International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 2022-2026

Received: 18-01-2019
Accepted: 21-02-2019

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Effect of different stimulants on off season flowering in *Jasminum sambac* L.

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Abstract
The present investigation entitled 'Off season flower induction through various stimulants in *Jasminum sambac* L.' was carried out at Floriculture Research Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during 2016-17. Foliar application of 0.5% $FeSO_4$ + 0.5% $ZnSO_4$ + 20 ppm NAA to jasmine plants after pruning significantly increased maximum plant height 94.13 cm, longest secondary shoot (19.26 cm), highest number of leaves (14.33) on secondary shoot, plant spread at N-S direction (112.98 cm) and E-W direction (117.07 cm). While Early flower bud initiation (32.58 days), highest flower bud length (11.92 mm) and diameter (8.30 mm), maximum weight of hundred flower bud (25.48 g), maximum shelf life of flower buds (28.26 hours), higher flower yield 181.77 g/plant, 727.08 g/plot and 1262.29 kg/ha) were observed with foliar application of 0.5% $FeSO_4$ + 0.5% $ZnSO_4$ + 20 ppm NAA (T_8). Looking to the economics of present investigation, higher cost benefit ratio (1.63) was obtained in treatment T_4 (0.5% *Panchgavya*).

Keywords: Off season, foliar application, stimulants, flower yield, panchgavya

Introduction
Flowers are inseparable from the social fabric of human life. Flowers being adorable creation of God, befits all occasions. *Jasminum sambac* is commonly known as Arabian jasmine, Tuscan jasmine, Motia or Mogra having chromosome no. of 2n = 39 and belongs to India. The term Jasmine was derived from Arabic word 'Jessamine' (Bailey, 1947) [1]. It is the national flower of Philippines, where it is known as *Sampaquita*. It is a small shrub or vine growing 0.5 m to 3 m in height with almost sessile leaves having waxy margins In *Jasminum sambac*, the crop produces good yield during the months March–August. Usually flower production is highly reduced during cooler months, leading to a hike in the price which can be termed as "off season" in jasmine cultivation. Remaining months are considered as off season in case of *Jasminum sambac*. Hence, it is important to produce flower during the lean season also in order to meet out the market demand of flowers to get good income to the farmers. By introducing the various stimulants, it may be possible to induce flower during off season and trying to hatch the better price and market. Keeping in view, present investigation has been planned to evaluate the performance of various stimulants for off season flowering in *Jasminum sambac.*

Materials and Methods
The present investigation to study the "Off season flower induction through various stimulants in *Jasminum sambac* L." was carried out during November-2016 to May-2017 at Floriculture Research Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari. The experiment was laid out in Randomized Blocked Design with three replication and twelve treatments *viz.* T_1 = 0.2% Humic Acid, T_2 = 0.4% Humic Acid, T_3 = 0.3% *Panchgavya*, T_4 = 0.5% *Panchgavya*, T_5 = 0.5% $FeSO_4$, T_6 = 0.5% $ZnSO_4$, T_7 = 0.5% $FeSO_4$ + 0.5% $ZnSO_4$, T_8 = 0.5% $FeSO_4$ + 0.5% $ZnSO_4$ + 20 ppm NAA, T_9 = 20 ppm NAA, T_{10} = 20 ppm NAA + 1% Urea, T_{11} = 1% Banana pseudostem enriched liquid fertilizer, T_{12} = Water spray. The gross plot size of the experiment 4.8 x 4.8 m and net plot size was 2.4 x 2.4 m. The spacing was 1.2 x 1.2 m. Three years old plants of *Jasminum sambac* L. were selected for experiment. Pruning was done at 50 cm height from the ground level in November, 2016 to get uniform height. The preparation of solution was done as per the said concentration. First spray was done immediately after pruning and then three sprays were done at 20 days interval with

the help of hand sprayer. Fresh stimulants solution was prepared at time of each spray and used immediately. Control plants were sprayed with water. All four plants were tagged for recording the observations and average value for each net plot was computed and recorded.

Results and Discussion

Vegetative parameters

The data recorded on various aspects were tabulated and subjected to statistical analysis in comparison with treatments. Data regarding the effect of different stimulants of vegetative characters of jasmine showed significant effect and have been presented in Table no.1. Significantly maximum plant height (94.13cm), longest secondary shoot (19.26 cm), number of leaves per secondary shoot (14.33), plant spread at N-S and E-W direction 112.98 cm and 117.07 cm respectively, were reported in treatment T_8 (0.5% $FeSO_4$+ 0.5% $ZnSO_4$ + 20 ppm NAA).Increase in growth may be attributed to the fact that zinc and iron act as the activator of several enzymes, alcoholic dehydrogenase, pyridine nucleotide dehydrogenase and carbonic anhydrase (Duarate *et al*., 1992) [2]. The iron applied with proper concentration acts as an important catalyst in the enzymatic reaction of metabolism. This ultimately would have helped in larger biosynthesis of photoassymilates, thereby enhanced vegetative growth of plant. Similarly, zinc closely involved in metabolism of RNA and ribosomal content in plant cell, which leads to stimulation of carbohydrates, proteins and DNA formation. It also helps in synthesis of tryptophan which acts as a growth promoting substance. Zinc and iron also favour the storage of more carbohydrates through photosynthesis, which may in turn be the attributing factor for the positive effect on growth attributes (Senthamizhselvi, 2000) [17]. The results are in conformity with the findings of Karuppaiah (2014) [10] and Chopde, Neha *et al*. (2016) [4] in chrysanthemum. Moreover, Metabolites partition and chanalization helped in apical dominance which ultimately improved the length of the longest shoot as application of NAA might be increased the plant vigour which ultimately increase in biomass may be attributed to the fact that NAA increases CO_2 fixation, photosynthate assimilation and chlorophyll content of leaves. The results are in agreement with the findings of Narayan (2015) in marigold. Other scientists have also reported significant influenced of $FeSO_4$ and $ZnSO_4$ in chrysanthemum by Ganga *et al*. (2008), in orchid (Ganga *et al*. 2009) [14], in gerbera (Khosa *et al*., 2011).

Flowering and Yield parameters

Data regarding the flowering characters of jasmine showed significant effect and have been presented in Table no. 2. Early flower bud initiation (32.58 days), highest bud diameter (8.30 mm), maximum bud length (11.92 mm), maximum weight of hundred buds (25.48 g), shelf life (28.26 hours) were observed in treatment T_8 (0.5% $FeSO_4$+ 0.5% $ZnSO_4$ + 20 ppm NAA). An early flowering might be due to enhanced growth and development of plant resulted by zinc sulphate, ferrous sulphate and NAA. Zinc favours the storage of more carbohydrates through photosynthesis and iron involves in synthesis of plant hormones and also plays an important role in chlorophyll synthesis, photosynthesis and respiration. This may be the attributing factor for the positive effectiveness of optimum dose of zinc and iron on reducing juvenile phase of the plant. Similar results are also obtained by Balakrishnan *et al*. (2007) [2] in African marigold and Chopde, Neha *et al*. (2016) [4]. Various quality parameters *viz*. flower bud diameter, length of flower bud and weight of hundred buds were significantly influenced by 0.5% $FeSO_4$ + 0.5% $ZnSO_4$+ 20 ppm NAA in jasmine. The increase in flowering attributes might be due to the beneficial role of zinc and iron in enhancing the translocation of carbohydrates, minerals, water and amino acid from the site of synthesis to the storage tissue especially on flowers which in turn increase number, size and weight of flowers. According to Chopde, Neha *et al*. (2016) [4] due to application of 0.5% $FeSO_4$ and 0.5% $ZnSO_4$ enhanced vegetative growth is resulted into production of more food material which in turn might have been utilized for better development of flowers of annual chrysanthemum. The results are in close conformity with the findings of Lahijie (2012) in gladiolus. According to Narayan (2015), the increase in fresh weight of floral heads with the spray of NAA might be due to mobilization or movement of nutrients in to flowers in which NAA helps to maintain sink-source ratio. The results are in accordance with the findings of Naveenkumar *et al*. (2009) [14] and Karuppaiah (2014) [10] and Chopde, Neha *et al*. (2016) [4] in chrysanthemum, Balakrishnan *et al*. (2007) [2] in marigold and Kakade, *et al*. (2009) [9] in china aster. Maximum shelf life (28.26 hours) was recorded in treatment T_8 = 0.5% $FeSO_4$ + 0.5% $ZnSO_4$ + 20 ppm NAA. Better quality of chrysanthemum flower might be due to higher carbohydrate, other essential nutrients, plant growth regulators and enzymes deposition in flower cells by the zinc and iron physiological role which resulted in production of good quality flowers. This good quality flowers suppress ethylene and abscisic acid and prolong shelf life and appearance of flowers. Similar findings were given by Tisdale *et al*. (1985) [22] in orchid and Vijaykumar (2009) [23] in asparagus.

With regards to flower yield, plants sprayed with 0.5% $FeSO_4$ + 0.5% $ZnSO_4$ + 20 ppm NAA after pruning recorded significantly highest flower bud yield per plant (181.77 g), flower bud yield (727.08 g/plot) and (1262.29 kg/ha) which was statistically at par with T_4 *i.e.* application of *Panchgavya* (0.5%) showed in Table no. 3. Application of zinc and iron not only relieved the chlorosis and produced healthy green plants but also increased the synthesis of chlorophyll, growth promoting substances and mobility of minerals, water, photosynthates and amino acids from the source to sink which may in turn increase the flower production and ultimately flower yield. The results are in agreement with the findings of Nag and Biswas (2002) [13] in tuberose, Balakrishnan *et al*., (2007) [2] in African marigold, Naveenkumar *et al*. (2009) [14], Karuppaiah (2014) [10] and Chopde, Neha *et al*. (2016) [4] in chrysanthemum.

Leaf analysis

Nutrient status of leaf was found to be non-significant variation for N, P, K in all stimulants treatments. Plants sprayed with 0.5% $FeSO_4$ + 0.5% $ZnSO_4$ + 20 ppm NAA after pruning recorded significantly maximum Fe content in leaves. Whereas, highest Zn content was found in plants sprayed with 0.4% Humic acid have been presented in Table no. 4. Micronutrient sprays increased the concentration of respective micronutrient in the leaves. Khoshgoftarmanesh *et al*., 2008 [11] also showed that genotypic difference and enough application of micronutrients in proper quantity and micronutrient absorption of leaf as compared to water spray. This may be due to that major raised in carbohydrates, nitrogen, phosphorus, potassium, zinc and copper percentages found in leaves compare with the control treatments in carnation plants (El-Naggar, 2009) [6]. Present finding is also

corroborated with the results obtained by Soni *et al*. (2009) [19] in gerbera, Ahmad *et al*. (2010) in rose and Bhattacharjee (1996) in rose. Nutrient status of leaf were found to be non-significant variation for Mn, Cu content in all stimulants treatments. Foliar application of 0.4% Humic acid (T_2) to jasmine plants significantly increased chlorophyll content. It might be due to its direct effect on plant growth which has been attributed to the increase in chlorophyll content, the acceleration of the respiration process, hormonal growth responses, increasing penetration in plant membranes or a combination of these processes. (Jariene *et al*. 2008) [8]. Iron is critical for chlorophyll formation and photosynthesis and is important in the enzyme systems and respiration of plants (Havlin *et al*. 1999) [7].

Economics

The data pertaining to the economics on various treatments have been presented in Table no. 5. It is evident from the data that, highest BCR (1.63) was obtained from T_4 (0.5% *Panchgavya*) and least (0.08) was recorded from Water spray.

Conclusion

Based on the results of present investigation, it can be concluded that foliar application of 0.5% $FeSO_4$ + 0.5% $ZnSO_4$ + 20 ppm NAA immediately after pruning and then 20 days interval after pruning (three spray) gave maximum flower yield during off season, while on the basis of economics foliar application of 0.5% *Panchgavya* as per above gave better response to produce marketable flower during off season along with fetching better price and get higher income.

Table 1: Effect of different stimulants on vegetative parameters in jasmine

Treatments	Plant height (cm)		Length of secondary shoot (cm)	No. of leaves per secondary shoot	Plant spread (cm)	
	At 2 MAP	At 4 MAP			N-S	E-W
T_1 = Humic acid (0.2%)	38.69	63.01	12.03	9.33	82.78	85.75
T_2 = Humic acid (0.4%)	41.42	71.90	13.35	10.87	94.63	95.33
T_3 = *Panchgavya* (0.3%)	44.48	67.13	12.39	9.93	93.25	95.10
T_4 = *Panchgavya* (0.5%)	51.38	87.19	18.41	13.20	103.30	109.73
T_5 = $FeSO_4$ (0.5%)	37.79	69.40	12.79	10.20	82.60	86.50
T_6 = $ZnSO_4$ (0.5%)	44.17	69.59	12.45	11.93	100.80	100.91
T_7 = $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%)	43.91	80.12	16.84	13.27	99.98	104.67
T_8 = $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%) + NAA (20 ppm)	57.53	94.13	19.26	14.33	112.98	117.07
T_9 = NAA (20 ppm)	44.58	74.39	13.92	9.47	86.57	99.30
T_{10} = NAA (20 ppm) + Urea (1%)	54.56	84.74	17.09	13.27	107.28	109.64
T_{11} = Banana pseudostem enriched liquid fertilizer (1%)	44.54	72.65	11.13	10.80	97.72	93.40
T_{12} = Water spray	35.49	64.27	10.73	8.67	79.03	82.23
S.Em.±	4.29	6.21	0.63	0.56	5.47	5.71
C.D. @ 5%	12.58	18.22	1.84	1.63	16.05	16.75
C.V.%	16.56	14.37	7.67	8.56	9.97	10.06

Table 2: Effect of different stimulants on flowering parameters in jasmine

Treatments	First flower bud initiation (days)	Bud diameter (mm)	Bud length (mm)	Weight of hundred bud (g)	Shelf life (hours)
T_1 = Humic acid (0.2%)	46.83	6.92	9.51	20.70	21.85
T_2 = Humic acid (0.4%)	38.08	7.20	10.05	21.31	21.45
T_3 = *Panchgavya* (0.3%)	41.08	7.05	9.87	21.24	26.16
T_4 = *Panchgavya* (0.5%)	38.17	8.00	11.22	22.54	27.60
T_5 = $FeSO_4$ (0.5%)	44.92	6.84	9.65	18.76	18.46
T_6 = $ZnSO_4$ (0.5%)	45.33	7.10	9.97	21.09	17.65
T_7 = $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%)	35.25	7.47	10.64	22.44	19.82
T_8 = $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%) + NAA (20 ppm)	32.58	8.30	11.92	25.48	28.26
T_9 = NAA (20 ppm)	44.75	6.47	8.73	17.21	18.79
T_{10} = NAA (20 ppm) + Urea (1%)	52.75	7.15	9.92	21.17	20.82
T_{11} = Banana pseudostem enriched liquid fertilizer (1%)	48.25	7.18	10.43	20.94	22.85
T_{12} = Water spray	56.58	6.33	8.73	18.76	14.52
S.Em.±	2.28	0.35	0.46	1.06	1.14
C.D. @ 5%	6.67	1.03	1.35	3.11	3.34
C.V.%	9.02	8.49	7.91	8.76	9.18

Table 3: Effect of different stimulants on yield parameters in jasmine

Treatments	Yield (g/plant)	Yield (g/plot)	Yield (kg/ha)
T_1 = Humic acid (0.2%)	109.01	436.05	757.04
T_2 = Humic acid (0.4%)	129.16	516.65	896.97
T_3 = *Panchgavya* (0.3%)	134.91	539.64	936.88
T_4 = *Panchgavya* (0.5%)	173.42	693.67	1204.28
T_5 = $FeSO_4$ (0.5%)	107.58	430.32	747.08
T_6 = $ZnSO_4$ (0.5%)	116.96	467.85	812.24
T_7 = $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%)	168.05	672.20	1167.01
T_8 = $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%) + NAA (20 ppm)	181.77	727.08	1262.29

T_9 = NAA (20 ppm)	121.23	484.92	841.87
T_{10} = NAA (20 ppm) + Urea (1%)	105.86	423.44	735.14
T_{11} = Banana pseudostem enriched liquid fertilizer (1%)	127.19	508.76	883.26
T_{12} = Water spray	63.11	252.44	438.26
S.Em.±	6.68	26.71	46.38
C.D. @ 5%	19.59	78.35	136.02
C.V.%	9.02	9.02	9.02

Table 4: Effect of different stimulants on Fe, Zn (mg/kg) content from the leaves in jasmine

Treatments	Fe (mg/kg)	Zn (mg/kg)
T_1 = Humic acid (0.2%)	401.67	3260.33
T_2 = Humic acid (0.4%)	415.67	3360.00
T_3 = *Panchgavya* (0.3%)	440.33	2820.67
T_4 = *Panchgavya* (0.5%)	454.67	2900.67
T_5 = $FeSO_4$ (0.5%)	461.33	3135.67
T_6 = $ZnSO_4$ (0.5%)	373.67	3220.67
T_7 = $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%)	436.00	3160.00
T_8 = $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%) + NAA (20 ppm)	470.00	3185.00
T_9 = NAA (20 ppm)	330.33	2875.00
T_{10} = NAA (20 ppm) + Urea (1%)	350.67	2995.67
T_{11} = Banana pseudostem enriched liquid fertilizer (1%)	414.33	3125.00
T_{12} = Water spray	210.67	2420.33
S.Em.±	17.17	140.64
C.D. @ 5%	50.35	412.51
C.V%	7.50	8.02

Table 5: Economics of different treatments

Treatments	BCR
T_1 =Humic acid (0.2%)	0.70
T_2 = Humic acid (0.4%)	0.90
T_3 = *Panchgavya* (0.3%)	1.13
T_4 = *Panchgavya* (0.5%)	1.63
T_5 = $FeSO_4$ (0.5%)	0.63
T_6 = $ZnSO_4$ (0.5%)	0.75
T_7 = $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%)	1.24
T_8 = $FeSO_4$ (0.5%) + $ZnSO_4$ (0.5%) + NAA (20 ppm)	1.30
T_9 = NAA (20 ppm)	0.86
T_{10} = NAA (20 ppm) + Urea (1%)	0.64
T_{11} = Banana pseudostem enriched liquid fertilizer (1%)	0.93
T_{12} = Water spray	0.08

References

1. Baily LH. Manual of cultivated plants. The Mc Millan Co. New York. 1947, 7-9.
2. Balakrishnan V, Jawaharlal M, Senthilkumar T, Ganga M. Response of micronutrients on flowering, yield and xanthophyll content in African marigold. J Ornam. Hort. 2007; 10(3):153-156.
3. Bini Sundar ST, Kannan M, Jawaharlal M. Off Season flower induction through fertigation and biostimulant spray in *Jasminum sambac* Ait. Asian J Hort. 2014; 9(1):32-35.
4. Chopde Neha, Borse GH, Ommala K, Ghodke AT. Effect of zinc sulphate and ferrous sulphate on growth and flowering of annual chrysanthemum. Plant Archives. 2016; 16(2):594-596.
5. Duarte UM, Leely UK, Narayanan N. Micronutrients status of Bombay state. J Indian Soc. Soil Sci. 1992; 9:41-43.
6. El- Naggar HA. Response of *Dianthus caryophyllus* L. plants to foliar nutrition. World J Agricultural Sci. 2009; 5(5):622-630.
7. Havlin JL, Beaton JD, Tisdale SK, Nelson WL. Soil Fertility and Fertilizers-An Introduction to Nutrient Management 6th Ed. Prentice Hall, New Jersey, 1999.
8. Jariene E, Danilcenko H, Kulaitiene J, Gajewski M. Effect of fertilizers on oil mustard seeds crude fat, fibre and protein quantity. Agronomy Research. 2008; 5(1):43-49.
9. Kakade DK, Rajput GS, Joshi KI. Effect of foliar application of 'Fe' and 'Zn' on growth, flowering and yield of China aster (*Callistephus chinensis* L. Nees). The Asian J Hort. 2009; 4(1):138-140.
10. Karuppaiah P. Effect of zinc and iron on growth, yield and quality of chrysanthemum (*Dendrathemum grandiflorum* Tzeuleu). The Asian J Hort. 2014; 9(1):232-236.
11. Khoshgoftarmanesh AH, Khademi H, Hosseini F, Aghajani R. Influence of additional micro-nutrient supply on growth, nutritional status and flower quality of three rose cultivars in a soilless culture. Journal of Plant Nutrition, 2008; 31:1543-1554.
12. Krishnamoorthy V. Enhancing flower productivity during off season in Jasmine (*Jasminum sambac*). Krishi Vigyan Kendra, Tamil Nadu Agricultural University, Vamban Colony, Padukkottai. 2014; 3(1):88-90.
13. Nag MR, Biswas J. Studies on effect of boron on vegetative and reproductive growth in tuberose (*Polianthes tuberosa*) cv. Single Orissa J Hort. 2002; 30(2):39-42.

14. Naveenkumar P, Misra BL, Ganga M, Dhiman SR, Kameshwari Lalitha. Effect of micronutrients sprays on growth and flowering of chrysanthemum. Indian J Hort. Sci., 2009; 76(6):426-428.
15. Panse VG, Sukhatme PV. Statistical methods for Agricultural workers. ICAR, New Delhi, 1967, 369.
16. Sendhilnathan R, Velmurugan V, Manimaran P. Effect of bio regulators along with organics on growth and yield of gundumalli (*Jasminum sambac* Ait). Journal Pharmacognosy and Phytochemistry. 2017; 6(5):234-238.
17. Senthamizhselvi B. Studies on the flowering and productivity of Gndumalli (*Jasminum sambac* Ait) as influenced by nutrient management technique. M.Sc. (Hort.) Thesis, Tamil Nadu Agricultural University, Coimbatore (T.N.) India, 2000.
18. Sobhana A. Effect of bioregulators and cows urine on flower production in jasmine (*Jasminum sambac*). *Hind Agri-Horticultural Society*, Muzaffarnagar. 2014; 9(1):160-163.
19. Soni SS, Godara AK, Goyal RK, Sehrawat SK. Effect of foliar application of micronutrients on nutrients and chlorophyll content of gerbera var. Winter Queen. Haryana J. Hortic. Sci. 2009; 38(3-4):274-275.
20. Swaminathan V. Studies on the effect of growth regulators on off season flower production *Jasminum sambac*. South Indian Horticultural Association, Coimbtore, 1999; 47(1): 319-321.
21. Thangaselvabai T, Jayasekar M, Eraivan K. Off Season Flower Induction in Jasmine – a Money Spinner. Krishi Vigyan Kendra, Pechiparai, Kanyakumari, 2014.
22. Tisdale SL, Nelson WL, Beaton JD. Elements required in plant nutrition. Soil fertility and fertilizers, 4th Ed. 1985, 27, 33, 61, 63.
23. Vijaykumar N. Effect of growing media and nutrients on growth, yield and quality of *Asparagus sprengeri* L. Kunth. M.Sc (Ag.) Hort. Thesis, Annamalai University, Annamalainagar, T.N. (India), 2009.