Effect of nutrient sprays and planting depths on growth and bulb production of Tulips

ABSTRACT

Studies were conducted to observe the effect of different frequencies of nutrient sprays in tulips at different planting depths under agro-ecological conditions of Kashmir Cheshmashahi Srinagar during 2016-17. Bulbs were planted at the depth of 10, 15 and 20cm and a water soluble fertilizer NPK (19-19-19) was sprayed with three frequencies 3, 5 and 7 sprays in two cultivars of tulip Apeldoom and Golden Oxford. The results reveal that minimum number of days for bulb sprouting was observed in the plants planted at a depth of 10cm irrespective of the variety. Plant height, number of leaves, leaf area and leaf area index was found maximum in the plants treated with 7 nutrient sprays which was at par with plants sprayed with 5 nutrient sprays in both the tulip cultivars. There was no significant effect of planting depth on vegetative parameters except plant height which was observed maximum at shallow depth of 10cm. In case of floral parameters days taken to flower bud appearance, color break and flower opening were minimum in plants planted at a depth of 10cm with 3 nutrient sprays. However flower bud length, flower diameter, scape length, scape thickness and flower duration were maximum in the plants treated with 7 nutrient sprays which were at par with the plants sprayed with 5 nutrient sprays and the effect of planting depth was found non-significant in these parameters. Similarly in the bulb parameters number of bulbs per plant, weight and size of main bulb was observed highest in plants planted at a depth of 20cm and sprayed with 7 nutrient sprays in both the tulip cultivars, however number and weight of bulblets per plant was found maximum in the plants planted at a depth of 10cm with 7 nutrient sprays and results were found at par with the plants treated with 5 nutrient sprays.

INTRODUCTION

Tulip (*Tulipa gesneriana* L.) is a monocotyledonous plant belonging to the family *Liliaceae* and is believed to be the native of Mediterranean and China but natural origin of garden tulips seems to be lost, though many workers believe that it is derived from Gesneriana [1]. *Tulipa* is mainly Asiatic centered in the hilly country of Asia minor, the southern Turkistan and Bukhara petering out in northeast Asia [2]. Tulip represents the largest geophyte crop worldwide among all the

ornamental bulbous plants. The species are perennials and include short low growing plant to tall upright, growing from 10 to 70 cm tall. Plants typically have 2 to 6 leaves, with some species up to 12 leaves. The tulip bulb has an annual replacement cycle, in which a key aspect is the continuous change that occurs in the various organs over time. At any time period, there are organs that are being initiated, developing or senescing. The Netherlands leads in the production of ornamental bulbous plant material. The most popular ornamental bulbs are tulips and lily [3] and [4]. Production of tulip bulbs takes place at least in 15 countries (viz. Netherland, Japan, France, Poland, Germany and New Zealand etc) with the largest production area being in the Netherlands with 10,800ha (88% of global production).The Netherland produces more than 4 billion tulip bulbs annually, of which 2.3 billion (53%) are used for cut flower production in different countries [4].

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. 19:19:19 is water soluble grade complete fertilizer containing 4% NO_3-N, 4.50% NH_4-N and 10.50% NH_2-N including 19% each of water soluble P and K. 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.

Planting depth plays an important role in determining the overall growth of a plant particularly in case of bulbous crops. The influence of planting depth on growth and flowering of some bulbous ornamental plants has been reported [7],[8]. Research work on planting depth was reported by [7] who defined two types of depth, linear (mm) and the physiological depth reflecting the array of physical conditions to which the plant is exposed. The highest yield of commercial bulbs in ridge cultivation was obtained when bulbs were planted at the depth of 12–15 cm. In flat cultivation, greater amount and weight of commercial yield bulbs and first grade bulbs was obtained by planting tulips at the depth of 15–19 cm [8].

MATERIALS AND METHODS

The present investigation was carried out at the Indhra Gandhi Memorial Tulip Garden, Cheshmashahi, Srinagar, Kashmir which is Asia's largest and World's second largest Tulip Garden, spread on an area of 30 hectares and about 8 km away from main city centre situated on the foothills of Zabarwan Range with an overview of Dal Lake during 2016-17.

The organic carbon of the soil was found to be 0.98 per cent and pH 6.93. The climate of the area in general is temperate-cum Mediterranean and of continental type characterized by hot summers and severe winters. Hottest months are July and August during which temperature shoots up to 32°C. The experiment was conducted in factorial randomized block design, the total number of treatments combinations were eighteen with three factors which include cultivars, frequencies of nutrient sprays and planting depths. Two cultivars (Apeldoom and Golden Oxford) were used with three frequencies of nutrient sprays NPK, 19-19-19 (3, 5, 7 sprays) and three planting depths (10, 15, 20cm) which were replicated thrice. Uniform bulb size in both the cultivars was reserved and were planted at three planting depths of 10, 15 and 20 cm with 25 bulbs per plot of $1m^2$ in the second week of November. Foliar application of NPK(19-19-19) was applied at the rate of 0. 4gm with three frequencies of 3, 5 and 7 sprays at an interval of 30, 15,10 days respectively started from 15^{th} of March up to 15^{th} of May. The harvesting of the bulbs was done in first week of June. The observations were recorded on number of days taken for sprouting, plant height, number of leaves, leaf area and leaf area index for vegetative parameters and in case of floral parameters observations were recorded on number of days taken for flower bud formation, flower bud length, days to color break, flower diameter, days to flower opening, scape length, scape thickness and flower duration.

For bulb parameters number of bulbs per plant, number of bulblets per plant, weight of main bulb, weight of bulblets per plant and size of main bulb were recorded. The statistical analysis was done at 5% level of significance.

RESULTS AND DISCUSSION

The present work was commenced to study the effect of different frequency of nutrient sprays of NPK (19-19-19) and planting depths in two cultivars of Tulip Apeldoom and Golden Oxford with the ultimate objective to improve the flower quality and bulb production in Tulip by optimizing number of nutrient sprays of NPK (19-19-19) and required planting depth. Result presented in Table 1, 2 and 3 revealed that the growth, floral and bulb parameters of Tulip in both the cultivars were significantly improved due to the application of NPK (19-19-19) at different planting depths.

Effect of NPK (19-19-19) and planting depth on vegetative parameters

The analysis of data (Table 1) revealed that influence of different frequency of NPK(19-19-19) and planting depths had significant effect on number of days taken to sprouting, plant height, leaf area and leaf area index. Minimum number of days taken to sprouting were recorded in the plants at a planting depth of 10 cm in Apeldoom and Golden Oxford respectively. As for the effect of frequencies of nutrient sprays, the results reveal that spraying the plants at an interval of 10 days with 7 sprays gave the highest significant records for Plant height, leaf area and leaf area index in both the cultivars of tulip. It can be noticed that there were no significant differences in plant height, number of leaves, leaf area and leaf area index due to treatment of 5 or 7 nutrient sprays. However maximum plant height was recorded in the plants planted at a depth of 10 cm followed by 15cm depth in both the tulip varieties. No significant differences were observed in number of leaves due to either of the treatments, but maximum number of leaves was observed in cultivar Apeldoom. Results further reveal that there were no significant differences observed in leaf area and leaf area index due to differences in planting depths.

Our results are in close agreement with those obtained by [9] Chaurasia *et al*. (2005) who reported that 5 foliar application with NPK 19-09-19 followed by NPK 19-19-19 recorded maximum growth parameters in tomatoes. This increase in the plant height, number of leaves, leaf area and leaf area index with 7 foliar applications might be a reason of supplying more nutrients at the critical stages of growth. The increase might be also due to the increased application of nitrogenous fertilizers which may result in enhanced

photosynthetic activity, hence maximizes the growth parameters. Similar findings were also reported by [10] Naik *et al.* (2002) in carrot, also by [11] Jeybal *et al.* (1998) and [12] Vibhute (1988). Plant height was also increased due to the decrease in planting depths and similar results were observed by [13] Mane *et al.*(2006) in tuberose Early sprouting may be reason that plants have to travel less distance to come out of soil as compared to the plants at deeper depths.

Effect of NPK (19-19-19) and planting depth on floral parameters

It is evident from the (Table 2) that all flowering parameters were significantly affected due to the application of nutrient sprays and planting depths. With respect to the frequencies of nutrient sprays, the results indicated that the plants treated with 7 number of sprays at an interval of 10 days recorded the highest values for parameters like flower bud length, flower diameter, scape length, scape thickness and flower duration, however these results were at par with the plants treated with 5 sprays at an interval of 15 days. Results further reveal that no significant differences were observed in above quoted parameters due to the varying planting depths. As for the tulip varieties, Apeldoom presented the maximum values for such parameters as compared to Golden Oxford. Minimum number of days were recorded to flower bud formation, days taken to color break and days taken to flower opening in the plants treated with 2 nutrient sprays and planted at a depth of 10 cm against the plants treated with 5 and 7 nutrient sprays at a planting depth of 15 and 20 cm. Between tulip varieties cultivar Golden Oxford recorded the minimum values for aforementioned floral parameters in comparison to Apeldoom.

This increase in the floral parameters may due the stimulatory effect of foliar application of NPK 19-19-19, resulted in better application of assimilates thereby resulting in better floral parameters and healthier results may also be the outcome of application of balanced ratio of macronutrients through NPK 19-19-19 at the time of maximum requirement to the plants. Similar findings were observed by [14] in carnation who observed that maximum A-grade flowers based on the stem length were recorded in the plants treated with 250 ppm N and K fertigation through urea and MOP + 250 ppm NPK 19-19-19 foliar spray through Sujala once a week as compared to recommended practices. These results are also in conformity with the findings of [15], [16], [17], [18], [19]. Also the maximum yield (631.66 q/ha) in tomatoes was recorded in the 5 foliar application of the NPK 19:09:19 as compared to 3 foliar applications [9]. The delay in flower bud formation and flower opening may be due to the vigorous growth due the more foliar

nutrient applications as compared to the plants that received the fewer nutrients and hence remained weak.

Effect of NPK (19-19-19) and planting depth on bulb parameters

Data presented in (Table 3) clearly revealed that the all the bulb parameters were significantly affected by the application of foliar nutrient sprays and planting depths. Maximum values for all the bulb parameters studied which include number of bulbs per plant, number of bulblets per plant, weight of main bulb, weight of bulblets per plant and size of main bulb were obtained in the plants treated with 7 nutrient sprays, however the results exhibited were at par in respect of the plants treated with 5 nutrient sprays. Regarding planting depth number of bulbs per plant, weight of main bulb and size of main bulb was recorded maximum in the plants at planting depth of 20 cm followed by the plants planted at 15 cm depth, however number and weight of bulblets per plant was found maximum in the plants planted at a depth of 10 cm and minimum in the plants at a planting depth of 20 cm. It was further observed that cultivar Apeldoom performed better in all bulb parameters in comparison to the Golden oxford. This may be probably be due to higher leaf area, resulting in greater photosynthetic surface, leading to higher carbohydrate synthesis and translocation from source to the sink. The results ascertained are in conformity with [20] who observed that 100% application of recommended dose of nitrogenous, phosphorus and potassium fertilizers via fertigation through micro sprinklers has a positive effect on plant growth and improves marketable bulb yield in onion. Higher bulb yields obtained with fertigation compared to soil application could result in saving in fertilizer (25 %) and higher nutrient productivity. This is in conformity with earlier findings of [21]. The obtained results are also in accordance with [22] who found that significantly greater number and mass of bulbs were produced by tulips cultivated at the depth of 19 cm when compared to those planted at the depth of 9 cm. It was further recorded that the most daughter bulbs of 11–12 cm circumference were formed when tulips were cultivated at 9 cm depth and the least at the depth of 12 cm. Moreover results reveal that with the increase of the planting depth from 9 to 19 cm the weight of bulbs of the biggest circumference increased.

Conclusion

The present work was commenced to study the effect of different frequency of nutrient sprays of NPK and planting depths in two cultivars of Tulip Apeldoom and Golden Oxford with the ultimate objective to improve the flower quality and bulb production in Tulip by optimizing number of nutrient sprays of NPK and required planting depth. Moreover results also reveal that with the increase of the planting depth from 9 to 19 cm the weight of bulbs of the biggest circumference increased.

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Table 1: **Effect of nutrient sprays and planting depth on vegetative parameters of Tulip.**

Treatment Code	Treatment combinations	Days to sprouting	Plant height (cm)	No. of leaves	Leaf area(cm^2)	Leaf area index
T_1	$V_1F_1D_1$	87.00	35.50	4.22	88.97	0.297
T_2	$V_1F_1D_2$	87.83	34.90	4.17	89.43	0.298
T_3	$V_1F_1D_3$	89.50	34.23	4.24	89.48	0.298
T_4	$V_1F_2D_1$	87.07	36.77	4.24	96.43	0.321
T_5	$V_1F_2D_2$	87.97	36.37	4.17	98.44	0.328
T_6	$V_1F_2D_3$	89.63	35.97	4.16	98.77	0.318
T_7	$V_1F_3D_1$	86.93	36.93	4.24	98.49	0.328
T_8	$V_1F_3D_2$	88.37	36.63	4.23	98.61	0.328
T_9	$V_1F_3D_3$	89.87	35.90	4.24	98.58	0.328
T_{10}	$V_2F_1D_1$	88.50	32.67	3.98	65.74	0.219
T_{11}	$V_2F_1D_2$	90.40	32.30	4.00	65.89	0.220
T_{12}	$V_2F_1D_3$	91.73	31.77	3.98	66.44	0.221
T_{13}	$V_2F_2D_1$	89.20	33.87	3.96	71.43	0.238

T_{14}	$V_2F_2D_2$	90.20	33.57	4.03	72.40	0.241
T_{15}	$V_2F_2D_3$	91.83	33.10	4.12	76.09	0.243
T_{16}	$V_2F_3D_1$	89.67	37.10	4.13	71.69	0.229
T_{17}	$V_2F_3D_2$	90.73	33.77	3.89	72.14	0.240
T_{18}	$V_2F_3D_3$	91.73	33.47	4.09	72.73	0.242
	Mean	89.34	34.71	4.12	82.88	0.274
	CD(0.05) Var.	0.287	0.692	0.121	1.388	0.005
	NPK 19-19-19	N/A	0.842	N/A	1.700	0.006
	Planting	0.352	0.842	N/A	N/A	N/A

Table 2: **Effect of nutrient sprays and planting depth on floral parameters of Tulip.**

Treatment Code	Treatment combination	Days to Flower bud appearance	Flower bud length (cm)	Days to colour break	Flower Diameter (cm)	Days to flower opening	Scape length (cm)	Scape thickness (mm)	Flower duration (days)
T_1	$V_1F_1D_1$	28.87	5.60	8.75	7.00	5.25	32.58	15.58	10.37
T_2	$V_1F_1D_2$	31.05	5.73	9.88	7.07	6.15	31.46	15.75	10.58
T_3	$V_1F_1D_3$	31.83	5.63	11.25	7.12	6.82	31.35	15.85	10.72
T_4	$V_1F_2D_1$	29.10	6.27	8.83	7.58	5.86	33.50	16.62	12.22
T_5	$V_1F_2D_2$	31.06	6.23	10.08	7.77	6.67	33.70	16.75	12.33
T_6	$V_1F_2D_3$	32.06	6.27	11.22	7.70	7.00	33.03	16.85	12.40
T_7	$V_1F_3D_1$	29.20	6.43	8.87	7.82	5.90	33.92	16.97	12.28
T_8	$V_1F_3D_2$	31.15	6.47	10.15	7.87	6.73	33.64	17.02	12.40
T_9	$V_1F_3D_3$	32.58	6.47	11.28	7.97	7.08	32.90	17.08	12.45
T_{10}	$V_2F_1D_1$	27.60	5.00	8.63	6.97	4.63	29.82	12.68	9.75
T_{11}	$V_2F_1D_2$	29.10	5.10	9.83	7.02	5.12	29.30	12.80	9.82
T_{12}	$V_2F_1D_3$	30.50	5.07	11.05	7.07	5.58	28.80	12.88	9.88
T_{13}	$V_2F_2D_1$	27.69	5.40	8.65	7.50	5.48	30.85	13.76	11.15
T_{14}	$V_2F_2D_2$	29.20	5.60	9.93	7.67	6.14	30.57	13.95	11.28
T_{15}	$V_2F_2D_3$	30.60	5.67	11.10	7.60	6.69	30.15	14.05	11.35
T_{16}	$V_2F_3D_1$	27.85	5.53	8.73	7.75	5.68	31.15	13.87	11.18

T_{17}	$V_2F_3D_2$	29.43	5.53	10.00	7.75	6.16	30.81	13.97	11.28
T_{18}	$V_2F_3D_3$	30.72	5.60	11.17	7.85	6.64	30.51	14.07	11.43
	Mean	29.98	5.76	9.97	7.50	6.09	31.56	15.03	11.27
	CD(0.05) Var.	0.192	0.106	0.132	0.068	0.118	0.198	0.086	0.096
	NPK 19-19-19	0.235	0.130	0206	0.0893	0.145	0.243	0.105	0.117
	Planting depth	0.235	NS	0.206	0.083	0.145	0.243	0.105	0.117

Table 3: **Effect of nutrient sprays and planting depth on bulb parameters of Tulip.**

Treatment Code	**Treatment combinations**	**No. of bulbs per plant**	**No. of bulblets per plant**	**Weight per bulb (g)**	**Weight of bulblets per plant (g)**	**Size of main bulb**
T_1	$V_1F_1D_1$	0.9	2.58	16.88	18.52	10.56
T_2	$V_1F_1D_2$	1.2	2.47	17.86	16.99	11.76
T_3	$V_1F_1D_3$	1.3	2.23	18.70	16.65	12.17
T_4	$V_1F_2D_1$	1.1	2.67	17.60	20.00	11.07
T_5	$V_1F_2D_2$	1.3	2.53	18.16	18.97	11.96
T_6	$V_1F_2D_3$	1.4	2.33	18.94	18.43	12.13
T_7	$V_1F_3D_1$	1.0	2.72	17.81	20.45	11.28
T_8	$V_1F_3D_2$	1.4	2.62	18.44	19.29	12.10
T_9	$V_1F_3D_3$	1.5	2.42	19.03	19.02	12.36
T_{10}	$V_2F_1D_1$	0.9	2.32	14.74	15.18	9.78
T_{11}	$V_2F_1D_2$	1.2	2.28	15.87	14.28	11.06
T_{12}	$V_2F_1D_3$	1.4	2.08	16.37	13.65	11.65
T_{13}	$V_2F_2D_1$	1.1	2.45	15.08	16.43	10.45
T_{14}	$V_2F_2D_2$	1.3	2.38	16.00	15.51	11.30
T_{15}	$V_2F_2D_3$	1.5	2.10	16.61	14.99	11.86
T_{16}	$V_2F_3D_1$	1.2	2.48	15.19	16.76	10.65
T_{17}	$V_2F_3D_2$	1.4	2.42	16.16	15.69	11.59

T_{18}	**$V_2F_3D_3$**	1.6	2.23	16.33	15.21	11.98
	Mean	1.3	2.41	16.99	17.00	11.43
	CD(0.05) Var.	NS	0.037	0.224	0.158	0.153
	NPK 19-19-19	0.103	0.046	0.274	0.0.194	0.187
	Planting depth	0.103	0.046	0.274	0.194	0.187