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Keerthishankar K
Ph.D., Scholar, Department of Floriculture and Landscape Architecture, College of Horticulture, Bengaluru, Karnataka, India

Balaji S Kulkarni
Professor and Head, Department of Floriculture and Landscape Architecture, College of Horticulture, Bengaluru, Karnataka, India

Yathindra HA
Assistant Professor and Head, Department of Floriculture and Landscape Architecture, College of Horticulture, Mysuru, Karnataka, India

Corresponding Author:
Keerthishankar K
Ph.D., Scholar, Department of Floriculture and Landscape Architecture, College of Horticulture, Bengaluru, Karnataka, India

Influence of different levels of fertigation supplemented with foliar application of micronutrients on vegetative, flowering and yield parameters of G.I. tagged *Jasminum sambac* cv. Mysuru Mallige

Keerthishankar K, Balaji S Kulkarni and Yathindra HA

Abstract
A plot experiment was carried to study the standardization of fertigation levels along with foliar spray of micronutrients on *Jasminum sambac* cv. Mysuru Mallige. There were 9 treatment combinations consisting of different recommended dose of fertilizers (60:120:120 NPK g/plant/year) along with the foliar spray of micronutrients (humic acid at 0.5%, chelated zinc and borax at 0.75g each per plant) were evaluated in RCBD design and replicated 3 times. The result of the study indicated that application of 100 per cent recommended dose of fertilizer (60:120:120 NPK g/plant/year) along with foliar spray of micronutrients (humic acid at 0.5%, chelated zinc and borax at 0.75g each per plant) significantly affected the vegetative parameters like plant height, plant spread, number of branches, flowering character like early flower bud initiation, flower initiation, 50 per cent flowering, duration of flowering and flower yield per.

Keywords: Jasmine, G.I. tagged, Mysuru, flowering, yield

Introduction
Jasmine (genus *Jasminum*) has more than 200 species of fragnant shrubs and vines of the olive family (Oleaceae). *Jasminum sambac, J. gradiflorum, J. multiflorum and J. auriculatum* are commercially cultivated in India. The cultivar Mysuru Mallige belongs to the species *sambac*, has been given the G.I status in 2006 from Government of India admiring its unique fragrance and flowering characteristics. Mysuru Mallige is commercially being cultivated extensively in Mysore and Mandya districts of Karnataka. These flowers are used for making garlands, *veni* and for other religious offerings. Among the various factors responsible for high crop yield, supply of appropriate quantity of nutrients at appropriate time plays a vital role in enhancing the productivity and quality. Nutrients are generally applied directly to the soil as basal dose and top dressing in the form of solid fertilizers which are substantially lost due to leaching and fixation. To overcome the above said drawbacks and ensure the maximum utilization of the inputs like fertilizer, a novel technology called fertigation has been evolved. Fertigation refers to application of water-soluble fertilizers, soil amendments or other water-soluble products through irrigation water. By the method of fertigation, it is possible to increase the productivity up to 40 per cent along with sparing irrigation water by 45 to 50 per cent. When fertilizer is applied through fertigation, it was observed that the yield has been increased and nearly 30 per cent of the fertilizer could be saved (Sivanappan, 1998). In addition to this, micronutrient plays an important role in obtaining better growth, yield and quality produce. However, application of required nutrients in appropriate time along with proper dosage plays a vital role in increasing the productivity. Keeping this in mind, a study was under taken to enhance the growth, flowering and yield characters of Mysuru Mallige.

Materials and Methods
The experiment was conducted on a newly planted Mysuru Mallige plants at farmer's field, Doddamaragowdanahalli village, near College of Horticulture, Mysuru, Karnataka. Soil of the experimental farm was red sandy loam with an almost uniform fertility having a pH range of 6.0-6.5. The experiment was laid out in RCBD design with 9 treatments and 3 replications.
The treatment details:
T1: Soil application 100% RDF (60:120:120 NPK g/plant/year)

T2: 100% RDF (60: 120:120 NPK g/plant through fertigation)
T3: 75% RDF (45:90:90 NPK g/plant through fertigation)
T4: 50% RDF (30:60:60 NPK g/plant through fertigation)
T5: Soil application 100% RDF (60:120:120 NPK g/plant/year) + foliar spray of humic acid at 0.5%, chelated zinc and borax at 0.75g each per plant
T6: 100% RDF (60: 120:120 NPK g/plant through fertigation) + humic acid at 0.5%, chelated zinc and borax at 0.75g each per plant
T7: 75% RDF (45:90:90 NPK g/plant through fertigation) + humic acid at 0.5%, chelated zinc and borax at 0.75g each per plant
T8: 50% RDF (30:60:60 NPK g/plant through fertigation) + humic acid at 0.5%, chelated zinc and borax at 0.75g each per plant
T9: Farmer's Practice (200g DAP, 200g MOP, 50g Urea / plant/ year)

FYM @ 20kg/plant/year was applied uniformly in all treatments including farmer's practice.

The entire plot was ploughed and brought to a fine tilth, about 45cm^3 pits were made with a spacing of 1.5m × 1.5m. FYM was added at the rate of 20 kg per plant. Water was pumped from the bore well through submersible pump set and it was conveyed to the main line after filtering through screen filter. From the source line, water was taken to the field through main line of 2.5" PVC pipes. Fertigation tank was installed for fertigation. From the main pipes, 2.0" PVC pipes were fixed as sub-main. From sub main, 12 mm laterals were taken and ran along with each row of plants. There was a tap control for each laterals pipe for imposing different level of fertigation treatments. Micro tubes with a discharge rate of 4.0 lph were fixed to the lateral pipes at a spacing of 1.5 m.

Four months old, uniformed height, healthy rooted cuttings of *Jasminum sambac* cv. Mysuru Mallige were planted in the experimental site at a spacing of 1.5m X 1.5m. Lite irrigation was given after transplanting for better establishment. Fertigation done fort nightly as per the treatment details. Monthly observations were recorded on growth, flowering and yield parameters. The data collected was subjected to statistical analysis as per Panse and Sukhatme (1978).

Table 1: Source of Fertilizers and micro nutrients

Type of application	Fertilizer resources	Nutrient content	Tarde name
Soil application	Urea	46% N	Mangala
	SSP (Single Super Phosphate)	16% P	Mangala
	MOP (Muriate of Potash)	60% K	Mangala
Fertigation	MAP (Mono Ammonium Phosphate)	12% N, 61% P	Mangala
	Potassium Nitrate (KNO3)	13% N 45% K	Mangala
Foliar spray	Zn EDTA	12% Zn	Nutrilex
	Borax	20% B	Nutrilex
	Humic acid.	12%	Power hum

Results and Discussion

The result obtaining with respect to growth, flowering and month wise flower yield of Mysuru Mallige are presented in the table 2, 3, 4, 5 and 6 respectively.

Vegetative parameters

Significant differences were obtained with respect to vegetative parameters like plant height, plant spread and number of branches. The data on vegetative parameters were presented in table 2, 3, 4 and 5 Plant height recorded was maximum (53.30, 60.75, 66.58, 72.70, 76.33 and 80.73 cm at 30, 60, 90, 120, 150 and 180 days after planting respectively) in a treatment consisting of 100 per cent recommended dose of fertilizers through fertigation along with foliar spray of humic acid, chelated zinc and borax (T6), which was on par with T7 (75 per cent recommended dose of fertilizers along with foliar spray of humic acid, chelated zinc and borax) (49.73, 59.17, 65.61, 70.53, 74.22 and 78.07 cm at 30, 60, 90, 120, 150 and 180 days after planting, respectively) and while, the lowest plant height was recorded in T9 (40.33, 44.56, 46.51, 47.22, 51.10 and 56.19 cm at 30, 60, 90, 120, 150 and 180 days after planting, respectively) comprising of farmer's practice.

Different treatments significantly influenced the spread of plant from both east to west and north to south direction at 30, 60, 90, 120, 150 and 180 days after planting. Highest plant

Spread was recorded in T6 (30.27, 32.17, 37.74, 39.77, 46.13 and 55.30 cm in east-west direction and 27.34, 29.69, 31.08, 36.47, 42.07 and 47.00 cm in north-south direction at 30, 60, 90, 120, 150 and 180 days after planting, respectively) throughout the period of crop growth and which was on par with T7 (28.63, 30.17, 36.10, 38.17, 44.97 and 53.40cm) in east-west direction and (24.98, 26.65, 28.97, 34.67, 39.33 and 44.30 cm at 30, 60, 90, 120, 150 and 180 days after planting, respectively) while T9 had the least plant spread throughout the growth period.

Significantly highest numbers of branches per plant was recorded in T6 (4.90, 5.53, 6.27, 6.77, 7.67 and 9.13) which includes application of 100 per cent water soluble fertilizers through fertigation along with foliar spray of humic acid, chelated zinc and borax, followed by T7 (75 per cent water soluble fertilizers through fertigation along with foliar spray of Humic acid, Chelated Zinc and Borax) (4.27, 4.97, 5.67, 6.23, 7.10 and 8.43) and T9 recorded the least

number of branches (1.50, 1.93, 2.37, 2.73, 3.13 and 5.10) which refers to farmer's practices.

Increased height and number of branches in the plant supplied with 100 per cent recommended dose of fertilizers along with foliar spray of humic acid, chelated zinc and borax was due to increase in the available nutrient status in the root zone of the plant and thus increasing the nutrient uptake and sufficient application of major and micronutrients will enhance cell elongation, cell division and also increases the growth hormonal activities inside the plant system. Increased plant spread might be due to better synthesis of assimilates in the large photosynthetic area and optimum nourishment to the growing meristematic tissues.

In addition to this, micronutrients are also essential components of several enzymes like dehydrogenase, proteinase and they promote growth hormones which are closely associated with plant growth. All these factors contributed to cell multiplication, cell enlargement and cell

differentiation resulting in increased photosynthesis, translocation of food materials and the formation of metabolites required for growth and ultimately encouraged the growth of the plant. Application of zinc to the plants helps in increasing the number of branches by continuous synthesis of auxins at growth period and micronutrients have role in activation of IAA protectors and influence the auxins level in plants and increases the number of shoots. These finding are concurred with Patel *et al.* (2016) [4] in rose, Ganga *et al.* (2009) [1] in orchid.

Table 2: Effect of different levels of fertigation and foliar spray of micronutrients on plant height in *Jasminum sambac* cv. Mysuru Mallige.

Treatment	Plant height (cm) Days after planting					
	30 days	60 days	90 days	120 days	150 days	180 days
T1	42.00	46.40	51.35	54.73	57.43	64.87
T2	45.70	49.37	58.08	63.05	67.86	71.53
T3	44.00	48.13	57.52	60.90	64.90	70.37
T4	41.23	45.77	48.50	53.10	56.77	60.83
T5	46.03	52.07	55.03	60.07	64.55	67.07
T6	53.30	60.75	66.58	72.70	76.33	80.43
T7	49.73	59.17	65.61	70.53	74.22	78.07
T8	42.07	46.87	50.25	55.50	58.20	63.03
T9	40.33	44.56	46.51	47.22	51.10	56.19
F value	*	*	*	*	*	*
S.Em ±	2.28	2.54	1.01	0.96	0.86	0.99
CD at 5%	6.85	7.62	3.04	2.87	2.58	2.97

*Significant at 5% level

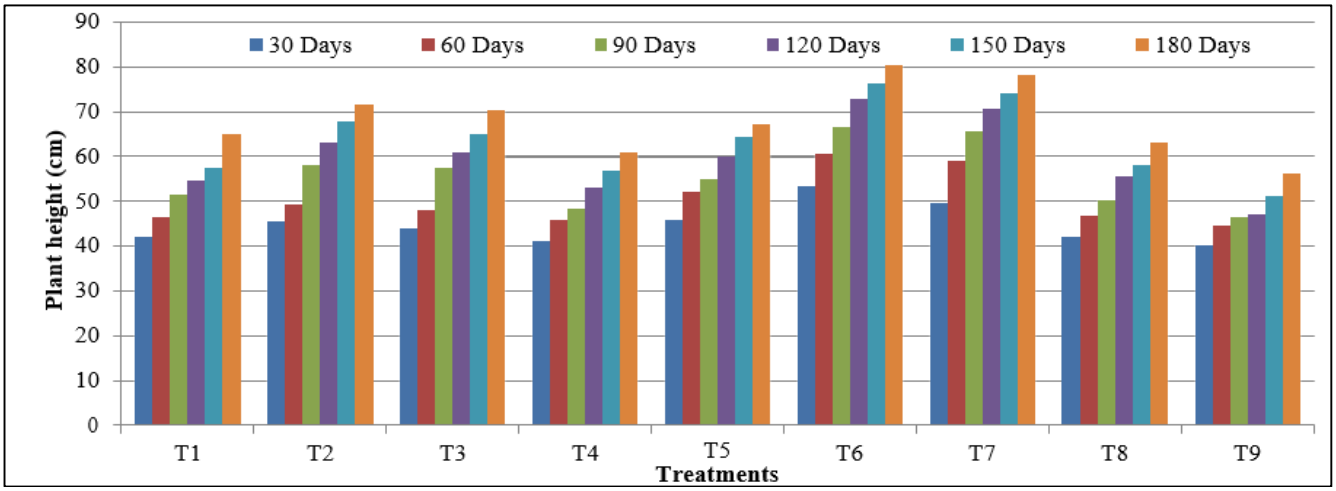

Fig 1: Effect of different levels of fertigation and foliar spray of micronutrients on plant heights

Table 3: Effect of different levels of fertigation and foliar spray of micronutrients on plant spread (North to south)

Treatment	Plant spread (cm) Days after planting					
	30 days	60 days	90 days	120 days	150 days	180 days
T1	22.33	24.17	26.56	29.67	33.27	37.93
T2	24.00	25.33	28.00	33.45	36.30	42.17
T3	21.33	24.27	26.70	30.73	34.27	39.33
T4	20.33	21.77	23.97	25.63	28.10	32.33
T5	23.67	25.77	28.63	32.07	36.63	40.50
T6	27.34	29.69	31.08	36.47	42.07	47.00
T7	24.98	26.65	28.97	34.67	39.33	44.30
T8	21.67	25.80	26.47	29.47	31.70	36.33
T9	19.00	21.60	23.00	25.11	27.17	31.67
F value	*	*	*	*	*	*
S.Em ±	1.23	1.02	0.71	0.77	1.66	1.33
CD at 5%	3.70	3.07	2.14	2.32	4.98	3.99

*Significant at 5% level

Table 4: Effect of different levels of fertigation and foliar spray of micronutrients on plant spread (East-West)

Treatment	Plant spread (cm) Days after planting					
	30 days	60 days	90 days	120 days	150 days	180 days
T1	24.20	26.97	28.03	34.20	37.90	41.47

T2	25.73	28.67	32.27	36.07	41.20	46.13
T3	24.93	27.87	33.37	34.93	40.00	44.57
T4	22.37	25.03	28.72	30.03	35.70	37.50
T5	25.93	28.67	33.80	36.30	40.50	47.50
T6	30.27	32.17	37.74	39.77	46.13	55.30
T7	28.63	30.17	36.10	38.17	44.97	53.40
T8	26.33	27.17	30.90	33.50	39.47	41.40
T9	20.83	24.36	27.07	27.80	33.17	34.47
F value	*	*	*	*	*	*
S.Em ±	0.62	1.09	0.46	0.53	0.64	0.66
CD at 5%	1.84	3.27	1.36	1.66	1.93	1.99

*Significant at 5% level

Table 5: Effect of different levels of fertigation and foliar spray of micronutrients on number of branches in *Jasminum sambac* cv. Mysuru Mallige

Treatment	Number of branches (No's)					
	Days after planting					
	30 days	60 days	90 days	120 days	150 days	180 days
T1	2.17	2.63	3.00	3.87	4.43	6.07
T2	3.67	4.23	4.67	5.33	5.73	7.33
T3	3.40	4.03	4.57	4.73	5.53	7.17
T4	2.33	2.63	2.90	3.40	3.97	5.37
T5	2.47	2.97	3.50	4.20	4.70	6.27
T6	4.90	5.53	6.27	6.77	7.67	9.13
T7	4.27	4.97	5.67	6.23	7.10	8.43
T8	1.87	2.27	2.57	3.70	4.40	5.97
T9	1.50	1.93	2.37	2.73	3.13	5.10
F value	*	*	*	*	*	*
S.Em ±	0.21	0.21	0.22	0.15	0.20	0.20
CD at 5%	0.64	0.63	0.65	0.44	0.59	0.60

*Significant at 5% level

Flowering character

The aim of any applied research is to get maximum income in terms of increased yield. The yield attributing characters like days for first flower bud emergence, days taken for first flowering, days taken for 50 per cent flowering and duration of flowering were significantly influenced by different levels of fertigation and micronutrients application. Data on vegetative parameters were presented in Table 6.

Table 6: Effect of different levels of fertigation and foliar spray of micronutrients flowering parameters in *Jasminum sambac* cv. Mysuru Mallige

Treatment	Flowering parameters (days)			
	Days taken for bud initiation	Days taken for first flowering	Days taken for 50% flowering	Duration of flowering
T1	226.67	237.67	279.00	79.34
T2	219.33	227.67	267.00	92.34
T3	225.67	234.33	273.00	83.67
T4	231.67	242.67	281.00	74.34
T5	223.00	233.67	266.67	81.64
T6	203.33	212.33	253.33	112.67
T7	214.00	223.33	265.00	96.67
T8	229.33	241.33	286.00	76.67
T9	235.67	244.00	289.00	72.83
F value	*	*	*	*
S.Em ±	1.75	1.74	2.71	2.48
CD at 5%	5.24	5.21	8.14	7.43

*Significant at 5% level

Fertigation treatment T6 involving 100 per cent recommended dose of fertilizers along with foliar spray of micronutrients viz., chelated zinc, borax and humic acid resulted in early bud initiation (203.33 days), less number of days (212.33 days) for flower initiation, 50 per cent flowering (253.33 days) and maximum duration of flowering (112.69 days). While, the late flowering was noticed in T9 (235.67 days for bud initiation, 244 days for first flowering, 289 days for 50 per cent flowering and 72.83days duration of flowering) which was farmers practice (200g DAP, 200g MOP, 50g Urea /plant/year).

Application of optimum dose of N, P and K through fertigation improved flowering characters. These are constituent of proteins, amino acids, nucleic acid, various enzymes and coenzymes which are associated with the increased stem and leaf area resulted in more photosynthesis and thus increased the transformation of manufactured food material from source (leaf) to sink (flower bud). And also applied micronutrients might be involved in the synthesis of plant hormones during bud initiation stage; boron helps in differentiation of meristematic tissue to bud, synthesis of amino acids, protein metabolism, translocation of sugars,

starches, phosphorus *etc.* might have utilized for better development of bud size and early flower bud opening. These findings confirm the reports of Patel *et al.* (2016) [4] in rose and Varsha *et al.* (2015) [9] in *Jasminum multiflorum*.

Flower yield characters

Significant differences were observed with respect to flower yield per plant between the treatments. The maximum flower yield of 725.80g/plant was recorded in treatment (T6) at 100 per cent recommended dose of fertilizers through fertigation along with foliar spray of humic acid, chelated zinc and borax. While the lowest flower yields (458.33 g) were recorded in control (T9) which refers to farmer's practice.

As the month advanced from february to may, the flower yield per plant increased in all the treatments. In general, the yield was more in march and april. Maximum flower yield was recorded in T6 (139.61g, 206.20g, 209.67g and 170.33 g in february, march, april and may, respectively) (100 per cent water soluble fertilizers through fertigation along with foliar spray of humic acid, chelated zinc and borax) followed by T5 (204.33 g) during March, T7 (165.33g) during May, while lowest yield was recorded in T9 during the flowering months.

Table 7: Effect of different levels of fertigation and foliar spray of micronutrients on month wise flower yield in *Jasminum sambac* cv. Mysuru Mallige

Treatment	Month wise flower yield (g/plant)			
	Feb	March	April	May
T1	0.00	180.33	183.33	155.00
T2	59.40	196.67	202.67	157.00
T3	13.76	187.67	201.33	153.33
T4	0.00	171.00	180.67	154.67
T5	7.50	204.33	196.67	158.00
T6	139.61	206.20	209.67	170.33
T7	81.51	193.67	200.00	165.33
T8	0.00	173.33	184.33	150.33
T9	0.00	169.00	175.00	114.33
F value	*	*	*	*
S.Em ±	3.18	2.67	1.73	2.29
CD at 5%	9.53	8.01	5.19	6.88

*Significant at 5% level

The continuous supply of macro and micro nutrients in an available form to the plant and accumulation of these macro and micro nutrients in both soil and plants have increased vegetative characters, like plant height, number of shoots, plant spread, increased number of photosynthates and flowering parameters like early flower bud initiation, first flowering, 50 per cent flowering, maximum duration of flowering. This is in concordance with the findings of Vijayselvaraj (2007) [10] in *J. grandiflorum*.

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