 - Dec. pruning + Cycocel @ 1000 ppm	58.00 gh	68.00 ghij	71.00 hi
P_3G_7 - Control	64.33 cd	70.33 efg	73.33 gh
S.Em±	1.296	1.386	0.883
CD @ 5%	2.628	2.811	1.79

Aug: August Oct: October Dec: December; DAP- Days after pruning

minimum for these growth parameters were noticed in Cycocel at 1000 ppm. However, maximum number of secondary branches was found in Cycocel at 1000 ppm (9.33, 11.33 and 16.33 per plant) at 30, 60 and 90 DAP, respectively. GA_3 at 200 ppm recorded least number of secondary branches per plants.

Among the interaction effect between pruning and growth regulators, treatment combination P_3G_3 (December pruning + GA_3 at 200 ppm) recorded significantly maximum plant height (69.67, 78.00 and 81.33 cm), plant spread in E-W (67.00, 75.67 and 79.33 cm) and N-S directions (40.67, 53.33 and 58.67 cm) which was on par with P_3G_2 (December pruning + GA_3 at 150 ppm). While studying the interaction effect, P_2G_3 plants (October pruning + GA_3 at 200 ppm) recorded maximum plant height (69.00, 77.33 and 81.00 cm), plant spread in E-W (61.00, 72.67 and 77.67cm) and N-S directions (40.33, 53.00 and 59.00 cm) followed by P_2G_2 (October pruning + GA_3 at 150 ppm) 30, 60, and 90 DAP, respectively. Whereas, minimum plant height, plant spread in E-W and N-S direction were recorded in P_1G_6 (August pruning + Cycocel at 1000 ppm) at 30, 60 and 90 DAP (Table 1-3). The difference in vegetative growth parameters might be due to the higher leaf area, increased plant chlrophyll content and less incidence of pests and diseases. GA_3 applied as foliar spray is readily absorbed by the leaves and translocated in both xylem and phloem tissues resulting in distribution throughout the plant system, stimulating the rate of cell division, elongation of internode and stem, ultimately enhancing the plant height and plant spread (Dhanshekaran, 2018). These observations were in conformity with the results obtained by Sujatha *et al.* (2009); Sobhana (2014); Sekhar *et al.* (2020) and Sendhilnathan *et al*. (2017) in jasmine.

In December pruning along with application of Cycocel at 1000 ppm (P_3G_6) maximum number of secondary branches (10.67, 12.67 and 17.67) were recorded followed by P_3G_5 (December pruning + Cycocel at 750 ppm) combination with significant difference between the treatments. Interaction between P_2G_6 (October pruning + Cycocel at 1000 ppm) recorded maximum number of secondary branches (8.67, 10.67 and 16.67) at 30, 60 and 90 DAP, respectively). While, P_1G_3 (August pruning + GA_3 at 200 ppm) had recorded least number of secondary branches per plant (Table 5). Similar observations were recorded by Sujatha *et al.* (2009) in jasmine. Also, inhibitory effect of cycocel on the cell division in the apical bud, subsequently might have stopped the growth of the main axis and induced more lateral shoot production as noticed in case of *Gardenia jasminoides* (Soliman *et al*., 2022) and *Chysanthemum frutescens* (Ghatas, 2016).

Influence of Pruning and Growth Regulators on Jasmine Flower Characteristics

Pruning of jasmine plants in different months influenced flower characteristics also the plants pruned during December month took minimum days to bud initiation (42.95 days), days to first flowering (54.95 days) and 50 per cent flowering (74.38 days). This was followed by off season pruning in October (P_2) which recorded 46.57 days to bud initiation, 58.67 days for first flowering and 77.71 days for 50 per cent flowering. Whereas, plants pruned during August (P_1) took maximum days for flower bud initiation (50.38 days), first flowering (60.52 days) and 50 per cent flowering (84.04 days) (Table 6). There was significant difference in duration of flowering, being maximum in October pruned plants (227.90 days) while plants pruned during December (P_3) recorded minimum duration of flowering (166.762 days) (Fig.1).

Minimum days taken for flower bud initiation (38.33 days), first flowering (49.22 days) and 50 per cent flowering (74.22 days) were recorded in plants sprayed with Cycocel at 1000 ppm (G_6) which was on par with Cycocel at 750 ppm (G_5). This was followed by Cycocel at 500 ppm (G_4). While, maximum days for flower bud initiation (56.33 days), days to first flowering (68.89 days) and 50 per cent flowering (85.11 days) respectively were recorded in G_3 (GA_3 at 200 ppm). Maximum duration of flowering (47.67 days) was recorded in plants sprayed with Cycocel at 1000 ppm (G_6) followed by G_5 (Cycocel at 750 ppm) and minimum duration of flowering (48.33 days) was recorded in G_3 (GA_3 at 200 ppm).

TABLE 2
Plant spread (East - West) as influenced by pruning and plant growth regulators and their interaction on *Jasminum sambac* (L.)

Treatments	Plant spread (E-W) Days		
	30	60	90
Pruning months			
P_1 -August	52.76 b	64.48 c	68.95 b
P_2 - October	54.33 ab	66.14 b	72.29 a
P_3-December (Control)	55.48 a	68.14 a	74.05 a
S.Em±	0.341	0.249	0.403
CD @ 5%	0.691	0.504	0.819
Plant growth regulators			
G_1- GA_3 @100 ppm	54.44 c	67.89 c	73.44 bc
G_2- GA_3 @ 150 ppm	56.67 b	70.11 b	75.44 ab
G_3- GA_3 @ 200 ppm	62.00 a	73.11 a	77.56 a
G_4-Cycocel @ 500 ppm	52.33 d	64.00 d	70.56 d
G_5-Cycocel @ 750 ppm	51.44 d	63.44 d	68.33 e
G_6- Cycocel @ 1000 ppm	49.11 e	58.33 e	64.56 f
G_7- Double distilled water (Control)	53.33 cd	66.89 c	72.44 cd
S.Em±	0.520	0.380	0.616
CD @ 5%	1.056	0.77	1.25
Interaction effect			
P_1G_1 - Aug. pruning + GA_3 @ 100 ppm	53.33 gh	66.00 gh	71.33 fgh
P_1G_2 - Aug. pruning + GA_3 @ 150 ppm	56.00 ce	68.33 ef	73.67 def
P_1G_3 - Aug. pruning + GA_3 @ 200 ppm	58.00 cd	71.00 cd	75.67 bcd
P_1G_4 - Aug. pruning + Cycocel @ 500 ppm	51.67 hijk	62.67 jk	67.33 i
P_1G_5 - Aug. pruning + Cycocel @ 750 ppm	50.67 ijk	61.67 k	64.67 j
P_1G_6 - Aug. pruning + Cycocel @ 1000 ppm	47.67 l	57.33 m	59.67 k
P_1G_7 - Aug. pruning + Control	52.00 ghij	64.33 i	70.33 gh
P_2G_1 - Oct. pruning + GA_3 @ 100 ppm	53.00 gh	68.67 e	74.00 de
P_2G_2 - Oct. pruning + GA_3 @ 150 ppm	56.00 ce	69.67 de	75.67 bcd
P_2G_3 - Oct. pruning + GA_3 @ 200 ppm	61.00 b	72.67 b	77.67 ab
P_2G_4 - Oct. pruning + Cycocel @ 500 ppm	51.33hi jk	64.00 ij	70.67 gh
P_2G_5 - Oct. pruning + Cycocel @ 750 ppm	50.67 ijk	62.67 jk	69.00 hi
P_2G_6 - Oct. pruning + Cycocel @ 1000 ppm	49.67 kl	58.33 lm	66.67 ij
P_2G_7 - Oct. pruning + Control	52.67 ghi	67.00 fg	72.33 efg
P_3G_1 - Dec. pruning + GA_3 @ 100 ppm	57.00 cde	69.00 e	75.00 cd
P_3G_2 - Dec. pruning + GA_3 @ 150 ppm	58.00 c	72.33 bc	77.00 bc
P_3G_3 - Dec. pruning + GA_3 @ 200 ppm	67.00 a	75.67 a	79.33 a
P_3G_4 - Dec. pruning + Cycocel @ 500 ppm	54.00 fg	65.33 hi	73.67 def
P_3G_5 - Dec. pruning + Cycocel @ 750 ppm	53.00 gh	66.00 gh	71.33 fgh
P_3G_6 - Dec. pruning + Cycocel @ 1000 ppm	50.00 jk	59.33 l	67.33 i
P_3G_7 - Control	55.33 ef	59.33 e	74.67 cde
S.Em±	0.901	0.658	1.068
CD @ 5%	1.829	1.335	2.166

Aug: August Oct: October Dec: December

TABLE 3

Influence of pruning and plant growth regulators and their interaction on plant spread of *Jasminum sambac* (L.) in North-South direction

Treatments	Plant spread (N-S) Days		
	30	60	90
Pruning months			
P_1 -August	41.95 b	44.62 b	50.10 c
P_2 - October	45.67 a	48.33 a	51.91 b
P_3-December (Control)	46.52 a	49.19 a	54.33 a
S.Em±	0.282	0.282	0.232
CD @ 5%	0.571	0.571	0.470
Plant growth regulators			
G_1- GA_3 @100 ppm	45.22 c	47.89 c	53.33 c
G_2- GA_3 @ 150 ppm	47.00 b	49.67 b	55.44 b
G_3- GA_3 @ 200 ppm	50.44 a	53.11 a	58.11 a
G_4-Cycocel @ 500 ppm	43.67 c	46.33 c	50.44 de
G_5-Cycocel @ 750 ppm	42.00 d	44.67 d	49.33 e
G_6- Cycocel @ 1000 ppm	40.44 d	43.11 d	47.00 f
G_7- Double distilled water (Control)	44.22 c	46.89 c	51.11 d
S.Em±	0.43	0.43	0.354
CD @ 5%	0.873	0.873	0.718
Interaction effect			
P_1G_1 - Aug. pruning + GA_3 @ 100 ppm	32.33 hi	45.00 hi	52.00 fh
P_1G_2 - Aug. pruning + GA_3 @ 150 ppm	34.67 def	47.33 defg	55.00 cd
P_1G_3 - Aug. pruning + GA_3 @ 200 ppm	40.33 a	53.00 a	56.67 b
P_1G_4 - Aug. pruning + Cycocel @ 500 ppm	30.67 j	43.33 j	48.33 j
P_1G_5 - Aug. pruning + Cycocel @ 750 ppm	28.33 k	41.00 k	47.00 jl
P_1G_6 - Aug. pruning + Cycocel @ 1000 ppm	26.33 l	39.00 l	44.00 n
P_1G_7 - Aug. pruning + Control	31.00 ij	43.67 ij	47.67 jkl
P_2G_1 - Oct. pruning + GA_3 @ 100 ppm	36.00 cd	48.67 cd	53.33 efg
P_2G_2 - Oct. pruning + GA_3 @ 150 ppm	38.00 b	50.67 b	56.00 bc
P_2G_3 - Oct. pruning + GA_3 @ 200 ppm	40.33 a	53.00 a	59.00 a
P_2G_4 - Oct. pruning + Cycocel @ 500 ppm	34.67 fg	47.33 defg	49.67 i
P_2G_5 - Oct. pruning + Cycocel @ 750 ppm	33.67 fgh	46.33 fgh	48.33 jk
P_2G_6 - Oct. pruning + Cycocel @ 1000 ppm	31.67 ij	44.33 ij	45.67 m
P_2G_7 - Oct. pruning + Control	35.33 def	48.00 def	51.33 h
P_3G_1 - Dec. pruning + GA_3 @ 100 ppm	37.33 bc	50.00 bc	54.67 cde
P_3G_2 - Dec. pruning + GA_3 @ 150 ppm	38.33 b	51.00 b	55.33 cd
P_3G_3 - Dec. pruning + GA_3 @ 200 ppm	40.67 a	53.33 a	58.67 a
P_3G_4 - Dec. pruning + Cycocel @ 500 ppm	35.67 de	48.33 de	53.33 ef
P_3G_5 - Dec. pruning + Cycocel @ 750 ppm	34.00 efg	46.67 efg	52.67f gh
P_3G_6 - Dec. pruning + Cycocel @ 1000 ppm	33.33 gh	46.00 gh	51.33 h
P_3G_7 - Control	36.33 cd	49.00 cd	54.33 de
S.Em±	0.745	0.745	0.613
CD @ 5%	1.512	1.274	1.243

Aug: August Oct: October Dec: December

TABLE 4

Influence of pruning and plant growth regulators and their interaction on number of primary branches in *Jasminum sambac* (L.)

Treatments	Number of Primary branches (Days)		
	30	60	90
Pruning months			
P_1 -August	2.38	2.38	2.38
P_2 - October	2.29	2.29	2.29
P_3-December (Control)	2.29	2.29	2.29
S.Em±	NS	NS	NS
CD @ 5%	NS	NS	NS
Plant growth regulators			
G_1- GA_3 @100 ppm	2.33	2.33	2.33
G_2- GA_3 @ 150 ppm	2.22	2.22	2.22
G_3- GA_3 @ 200 ppm	2.33	2.33	2.33
G_4-Cycocel @ 500 ppm	2.33	2.33	2.33
G_5-Cycocel @ 750 ppm	2.33	2.33	2.33
G_6- Cycocel @ 1000 ppm	2.44	2.44	2.44
G_7- Double distilled water (Control)	2.22	2.22	2.22
S.Em±	NS	NS	NS
CD @ 5%	NS	NS	NS
Interaction effect			
P_1G_1 - Aug. pruning + GA_3 @ 100 ppm	2.33	2.33	2.33
P_1G_2 - Aug. pruning + GA_3 @ 150 ppm	2.33	2.33	2.33
P_1G_3 - Aug. pruning + GA_3 @ 200 ppm	2.33	2.33	2.33
P_1G_4 - Aug. pruning + Cycocel @ 500 ppm	2.33	2.33	2.33
P_1G_5 - Aug. pruning + Cycocel @ 750 ppm	2.33	2.33	2.33
P_1G_6 - Aug. pruning + Cycocel @ 1000 ppm	2.67	2.67	2.67
P_1G_7 - Aug. pruning + Control	2.33	2.33	2.33
P_2G_1 - Oct. pruning + GA_3 @ 100 ppm	2.33	2.33	2.33
P_2G_2 - Oct. pruning + GA_3 @ 150 ppm	2.33	2.33	2.33
P_2G_3 - Oct. pruning + GA_3 @ 200 ppm	2.33	2.33	2.33
P_2G_4 - Oct. pruning + Cycocel @ 500 ppm	2.33	2.33	2.33
P_2G_5 - Oct. pruning + Cycocel @ 750 ppm	2.33	2.33	2.33
P_2G_6 - Oct. pruning + Cycocel @ 1000 ppm	2.33	2.33	2.33
P_2G_7 - Oct. pruning + Control	2.00	2.00	2.00
P_3G_1 - Dec. pruning + GA_3 @ 100 ppm	2.33	2.33	2.33
P_3G_2 - Dec. pruning + GA_3 @ 150 ppm	2.00	2.00	2.00
P_3G_3 - Dec. pruning + GA_3 @ 200 ppm	2.33	2.33	2.33
P_3G_4 - Dec. pruning + Cycocel @ 500 ppm	2.33	2.33	2.33
P_3G_5 - Dec. pruning + Cycocel @ 750 ppm	2.33	2.33	2.33
P_3G_6 - Dec. pruning + Cycocel @ 1000 ppm	2.33	2.33	2.33
P_3G_7 - Control	2.33	2.33	2.33
S.Em±	NS	NS	NS
CD @ 5%	NS	NS	NS

NS- non significant; Aug : August; Oct : October; Dec : December

TABLE 5

Influence of pruning and plant growth regulators and their interaction on number of secondary branches in *Jasminum sambac* (L.)

Treatments	Number of secondary branches (Days)		
	30	60	90
Pruning months			
P_1 -August	6.19 b	8.33 b	11.81 b
P_2 - October	6.76 ab	8.91 b	13.14 ab
P_3-December (Control)	7.67 a	9.95 a	14.19 a
S.Em±	0.178	0.185	0.251
CD @ 5%	0.361	0.375	0.508
Plant growth regulators			
G_1- GA_3 @100 ppm	6.56 cd	8.89 cd	13.33 bc
G_2- GA_3 @ 150 ppm	6.00 d	8.22 d	11.67 d
G_3- GA_3 @ 200 ppm	4.11 e	6.22 e	9.67 e
G_4-Cycocel @ 500 ppm	7.44 bc	9.78 bc	13.56 bc
G_5-Cycocel @ 750 ppm	8.11 b	10.22 b	14.33 b
G_6- Cycocel @ 1000 ppm	9.33 a	11.33 a	16.33 a
G_7- Double distilled water (Control)	6.56 cd	8.78 cd	12.44 cd
S.Em±	0.272	0.282	0.383
CD @ 5%	0.551	0.573	0.777
Interaction effect			
P_1G_1 - Aug. pruning + GA_3 @ 100 ppm	6.00 ghi	8.33 fg	12.67 fg
P_1G_2 - Aug. pruning + GA_3 @ 150 ppm	5.67 hi	7.67 gh	10.67 h
P_1G_3 - Aug. pruning + GA_3 @ 200 ppm	2.33 k	4.33 k	7.00 i
P_1G_4 - Aug. pruning + Cycocel @ 500 ppm	7.00 def	9.33 def	13.00 efg
P_1G_5 - Aug. pruning + Cycocel @ 750 ppm	7.67 cde	9.67 cde	13.67 def
P_1G_6 - Aug. pruning + Cycocel @ 1000 ppm	8.67 bc	10.67 bc	14.67 cd
P_1G_7 - Aug. pruning + Control	6.00 ghi	8.33 fg	11.00 h
P_2G_1 - Oct. pruning + GA_3 @ 100 ppm	6.33 fgh	8.67 efg	13.33 def
P_2G_2 - Oct. pruning + GA_3 @ 150 ppm	6.00 ghi	8.33 fg	11.67 gh
P_2G_3 - Oct. pruning + GA_3 @ 200 ppm	4.67 j	6.67 hj	10.33 h
P_2G_4 - Oct. pruning + Cycocel @ 500 ppm	7.33 def	9.67 cde	13.33 def
P_2G_5 - Oct. pruning + Cycocel @ 750 ppm	7.67 cde	9.67 cde	14.00 cde
P_2G_6 - Oct. pruning + Cycocel @ 1000 ppm	8.67 bc	10.67 bc	16.67 ab
P_2G_7 - Oct. pruning + Control	6.67 efg	8.67 efg	12.67 fg
P_3G_1 - Dec. pruning + GA_3 @ 100 ppm	7.33 def	9.67 cde	14.00 cde
P_3G_2 - Dec. pruning + GA_3 @ 150 ppm	6.33 fgh	8.67 efg	12.67 fg
P_3G_3 - Dec. pruning + GA_3 @ 200 ppm	5.33 ij	7.67 ghi	11.67 gh
P_3G_4 - Dec. pruning + Cycocel @ 500 ppm	8.00 bcd	10.33 bcd	14.33 cde
P_3G_5 - Dec. pruning + Cycocel @ 750 ppm	9.00 b	11.33 b	15.33 bc
P_3G_6 - Dec. pruning + Cycocel @ 1000 ppm	10.67 a	12.67 a	17.67 a
P_3G_7 - Control	7.00 defg	9.33 def	13.67 def
S.Em±	0.471	0.489	0.663
CD @ 5%	0.955	0.992	1.345

Aug : August; Oct : October; Dec : December

TABLE 6

Influence of pruning and plant growth regulators and their interaction on flower characteristics in *Jasminum sambac* (L.)

Treatments	Days to Bud Initiation	Days to first flowering	Days to 50% flowering
Pruning months			
P_1 -August	50.381 [a]	60.524 [a]	84.048 [a]
P_2 - October	46.571 [b]	58.667 [b]	77.714 [b]
P_3-December (Control)	42.952 [c]	54.952 [c]	74.381 [c]
S.Em±	0.332	0.304	0.304
CD @ 5%	0.672	0.617	0.617
Plant growth regulators			
G_1- GA_3 @100 ppm	48.111 [c]	60.222 [c]	79.111 [c]
G_2- GA_3 @ 150 ppm	52.111 [b]	64.000 [b]	81.778 [b]
G_3- GA_3 @ 200 ppm	56.333 [a]	68.889 [a]	85.111 [a]
G_4-Cycocel @ 500 ppm	44.889 [d]	55.333 [d]	76.556d [e]
G_5-Cycocel @ 750 ppm	40.333 [e]	49.889 [e]	75.778 [ef]
G_6- Cycocel @ 1000 ppm	38.333 [e]	49.222 [e]	74.222 [f]
G_7- Double distilled water (Control)	46.333 [d]	58.778 [c]	78.444 [cd]
S.Em±	0.506	0.465	0.465
CD @ 5%	1.027	0.942	0.942
Interaction effect			
P_1G_1 - Aug. pruning + GA_3 @ 100 ppm	52.667 [c]	64.000 [c]	85.333 [c]
P_1G_2 - Aug. pruning + GA_3 @ 150 ppm	57.333 [b]	67.333 [b]	87.667 [b]
P_1G_3 - Aug. pruning + GA_3 @ 200 ppm	60.667 [a]	74.667 [a]	91.000 [a]
P_1G_4 - Aug. pruning + Cycocel @ 500 ppm	47.000 [ef]	55.667 [f]	81.667 [d]
P_1G_5 - Aug. pruning + Cycocel @ 750 ppm	43.000 [g]	49.667 [i]	80.000 [de]
P_1G_6 - Aug. pruning + Cycocel @ 1000 ppm	41.333 [gh]	50.333 [hi]	78.000 [eg]
P_1G_7 - Aug. pruning + Control	50.667 [d]	62.000 [d]	84.667 [c]
P_2G_1 - Oct. pruning + GA_3 @ 100 ppm	48.667 [e]	59.667 [e]	77.667 [gh]
P_2G_2 - Oct. pruning + GA_3 @ 150 ppm	51.000 [cd]	64.667 [c]	80.667 [d]
P_2G_3 - Oct. pruning + GA_3 @ 200 ppm	56.000 [b]	68.000 [b]	84.333 [c]
P_2G_4 - Oct. pruning + Cycocel @ 500 ppm	45.333 [f]	57.000 [f]	76.000 [ghi]
P_2G_5 - Oct. pruning + Cycocel @ 750 ppm	40.333 [hi]	52.000 [gh]	75.667 [hij]
P_2G_6 - Oct. pruning + Cycocel @ 1000 ppm	38.667 [ij]	50.333 [hi]	73.667 [jk]
P_2G_7 - Oct. pruning + Control	46.000 [f]	59.000 [e]	76.000 [ghi]
P_3G_1 - Dec. pruning + GA_3 @ 100 ppm	43.000 [g]	57.000 [f]	74.333 [ij]
P_3G_2 - Dec. pruning + GA_3 @ 150 ppm	48.000 [e]	60.000 [e]	77.000 [gh]
P_3G_3 - Dec. pruning + GA_3 @ 200 ppm	52.333 [cd]	64.000 [c]	80.000 [def]
P_3G_4 - Dec. pruning + Cycocel @ 500 ppm	42.333 [g]	53.333 [g]	72.000 [kl]
P_3G_5 - Dec. pruning + Cycocel @ 750 ppm	37.667 [j]	48.666 [j]	71.667 [k]
P_3G_6 - Dec. pruning + Cycocel @ 1000 ppm	35.000 [k]	47.000 [k]	71.000 [l]
P_3G_7 - Control	42.333 [g]	55.333 [f]	74.667 [ij]
S.Em±	0.877	0.810	0.805
CD @ 5%	1.779	1.630	1.632

Aug : August; Oct : October; Dec : December;

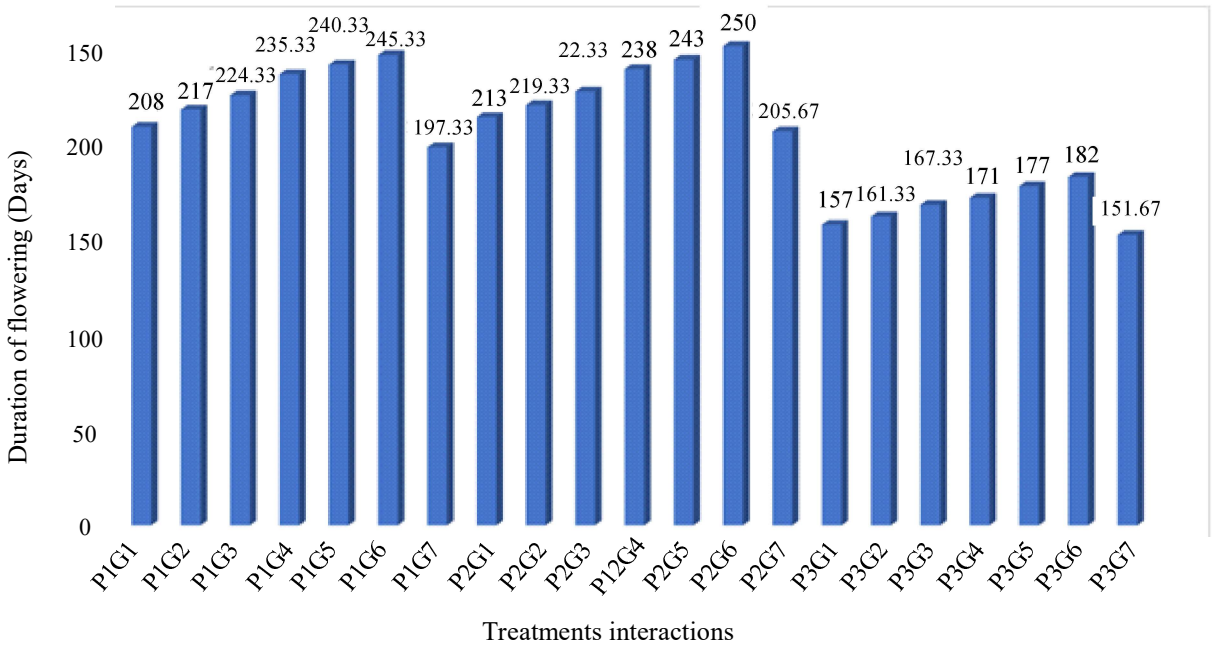

Fig. 1: Influence of pruning and growth regulators on duration of flowering of *Jasminum sambac*

The interactions between pruning month and different growth regulators showed that there was a significant difference in off season pruning. The interaction (P_2G_6) consisting of plants pruned during October month along with spray of Cycocel at 1000 ppm recorded minimum days for bud initiation (38.67 days), first flowering (50.33 days) and 50 per cent flowering (73.67 days). Whereas, maximum days for flower bud initiation (60.67 days), first flowering (74.67 days) and 50 per cent flowering (91.00 days) was recorded in plants pruned during August with GA_3 at 200 ppm (Table 6). Maximum flowering duration of 250 days was recorded in October pruning along with Cycocel 1000 ppm (P_2G_6), whereas, minimum duration for flowering (151 days) was observed in the control (P_3G_7) (Fig. 1). The extended flowering in P_2G_6 may be because of winter (Nov.-Dec.) which would advance flowering. There could be accumulation of certain metabolites / physiological factors during winter months favouring subsequent flower initiation in later months. Application of cycocel might be potentially improving the carbohydrate accumulation, resulting in changes in morphogenesis, photosynthetic capacity and phytohormonal balance, as well as, promoting the sucrose content in leaves by a considerable coefficient during the full blossoming period (Zheng *et al*., 2012). Similar results were shown by Kumaresan, 2016 and Palanikumar & Chelvi Ramesh (2021). Application of Cycocel has inhibitory role in the cell division and elongation of apical meristematic cells as anti-gibberellin compound. This would have helped in the early shift from the vegetative phase to reproductive phase as in case of *Gardenia jasminoides* (Soliman *et al*., 2022) and *Chrysanthemum frutescens* (Ghatas, 2016).

Influence of Pruning and Growth Regulators on Jasmine Flower Yield

The maximum yield per plant and ha (0.114 kg and 0.508 t, respectively) was in plants pruned during October (P_2) followed by August (P_1). Maximum yield per plant (0.093 kg) and per ha (0.413 t) were recorded in plants sprayed with Cycocel at 1000 ppm (G_6) followed by Cycocel at 750 ppm (G_5) presented in (Table 7).

Among the combined pruning and growth regulator treatments, off season yield per plant (0.141 kg) and per ha (0.628 t) were higher in the October pruning with Cycocel at 1000 ppm (P_2G_6) which was on par with October pruning with Cycocel at 750 ppm (P_2G_5)

TABLE 7

Effect of pruning and plant growth regulators and their interaction on yield parameters in *Jasminum sambac* (L.) under open condition

Treatments	Off season yield /plant (kg)	Off season yield /ha (tonnes)
Pruning months		
P_1 -August	0.103 [b]	0.460 [b]
P_2 - October	0.114 [a]	0.508 [a]
P_3-December (Control)	0.000 [c]	0.000 [c]
S.Em±	0.001	0.005
CD @ 5%	0.002	0.01
Plant growth regulators		
G_1- GA_3 @100 ppm	0.073 [d]	0.324 [d]
G_2- GA_3 @ 150 ppm	0.068 [e]	0.301 [e]
G_3- GA_3 @ 200 ppm	0.057 [f]	0.254 [f]
G_4-Cycocel @ 500 ppm	0.081 [c]	0.361 [c]
G_5-Cycocel @ 750 ppm	0.090 [b]	0.400 [b]
G_6- Cycocel @ 1000 ppm	0.093 [a]	0.413 [a]
G_{7-} Double distilled water (Control)	0.046 [g]	0.203 [g]
S.Em±	0.002	0.007
CD @ 5%	0.004	0.015
Interaction effect		
P_1G_1 - Aug. pruning + GA_3 @ 100 ppm	0.103 [h]	0.456 [i]
P_1G_2 - Aug. pruning + GA_3 @ 150 ppm	0.090 [j]	0.398 [k]
P_1G_3 - Aug. pruning + GA_3 @ 200 ppm	0.078 [k]	0.348 [l]
P_1G_4 - Aug. pruning + Cycocel @ 500 ppm	0.115 [f]	0.512 [g]
P_1G_5 - Aug. pruning + Cycocel @ 750 ppm	0.134 [c]	0.598 [d]
P_1G_6 - Aug. pruning + Cycocel @ 1000 ppm	0.138 [ab]	0.611 [b]
P_1G_7 - Aug. pruning + Control	0.066 [m]	0.295 [n]
P_2G_1 - Oct. pruning + GA_3 @ 100 ppm	0.116 [e]	0.517 [f]
P_2G_2 - Oct. pruning + GA_3 @ 150 ppm	0.114 [g]	0.506 [h]
P_2G_3 - Oct. pruning + GA_3 @ 200 ppm	0.093 [i]	0.414 [j]
P_2G_4 - Oct. pruning + Cycocel @ 500 ppm	0.129 [d]	0.572 [e]
P_2G_5 - Oct. pruning + Cycocel @ 750 ppm	0.136 [ab]	0.604 [c]
P_2G_6 - Oct. pruning + Cycocel @ 1000 ppm	0.141 [a]	0.628 [a]
P_2G_7 - Oct. pruning + Control	0.070 [l]	0.312 [m]
P_3G_1 - Dec. pruning + GA_3 @ 100 ppm	0.000 [n]	0.000 [o]
P_3G_2 - Dec. pruning + GA_3 @ 150 ppm	0.000 [n]	0.000 [o]
P_3G_3 - Dec. pruning + GA_3 @ 200 ppm	0.000 [n]	0.000 [o]
P_3G_4 - Dec. pruning + Cycocel @ 500 ppm	0.000 [n]	0.000 [o]
P_3G_5 - Dec. pruning + Cycocel @ 750 ppm	0.000 [n]	0.000 [o]
P_3G_6 - Dec. pruning + Cycocel @ 1000 ppm	0.000 [n]	0.000 [o]
P_3G_7 - Control	0.000 [n]	0.000 [o]
S.Em±	0.003	0.013
CD @ 5%	0.006	0.026

Aug: August Oct: October Dec: December

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and August pruning with Cycocel at 1000 ppm (P_1G_5) (Table 7). The observation in the present study in *J. sambac* be due to the accelerated mobility of photosynthates from the source to the sink as influenced by growth hormone released or synthesized due to higher number of leaves and the chlorophyll content. Also, during flowering of October pruned plants, they are exposed to higher brighter sunshine hours and cumulative heat summation influenced flower production. Further, it has been observed that, there was a diurnal variation 9-10°C temperature which influences flower production. Cycocel will help to redirecting the plants energy away from excessive vegetative growth and towards flowering. It has potential to increase the number of flowers produced lead to a more abundant and prolonged flowering period (Soliman *et al*., 2022) as observed in *Gardenia jasminoides*.

The present study showed that October pruning with foliar application of Cycocel at 1000 ppm at 15 days after pruning enhanced the growth with higher off season flower production and yield in *J. sambac.*

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