Int.J.Curr.Microbiol.App.Sci (2021) *10*(03): 1519-1526

EXCELLENT PUBLISHERS

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 10 Number 02 (2021)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2021.1003.187

Development of Specific Foliar Formulation for Improving the Flowering and Yield in Jasmine (*Jasminum sambac*)

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Keywords

Specific Foliar formulation, Flower bud, Yield, SPAD, Photosynthetic rate

Article Info

Accepted:
12 February 2021
Available Online:
10 March 2021

ABSTRACT

An experiment was conducted for the development of specific foliar formulation to increase the flower characters and yield in *Jasminum sambac* in the field level for two years 2018-2020. Two or three micro nutrients deficiencies occurring simultaneously in the flower crop is difficult to be corrected by spraying a single nutrient or multiple sprays. The investigation was conducted with Ramanathapuram Gundu variety with six treatments with three replications and in RBD model. The foliar formulations sprays were carried out for three times during January, February and March 2018 to 2020 and measurement of growth, flowering characters, estimation of gas exchange traits and physiological parameters were estimated.Among the treatments the foliar application of $MgSO_4$ (0.3%) + $FeSO_4$ (0.5%) + K_2SO_4 (0.5%) + Borax (0.3%) (T_4) recorded the highest flower diameter, bud length and the physiological parameters like NRase activity and soluble protein and the SPAD value were found to the highest in the above foliar formulation with an estimated yield of 7.55 t ha^{-1} and the yield increment of 42% over the control (5.30 t ha^{-1}) with a BC ratio of 3.05.

Introduction

Floriculture in India is estimated to cover an area of 2.55 lakh ha with a production of 17, 54, 000 MT of loose flowers and 5.43 lakh MT (NHB, 2015).Presently, India is the second largest producer of flowers after china. The Trade of Indian flowers worth Rs. 37,000 crores / annum. Nearly 77% of area under floricultural crops is concentrated in seven states comprising Tamil Nadu, Karnataka, Andhra Pradesh, West Bengal, Maharashtra, Haryana, Uttar Pradesh and Delhi. Among different states, Tamil Nadu ranks first in area followed by Karnataka, West Bengal and Andhra Pradesh and TN occupied more than two-fifths of total flower area in the state. Tamil Nadu ranks first among the flower producing states of India. It occupies 25% of the country's flower production. About an area of 32,400 hectares under cultivation of flowers in the state of Tamil Nadu. The state's major crops include the iconic jasmine besides rose, chrysanthemum, marigold, crossandra, nerium and tuberose.12000 hectares estimated area under cultivation of Jasmine (aka Mogra) in the state 60000 tonnes annual production of jasmine in the state. Deficiencies by nutrients micro and macro affect the yield and quality of flower crops. The primary symptoms of deficiency is interveinal chlorosis by iron and magnesium, reduced leaf size by zinc, flower abortion by boron, 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. The causes of chlorosis are complex. Many plant reactions govern nutrient availability and contribute to the complexity of the nutrient chemistry in soil. The micro nutrient chlorosis frequently occurs in soils that are alkaline (pH greater than 7.0) and that which contain lime most soils contain abundant levels of iron but deficiencies develop because soil chemical reactions render this iron unavailable to plants. Several ways are available for addressing the nutrient deficiencies. Among the methods, foliar spray of ferrous sulphate gives better result to correct the iron deficiency (Koenig and Juhns, 2010). However, more micro nutrient deficiencies occurring simultaneously in the same crop is very difficult to correct by spraying a single multiple sprays with different nutrients especially in a perennial crop like jasmine. The effect of amending a foliar applied spray containing (N, P, K, Mg, Zn, Fe, Mn, Cu and B) improved the growth, yield, fruit quality and nutritional status of vines and with respect to the nutrients applied (Ahmed *et al.,* 1997). Application of iron and zinc relieved the plants from chlorosis and produced healthy green leaves which resulted in higher assimilate synthesis and partitioning of the flower growth which may in turn increase the flower production and ultimately flower yield. Similar results were also obtained by Nath and Biswas, (2002) in tuberose and Pal *et al.,* (2016) in Gerbera. Foliar spray of 0.2% Iron + 0.4% Zinc + RDF found to be best in terms of plant growth, weight of 50 flower bud and yield parameters of *Jasminum grandiflorum* (Deo Kumar Paswan. 2019). The highest individual leaf area and chlorophyll content of the leaf was recorded (28.50 cm^2 and 57.45 SCMR value) in the treatment comprising of application of 100 per cent water soluble fertilizers through fertigation along with foliar spray of humic acid, chelated zinc and borax (Keerthishankar *et al.,* 2019). As there is no micronutrient formulation specifically for Jasmine crop. Based on this background research was carried out to address the problem in Jasmine by formulating a micronutrient formulation for the long term benefit of the Jasmine crops nutrition and yield.

Materials and Methods

The study was undertaken to find out the effect of different foliar formulations and nutrient combinations with growth regulators on growth, physiological parameters and yield in Jasmine (*Jasminum sambac*) in the farmer's field at Kaveripattinam village, Krishnagiri, Tamil Nadu during 2018-2020. The experiment was conducted with the variety Ramanathapuram gundu. Foliar sprays with six treatments *viz*., T_1: Control (Water spray), T_2: Brassinolide (1 ppm) + K_2SO_4 (1%) + Borax (0.3%) + $FeSO_4$ (0.5%), $T_{3:}$ $FeSO_4$ (0.5%) + K_2SO_4 (1%) + Borax (0.3%), $T_{4:}$ $MgSO_4$ (0.3%) + K_2SO_4 (0.5%) + Borax (0.3%) + $FeSO_4$ (0.5%), $T_{5:}$ FeSO4 (0.5%) + K_2SO_4 (1%) + Borax (0.3%)+NAA (20 PPM), $T_{6\,:}$ $MgSO_4$ (0.3%) + K_2SO_4 (0.5%) + Borax (0.3%) + $FeSO_4$ (0.5%) + NAA (20 ppm) with three replications and in RBD model. The treatmental sprays were carried out for three times during January, February and March 2018 to 2020.The crop was pruned during November 2017 and the supplied with fertilizers and other cultivation practices including plant protection measures practiced as per the recommended package of practices of TNAU, Coimbatore.

The physiological parameters were recorded 15 days after the third spray. Chlorophyll index was recorded using chlorophyll meter (SPAD 502) designed by Soil Plant Analytical Department, Minolta, Japan. The data was recorded as per Peng *et al.,* (1996). Soluble protein content of the leaf was estimated using the method of Lowry *et al.,* (1951) and expressed in mgg^{-1} fresh weight. Nitrate reductase activity was estimated by Nicholas *et al.,* (1976) and expressed in µg NO_2 g^{-1} h^{-1}. Sucrose phosphate synthase activity was estimated as per the procedure Huber *et al.,* (1989).

Estimation of gas exchange traits like transpiration rate, photosynthetic rate were measured by using Portable Photosynthesis System LICOR -6400 XT instrument and expressed in µmol m^{-2} s^{-1} units.

Flower and yield parameters like Single flower bud weight, Flower bud diameter, Flower bud length, yield was recorded during each harvest and pooled together and yield t/ha was estimated. Estimation of yield parameters and statistical analysis were carried out as per Panse and Sukhatme (1985).

Results and Discussion

The data on the plant height significantly differed between the treatments (Table 1). Among the various treatments, the foliar formulation spray of $MgSO_4$ (0.3%) + K_2SO_4 (0.5%) + Borax (0.3%) + $FeSO_4$ (0.5%) + NAA (20 ppm) (T_6) recorded highest plant height of 107.67 cm followed by the foliar formulation spray of $FeSO_4$ (0.5%) + K_2SO_4 (1%) + Borax (0.3%) + NAA (20 ppm) (T_5) with 101.83cm which shows the formulation when sprayed as foliar spray absorbed by the leaves and readily translocated in both xylem and phloem tissues resulting in distribution throughout the plant system while the control recorded 89.33cm.

The highest plant height was due to vermicompost and micro nutrients *viz.,* $ZnSO_4$, $FeSO_4$, $MnSO_4$ and B which might have enhanced the microflora and enzymatic activity which might have augmented the plant growth and development. This study is in close agreement with the findings of Weena Nilawonk and Arnat Tancho (2015) in Jasmine.

The physiological parameters like chlorophyll index (SPAD) was estimated and the highest SPAD value of 25.58 was registered by foliar formulation spray of $MgSO_4$ (0.3%) + K_2SO_4 (0.5%) + Borax (0.3%) + $FeSO_4$ (0.5%) (T_4) followed by spray of $MgSO_4$ (0.3%) + K_2SO_4 (0.5%) + Borax (0.3%) + $FeSO_4$ (0.5%) + NAA (20 ppm) (T_6) while the control (T_1) registered the lowest of 10.71.

This may be due to the enhanced photosynthesis by the increased chlorophyll index (SPAD value) and the intensity of greenness in terms of SPAD value of the plant had influenced the photosynthetic rate and the efficiency of the plant for increased biomass production.

The first signs of deficiency observed for Ferrous and Boron, followed by Manganese and Zinc, while no symptoms were observed for Copper deficiency. The micronutrient omission reduced the dry matter yield, chlorophyll content and photosynthetic rate of the plants differently for each omitted nutrient. (Elcio Ferreira dos Santos *et al.*, 2013)

Table.1 Impact of nutrient formulation on the plant height and gas exchange parameters in Jasmine

Treatments	Plant height (cm)	Photosynthetic rate (µmol m^{-2} s^{-1})	Transpiration rate (mmol m^{-2} s^{-1})	Chlorophyll index
T_1 : Control(Water spray)	83.95	10.26	2.05	10.71
T_2 :Brassinolide (1 ppm) + K_2SO_4 (1%) + Borax (0.3%) + $FeSO_4$ (0.5%),	91.07	11.85	2.88	14.73
T_3 : $FeSO_4$ (0.5%) + K_2SO_4 (1%) + Borax (0.3%)	94.75	11.17	2.86	18.32
T_4 :$MgSO_4$ (0.3%) + K_2SO_4 (0.5%) + Borax (0.3%) + $FeSO_4$ (0.5%)	99.45	13.32	3.38	25.58
T_5 :$FeSO_4$ (0.5%) + K_2SO_4 (1%) + Borax (0.3%)+NAA (20 ppm).	101.83	12.69	3.18	19.22
T_6 : $MgSO_4$ (0.3%) + K_2SO_4 (0.5%) + Borax (0.3%) + $FeSO_4$ (0.5%) + NAA (20 ppm)	107.66	14.72	3.63	23.48
Mean	96.451	12.333	2.997	18.673
SEd	5.6278	0.619165	0.127449	0.853503
CD (5%)	12.066	1.349161	0.277711	1.829911

Table.2 Impact of foliar formulations on physiological parameters, flower characters and yield of *Jasminum sambac*

Treatments	NR activity (µg NO_2 g^{-1} h^{-1})	Soluble protein (mg g^{-1})	SPS activity mg sucrose mg $protein^{-1}$	Relative water content (%)	Single flower bud weight (g)	Flower bud length (cm)	Flower bud diameter (cm)	Cumulative Flower yield (g $plant^{-1}$)	Estimated yield (t ha^{-1})
T_1: Control (Water spray)	103.117	10.050	1.077	61.68	0.162	1.273	0.935	859.05	5.309
T_2: Brassinolide (1 ppm) + K_2SO_4 (1%) + Borax (0.3%) + $FeSO_4$ (0.5%),	115.850	11.817	1.240	68.10	0.194	1.693	1.085	951.81	5.851
T_3: $FeSO_4$ (0.5%) + K_2SO_4 (1%) + Borax (0.3%)	116.367	11.933	1.280	67.59	0.208	1.802	1.153	957.14	5.860
T_4: $MgSO_4$ (0.3%) + K_2SO_4 (0.5%) + Borax (0.3%) + $FeSO_4$ (0.5%)	122.833	14.307	1.317	70.73	0.234	2.175	1.478	1215.583	7.555
T_5: $FeSO_4$ (0.5%) + K_2SO_4 (1%) + Borax (0.3%) + NAA (20 ppm).	118.867	12.267	1.203	69.76	0.208	2.010	1.427	963.0833	6.009
T_6: $MgSO_4$ (0.3%) + K_2SO_4 (0.5%) + Borax (0.3%) + $FeSO_4$ (0.5%) + NAA (20 ppm)	121.817	13.233	**1.323**	71.89	0.221	2.091	1.457	1150.2	7.119
Mean	116.475	12.2677	1.2421	68.2927	0.2062	1.8405	1.2558	1016.144	6.2839
SEd	7.88265	1.507265	0.125016	1.32349	0.01081	0.131337	0.147861	93.73156	0.29080
CD @5%	17.17629	3.284331	0.272409	2.88390	0.02318	0.286183	0.317013	204.2411	0.62348

The gas exchange parameters were recorded using portable photosynthesis system (PPS) showed the highest photosynthetic rate (14.72 µmol m^{-2} s^{-1}) and transpiration rate (3.63 mmol m^{-2} s^{-1}) were recorded in the formulation ($MgSO_4$ (0.3%) +$FeSO_4$ (0.5%) + K_2SO_4 (1%) + Borax (0.3%) + NAA (20 ppm) (T_6) while the control (water spray) T_1 recorded the lowest SPAD value (10.71), photosynthetic rate (10.26 µmol m^{-2} s^{-1}) and transpiration rate (2.05 mmol m^{-2} s^{-1}).

The experiments on biochemical parameters (Table 2) indicated that there was significant difference between the treatments. The highest NR activity 122.83 µg NO_2 g^{-1} h^{-1} was recorded by the foliar formulation spray of (T_4) $MgSO_4$ (0.3%) + K_2SO_4 (0.5%) + Borax (0.3%) + $FeSO_4$ (0.5%) followed by the foliar formulation spray of (T_6) $MgSO_4$ (0.3%) + K_2SO_4 (0.5%) + Borax (0.3%) + $FeSO_4$ (0.5%)+ NAA (20 ppm) 121.817 µg NO_2 g^{-1} $h^{-1.}$ The lowest NR activity was registered by control (103.117 µg NO_2 g^{-1} h^{-1}). Soluble protein occupies 40% of RuBisCo protein which is major enzyme involved in photosynthesis. Among the various foliar formulations studied the spray of T_4 $MgSO_4$ (0.3%) + K_2SO_4 (0.5%) + Borax (0.3%) + $FeSO_4$ (0.5%) recorded the highest soluble protein of 14.307 mg g^{-1}.The formulation increased the soluble protein content up to 42.35% compared to control (Table 2). These results are in line with Sivakumar *et al.,* (2014) In case of sucrose phosphate synthase activity, no significant difference was observed between the treatments.

Application of micronutrients stimulate metabolic activity in terms of cell wall loosening, cell elongation, cell enlargement, it results in enlarging bud length, bud diameter, and increases the yield. The flower characters like the single flower bud weight (g) was the highest with the foliar formulation spray of $MgSO_4$ (0.3%) + K_2SO_4 (0.5%) + Borax (0.3%) + $FeSO_4$ (0.5%) (T_4) with 0.234g followed by the foliar formulation spray of $MgSO_4$ (0.3%) + K_2SO_4 (0.5%) + Borax (0.3%) + $FeSO_4$ (0.5%) + NAA (20 ppm) (T_6) with 0.221g.Ma *et al.,* (1995) reported highly significant correlation of SPAD readings with photosynthetic rate in Soyabean and lowest was recorded in control (0.162 g). Flower bud length (cm) and bud diameter (cm) recorded the maximum in the foliar formulation spray of $MgSO_4$ (0.3%) + K_2SO_4 (0.5%) + Borax (0.3%) + $FeSO_4$ (0.5%) (T_4) 2.175cm and 1.478 cm while the control recorded the lowest bud length and the flower bud diameter of 1.273 cm and 0.935cm.The superiority of the flower characters is due to the improvement of soluble protein content and NRase activity in the foliar formulation T_4 spray which has the concoction of nutrients and micronutrient for the advantageous effect.

The yield data revealed that the foliar application of $MgSO_4$ (0.3%) + $FeSO_4$ (0.5%) + K_2SO_4 (0.5%) + Borax (0.3%) (T_4) recorded the highest estimated yield of 7.55 t ha^{-1} with the yield increment of 42% over the control (5.30 t ha^{-1}) (Table 2) due to the efficient translocation of photosynthates to the flower is one reason for increment in flower bud weight which in turn correlated to yield, while the potassium, magnesium, Iron and boron present in the foliar formulation responsible for better translocation of assimilates, with BC ratio of 3.05 (Table 2) followed by the formulation of $MgSO_4$ (0.3%) + K_2SO_4 (0.5%) + Borax (0.3%) + $FeSO_4$ (0.5%) + NAA (20 ppm) (T_6) 7.119 t/ha compared to other treatments. Diethelm and Shibles (1989) opined that the RuBisCo content per unit leaf area was positively correlated with that of soluble protein content of the leaf. The increment is due to the magnesium present in the spray which is a cofactor for the RuBisCo enzyme and essential for the assembly of RuBisCo. The overall yield increment by the foliar formulation of T_4 (iron, magnesium, boron, potassium) might be due to the improvement of chlorophyll by iron, magnesium and improved soluble protein and enhanced NRase activity better translocation by boron and magnesium. Foliar application of micronutrients vigorously activated the vegetative development of plants and quick uptake of nutrients by the Jasmine plants to have better performance. Similar findings were also reported by Sharma *et al.*, (2010) in carnation and Patel *et al.*, (2011) in marigold.

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How to cite this article:

Srividhya, S., R. Siva Kumar and Vijaya Kumar, M. 2021. Development of Specific Foliar Formulation for Improving the Flowering and Yield in Jasmine (*Jasminum sambac*). *Int.J.Curr.Microbiol.App.Sci.* 10(03): 1519-1526.
doi: https://doi.org/10.20546/ijcmas.2021.1003.187