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Effect of foliar nutrient sprays on flowering and bulb production of *Tulipa gesneriana* L

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Abstract

An experiment was undertaken at the Indra Gandhi Memorial Tulip Garden, Directorate of Floriculture, Government of Jammu and Kashmir during the year 2016-17 and 2017-18, with two cultivars (Blushing lady & Ile-de-france) and seven nutrient sprays i.e. N₁ (Distilled water), N₂ (NPK:19-19-19 @ 2g L⁻¹), N₃ (NPK:19-19-19 @ 4g L⁻¹), N₄ (NPK:19-19-19 @ 6g L⁻¹), N₅ (NPK: 19-19-19 @ 2g L⁻¹+Calimax gold @ 1.0 ml L⁻¹), N₆ (NPK : 19-19-19 @ 4g L⁻¹+Calimax gold @ 1.0 ml L⁻¹), N₇ (NPK: 19-19-19 @ 6g L⁻¹+Calimax gold @ 1.0 ml L⁻¹). All the treatments were replicated thrice under split plot design. Cultivar had a significant effect on all flowering parameters. Early flower bud appearance (37.19 day), flower bud length (6.84 cm), flower bud circumference (6.71 cm), colour break (8.39 day), flower opening (4.81 day), flower diameter (9.41 cm), scape length (40.43 cm), scape thickness (32.30 mm), flowering duration (17.38 day), were recorded with cv. Blushing lady while leaf chlorophyll content (47.35 SPAD), bulblet number/plant (2.61), weight of bulblets/plant (9.28 g) and propagation coefficient (241.64%) were maximum in cv. Ile-de-france. Nutrient sprays had a positive influence on growth parameters. Combined application of macronutrients (NPK: 19-19-19) and micronutrients (Calimax gold) was more effective than macronutrients alone. Maximum flower bud length (6.92 cm), flower bud circumference (7.14 cm), flower diameter (9.14 cm), scape length (41.36 cm), scape thickness (33.47 mm), flowering duration (17.29 day), bulb number/plant (1.33), weight of main bulb (25.00 g) and size of main bulb (12.62 cm), bulblet number/plant (2.83), weight of bulblets/plant (10.36 g) and propagation coefficient (242.24%) were recorded with the application of N₇ (NPK:19-19-19 @ 6g L⁻¹+Calimax gold @ 1.0 ml L⁻¹) and minimum values for all these parameter were recorded in treatment N₁ (Distilled water).. However, days to flower bud appearance (34.12), colour break (8.01 day) and flower opening (4.46 day) were maximum with N₅ (NPK:19-19-19 @ 2g L⁻¹+Calimax gold @ 1.0 ml L⁻¹).

Keywords: foliar nutrient sprays, flowering, bulb production, *Tulipa gesneriana* L

Introduction

Garden tulips (*Tulipa gesneriana* L.) are geophytes that produce bulbs with an annual renewal and are composed of two to six concentric fleshy scales attached to a basal plate and enclosed in a tunic [1, 2]. Roots are produced on the surface of the basal plate. The tunic is a very thin, papery external scale. Buds located at the inner bases of the fleshy scales give rise to the organs of the mother plant. The apical bud gives rise to the aerial organs (leaves, scape, and flower) and the lateral buds give rise to daughter-bulbs. The innermost daughter-bulb (A-bulb) is the oldest and largest [3]. From the A-bulb outward, daughter-bulbs become progressively smaller and are designated alphabetically (A, B, C, etc.), with the exception of the outermost bulb which is designated as the H-bulb (H for Dutch huid meaning "skin" or "tunic"). Late in development, the H-bulb grows larger than some of the daughter-bulbs when food reserves from the outermost scale are transferred to this outermost bulb as the scale dries to become the tunic. A schematic of the replacement cycle is presented by [4]

In flowering tulip bulbs, three to five leaves are produced on a scape bearing a terminal flower [1]. Although some cultivars and species can produce more than one flower per scape, most produce only one flower per scape. The annual replacement cycle of the tulip bulb can be divided into three phases. (1) Root growth occurs rapidly following planting in the autumn. The apical bud, which has already differentiated into aerial organs, slowly elongates throughout the winter. (2) In the spring, as temperatures rise, plant growth accelerates. The scape and flower bud rapidly elongate culminating in flowering. The transformation of the vegetative buds (daughter-bulbs) into the next generation of mother-bulbs is initiated and increases after flowering. At the same time, the original mother-bulb scales desiccate. (3) Near the end of spring, the aerial organs and roots senesce and daughter-bulb growth ceases.

However, in the summer, bud differentiation (vegetative and floral) occurs within former daughter-, now mother-bulbs. Bulbs must reach a critical size (weight) before a flower bud can be initiated. Although the critical size varies by genotype, the minimum size is usually six to eight grams. This range corresponds to approximately six to nine centimeters in circumference [3, 5, 6]. If tulip bulb growers and gardeners are concerned with annual growth cycles, it has to be noticed that the botanical life cycle of a tulip bulb can span 29 to 41 months [7, 8]. The duration of that period is affected by internal factors (bud position inside the bulb) and environmental factors, with fertilization being an important one.

Balanced fertilization is very essential for obtaining optimum plant growth and higher yield of good quality flowers. For commercial flower and bulb production, foliar application of nutrients has been found very effective and gained importance nowadays. Plant response to foliar applied nutrients is a function of the amount of nutrients absorbed by the leaf tissues, the mobility of the nutrients within the plant and the phytotoxicity of the nutrients solution to the foliage. The largest potential benefit derived from foliar nutrient applications are achieved when applied at the critical growth stages, especially when the nutrient requirement by the shoot is high [5, 6]. Thus an ideal nutritional situation may be achieved through the promotion of plant growth by application of basal soil treatments in combination with foliar-applied nutrients. NPK are three-component fertilizers providing nitrogen, phosphorus and potassium in different grades (00-52-34, 13-00-45, 12-61-00, 00 00- 50,19-19-19 etc.). NPK 19:19:19 is a complete water soluble, ideal fertilizer which provides major macronutrients N-P-K in a balanced ratio to the plants through foliar spray or fertigation at the time of maximum requirement with the lowest losses. NPK: 19:19:19 is water soluble grade complete fertilizer containing 4% NO₃-N, 4.50% NH₄-N and 10.50% NH₂-N including 19% each of water soluble N, P and K. CalMax Gold contains high levels of calcium with magnesium and full complement of trace elements along with nitrogen for their easy uptake. Calcium is found in cell walls where it contributes to cell integrity and overall strength to the plants. The foliar spray of these water soluble grade fertilizers at different stages of plant development may significantly enhance growth of the plants, provided optimum concentrations of nutrients are supplied through foliar spray synchronizing with crop requirement.

Change in climate in terms of temperature, total precipitation and its pattern brought dramatic changes in the requirements of plants for their proper growth and development. Soil moisture becoming the most limiting factor due to the erratic behavior of the rainfall as most of time untimely rains had been observed along with rising temperatures which drastically affected the plant growth and development. Under such circumstances providing of proper environment is prerequisite for reclaiming the quality as well as quantity of any particular crop.

Materials And Methods

The present investigations entitled "Effect of foliar nutrient sprays on flowering and bulb production of Tulips" was conducted during 2016-17 and 2017-18 at the Indra Gandhi Memorial Tulip Garden, Srinagar. Srinagar, the summer capital of Jammu and Kashmir is situated between 34°05' to 34°07' North latitude and 74°08' to 74°09' East longitude at an altitude of about 1587 m above mean sea level. It is flanked

on the Southeast and Northeast by the lofty Himalayan ranges. The Indra Gandhi Memorial Tulip Garden, Directorate of Floriculture, Government of Jammu and Kashmir which is Asia's largest and World's second largest Tulip Garden, spread over an area of 30 hectares situated on the foothills of Zabarwan range with an overview of Dal Lake. The climate, in general, is temperate cum Mediterranean and of continental type. Winter is severe extending from middle of December to early March, when the temperature sometimes goes below freezing point and whole of the valley remains snowbound. The average annual precipitation is 660mm (average over last 30 years) and more than 80% of precipitation is received from western disturbances. Area of study carried out between November 2016 to June 2017 and November 2017 to June 2018, using bulbs of the two varieties of Tulip (Blushing Lady and Ile-de - France) as test plants were, to improve flower quality. Treatments were replicated thrice using split plot design (SPD).

Bulbs were planted on 15th November, 2016 and 18th November, 2017 at the experimental site of Indra Gandhi Memorial Tulip Garden, Directorate of Floriculture. Vigorous and healthy tulip bulbs were planted at a depth of 15 cm at the rate of 25 bulbs plot⁻¹ in case of flowering size planting stock. Spraying of NPK (19-19-19), CalMax gold and MS media to the experimental field was started after 15 days of complete sprouting. Spraying was done with hand compressed sprayer to spray a fine mist. Observations were recorded from five representative plants per plot per replication during both the years. The mean values for different characters were subjected to statistical analysis.

Results and Discussion

All floral parameters were significantly influenced by cultivar and different foliar nutrient sprays. Foliar application of water soluble fertilizer NPK (19-19-19) revealed significant differences among the different treatments in all the floral parameters studied. Minimum number of days to flower bud appearance (32.66), days to colour break (7.49) and days to flower opening (3.91) were observed under the treatment N₄ (NPK: 19-19-19 @ 6 g l⁻¹) as compared to the control and other treatments. The probable reason of earliness in these floral characteristics might be due to balanced ratio of macronutrients through NPK 19-19-19, as phosphorus and potassium play an important role in commencement of flowering in the plants. Potassium also is highly beneficial in overcoming the adverse effects of nitrogen and one among them is delaying of flowering. These results are in close conformity with the results of [9] who found that in tulip number of days taken to flowering were increased with the increase in nitrogen and decreased with phosphorus, potassium and zinc. Similar results were also reported by [10] in carnation, as they recorded lesser number of days to flower bud formation, first flowering and harvesting stage with the application of nutrient treatment (250 ppm N and K fertigation through Urea and MOP + 250 ppm NPK foliar spray through Sujala once a week). However, the number of days taken to flower bud appearance, days to colour break and days to flower opening were increased with the foliar application of CalMax Gold in combination with NPK 19-19-19. The reason for delaying of these parameters may be attributed to additional supply of nitrogen through CalMax Gold as higher doses of nitrogen may have caused excessive vegetative growth, hence resulted in postponement of such

floral attributes. Our findings are in agreement with the results of [9] who reported that with the excessive use of nitrogen in tulip days to flowering were maximum against the control. These findings are also on accordance with the observation of earlier workers [11, 12]. Balanced use of macro and micronutrients improves the overall development of plant, prolonging the vegetative phase with increased leaf size and scape characteristics, which lead to delay in flowering.

Cultivar also had a significant effect on above discussed floral parameters. Cultivar Ile-de-france recorded minimum duration to flower bud appearance (29.60 days), colour break (7.18 days) and flower opening (3.57 days), whereas maximum duration for these parameters was recorded in cv. Blushing lady. The difference may be purely due to their genetic makeup as the cv. Blushing lady belongs the late variety group and cv. Ile-de-france falls into the mid variety group of tulips.

In the foregoing study other floral parameters viz., flower bud length, flower bud circumference, flower diameter, scape length, scape thickness, and flower duration were significantly improved with the foliar nutrient sprays. All these characters were enhanced with the increase in the concentration of NPK: 19-19-19 from 2 g to 6 g. Treatment N₄ (NPK: 19-19-19 @ 6 g⁻¹) put forth the maximum flower bud length (6.66 cm), flower bud circumference (6.67 cm), flower diameter (8.83 cm), scape length (39.99 cm), scape thickness (32.24 mm), and flower duration (15.66 day). The improvement in all these floral parameters may be due to the stimulatory effect of foliar application of NPK: 19-19-19, that might have resulted in better application of assimilates which in turn had resulted in better outcome in terms of floral parameters. Also, with the increase in the concentration of nutrients from 2-6 g⁻¹ resulted in significant increase in these floral characteristics. This is in conformity to overall trend of improved vegetative attributes with the increased concentration of nutrient sprays. These results are in harmony with [13] who reported that stalk length and tepal diameter was increased with humic acid application and foliar sprays of NPK: 17-17-17. Our findings are also in line with the findings of [9] who recorded the significant effects on both scape length and flower diameter due to the increased doses of nitrogen, phosphorus and potassium. Spike length and flower size have also been found to be positively correlated with nitrogen dose in tuberose [14]. Due to the combined application of NPK: 19-19-19 and CalMax Gold the results further improved. Treatment N₇ (NPK: 19-19-19 @ 6 g L⁻¹ + CalMax Gold @ 1 ml L⁻¹) put forth the maximum flower bud length(6.92 cm), flower bud circumference (7.14 cm), flower diameter (9.14 cm), scape length (41.36 cm), scape thickness (33.47 mm), and flower duration (17.29 day). The reason for the additional improvement in these flowering traits may be attributed to the extra dose of nitrogen and balanced quantity of micronutrients through foliar spray of CalMax Gold. Calcium and other micronutrients applied through the sprays of CalMax Gold might have facilitated the plants in attaining the better floral parameters in comparison to NPK application alone. In rose application of Ca promotes plant growth and can maintain the integrity of the membranes in the petals, reduces ethylene production, facilitates the transport of solutes and increases firmness in stems [15]. Zinc is an essential constituent of cell component and constituents of the various cell membranes that are also important for the maintenance of cell structure and induce cell division resulting in enhanced the vegetative growth. It was further recorded that Zn sprays were most

effective in increasing the flower stalk, size of flower and weight of individual flowers in chrysanthemum [16]. Significant increase in the spike length of tuberose was also observed due to the Zn application [17-19] reported that number of florets, floret diameter and flower duration in tuberose was increased with the boron application. Significant values for floral parameters in liliun, viz. flowering date, flowering duration, petiole length, and flower fresh and dry weights were observed with highest concentration of amino acids @ 2 ml l⁻¹, [20].

Significant differences in the aforementioned floral parameters were also noticed between the cultivars investigated. Cultivar Blushing lady out shined in all the floral parameters, recording maximum flower bud length (6.84 cm), flower bud circumference (6.71 cm), flower diameter (9.41 cm), scape length (40.43 cm), scape thickness (32.30 mm) and flower duration (17.38 day). Values for all these parameters were observed minimum in cv. Ile-de-france. The differences may be to attributed to the genetic makeup of cultivars as same is evident from their growth parameters as well.

Significant interaction effect of cultivars and nutrient sprays was recorded on flower bud circumference. In case of tulips flower bud formation is terminal and due to foliar application of nutrients, flower bud might have responded because of more availability of nutrients particularly Ca and B which otherwise are less mobile.

Cultivar and nutrient sprays had a significant influence on all the bulb attributes, viz. number of bulbs per plant, number of bulblets per plant, weight of main bulb, weight of bulblets per plant, size of main bulb and propagation coefficient.

Cultivar Blushing lady reflected maximum values for bulb attributes, viz. number of bulbs per plant (1.25), weight of main bulb (25.62 g) and size of main bulb (12.39 cm), whereas cv. Ile-de-france recorded highest data for number of bulblets per plant (2.61), weight of bulblets per plant (9.28 g) and propagation coefficient (241.64%). The different results obtained may be attributed to their different genetic architecture.

Nutrient sprays played a significant role in enhancing all the bulb characters in both the cultivars studied. Treatment N₄ (NPK: 19-19-19@6 g l⁻¹) put forth the maximum mean values for number of bulbs per plant(1.25), number of bulblets per plant (2.54), weight of main bulb(22.08 g), weight of bulblets per plant(8.97 g), size of main bulb (12.06 cm) and propagation coefficient (228.25%) in comparison to the control. A noticeable increase in the bulb parameters may be attributed to better availability of nutrients particularly phosphorus which is required for the growth of bulbs because most of the photosynthates tend to mobilize first towards the major sink i.e., flower. Hence, supplying nutrients directly to the sink area might have resulted in greater assimilation of photosynthates into the bulbs, thus increasing its production. The results obtained are in close conformity with [21] who reported that the number of bulbs and bulblets per plant, weight of main bulb and bulblets per plant and size of main bulb were enhanced in tulip with the increase in the frequency of nutrient sprays with NPK: 19-19-19. Similar results were also reported by [22], who revealed that 100% application of recommended dose of nitrogen, phosphorus and potassium via fertigation through micro sprinklers had a positive effect on plant growth and improved marketable bulb yield in onion. [23] reported that the number of bulbs per plant was significantly improved by all the nutrients (N, P, K and Zn) in tulip during

the first year but in the second year, nitrogen and phosphorus showed significant effects whereas, potassium and zinc could not perform significantly. Further improvement in all bulb parameters was noticed with the combined application of macronutrients (NPK: 19-19-19) and micronutrients (CalMax Gold). The maximum improvement was observed with the treatment N₇ (NPK: 19-19-19 @ 6 g L⁻¹ + CalMax Gold @ 1 ml L⁻¹) in all the bulb parameters, viz., number of bulbs per plant (1.33), number of bulblets per plant (2.83), weight of main bulb (25.00 g), weight of bulblets per plant (10.36 g), size of main bulb (12.62 cm) and propagation coefficient (242.24%). Improvement in bulb parameters may be credited to increased vegetative growth parameters particularly leaf area and also delaying of plant senescence, which might have resulted in enhanced assimilation of photosynthates and their translocation from source to sink. The improvement in bulb characteristics may also be attributed to balanced supply of all essential nutrients to plants in the form of nutrient sprays, which might have accelerated various physiological and metabolic growth processes resulting in improved plant and bulb growth. The results are in line with that of [23] who recorded maximum number of bulbs and maximum weight of bulblets per plant with the increase in the concentration of N, P, K and Zn. [24] also reported similar findings in dahlia cv. Swami Lokeshwarananda. Application of calcium nitrate @1.5% at 10 days interval proved significantly superior in improving rhizome parameters in *Alstroemeria*, viz. number

of rhizomes, fresh and dry weight of rhizomes, rhizome diameter, number of new storage roots and propagation coefficient, [25] In liliu foliar application of ZnSO₄ at 0.4% showed significant increase in number of bulblets plant⁻¹ (5.00), number of scales bulb⁻¹ (11.00), weight of bulblets plant⁻¹ (0.42 g) and diameter of bulb (3.05 cm). Application of FeSO₄ at 0.4% significantly improved the weight of bulbs in liliu, [26, 20] reported highest bulb circumference and also fresh and dry weight of bulbs in plants treated with amino acids against the control.

It may be concluded that Cultivar Blushing lady was found superior in flowering parameters (flower bud length, flower bud circumference, flower diameter, scape length, scape thickness and flower duration) and bulb parameters (number of bulbs/plant, weight of main bulb and size of main bulb) whereas, cv. Ile-de-france performed better in few of the bulb parameters viz. number of bulblets, weight of bulblets per plant and propagation coefficient. Improved relative growth rate (RGR) of both shoot and bulb was observed in the cv. Blushing lady as compared to cv. Ile-de-france. It was also observed that cv. Blushing lady is a late blooming variety and cv. Ile-de-france an early blooming variety. Combined application of macronutrient (NPK: 19-19-19@ 6 g l⁻¹) and micronutrients nutrient (CalMax Gold@ 1 ml⁻¹) improved all growth, flowering and bulb parameters in both the cultivars studied during the course of investigation as compared to nutrient sprays of macronutrients alone.

Table 1: Effect of foliar nutrient sprays on flowering in *Tulipa gesnariana* L.

Treatment combinations	Days to flower bud appearance	Flower bud length (cm)	Flower bud circumference (cm)	Days to colour break	Days to opening of flower	Flower diameter (cm)	Scape length (cm)	Scape thickness (mm)	Flower duration (days)	
Distilled water(N ₁)	33.98	5.73	5.89	8.03	4.42	7.96	33.52	29.41	13.79	
NPK (19-19-19) @2gl ⁻¹ (N ₂)	33.72	6.00	6.08	7.83	4.31	8.17	35.13	29.66	14.06	
NPK (19-19-19) @4gl ⁻¹ (N ₃)	32.80	6.56	6.51	7.55	3.97	8.72	38.91	31.04	15.41	
NPK (19-19-19) @6gl ⁻¹ (N ₄)	32.66	6.66	6.67	7.49	3.91	8.83	39.99	32.24	15.66	
NPK (19-19-19) @2gl ¹ +Calimax gold@1ml ⁻¹ (N ₅)	34.12	6.29	6.42	8.01	4.46	8.47	37.63	30.75	15.27	
NPK (19-19-19) @4gl ⁻¹ +Calimax gold@1ml ⁻¹ (N ₆)	33.25	6.84	7.06	7.81	4.16	9.03	40.88	32.90	16.82	
NPK (19-19-19) @6gl ⁻¹ +Calimax gold@1ml ⁻¹ (N ₇)	33.22	6.92	7.14	7.80	4.11	9.14	41.36	33.47	17.29	
C.D(p<0.05)	0.356	0.221	0.128	0.236	0.101	0.366	0.721	0.419	0.457	
Variety mean	V ₁	37.19	6.84	6.71	8.39	4.81	9.41	40.43	32.30	17.38
	V ₂	29.6	6.02	6.36	7.18	3.57	7.82	35.97	30.40	13.57
C.D(p<0.05)	0.545	0.580	0.091	0.244	0.140	0.189	0.201	0.291	0.347	

Table 2: Effect of foliar nutrient sprays on bulb attributes in *Tulipa gesnariana* L.

Treatment combinations	Number of bulbs plant ⁻¹	Number of bulblets plant ⁻¹	Weight of main bulb (g)	Weight of bulblets plant ⁻¹ (g)	Size of main bulb (cm)	Propagation coefficient (%)
Distilled water(N ₁)	1.10	1.75	16.30	6.41	10.81	190.17
NPK (19-19-19) @2gl ⁻¹ (N ₂)	1.12	1.95	18.06	7.19	11.23	202.86
NPK (19-19-19) @4gl ⁻¹ (N ₃)	1.24	2.45	21.49	8.61	11.92	223.18
NPK (19-19-19) @6gl ⁻¹ (N ₄)	1.25	2.54	22.08	8.97	12.06	228.25
NPK (19-19-19) @2gl ¹ +Calimax gold@1ml ⁻¹ (N ₅)	1.21	2.27	20.78	8.40	11.69	216.57
NPK (19-19-19) @4gl ⁻¹ +Calimax gold@1ml ⁻¹ (N ₆)	1.31	2.78	24.45	9.95	12.48	238.14
NPK (19-19-19) @6gl ⁻¹ +Calimax	1.33	2.83	25.00	10.36	12.62	242.24

gold@1ml ⁻¹ (N ₇)							
C.D(p≤0.05)		0.023	0.076	0.350	0.273	0.081	7.715
Variety mean	V ₁	1.25	2.11	25.62	7.82	12.39	198.76
	V ₂	1.20	2.61	16.70	9.28	11.26	241.64
C.D(p≤0.05)		0.021	0.050	0.327	0.094	0.043	5.287

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