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EFFECT OF FOLIAR CONCOCTION ON GROWTH, YIELD AND QUALITY OF JASMINE (*JASMINUM SAMBAC* Ait.)

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Abstract

A field study was conducted for development of foliar concoction to increase the growth, yield and quality of jasmine (*Jasminum sambac* Ait.) – Gundumalli. The experiment was laid out by adopting RBD with ten treatments in five replications. The treatment combinations such as T_3-T_2 + MKP 1% + 0.3% Ferrous sulphate + 0.5% Seaweed extract + 100 ppm Salicylic acid, T_4-T_2 + MKP 1% + 0.3% Zinc sulphate + 0.5% Seaweed extract + 100 ppm Salicylic acid, T_5-T_2 + MKP 1% + 0.3% Magnesium sulphate + 0.5% Seaweed extract + 100ppm Salicylic acid, T_6-T_2 + MKP 1% + 0.3% Borax + 0.5% Seaweed extract + 100ppm Salicylic acid, T_7-T_2 + MKP 1% + 0.5% Seaweed extract + 100 ppm Salicylic acid, T_8-T_2 + 0.5% Seaweed extract + 100ppm Salicylic acid, T_9-T_2 + 0.3% Ferrous sulphate + 0.3 % Magnesium sulphate + 0.3% Zinc sulphate + 0.3% Borax + 0.5% Seaweed extract + 100 ppm Salicylic acid and T_{10}-T_2 + MKP 1% + 0.3% Ferrous sulphate + 0.3 % Magnesium sulphate + 0.3% Zinc sulphate + 0.3% Borax + 0.5% Seaweed extract + 100 ppm Salicylic acid were made as foliar concoction application by three sprays at monthly intervals from the date of pruning along with FYM 25 t ha^{-1} + 60: 120: 120 kg NPK ha^{-1} as soil application. T_2 was with the soil application of FYM 25 t ha^{-1} + 60: 120: 120 kg NPK ha^{-1} without foliar concoction. The T_1 - control was maintained without any application. The various treatments significantly influenced the growth, yield and quality attributes of jasmine. Among the different treatments, T_{10} (T_2 + MKP 1% + 0.3% Ferrous sulphate + 0.3 % Magnesium sulphate + 0.3% Zinc sulphate + 0.3% Borax + 0.5% Seaweed extract + 100ppm Salicylic acid) was found to be the best in all growth, physiological, yield and quality characters followed by T_9 and T_3. Control (T_1) recorded the minimum values. However, the earliness in flowering was observed in control (T_1). The maximum flowering duration was recorded in T_{10} followed by T_9.

***Key words*:** Jasmine, Foliar concoction, Micronutrients, Mono Potassium Phosphate (MKP), Sea weed extract, Salicylic acid and Shelf life.

Introduction

Jasmine (*Jasminum sambac* Ait.) popularly known as Gundumalli, is an important leading traditional flower crop of India which constitutes an important group of high value commercial loose flower. Jasmines are highly valued and are used for making garlands, bouquets, chaplets and venis used for hair ornamentation of the women's for religious and other ceremonies. In India, Jasmine is cultivated in an area of about 255.02 million hectares with an annual production of 2167 million tonnes. In Tamil Nadu, Jasmine cultivation is in the area of 11900 hectare with an annual production of 88,112 tonnes (NHB, 2017). Jasmine flower produced from Tamil Nadu are being lifted to other parts of India and foreign countries. Normally crop plants require a wide range of nutrients for growth and development, so as to express their maximum genetic potential. Macro and micro nutrients plays a major role in the jasmine cultivation. Generally nutrient deficiencies affect the yield and quality of Jasminum flower crops. The primary symptom of nutrient deficiency is interveinal chlorosis by iron and magnesium, reduced leaf size by zinc, flower abortion by boron and leaf edge burns by potassium. In severe cases, the entire leaf turns yellow or white and the outer edges may scorch and turn brown as the plant cells die. In addition, chlorotic plants often produce smaller flower with poor quality. The causes of nutrient chlorosis are complex and not clearly understood.

Several methods are available for treating the nutrient deficiencies. Among the methods, foliar spray of ferrous sulphate gives better result to correct the iron deficiency (Koenig and Jushan, 2010). However, two or three micronutrients deficiencies occurring simultaneously in the same crop is very difficult to be corrected by spraying a single nutrient or multiple sprays with different nutrients especially in a perennial crop like jasmine. The effect of amending a foliar spray containing N, P, K, Mg, Zn, Fe, Mn, Cu and B improved the growth, yield, fruit quality and nutritional status of grape vines (Ahmed *et al*., 1997). Leaf chlorophyll contents, leaf B and Fe content, flower quality and flower stalk diameter were found to be the maximum when plants were sprayed with a combination of micronutrients and bioregulators (Iftikhar *et al.*, 2010). The presence of macro and micronutrients, vitamins, growth hormones and other constituents in the seaweed extract might be very much useful to the crops but their level should be appropriated to enhance growth and productivity (Crouch, 1990). Application of salicylic acid induced early flowering and improved flower quality were reported in crop plants by Hayat and Ahmad (2007). The demand for increasing flower production will require a thorough knowledge on the foliar application of macro and micronutrients with growth regulators and bio stimulants as concoction on flower crops growth and flowering (Ganesh *et al.*, 2013). The available information regarding the impact of foliar concoction on the flower crop is scanty. Keeping in view of the above facts, the present study was undertaken.

Materials and Method

The present study was carried out in the Floriculture and Medicinal Unit, Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu, India during 2014-2016. The experiment was laid out in Randomized block design with the plant spacing of 1.25 × 1.25 m. The treatments used in the study are (T1)control, (T2) 25 t FYM ha^{-1} + Recommended dose of 60: 120: 120 kg NPK ha^{-1}, (T3) T_2 + MKP (Mono Potassium phosphate) 1% + 0.3% Ferrous sulphate + 0.5% Seaweed extract + 100ppm Salicylic acid, (T4) T_2 + MKP 1% + 0.3% Zinc sulphate + 0.5% Seaweed extract + 100ppm Salicylic acid, (T5) T_2 + MKP 1% + 0.3% Magnesium sulphate + 0.5% Seaweed extract + 100ppm Salicylic acid, (T6) T_2 + MKP 1% + 0.3% Borax + 0.5% Seaweed extract + 100ppm Salicylic acid, (T7) T_2 + MKP 1% + 0.5% Seaweed extract + 100ppm Salicylic acid, (T8) T_2 + 0.5% Seaweed extract + 100ppm Salicylic acid, (T9) T_2 + 0.3% Ferrous sulphate + 0.3 % Magnesium sulphate + 0.3% Zinc sulphate + 0.3% Borax + 0.5% Seaweed extract + 100ppm Salicylic acid and (T10) T_2 + MKP 1% + 0.3% Ferrous sulphate + 0.3 % Magnesium sulphate + 0.3% Zinc sulphate + 0.3% Borax + 0.5% Seaweed extract + 100ppm Salicylic acid. Three replications were maintained for each treatment.

The plants selected for the study are already existing one, which were pruned on first week of December 2014 uniformly and the treatments were imposed during the first week of January 2015. Recommended dose of nutrients such NPK @ 60:120:120 kg ha^{-1} were applied in the form of urea (46.4% N), single super phosphate (16.5% P_2O_5) and muriate of potash (60.0% K_2O) respectively. One third of nitrogen, full dose of P_2O_5 and K_2O were applied, to all the treatments except control immediately after pruning as basal along with 25 t FYM ha^{-1}, while the remaining nitrogen was applied at 30 and 90 days after pruning as top dressing. The control treatment plants were maintained without the application of FYM, fertilizers and foliar concoctions. Irrigation was done as flooding for the individual replication once in a week or once in ten days depending upon the soil and climatic conditions. Weeds were removed periodically by hand weeding. Other cultivation practices including plant protection measures were carried out as per the recommended package of practices.

The foliar concoctions were prepared as per the treatment schedule. Except the salicylic acid, all the other chemicals such as MKP (Mono Potassium Phosphate), ferrous sulphate, magnesium sulphate, zinc sulphate, borax and seaweed extracts are water soluble. Salicylic acid was first dissolved in acetone and then used for foliar concoction preparation. The required foliar concoctions were prepared as spray solutions in water as per the treatment requirements. Three sprays of foliar concoction were given during the month of January, February and March, 2015.

The biometric observations like growth and physiological parameters, plant height (cm), number of primary shoots per plant, number of secondary shoots per plant, number of nodes per primary shoot, internodal length (cm), number of leaves per plant, pant spread (cm^2), leaf area (cm^2), chlorophyll content (mg g^{-1}), yield and quality parameters such as days taken for first flower initiation, duration of flowering (days), flower yield per plant (g $plant^{-1}$), flower yield per plot (kg $plot^{-1}$), flower yield per hectare (t ha^{-1}), hundred flowers weight (g), flower bud length (cm), corolla tube length (cm), flower bud diameter (cm) and shelf life (hours) were taken during this study. The chlorophyll content was measured as per the procedure given by Arnon (1949). The data on various parameters were analysed statistically as per the procedure suggested by Panse and Sukhatme (1997).

Results and Discussion

The various treatments significantly influenced the plant growth, physiological, yield and quality characters. The data on growth & physiological parameters (Table 1) showed that the maximum plant height was recorded in T_{10} (T_2 + MKP 1% + 0.3% Ferrous sulphate + 0.3 % Magnesium sulphate + 0.3% Zinc sulphate + 0.3% Borax + 0.5% Seaweed extract + 100ppm Salicylic acid foliar concoction 3 spray at monthly intervals from the date of pruning) with the value of 163.33 cm on 180 DAP, followed by T_9 (T_2 + 0.3% Ferrous sulphate + 0.3 % Magnesium sulphate + 0.3% Zinc sulphate + 0.3% Borax + 0.5% Seaweed extract + 100ppm Salicylic acid foliar concoction 3 spray at monthly intervals from the date of pruning) with the value of 158.02 cm on 180 DAP. The minimum plant height of 63.21 cm on 180 DAP was observed in control (T_1). Similar increase in plant height was obtained by Chaturvedi *et al.*, (1986) in gladiolus by spraying Agromin containing micronutrients viz. B, Zn, Cu, Mn, Mg and Mo. Ganesh *et al*. (2013) also reported in their studies that increased plant height in marigold might be due to the combined effect of micronutrients.

The data on number of primary shoots per plant and secondary shoots per plant also showed that T_{10} has recorded the highest values of 17.33 and 64 respectively on 180 DAP, followed by T_9 with values of 16.30 and 61.58 respectively on 180 DAP. The minimum number of primary shoots per plant and secondary shoots per plant of 6.94 and 25.81 respectively on 180 DAP were recorded in control (T_1). The number of primary and secondary shoots per plant is the most important characters, since it has an important role in photosynthetic partitioning and carbohydrate metabolism. Apart from this, jasmines produce flowers more on current season growth especially on secondary shoots. Hence, more secondary shoots per plant is an important yield attributing character. Karuppaiah (2014) observed more number of branches per plant in chrysanthemum due to the applications of micronutrients. The results are in line with the above findings.

The results of the present study have indicated that the higher number of nodes per primary shoots and intermodal length were expressed by treatment T_{10} with the highest number of internodes per primary shoots of 25.52 and recorded the maximum intermodal length of 9.50 cm on 180 DAP, followed by T_9 with the value of 23.90 and intermodal length of 9.18 cm on 180 DAP. The minimum number of nodes per primary shoots of 9.61 and minimum intermodal length of 4.20 on 180 DAP were recorded in control (T_1). This indicates that the higher carbohydrate accumulation in the shoots facilitated by a favorably influenced combination of foliar concoction application which might have lead to higher photosynthetic activities and ultimately resulting in an increased number of nodes and intermodal length. Similar results were observed by Senthamizhselvi. (2000) in jasmine and Rakeshkumar *et al.* (2015) in rose.

The number of leaves per plant was significantly enhanced by all the treatments over the control and the maximum number of leaves per plant were observed in T_{10} with the values of 1910.10 on 180 DAP, followed by T_9 with the value of 1851.00 on 180 DAP. The minimum number of leaves per plant of 778.59 on 180 DAP were recorded in control (T_1). The leaves are the main photosynthetic apparatus in plant and synthesize various metabolites required for plant growth and development. The number, spread and total area play an impressive role in photosynthetic efficiency of the plant. Among the different treatments, the maximum plant spread were observed in T_{10} with the value of 95.66 cm^2 on 180 DAP, followed by T_9 with the value of 92.77 cm^2 on 180 DAP. The minimum plant spread of 34.78 cm^2 on 180 DAP was recorded in control (T_1). There were significant differences among the treatments with regard to leaf area. T_{10} recorded the maximum leaf area of 47.93 cm^2 on 180 DAP, followed by T_9 with the value of 39.00 cm^2 on 90 DAP. The minimum leaf area of 11.23 cm^2 on 90 DAP was recorded in control (T_1). This indicates that the higher carbohydrate accumulation in leaves facilitated by a favorably influenced combination of foliar concoction application which might have lead to higher photosynthetic activities and ultimately resulting in an increased plant spread and leaf area. The plant spread and leaf area is more directly related to the photosynthetic efficiency as reported by Hardeep Kumar *et al*. (2003) in gladiolus, Prabhat Kumar *et al*. (2010) in African marigold and Karuppaiah (2014) in chrysanthemum. Chandra *et al*. (2007) reported that application of salicylic acid increased total soluble sugar and soluble protein of cowpea plants. This can be attributed to the role of salicylic acid to improve membrane permeability, absorption and utilization of mineral nutrients. This would also contribute towards enhancing the capacity of the treated plants for more leaves, plant spread and leaf area.

The chlorophyll is an essential component for photosynthesis and it occurs in chloroplasts as green pigments in all photosynthetic plant tissues. Different treatments significantly influenced chlorophyll content. Among the various treatments, T_{10} recorded the maximum value of 0.783 mg g^{-1}, followed by T_9 with the values of 0.662 mg g^{-1}. The lowest value was recorded (T_1) in control (0.311 mg g^{-1}), The significant variation in chlorophyll content might be due to the positive effects of foliar concoction and its appropriate combination as reported by Hardeep kumar *et al.* (2003) in tuberose and Balakrishnan *et al.* (2007) in marigold.

The experiments on yield and quality parameters (Table 2) indicated that there was significant difference between the treatments. Yield is a complex phenomenon which can be controlled both by morphological and it can also be manipulated by either genetic factors (or) cultural operations. The data on days to commencement of flowering revealed that earliness in flowering (30.10) was recorded in (T_1) control, followed by T_2, T_8 and T_9. In this study, the earliness in flowering in control was due to the stress of less nutrient availability as reported by Rakeshkumar *et al*. (2015).

The data related the effect of foliar concoction on duration of flowering (days) are recorded. The maximum flowering duration was in T_{10} which recorded the 172.53 days of flowering period. It was followed by T_9 with the duration of 166.85 days. The minimum flowering duration (111.23 days) was recorded in control (T_1). Lengthy flowering period in the best treatment combinations might be due to the appropriate supply of macro and micronutrients, such as K, P, Fe, Mn, Zn and B along with growth regulators, minerals, vitamins and proteins present in the foliar concoction. Similar observation was made by Senthamizhselvi (2000). The flower yield per plant, per plot and flower yield per hectare are significantly influenced by the application of foliar concoction. However, the maximum flower yield per plant (140.61 g plant^{-1} on 180 DAP), flower yield per plot (69.34 kg plot^{-1}), flower yield per hectare (6.24 t ha^{-1}) and hundred flower weight (23.09 g) were observed in T_{10}, followed by T_9. The improvement in yield due to the application of foliar concoction might basically be due to the enhanced photosynthetic and other metabolic activities related to cell division and elongation as reported by Anuradha *et al*. (1990) in African marigold.

Application of foliar concoction significantly influenced the flower quality characters of jasmine. The maximum flower bud length (2.96 cm), corolla tube length (1.58 cm) and flower bud diameter (2.55 cm), were observed in the treatment T_{10} (T_2 + MKP 1% + 0.3% Ferrous sulphate + 0.3 % Magnesium sulphate + 0.3% Zinc sulphate + 0.3% Borax + 0.5% Seaweed extract + 100ppm Salicylic acid foliar concoction 3 spray at monthly intervals from the date of pruning), followed by T_9 and T_3. The minimum values were recorded in control (T_1). The increase in flower quality attributes might be due to the beneficial role of micronutrients in enhancing the translocation of carbohydrates, minerals and amino acids from the site of the synthesis to the flowering tissue especially on flowers as reported by Balakrishnan *et al*. (2007) and Naveen Kumar *et al*. (2009) in African marigold.

With regards to the other quality aspects viz., visual scoring (9.79 Excellent) and shelf life (31.86 hours), the treatment T_{10} was found to be excellent treatment followed by T_9. Extension in shelf life of flowers is a key issue in post harvest management of flowers and post harvest management assumes greater significance in flowers like jasmine which is highly perishable and sensitive to ethylene. Better quality of jasmine flowers might be due to higher carbohydrate, other essential nutrients, plant growth regulators and enzymes deposition in flower cells by the foliar concoction physiological role which resulted in production of good quality attractive flowers. This good quality flower suppresses ethylene and abcisic acid and prolong the shelf life and appearance of flowers. Similar findings were given by Bhagyalakshmamma (1998) in gerbera, Karuppaiah (2006) in French marigold and Vijayakumar (2009) in Asparagus.

Table 1 : Effect of foliar concoction on growth and physiological parameters of Jasmine – Gundumalli

Treatments	Plant height (cm)	No. of primary shoots per plant	No. of secondary shoots per plant	No. of nodes per primary shoots	Inter-nodal length (cm)	Number of leaves per plant	Plant spread (cm^2)	Leaf area (cm^2)	Chlorophyll content (mg g^{-1})
Control	63.21	6.94	25.81	9.61	4.20	778.59	34.78	11.23	0.311
25 t FYM ha^{-1} + Recommended dose of 60:120:120 kg NPK ha^{-1}	102.00	10.14	43.94	16.97	7.00	1240.00	56.90	21.26	0.381
T_2 + MKP 1% + 0.3% Ferrous sulphate +0.5% Seaweed extract + 100 ppm Salicylic acid	153.00	15.00	59.15	22.30	9.02	1782.33	89.28	33.26	0.649
T_2 + MKP 1% + 0.3% Zinc sulphate + 0.5% Seaweed extract + 100 ppm Salicylic acid	148.66	19.26	56.63	21.95	8.90	1689.04	85.40	28.90	0.455
T_2 + MKP 1% + 0.3% Magnesium sulphate + 0.5% Seaweed extract + 100 ppm Salicylic acid	143.70	13.88	53.89	20.66	8.20	1591.10	81.00	26.53	0.448
T_2 + MKP 1% + 0.3% Borax + 0.5% Seaweed extract + 100 ppm Salicylic acid	138.60	12.10	51.40	19.76	7.80	1450.33	78.57	25.16	0.425
T_2 + MKP 1% + 0.5% Seaweed extract + 100 ppm Salicylic acid	133.45	11.26	48.96	19.18	7.38	1350.00	76.10	26.33	0.419
T_2 + 0.5% Seaweed extract + 100 ppm Salicylic acid	127.00	10.40	46.52	18.51	7.06	1261.42	73.71	21.26	0.410
T_2 + 0.3 Ferrous sulphate + 0.3% Magnesium sulphate + 0.3% Zinc sulphate + 0.3% Borax + 0.5% Seaweed extract + 100 ppm Salicylic acid	158.02	16.30.	61.58	23.90	9.18	1851.00	92.77	39.00	0.662
T_2 + MKP 1% + 0.3 Ferrous sulphate + 0.3% Magnesium sulphate + 0.3% Zinc sulphate + 0.3% Borax+0.5% Seaweed extract + 100 ppm Salicylic acid	163.33	17.33	64.00	25.52	9.50	1910.10	95.66	47.93	0.783
S.Ed.	**0.95**	**0.23**	**0.58**	**0.29**	**0.15**	**13.21**	**0.57**	**0.39**	**0.01**
CD (P=0.05)	**1.90**	**0.46**	**1.15**	**0.60**	**0.29**	**26.42**	**1.14**	**0.78**	**0.02**

Table 2. : Effect of foliar concoction on yield and quality parameters of jasmine – Gundumalli

Treatment	Days taken for first flower initiation	Duration of flowering (days)	Flower yield per plant (g plant^{-1})	Flower yield per plot (kg plot^{-1})	Flower yield per hectare (t ha^{-1})	Hundred flowers weight (g)	Flower bud length (cm)	Corolla tube length (cm)	Flower bud diameter (cm)	Visual scoring	Shelf life (Hours)
Control	30.10	111.23	54.89	28.11	2.44	11.92	2.01	0.96	1.57	5.10	18.64
25 t FYM ha^{-1} + Recommended dose of 60:120:120 kg NPK ha^{-1}	32.10	121.83	99.00	49.55	4.46	14.84	2.55	1.26	1.66	6.49	20.10
T_2 + MKP 1% + 0.3% Ferrous sulphate + 0.5% Seaweed extract + 100 ppm Salicylic acid	33.19	158.36	124.58	62.33	5.61	21.10	2.80	1.46	2.44	8.49	30.17
T_2 + MKP 1% + 0.3% Zinc sulphate + 0.5% Seaweed extract + 100 ppm Salicylic acid	35.32	155.62	112.46	56.22	5.06	20.86	2.75	1.41	2.39	8.24	29.61
T_2 + MKP 1% + 0.3% Magnesium sulphate + 0.5% Seaweed extract + 100 ppm Salicylic acid	37.83	147.75	100.59	50.33	4.53	20.20	2.71	1.38	2.30	7.89	29.01
T_2 + MKP 1% + 0.3% Borax + 0.5% Seaweed extract + 100 ppm Salicylic acid	40.38	141.06	96.48	48.33	4.35	19.69	2.67	1.35	2.27	7.48	28.11
T_2 + MKP 1% + 0.5% Seaweed extract + 100 ppm Salicylic acid	41.76	131.89	93.51	46.10	4.15	19.20	2.65	1.33	2.20	7.01	27.15
T_2 + 0.5% Seaweed extract + 100 ppm Salicylic acid	43.56	125.10	84.76	43.87	3.95	18.19	2.60	1.29	2.30	6.66	26.11
T_2 + 0.3 Ferrous sulphate + 0.3% Magnesium sulphate + 0.3% Zinc sulphate + 0.3% Borax + 0.5% Seaweed extract + 100 ppm Salicylic acid	37.41	166.85	132.80	66.41	5.88	21.86	2.86	1.52	2.47	9.60	30.73
T_2 + MKP 1% + 0.3 Ferrous sulphate + 0.3% Magnesium sulphate + 0.3% Zinc sulphate + 0.3% Borax + 0.5% Seaweed extract + 100 ppm Salicylic acid	36.46	172.53	140.61	69.34	6.24	23.09	2.96	1.58	2.55	9.79	31.86
S.Ed.	**0.32**	**2.39**	**1.38**	**1.04**	**0.08**	**0.12**	**0.02**	**0.02**	**0.01**	**0.06**	**0.23**
CD (P=0.05)	**0.65**	**4.78**	**2.78**	**2.08**	**0.16**	**0.24**	**0.04**	**0.04**	**0.02**	**0.12**	**0.47**

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