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Effect of different levels of NPK on plant growth, flower quality and spike yield of snapdragon (*Antirrhinum majus* L.)

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Abstract
The experiment entitled "Effect of different levels of NPK on plant growth, flower quality and spike yield of Snapdragon (*Antirrhinum majus* L.)", was carried out under Prayagraj agro- climatic condition 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 laid out in Randomized Block Design with three replications and twelve different levels of N, P and K. The study revealed that all the characters were significantly affected by the combination of N.P.K. fertilizers. On the basis of present investigation it is concluded that, the application of T_{11} N:P:K in the ratio of 91:66:91 kg NPK kg/ ha^{-1} treatment was found superior in the terms of plant growth, flower quality and spike yield *viz*., plant height (99.65 cm), number of leaves per plant (474.53), number of branches per plant (36.40),days to 1^{st} spike emergence (63.07), days to opening of 1^{st} floret (69.07) days, spike length (23.52 cm), no of florets per spike (27.33), no. of spikes per plant (8.33), days taken for first harvest (107.53), no of spike ha^{-1} (9.26) and vase life (days) (7.33) days of snapdragon. Hence, application of T_5 (91:66:91 NPK kg/ha) on snapdragon plants can be recommended for better growth and flowering under Prayagraj agro- climatic conditions.

Keywords: Plant growth, flower quality, spike yield, snapdragon

Introduction

Snapdragon (*Antirrhinum majus* L.), also known as dog flower, is a popular winter season annual flowering plant belonging to family Scrophulariaceae. It is an important cut flower crop in the international market. But in India, it is not popular as a cut flower and is mainly grown in beds, pots, edging purpose, herbaceous border and in rock garden. Magnificent and charming flowers of many colours except blue, with numerous shades are borne on long terminal spikes. Evaluation is the first important step in any crop improvement programme. It is tool for assessing the genetic variability present in any crop species, which could be exploited for its commercialization (Verma *et al*., 2018) [20].

Nitrogen is one of the most prevalent elements and it is a component of amino acids, proteins, nucleic acids, chlorophyll and many other metabolites, essential for survival of the plant. Nitrogen application is one of the important nutrient amendments made to the soil to improve growth and yield of many crop plants (Kishore, 2016) [9]. Next to nitrogen, phosphorus is the second important nutrient required by plants. It is an essential component of nucleic acids, phosphorylated sugars, lipids and proteins, which control all life process. Phosphorus is of paramount importance for energy transfer in living cells by mean of high energy phosphate bonds of ATP (Dali *et al.*, 2020) [3].

Potassium is needed for healthy roots and stems, and aids plant with the respiration process. It is sometimes called potash (Parekh *et al*., 2010).

Materials and Methods

The present investigation entitled, "Effect of different levels of NPK on plant growth, flower quality and spike yield of snapdragon'' carried out in Department of Horticulture, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during the rabi season (2020-2021). The experiment was laid out in Randomized Block Design with three replications and twelve treatment combinations to evaluate the effect of N, P and K on snapdragon. Snapdragon seedlings of 30 days old were planted in well prepared field in the month of November.

Well rotten FYM was applied at the time of field preparation. Urea was applied in two split doses as first dose was applied at the time of planting and second dose after 30 days of planting, while Single Super Phosphate and Muriate of Potash was used in single dose as basal application. Observations were recorded on five tagged plants and mean were calculated.

Results and Discussions

The results of the study regarding the effect of NPK rate on crop characters of snapdragon have been presented here

Plant height: Results showed that significantly, taller plants (99.65 cm) were recorded in treatment T_5NPK (91:66:91 kg ha^{-1}) which was at par with treatment T_4NPK(87:62:87 kg ha^{-1}) followed by treatment T_1NPK(75:50:75 kg ha^{-1}), T_3NPK(83:58:83 kg ha^{-1}) and T_2 NPK (79:54:79 kg ha^{-1}). The plant height was found to be shorter (82.09 cm) in the treatment T_{12} NPK (119:94:119 kg ha^{-1}). The increase in plant height is due to the optimum dose of nitrogen which increases the transport of metabolites and rate of photosynthates in plant furthering as the rate of photosynthesis. Similar kind of observations with an increase in vegetative growth by the external application of higher dose of fertilizers was noticed by Joshi (2002), Patel (2004), Karavadia and Dhaduk (2002) in annual chrysanthemum.

Number of leaves: Different levels of NPK application on snapdragon had significant effect on number of leaves. Results showed that higher number of leaves per plant (474.53) were recorded in treatment T_5NPK (91:66:91 kg ha^{-1}) which was at par with treatment T_4NPK (87:62:87 kg ha^{-1}) followed by treatment T_1NPK (75:50:75 kg ha^{-1}), T_2NPK (79:54:79 kg ha^{-1}) and T_3NPK (83:58:83 kg ha^{-1}). The lower number of leaves per plant (422.87) was recorded in the treatment T_{12}NPK (119:94:119 kg ha^{-1}). The favourable effect of nitrogen in promoting number of leaves might be due to the fact that nitrogen is a constituent part of protein and component of protoplasm which increases the chlorophyll contents in leaves. These factors led to cell multiplication, cell enlargement and cell differentiation which have resulted in increasing of number of leaves reported by (Rajwal and Singh, 2018) in tuberose.

Table 1: Effect of different levels of NPK on vegetative parameters of snapdragon

Treatments	Vegetative parameters		
	Plant height (cm)	No. of leaves per plant	No. of branches per plant
T_1	93.47	467.40	35.73
T_2	92.68	463.87	34.80
T_3	93.22	466.00	34.67
T_4	99.61	471.80	35.93
T_5	99.65	474.53	36.40
T_6	88.37	459.53	34.40
T_7	87.91	459.40	34.13
T_8	85.77	449.33	33.40
T_9	85.32	446.20	34.07
T_{10}	84.37	444.33	33.13
T_{11}	84.02	434.73	32.73
T_{12}	82.09	422.87	22.07
S. Ed (±)	11.48	24.15	2.22
$CD_{0.05}$	5.53	11.64	1.07

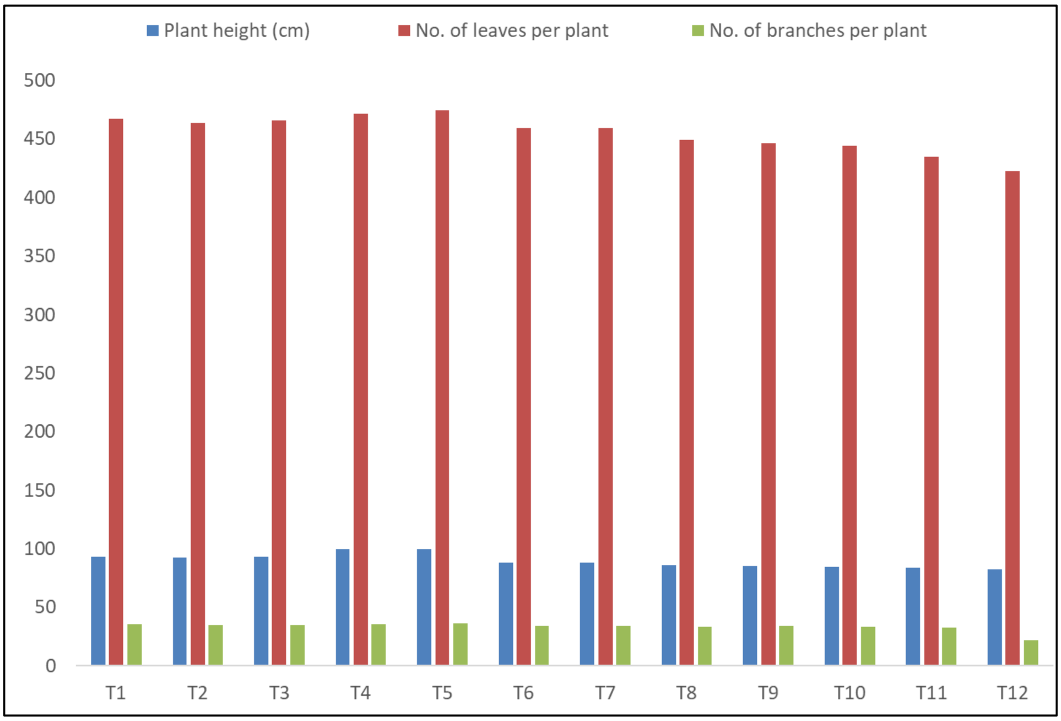

Fig 1: Effect of different levels of NPK on vegetative parameters of snapdragon

Number of branches: Results showed that significantly, more number of branches per plant (36.40) were recorded in treatment T_5NPK (91:66:91 kg ha^{-1}) which was at par with treatment T_4NPK (87:62:87 kg ha^{-1}), followed by T_1NPK (75:50:75 kg ha^{-1}), T_3NPK (83:58:83 kg ha^{-1}) and T_6NPK (95:70:95 kg ha^{-1}). The lesser number of branches per plant (22.07) was recorded in the treatment T_{12}NPK (119:94:119 kg ha^{-1}). Potassium nutrient might have enhanced the carbohydrate supply to the growing meristematic tissue thereby an increase in cell division and cell differentiation might have taken place which increased the number of branches. Similar kind of observations with an increase in number of branches was noticed by Pal and Ghosh (2010) [13] and Kishore *et al*., (2010) in African marigold.

Number of days taken for first spike emergence: Results showed that significantly, lesser number of days (63.07) taken for first spike emergence were recorded in treatment T_5NPK (91:66:91 kg ha^{-1}). The number of days taken for first spike emergence (96.20) was found to be more in treatment T_{12} NPK (119:94:119 kg ha^{-1}). This might be due to optimum availability of nitrogen resulting in more protein and carbohydrate synthesis resulting in early floral primordial development. These results obtained are in close conformity with the findings of Satar *et al.,* (2012) in annual chrysanthemum.

Number of days taken for opening of first floret: Results showed that significantly, lesser number of days (69.07) taken for opening of first floret were recorded in treatment T_5NPK (91:66:91 kg ha^{-1}) whereas, the number of days taken for opening of first floret (104.80) was found to be more in treatment T_{12} NPK (119:94:119 kg ha^{-1}). This might be due to adequate availability of nitrogen resulting in more protein and carbohydrate synthesis resulting in early floral primordial development. These results obtained are in close conformity with the findings of Satar *et al.,* (2012) in annual chrysanthemum.

Spike length: Significantly, higher spike length (23.52 cm) were recorded in treatment T_5NPK (91:66:91 kg ha^{-1}) which was at par with treatment T_4NPK (87:62:87 kg ha^{-1}), followed by treatment T_1NPK (75:50:75 kg ha^{-1}), T_3NPK (83:58:83 kg ha^{-1}) and T_6NPK (95:70:95 kg ha^{-1}). The spike length (17.71 cm) was found to be lower in treatment T_{12} NPK (119:94:119 kg ha^{-1}). Nitrogen and potassium when applied at optimum level increased photosynthesis rate and translocation of photo-assimilates to different parts of plant may have resulted in obtaining good quality flowers. Similar results were found by Ahmad *et al.,* (2011) and Kishore *et al.,* (2016) [9] in African marigold.

Table 2: Effect of different levels of NPK on floral parameters of snapdragon

Treatments	Number of days taken for first spike emergence	Number of days taken for opening of first floret	Spike length (cm)	Number of florets per spike	Number of spikes per plant	Days taken for the first harvest	Number of spikes ha^{-1}	Vase life (days)
T_1	91.60	95.73	22.49	23.87	7.80	107.87	8.67	7.00
T_2	93.53	96.60	20.82	23.67	6.87	109.80	7.63	6.80
T_3	92.00	95.87	21.72	23.33	7.60	108.73	8.44	6.87
T_4	91.13	94.47	22.76	25.00	7.87	107.83	8.74	7.20
T_5	63.07	69.07	23.52	27. 33	8.33	107.53	9.26	7.33
T_6	94.27	97.93	21.62	23.47	7.53	110.00	7.04	6.73
T_7	94.07	100.27	20.95	22.53	6.33	109.00	6.96	6.53
T_8	94.93	102.07	21.39	23.07	7.20	109.80	8.37	7.0
T_9	95.67	100.87	21.07	23.33	6.27	110.33	6.59	6.73
T_{10}	96.00	101.67	20.82	22.87	6.87	109.73	8.00	7.20
T_{11}	94.93	102.80	19.45	23.13	5.87	110.80	6.52	6.67
T_{12}	96.20	104.80	17.71	19.40	5.27	111.33	6.44	6.47
S. Ed (±)	2.74	15.78	2.33	3.49	1.86	2.37	2.07	0.35
$CD_{0.05}$	1.32	7.61	1.12	1.68	0.90	1.15	1.00	0.17

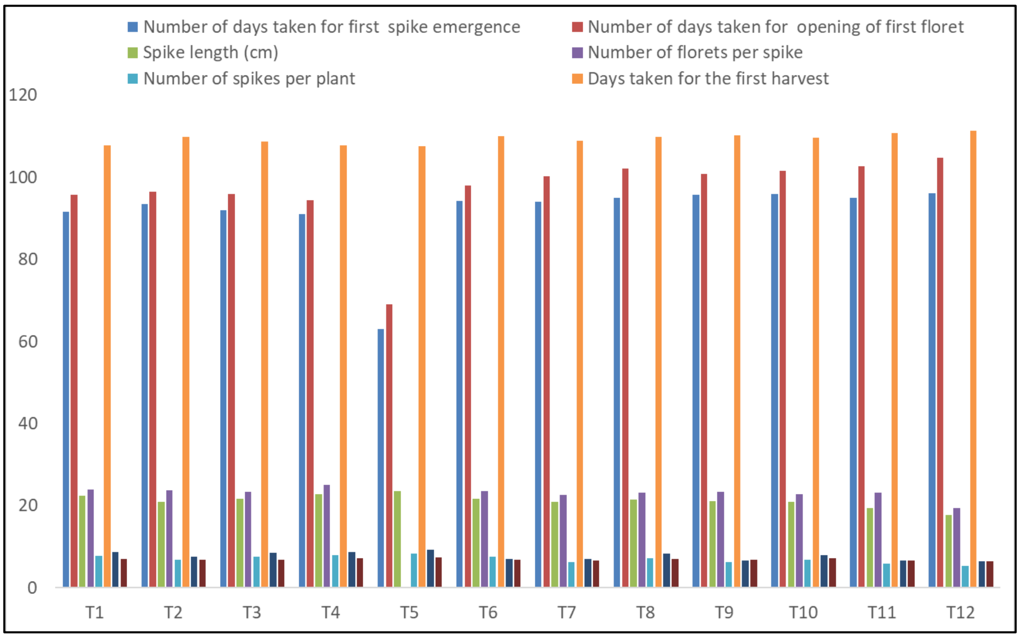

Fig 2: Effect of different levels of NPK on floral parameters of snapdragon

Number of florets per spike: Significantly, more number of florets per spike (27.33) were recorded in treatment T_5NPK (91:66:91 kg ha^{-1}) which was at par with treatment T_4NPK (87:62:87 kg ha^{-1}) and T_1NPK (75:50:75 kg ha^{-1}). The number of florets per spike (19.40) was found to be lower in treatment T_{12} NPK (119:94:119 kg ha^{-1}). Increase in the flowering shoots with application of optimum nitrogen doses might be attributed to increased metabolite transport required for growth (Marschner, 1983). These results are in agreement with the findings of Rathore and Singh (2013) in tuberose.

Number of spikes per plant: Significantly, more number of spikes per plant (8.33) were recorded in treatment T_5NPK (91:66:91 kg ha^{-1}) which was at par with treatment T_4NPK (87:62:87 kg ha^{-1}), T_1 NPK (75:50:75 kg ha^{-1}), T_3NPK (83:58:83 kg ha^{-1}) and T_6NPK (95:70:95 kg ha^{-1}). The number of spikes was found to be lower (5.27) in the treatment T_{12} NPK (119:94:119 kg ha^{-1}). Increased yield might be due to optimum availability of phosphorus in the rooting medium which affects the earlier maturation of plant that tends to develop the flower, also crop produced maximum vegetative growth which resulted in production of maximum number of spikes. Similar results were reported by Solanki and Ganie (2009) and Kumar and Moon (2014) in African marigold.

Days taken for first harvest: Significantly, lesser number of days (107.53) taken for the first harvest were recorded in treatment T_5NPK (91:66:91 kg ha^{-1}) which was at par with treatment T_4NPK (87:62:87 kg ha^{-1}), T_1NPK (75:50:75 kg ha^{-1}) and T_3NPK (83:58:83 kg ha^{-1}). The number of days taken for first harvest was found to be more (111.33) in treatment T_{12} NPK (119:94:119 kg ha^{-1}). The increase in flower quality characters might be due to nitrogen and phosphorus which are essential constituents which helps in the formation of starch and sugar in plant body, it is also very important in forming carbohydrate and translocation of starch resulting in improved plant growth which might have favored increase in flowering as well as qualitative characters. This finding was also supported by Acharya and Dashora (2004) in Marigold.

Number of spikes ha^{-1}: Significantly, more number of spike ha^{-1} (9.26) were recorded in treatment T_5NPK (91:66:91 kg ha^{-1}) which was at par with treatment T_4NPK (87:62:87 kg ha^{-1}), T_1NPK (75:50:75 kg ha^{-1}) followed by treatment T_3NPK (83:58:83 kg ha^{-1}) and T_6NPK (95:70:95 kg ha^{-1}). The number of spikes $ha^{-1}$was found to be lesser (6.44) in treatment T_{12} NPK (119:94:119 kg ha^{-1}). Increased yield might be due to optimum availability of phosphorus in the rooting medium which affects the earlier maturation of plant that tends to develop the flower, also crop produced maximum vegetative growth which resulted in production of maximum number of spikes. Similar results were reported by Solanki and Ganie (2009) and Kumar and Moon (2014) in African marigold.

Vase life (days): Significantly, longer vase life (7.33) were recorded in treatment T_5NPK (91:66:91 kg ha^{-1}) which was at par with treatment T_4NPK (87:62:87 kg ha^{-1}), T_{10}NPK (111:86:111 kg ha^{-1}), T_1NPK (75:50:75 kg ha^{-1}) and T_8NPK (103:78:103 kg ha^{-1}).The vase life was found to be shorter (6.47) in treatment T_{12} NPK (119:94:119 kg ha^{-1}). Vase life of flower might have enhanced with nitrogen application as nitrogen is a very important constituent of nucleic acid, protoplasm and it might have increased carbohydrate synthesis, amino acids etc. from which phytohormones like auxins, cytokinin, gibberellins have been synthesized resulting in enhancing the vase life and flower quality. These results are in close conformity with those of Sonawane *et al.*, (2009), Kishore *et al.*, (2010) in gladiolus and Somendra *et al.*, (2018) in snapdragon.

Conclusion
It can be concluded from the findings of the present investigation that application of T_5 (91:66:91 NPK kg/ha) treatment was significantly superior in terms of plant height (99.65 cm), number of leaves per plant (474.53), number of branches per plant (36.40), number of days taken for first spike emergence (63.07), number of days taken for opening of first floret (69.07), spike length (23.52 cm), number of florets per spike (27.33), number of spikes per plant (8.33), number of days taken for first harvest (107.53), number of spike ha^{-1} (9.26) and vase life (7.33) of Snapdragon (*Antirrhinum majus* L.). Hence, application of T_5 (91:66:91 NPK kg/ha) on snapdragon plants can be recommended for better growth and flowering under Prayagraj agro- climatic conditions.

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