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Effect of nitrogen, phosphorus and potassium on growth and flowering of chrysanthemum

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Abstract
The present investigation was conducted at the experimental field of Dau Kalyan Singh College of Agriculture and Research Station, Bhatapara, under Department of Floriculture and Landscape Architecture, IGKV, Raipur (C.G.) during 2018 - 19 in *rabi* season. The experiment was designed in a randomized block design with a factorial design, with three levels of nitrogen *viz*., 100 kg N/ha (N_1), 150 kg N/ha (N_2) and 200 kg N/ha (N_3), two levels of phosphorus *viz*., 100 kg P_2O_5/ha (P_1), 200 kg P_2O_5/ha (P_2) and three levels of potassium *viz*., 100 kg K_2O/ha (K_1), 150 kg K_2O/ha (K_2) and 200 kg K_2O/ha (K_3). Result revealed that application of nitrogen at 200 kg ha^{-1} recorded significantly highest plant height, number of leaves per plant, number of branches per plant, number of flowers per plant, weight of single flower and diameter of flower although maximum plant spread noticed with 150 kg/ha nitrogen. Phosphorus was also important in improving all of these attributes at a higher level. While application of potassium @ 150 kg/ha give maximum improvement in vegetative growth and flowering characters.

Keywords: Nitrogen, phosphorus, potassium, vegetative growth, flowering

Introduction
Chrysanthemum is a commercial flower that is grown primarily for loose and cut flower production, which is used in floral arrangements and for marking garlands, veni, and bouquets. Nitrogen, phosphorus and potassium play a vital role in the production of good quality flowers. “Nitrogen is considered to be the most crucial because it is a constituent of protein and nucleic acid which is helpful in plant growth” (Haque, 2001) as well as to promotes rapid growth. This is due to higher nitrogen concentrations, which have a tendency to increase leaf cell number and size, resulting in an overall increase in number of leaves as reported by Meyer *et al*. (1973). Potassium has been linked to the synthesis of peptide bonds, protein and carbohydrate metabolism, as well as rapid cell division and differentiation. (Belorkar *et al*., 1992). The growth and development of stock or production plants are heavily reliant on proper feeding from the start. Investigations into the requirements of various nutrients, conducted in various locations, resulted in varying recommendations. According to the literature, very little research has been conducted in Chhattisgarh state on the response of chrysanthemum to different levels of nitrogen, phosphorus, and potash for growth and flowering parameters. As a result, the current study was undertaken to assess the effect of N, P, and K on yield and yield attributes of chrysanthemum, as well as to determine the optimum NPK doses for optimizing yield of chrysanthemum in the Chhattisgarh plains.

Material and Methods
The field experiment was conducted in the rabi season of 2018-19 at the experimental field Dau Kalyan Singh College of Agriculture and Research Station, Bhatapara, under the Department of Floriculture and Landscape Architecture, IGKV, Raipur (C.G.). The experimental site was located at 21°43' North latitude and 81°59' East longitude, with an elevation of approximately 273 m above mean sea level (MSL). This experiment used a Factorial Randomized Block Design of 18 treatment combinations and three replications. The experiment was designed in a randomized block design with a factorial model, with three levels of nitrogen *viz*., 100 kg N/ha (N_1), 150 kg N/ha (N_2) and 200 kg N/ha (N_3), two levels of phosphorus *viz*., 100 kg P_2O_5/ha (P_1), 200 kg P_2O_5/ha (P_2) and three levels of potassium *viz*., 100 kg K_2O/ha (K_1), 150 kg K_2O/ha (K_2) and 200 kg K_2O/ha (K_3). The important growth and flowering parameter *viz*., plant height (cm) number of leaves per plant, number of branches per plant, spread of plant (cm), number of flowers per plant, flower size (cm) and single flower

weight (g) were recorded in five randomly selected and tagged plants per replication in each treatment.

Result and Discussion

Effect on vegetative characters

Effect of nitrogen

Plant height, number of branches per plant, number of leaves and plant spread were significantly varied due to varying level of nitrogen. It was increased with increasing level of nitrogen and significantly, maximum plant height (43.4 cm) and number of branches (18.3) was recorded with the application of 200 kg nitrogen ha^{-1} (N_3). However, significantly maximum number of leaves plant^{-1} (74.0) was also observed with the application of nitrogen at the rate of 200 kg ha^{-1} but it was remains *at par* with 150 kg ha^{-1}. The maximum plant spread (22.6 cm) observed with the dose of nitrogen @ 150 kg ha^{-1} which was found statistically similar with its higher dose @ 200 kg ha^{-1}. The significantly minimum plant height (36.2 cm), number of branches (13.3), lowest number of leaves plant^{-1} (54.0) and palnt spread (18.6 cm) were observed with the lowest amount of nitrogen application @ 100 kg ha^{-1}. "Photosynthates transported to sites of growth are used predominantly in the synthesis of nucleic acid and protein, hence N nutrition of plants to a large extent controls the growth of the plant during the vegetative stage" (Mengel and Kirkby, 1982). Thus, a higher nitrogen dose of 200 kg/ha enhanced cell division, resulting in greater plant height, number of leaves per plant, plant spread, number of branches. The finding corroborates the reports of Patel *et al.* 2004, Joshi *et al.* 2013 [1], Mali *et al.* 2016, Chopde *et al.* 2015 [5] in chrysanthemum

Effect of phosphorus

Plant height at all growth stages was significantly altered by two phosphorus levels during both the years and pooled results. Treatment of higher dose phosphorus @ 200 kg/ha (P_2) recorded significantly taller plant (42.0 cm), number of leaves plant^{-1} (68.6), number of branches plant^{-1} (16.3) and plant spread (21.8 cm) as compare to its lower level. Conversely, lowest plant height was (38.0), number of leaves (59.0) number of branches (15.6), plant spread (20.1 cm) recorded under treatment of 100 kg ha^{-1}.

The increased vegetative characters of chrysanthemum due to higher dose of phosphorus might be result of significant increase in meristematic tissue, which helped plant in acceleration the growth of the tissues. Similar results were also observed by Chawla *et al.*, (2007) [4], Dorajeerao *et al.* (2012), in chrysanthemum Karetha *et al.* 2011 [3] in gaillardia, Samoon *et al.* 2018 [2] Calendula.

Effect of potassium

Application of potassium @ 150 kg ha^{-1} noted significantly maximum Plant height was maximum (41.5 cm), number of leaves plant^{-1} (68.7), number of branches (16.8), plant spread (22.7 cm) whereas, significantly shortest plant (39.3 cm), minimum number of leaves plant^{-1} (59.5), number of branches (14.8), plant spread (19.2 cm) noted with the application of potassium at the rate of 100 kg ha^{-1}.

The maximum vegetative growth was observed in this study at a certain dose of potassium, which decreased as more of the nutrient was added. The uptake of the nutrient led to an increase in the plant height, number of leaves, branches, and plant spread only up to K 150, but potassium could not promote growth beyond this level. which mayin v be due to a lack of other nutrients whose uptake could have been inhibited by high potassium levels.

Vegetative growth being maximum at the application of 150 kg potassium and decreased at its lower and higher dose *i.e.*, 100 kg and 200 kg/ha. Potassium plays a vital role in the cell division and cell differentiation in the plant system. Collins and Duke (1981) opined that potassium increases the rate of carbon exchange in the plant system thereby enhances the movement of photosynthates in the phloem tissue which led to an increase in the meristematic activity of the plant system Agrawal *et al.* (2002). The above results were in conformity with the earlier findings of Verma *et al.* (2017) [6], Nikam *et al.* (2018) [7] in chrysanthemum, Kishore *et al.* (2010) [8] and Pal and Ghosh (2010) in African marigold.

Interaction

The interactive impact of nitrogen and phosphorus was found to be significant only on plant height. Significantly, maximum plant height (45.3 cm) was obtained under the treatment combination of N_3P_2 (N 200 kg and P 200 kg). However, among the different treatment combination of NP, lowest plant height (34.1 cm) noted with the treatment combination of N_1P_1.

None of other interactive effect found significant effect on any vegetative characters.

Effect on flowering characters

Effect of nitrogen

Among the different nitrogen levels, applying dosage of nitrogen @ 200 kg/ha recorded significantly more number of flowers plant^{-1} (41.6), fresh weight of flower (2.27), and diameter of flower (5.17, cm) This was also noted that nitrogen level at 200 kg/ha and 150 kg/ha performed similar on number of flower per plant. The significantly lowest number of flowers plant^{-1} (34.4) fresh weight of flowers (1.99) minimum diameter of flower (4.46) was observed with the lowest nitrogen application *i.e.*, 100 kg/ha.

The enhancement in number of flowers plant^{-1} might be due to enhanced the structural development as well as biochemical activities of the plant helps in diversion of more food reserves towards the developing flower buds which resulted in more number of flowers per plant. Increase in fresh weight of flower could might have stimulated photosynthetic activity by enhancing the size of source (number of branches and leaf area), hence, enhancing the availability of more photo assimilates to the developing flower buds and stimulated cell division and cell expansion of the flower tissue which might have led to ultimate increase in the increased flower size in terms of flower diameter as well as weight of the fresh flower. Similar results were noticed by Nikam *et al.* (2018) [7], Ahmed *et al.* (2017) [9], Verma *et al.* (2017) [6], Teja *et al.* (2017), Joshi *et al.* (2013) [1], Dorajeerao *et al.* (2012) in chrysanthemum.

Effect of phosphorus

The higher number of flowers plant^{-1} (40.8), maximum fresh weight, (2.25). and flower diameter (5.01 cm) whereas, minimum number of flowers plant^{-1} (36.4) weight of flower (2.06), diameter of flower (4.46 cm) was noted with application of phosphorus @ 100 kg/ha.

The increase in number of flowers in P_2 (200 kg) treatment might be due to the beneficial effect of phosphorus on root development, stimulation of growth, development of plant and formation of flower and showed improved flowering

attributes. It also might have helped in the uptake of nitrogen and other nutrients from soil (Gill *et at al.,* 1974; Kumar and Pillai, 1979). phosphorus fertilization also improved assimilate translocation and partitioning to floral sections, resulting in increased single flower weight, and size of flower. The observations are in accordance with that of Verma *et al.* (2017) [6], Sajid and Amin (2014) [10], Dorajeerao *et al.* (2012) in chrysanthemum and Samoon *et al.* (2018) [2] in Calendula.

Effect of potassium

The among the different levels of potassium, significantly higher number of flowers plant^{-1} (40.0) and weight of flower (2.33) produced @ 150 kg/ha (K_2) and it was statistically similar performed to K_3 (300 kg/ha) on number flower per plant. while minimum number of flowers plant^{-1} (37.6) and fresh weight of flower (1.99) and recorded in potassium level @ 100 kg/h.

The increase in floral attributes in plants which were treated with potassium at 150 kg ha^{-1}. It might be due to the production of increased number of primary and secondary branches, increased dry matter production and partitioning of dry matter into the floral organs. The present results are in agreement with the results obtained by Nikam *et al.* (2018) [7], Verma *et al.* (2017) [6], Sajid and Amin (2014) [10] in chrysanthemum and Saeed and Amin (2019) [11] in Rose.

Table 1: Effect of different levels of nitrogen, phosphorus and potassium on vegetative growth

Treatments	Plant height (cm)	Number of leaves per plant	Number of branches per plant	Plant spread (cm)
Nitrogen				
N_1	36.2	54.0	13.3	18.6
N_2	40.3	63.5	16.1	22.6
N_3	43.4	74.0	18.3	21.6
S.Em±	0.49	1.25	0.24	0.47
CD at 5%	1.42	3.61	0.70	1.35
Phosphorus				
P_1	38.0	59.0	15.6	20.1
P_2	42.0	68.6	16.3	21.8
S.Em±	0.40	1.02	0.20	0.38
CD at 5%	1.16	2.95	0.57	1.10
Potassium				
K_1	39.3	59.5	14.8	19.2
K_2	41.5	68.7	16.8	22.7
K_3	39.1	63.3	16.1	20.9
S.Em±	0.49	1.25	0.24	0.47
CD at 5%	1.42	3.61	0.70	1.35
Interactions				
NP	S	S	S	S
PK	NS	NS	NS	NS
NK	NS	NS	NS	NS
NPK	NS	NS	NS	NS

Table 2: Effect of nitrogen, phosphorus and potassium flowering characters

Treatments	Number of flower/plant	Flower weight (g)	Diameter of flower (cm)
Nitrogen			
N_1	34.4	1.99	4.46
N_2	39.9	2.21	4.85
N_3	41.6	2.27	5.17
S.Em±	0.70	0.02	0.10
CD at 5%	2.01	0.07	0.28
Phosphorus			
P_1	36.4	2.06	4.64
P_2	40.8	2.25	5.01
S.Em±	0.57	0.02	0.08
CD at 5%	1.64	0.05	0.22
Potassium			
K_1	37.6	1.99	4.73
K_2	40.0	2.33	5.00
K_3	38.2	2.15	4.74
S.Em±	0.70	0.02	0.10
CD at 5%	2.01	0.07	NS
Interactions			
NP	NS	NS	NS
PK	NS	NS	NS
NK	NS	NS	NS
NPK	NS	NS	NS

Conclusion

The overall findings of this study revealed that 200 kg nitrogen per ha., 200 kg phosphorus per ha., and 150 kg potassium were superior for chrysanthemum vegetative growth, flower quality, and yield.

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