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Effect of nitrogen, phosphorus and potassium on growth, flower yield and quality of Stock (*Matthiola incana*)

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Abstract
The present experiment entitled "Effect of nitrogen, phosphorus and potassium on growth, flower yield and quality of Stock (*Matthiola incana)*" was carried out in the Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during the month of November 2020 to March 2021. The experiment was conducted in Randomized Block Design replicated thrice with twelve treatments i.e., T_1 NPK (25:15:15) (g/m^2) (RDF); T_2 NPK (10:12:15) (g/m^2); T_3 NPK (12:12:15) (g/m^2); T_4 NPK (15:15:15) (g/m^2); T_5 NPK (20:15:15) (g/m^2); T_6 NPK (20:20:20) (g/m^2); T_7 NPK (22:20:20) (g/m^2); T_8 NPK (25:25:25) (g/m^2); T_9 NPK (27:25:30) (g/m^2); T_{10} NPK (30:25:30) (g/m^2); T_{11} NPK (30:30:30) (g/m^2) and T_{12} NPK (32:30:32) (g/m^2).
The maximum plant height (34.80 cm), and number of leaves per plant (69.42) was observed in T_8 NPK (25:25:25) (g/m^2). Days to bud initiation (42.19 days) and 50% flowering (60.38) was found to be least in T_8 NPK (25:25:25) (g/m^2). The treatment T_8 NPK (25:25:25) (g/m^2) has maximum number of flowers per spike (13.89), floret diameter (4.08 cm) and self-life (13.75 days). The number of spikes yield per plant (7.35), yield of spikes per plot (44.08) and yield of spikes per hectare (1653000 ha^{-1}) was recorded highest in T_8 NPK (25:25:25) (g/m^2).

Keywords: Stock, nitrogen, phosphorus, potassium

1. Introduction

Stock or Gilly flower is an annual plant flowering in terminal cluster. It exists both single and double forms and valued for fragrant flowers that can be used as fresh or dried flowers. Stocks are a most valuable race of garden plants for they are easy to grow and can be in bloom in greater part of the year. They are excellent pot plants in winter and spring. Flowers are well arranged in column and the colours are variable white to rose, crimson, purple, yellow, mauve, pink, etc. seeds of stock are aphrodisiac, bitter, diuretic, expectorant, stimulant and are use as tonic. An infusion has been used in the treatment of cancer and when mixed with wine, it has been used as an antidote to poisonous bites. The highly fragrant flowers are used as a garnish, especially with sweet deserts. *Matthiola incana* (L.) R.Br. is an important ornamental plant native to Mediterranean region and belongs to family Brassicaceae Onyilagho *et al.*, (2003) and Hisamatsu *et al.*, (1997). Stock is hardy annual, biennial and perennial free flowering plant with fragrant flower. The different kinds varying height from 20-90 cm and all have narrow, oblong or lance-shaped leaves, which are 3-8 cm in length are green. The varieties usually cultivated are of *Matthiola incana*.

Stock requires full to light shade and is frost tolerant. Temperature plays an important role on growth and flowering of stock. The crop should be grown at the night temperature of 16ºC until ten fully developed leaves are produced and then temperature should be maintained at 10ºC for at least three weeks and can be raised again to 16 ºC. Stock will not flower if it is exposed more than 6 hrs/day to 18 ºC. For obtaining better quality flower the night temperature should be 2-4ºC. High temperature encouraged formation of more leaves before flower initiation. Flowering is also influenced by duration of low temperature and cultivars.

Stocks are propagated through seeds. Around 18-24 ºC temperature is required for germination. Sowing of seeds is done in well prepared nursery beds or pots from mid-September to mid-October in plain and February to March in hilly areas. Thin layer of seed is scattered over surface and covered with sand or manure. When the seedlings are 2.5-3 cm tall or have developed 3 to 4 true leaves, they should be transplanted.

Nitrogen, phosphorus and potassium are considered to be primary macronutrients. These macronutrients play significant role during the entire plant life by performing various beneficial activities in plant metabolism.

They also help to increase yield, growth and quality of various crops (Morgan and Connolly, 2013) [5]. Among the essential nutrients, nitrogen, phosphorus and potassium are most important for plant growth and flowering. These also play a key role in the production of higher flower and seed yield of ornamentals (Kashif, 2001) [4]. These also enhance the vegetative growth and assist the plant during the blooming period to mobilize the process of flower opening. Flowering can be increased with increased level of NPK application (Anamika and Lavania, 1990) [1].

Nitrogen is essential for plant development, since it plays a fundamental role in energy metabolism and protein synthesis. Nitrogen is absorbed by the plant in the form of a nitrate. This macronutrient is directly related to plant growth. It is indispensable for photosynthesis activity and chlorophyll formation. Nitrogen is involved, above all, in the aerial zone, the part of the plant that a person sees. It promotes cellular multiplication. A nitrogen deficiency results in a loss of vigour and colour. Growth becomes slow and leaves fall off, starting at the bottom of the plant.

Phosphorus is regarded as an essential component for crop growth and development of plants; however, its availability in soil is often low and therefore, its high amount in the form of organic phosphate is exogenously used to attain high crop yields (Huang *et al.*, 2011) [3]. It also promotes the rapid growth of plants as well as root systems. In the aerial zone it favours flowering. Although phosphorus is also necessary during the plant’s growth period, it is much more involved in the flowering stage and seed formation.

Potassium is regarded as one of the most valuable elements for the growth and development of plants and is alkaline in nature. Potassium is necessary and extremely mobile macronutrient in plants that is abundantly present in young parts of the plants. Potassium is involved in the regulation of water and the transport of the plant’s reserve substances. It increases photosynthesis capacity, strengthens cell tissue, and activates the absorption of nitrates. Potassium stimulates flowering and the synthesis of carbohydrates and enzymes. This, in turn, provides an increase in the plant’s ability to withstand unfavourable environments such as low temperatures, and prevents withering.

2. Materials and Method

The details pertaining to the materials and methods adopted in this experiment are presented below:

2.1 Experimental site

A field experiment entitled Effect of nitrogen, phosphorus and potassium in growth, quality of flower and yield of Stock (*Matthiola incana*) was carried out at Horticultural Research Field, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, during rabi season of 2020-2021. Department of Horticulture, SHAUTS, Prayagraj is situated in the agro climatic zone (Sub-tropical belt) of Uttar Pradesh state. Geographically, Prayagraj is located at 20˚15’ North latitude, 60˚3’ East longitude and at an altitude of 678 meters above mean sea level. The South east of Uttar Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46 °C – 48 °C and seldom falls as low as 4 °C – 5 °C. The relative humidity ranged between 20 to 94 percent. The average rainfalls in this area are around 1013.4 mm annually.

2.2 Treatment details

Sl. No.	Treatment notation	Treatment Details
1.	T1	N:P:K (25:15:15) (g/m^2) (RDF)
2.	T2	N:P:K (10:12:15) (g/m^2)
3.	T3	N:P:K (12:12:15) (g/m^2)
4.	T4	N:P:K (15:15:15) (g/m^2)
5.	T5	N:P:K (20:15:15) (g/m^2)
6.	T6	N:P:K (20:20:20) (g/m^2)
7.	T7	N:P:K (22:20:20) (g/m^2)
8.	T8	N:P:K (25:25:25) (g/m^2)
9.	T9	N:P:K (27:25:30) (g/m^2)
10.	T10	N:P:K (30:25:30) (g/m^2)
11.	T11	N:P:K (30:30:30) (g/m^2)
12.	T12	N:P:K (32:30:32) (g/m^2)

3. Results and Discussion

3.1 Growth parameter

Influence of growth retardants, under study on vegetative growth under different treatments is described below:

The plant height was influenced by different levels of NPK at 30 DAT and the result was found to be significant. The maximum plant height (15.17 cm) was observed in the treatment T_8 N:P:K (25:25:25) (g/m^2) followed by treatment T_6 N:P:K (20:20:20) (g/m^2) and T_4 N:P:K (15:15:15) (g/m^2). The plant height was found to be minimum (7.89) in the treatment T_2 N:P:K (10:12:15) (g/m^2). The plant height was influenced by different levels of NPK at 60 DAT and the result was found to be significant. The maximum plant height (24.17 cm) was observed in the treatment T_8 N:P:K (25:25:25) (g/m^2) followed by treatment T_6N:P:K (20:20:20) (g/m^2) and T_4N:P:K (15:15:15) (g/m^2). The plant height was found to be minimum (14.09 cm) in the treatment T_2 N:P:K (10:12:15) (g/m^2). The plant height was influenced by different levels of NPK at 90 DAT and the result was found to be significant. The maximum plant height (34.80 cm) was observed in the treatment T_8 N:P:K (25:25:25) (g/m^2) followed by treatment T_6N:P:K (20:20:20) (g/m^2) and T_{12}N:P:K (32:30:32) (g/m^2). The plant height was found to be minimum (17.96 cm) in the treatment T_2 N:P:K (10:12:15) (g/m^2). The plant height was affected significantly by the application of nitrogen, phosphorus and potassium. The increase in the plant height with NPK application can be attributed to the fact that macronutrients, particularly nitrogen promotes plant growth which results in progressive increase in plant height. The experiment revealed that plant height increased as the dose of NPK increased. The result was in close agreement with the findings of Fayaz (2016) in Gerbera.

The number of leaves per plant was influenced by different levels of NPK at 30 DAT and the result was found to be significant. The maximum number of leaves per plant (17.97) was observed in the treatment T_8 N:P:K (25:25:25) (g/m^2) followed by treatment T_6 N:P:K (20:20:20) (g/m^2) and T_{11}N:P:K (30:30:30) (g/m^2). The number of leaves per plant was found to be minimum (10.79) in the treatment T_2 N:P:K (10:12:15) (g/m^2). The number of leaves per plant was influenced by different levels of NPK at 60 DAT and the result was found to be significant. The maximum number of leaves per plant (37.74) was observed in the treatment T_8 N:P:K (25:25:25) (g/m^2) followed by treatment T_6 N:P:K (20:20:20) (g/m^2) and T_{11} N:P:K (30:30:30) (g/m^2). The number of leaves per plant was found to be minimum (20.05) in the treatment T_2 N:P:K (10:12:15) (g/m^2). The number of leaves per plant was influenced by different levels of NPK at 90 DAT and the result was found to be significant. The maximum number of leaves per plant (69.42) was observed in the treatment T_8 N:P:K (25:25:25) (g/m^2) followed by treatment T_6N:P:K (20:20:20) (g/m^2) and T_9N:P:K (27:25:30) (g/m^2). The number of leaves per plant was found to be minimum (43.93) in the treatment T_2 N:P:K (10:12:15) (g/m^2). The results showed that the treatment T_8 N:P:K (25:25:25) (g/m^2) have significant effect on number of leaves. The higher doses of NPK enhanced the vegetative growth of the plants by increasing the number of leaves. The result was in close agreement with the findings of Fayaz (2016) and Tovika (2017) [6] in Gerbera.

3.2 Flowering parameter
Influence of NPK, under study on flowering parameter under different treatments is described below:
The days to bud initiation was found to be minimum (42.19 days) in the treatment T_8 N:P:K (25:25:25) (g/m^2) followed by treatment T_6 N:P:K (20:20:20) (g/m^2) and T_{10} N:P:K (30:25:30) (g/m^2). The days to bud initiation were found to be maximum (53.37 days) in the treatment T_2 N:P:K (25:15:15) (g/m^2).The least number of days to bud initiation is considered as the important parameter of growth of plant and it is directly related to the availability of macronutrients to the plant. The above result, treatment T_8 N:P:K (25:25:25) (g/m^2) in which it is evident that as nitrogen, phosphorus and potassium was provided in proper combination and ratio, thus, days to bud initiation was decreased. The result was in close agreement with the findings of Fayaz *et al* (2016) in Gerbera.
The days to 50% flowering was found to be minimum (60.38 days) in the treatment T_8 N:P:K (25:25:25) (g/m^2) followed by treatment T_6 N:P:K (20:20:20) (g/m^2) and T_1 (25:15:15) (g/m^2). The days to 50% flowering were found to be maximum (71.42 days) in the treatment T_2 N:P:K (10:12:15) (g/m^2). The results showed that the combination T_8 N:P:K (25:25:25) (g/m^2) induced early flowering, so the above nutrient was best due to high nutrients concentration. Early flower is very important and balanced nutrition is one of the best practices to get early flowering in plants Kumar and Haripriya (2010).
Maximum number of flowers per spike was recorded in the treatment T_8 N:P:K (25:25:25) (g/m^2) (13.89) followed by treatment T_6 N:P:K (20:20:20) (g/m^2) and T_1 (25:15:15) (g/m^2), T_{11} N:P:K (30:30:30) (g/m^2). The Total number of flowers per spike was found to be minimum (7.45) in treatment T_2 NPK (10:10:15) (g/m^2). Effect of nitrogen, phosphorus and potassium was significantly on number of flowers with treatment T_8 N:P:K (25:25:25) (g/m^2). High nitrogen promotes vegetative growth. Excessive nitrogen may produce vegetative growth at the expense of reproduction. While the addition of phosphorus increased the number of flowers **(**Alkurdi, 2014**)**. Similar findings were found in Zinnia by Javid *et al.*, (2005).

3.3 Quality parameter
It was recorded that the treatment T_8 N:P:K (25:25:25) (g/m^2) has maximum florets size (cm) (4.08) followed by treatment T_6 N:P:K (20:20:20) (g/m^2) and T_1 N:P:K (25:15:15) (g/m^2). The florets size (cm) was found to be minimum (2.38) in treatment T_2 N:P:K (10:12:15) (g/m^2). Application of nitrogen, phosphorus and potassium had significant effect on floret diameter. Increased NPK content may have increased the number of leaves which might have increased the production of photosynthates that is needed to enhance reproductive growth **(**Sarwar *et al*., 2013**)**. The result was in close agreement with the findings of Fayaz (2016) in Gerbera.
It was recorded that the treatment T_8 N:P:K (25:25:25) (g/m^2) has maximum flower shelf-life in plant (13.75 days) followed by treatment T_4 N:P:K (15:15:15) (g/m^2) and T_6 N:P:K (20:20:20) (g/m^2). The flower shelf-life in plant was found to be minimum (8.81days) in treatment T_2 N:P:K (10:12:15) (g/m^2). The shelf-life of flower was influenced by the doses of NPK. It might be due to the availability of nutrients to plants that forced towards the growth of vegetative parts then it takes time to complete wilting as compared to other treatments.

3.4 Yield parameter
It was recorded that the treatment T_8 N:P:K (25:25:25) (g/m^2) has maximum number of spike per plant (7.35) followed by treatment T_6 N:P:K (20:20:20) (g/m^2) and T_9 N:P:K (27:25:30) (g/m^2). The number of spike per plant was found to be minimum (2.60) in treatment T_2 N:P:K (10:12:15) (g/m^2). The number of spikes per plant was influenced by different doses of NPK. The maximum spike yield was found in treatment T_8 N:P:K (25:25:25) (g/m^2). It may be due to the sufficient availability of proper nutrients to the plant at growth stage. The result was in close agreement with the findings of Fayaz (2016) in Gerbera.
It was recorded that the treatment T_8 N:P:K (25:25:25) (g/m^2) has maximum number of spike per plot (44.08) followed by treatment T_6 N:P:K (20:20:20) (g/m^2) and T_9 N:P:K (27:25:30) (g/m^2). The number of spike per plot was found to be minimum (15.62) in treatment T_2 N:P:K (10:12:15) (g/m^2). The number of spikes per plant was influenced by different doses of NPK. The maximum spike yield was found in treatment T_8 N:P:K (25:25:25) (g/m^2). It may be due to the sufficient availability of proper nutrients to the plant at growth stage.

Table 1: Effect of nitrogen, phosphorus and potassium on growth parameter

Sl. No.	Treatments No.	Treatment Details	Plant height (cm)			No. of leaves per plant		
			30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
1.	T1	N:P:K (25:15:15)	11.44	19.78	25.73	11.56	24.40	46.92
2.	T2	N:P:K (10:12:15)	7.89	14.09	17.96	10.79	20.05	43.95
3.	T3	N:P:K (12:12:15)	11.44	17.37	24.36	12.84	32.04	55.89
4.	T4	N:P:K (15:15:15)	13.40	22.06	26.28	13.85	29.01	61.41
5.	T5	N:P:K (20:15:15)	12.06	18.66	24.12	14.28	27.73	56.87
6.	T6	N:P:K (20:20:20)	14.41	22.34	30.04	16.43	35.91	66.30
7.	T7	N:P:K (22:20:20)	10.65	15.33	21.37	13.68	32.52	57.92
8.	T8	N:P:K (25:25:25)	15.17	24.17	34.80	17.97	37.74	69.42
9.	T9	N:P:K (27:25:30)	11.11	16.56	23.46	14.92	32.52	63.19
10.	T10	N:P:K (30:25:30)	12.67	17.89	25.26	13.73	32.56	60.18
11.	T11	N:P:K (30:30:30)	13.00	18.33	25.10	15.77	33.15	57.55
12.	T12	N:P:K (32:30:32)	12.89	18.11	26.83	15.05	32.74	57.50

Table 2: Effect of nitrogen, phosphorus and potassium on flowering parameter

Sl. No.	Treatments No.	Treatment Details	Days to bud initiation	Days to 50% flowering	Total number of flowers per spike
1.	T1	N:P:K (25:15:15)	44.94	63.56	11.56
2.	T2	N:P:K (10:12:15)	53.57	71.42	7.45
3.	T3	N:P:K (12:12:15)	46.33	66.33	10.89
4.	T4	N:P:K (15:15:15)	47.11	67.11	10.00
5.	T5	N:P:K (20:15:15)	48.22	68.22	9.33
6.	T6	N:P:K (20:20:20)	43.46	61.70	12.56
7.	T7	N:P:K (22:20:20)	45.56	65.56	10.22
8.	T8	N:P:K (25:25:25)	42.19	60.38	13.89
9.	T9	N:P:K (27:25:30)	45.11	65.11	9.96
10.	T10	N:P:K (30:25:30)	44.18	64.11	10.22
11.	T11	N:P:K (30:30:30)	44.44	64.44	11.33
12.	T12	N:P:K (32:30:32)	44.22	64.22	8.80

Table 3: Effect of nitrogen, phosphorus and potassium on quality parameter

Sl. No.	Treatments No.	Treatment Details	Floret size (cm)	Flower self-life in plant (days)
1.	T1	N:P:K (25:15:15)	3.78	10.62
2.	T2	N:P:K (10:12:15)	2.38	8.81
3.	T3	N:P:K (12:12:15)	3.56	11.69
4.	T4	N:P:K (15:15:15)	3.50	12.76
5.	T5	N:P:K (20:15:15)	3.56	12.59
6.	T6	N:P:K (20:20:20)	3.97	12.59
7.	T7	N:P:K (22:20:20)	3.39	11.88
8.	T8	N:P:K (25:25:25)	4.08	13.75
9.	T9	N:P:K (27:25:30)	3.44	11.33
10.	T10	N:P:K (30:25:30)	3.50	11.71
11.	T11	N:P:K (30:30:30)	3.78	11.45
12.	T12	N:P:K (32:30:32)	3.72	11.00

Table 4: Effect of nitrogen, phosphorus and potassium on yield parameter

Sl. No.	Treatments No.	Treatment Details	Number of spikes per plant	Number of spikes per plot
1.	T1	N:P:K (25:15:15)	4.94	29.64
2.	T2	N:P:K (10:12:15)	2.60	15.62
3.	T3	N:P:K (12:12:15)	4.22	25.33
4.	T4	N:P:K (15:15:15)	3.67	22.00
5.	T5	N:P:K (20:15:15)	4.23	25.38
6.	T6	N:P:K (20:20:20)	6.43	38.60
7.	T7	N:P:K (22:20:20)	4.89	29.33
8.	T8	N:P:K (25:25:25)	7.35	44.08
9.	T9	N:P:K (27:25:30)	5.89	35.33
10.	T10	N:P:K (30:25:30)	5.19	31.15
11.	T11	N:P:K (30:30:30)	5.47	32.84
12.	T12	N:P:K (32:30:32)	4.78	28.67

4. Conclusion

On the basis of present investigation it is concluded that, the application of T_8 N:P:K (25:25:25) (g/m^2) treatment was found the best in the terms of plant height (15.17 cm, 24.17 cm and 34.80 cm), number of leaves per plant (17.97, 37.74 and 69.42), days to bud initiation (42.19 days), days to 50% flowering (60.38 days), total number of flower per spike (13.89), florets size (cm) (4.08), number of spike per plant (7.35) and number of spike per plot (44.08) of Stock (*Matthiola incana*). Thus, treatment T_8 N:P:K (25:25:25) (g/m^2) can be recommended for cultivation of Stock under the agro climatic zone of Prayagraj.

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