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EFFECT OF GRADED LEVELS OF NITROGEN AND POTASSIUM ON GROWTH AND FLOWER YIELD OF ANNUAL CHRYSANTHEMUM (*CHRYSANTHEMUM CORONARIUM* L.)

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Abstract

An investigation was carried out at Horticultural College & Research Institute, Venkataramannagudem, West Godavari district of Andhra Pradesh during the year 2015-16 to evaluate the effect of nitrogen and potassium doses on the growth and flower yield of annual chrysanthemum. The study has revealed that number of flowers per plant or per plot or per hectare was found significantly maximum with the application of nitrogen at the rate of 200 kg ha^{-1} in combination with potassium applied at the are of 150 kg ha^{-1} along with common dose of application of phosphorus at the rate of 100 kg ha^{-1} during *rabi* season. With every increment of nitrogen dose there was an increase in the growth and development of annual chrysanthemum. A similar kind of effect was observed with the application of potassium upto 150 kg ha^{-1}. Plant height, number of primary branches, number of secondary branches, plant spread, number of leaves and dry weight of the plant were found significantly maximum with the application of nitrogen and potassium each at the rate of 200 and 150 kg ha^{-1}.

Key words: Annual chrysanthemum, graded levels, nitrogen, potasium, plant growth.

Introduction

Annual or garland chrysanthemum (*Chrysanthemum coronarium* L.) is one of the commercially important cultivated flower crops grown for its loose flowers in several parts of India. The species is also referred to as *Leucanthemum coronarium* or *Glebionis coronarium*. It is a winter season annual and propagated by seeds. It produces white and yellow coloured blooms and generally used in garland making as well as bedding material in the landscape gardens. The flowers are generally used for making garlands, veni and also used in the floral decorations during social and religious functions. Annual chrysanthemum differs from florist chrysanthemum in many aspects. The crop has relatively short duration and further considered photo-insensitive. Under moderate climatic conditions flowering is observed almost throughout the year. The plant is considered to be hardier, vigorous and grows taller. The plant is considered to have several medicinal properties. In India, Andhra Pradesh is considered the most prominent chrysanthemum growing state with a cultivated area of about 6.14 thousand hectares with an annual production of 70.55 thousand MT followed by Karnataka, Maharashtra, Telangana and Chhattisgarh. However, the cultivation of annual chrysanthemum is considered to be strange in this region. In Andhra Pradesh, the crop is coming up very well under coastal tropical humid climatic conditions, hence there is a need to develop package of practices to increase the flower yield coupled with quality. Application of major nutrients *viz*., nitrogen, phosphorous and potassium play an important role in growth and development of many flower crops there by increase the flower yield. Based on the available literature, it is evident that very little research work was carried out earlier on vegetative growth and floral responses of garland chrysanthemum to different levels of nitrogen, phosphorus and potassium in many parts of the country especially in the coastal regions. Keeping all these things in view, the present investigation has been planned to study the requirement of optimum dose/level of nitrogen and potassium for good constructive vegetative growth and flower yield of annual chrysanthemum with the aim to find out the effect of

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graded levels of nitrogen, potassium and their interactions on vegetative growth and flower yield of annual chrysanthemum.

Materials and Methods

The present investigation was carried out at Horticultrual College and Research Institute, Venkataramannagudem, Andhra Pradesh during the year 2015-2016 *rabi* season. The experimental site had a medium red soil and sandy loam texture with a pH of 6.57. The soil was moderately fertile. There were 16 treatments consisting of 4 doses each of Nitrogen *viz.,* N_1 (50 kg ha^{-1}), N_2 (100 kg ha^{-1}), N_3 (150 kg ha^{-1}) and N_4 (200 kg ha^{-1}) and Potassium K_1 (50 kg ha^{-1}), K_2 (100 kg ha^{-1}), K_3 (150 kg ha^{-1}) and K_4 (200 kg ha^{-1}) with a constant dose of Phosphorus (100 kg ha^{-1}) application in the soil. The experiment was laid out in factorial randomized block design with three replications. The gross plot size was 2.5×2.5 m^2 and the net plot size was 2.25×2.25 m^2. The spacing adopted was 40 cm between the rows and plants within a row. The straight fertilizers *viz*., Urea, Single Super Phosphate and Muriate of Potash were taken as the sources of N, P_2O_5 and K_2O, respectively. Entire dose of phosphorus was applied as a basal dose and the graded doses of nitrogen and potassium were applied in two split doses at 30 and 60 days after planting as per the treatments fixed. Growth parameters *viz*., plant height, plant spread, number of leaves per plant, number of branches per plant, dry weight, leaf area per plant were recorded at 30 days interval starting from 30th day after transplanting (DAT). A total of three observations at 30, 60 and 90 DAT were recorded during *rabi* season. The data recorded on each character were analyzed by the ANOVA technique as described by Panse and Sukhatme (1967). The treatment means were compared using the critical difference values calculated at 5 per cent level of significance.

Results and Discussion

Significant differences were observed in the plant height due to the application of nitrogen and potassium in different doses as well as their interactions (table 1) in the *rabi* season at 90 DAT. Significantly highest plant height was recorded with the application of nitrogen at the rate of 200 kg ha^{-1} (88.85 cm) when compared with all other doses. Based on the result obtained it may be concluded that significant differences were observed in the plant height with regard to the application of graded levels of nitrogen and potassium both individually and in different combinations. Plant height was found increased with increased dose of nitrogen upto 200 kg ha^{-1}. It is considered that nitrogen acts as an essential part in the biosynthesis of nucleic acids hence, plays a vital role in promoting the plant growth. Further, nitrogen has been identified as an important constituent of chlorophyll, proteins and amino acids thereby enhancing the rate of photosynthesis. Among the potassium doses, application of potassium at the rate of 150 kg ha^{-1} recorded singificantly highest plant height (84.82 cm) and was at par with the application of potassium at the rate of 200 kg ha^{-1}. Potassium plays a vital role in the cell division and cellular differentiation in the plant system. In the present, study it was observed that under the deficient condition or inadequate application of potassium reduced the plant height, which led to stunted growth. Collins and Duke (1981) opined that potassium increased the rate of carbon exchange in the plant system thereby enhanced the movement of photosynthates in the phloem tissue which led to an increase in the meristematic activity of the plant system. The interaction effect between the nitrogen and potasium doses was also found signficant. Application of nitrogen at the rate of 200 kg ha^{-1} in combination with potassium at the rate of 150 kg ha^{-1} recorded singificantly highest plant height (91.50 cm) among all the combinations. The increase in plant height also thought might be due to greater uptake of nutrients into the plant system through soil application which finally involved in the cell division, cell elongation as well as protein synthesis which ultimately enhanced the stem length and vegetative growth. Similar kind of observations with an increase in plant height by the external application of higher dose of fertilizers was noticed by Barman and Pal (1999) in chrysanthemum cv. 'Chandrama' and also by Singh and Sangama (2000) in China aster and Karavadia and Dhaduk (2002) in annual chrysanthemum.

Significantly highest number of primary branches was recorded by the application of nitrogen at the rate of 200 kg ha^{-1} (27.12), when compared with all other doses (table 1). The increase in the number of primary branches per plant applied with higher quantities of nitrogen recorded significantly more number of primary branches due to the reason that nitrogen generally involved in the basic reaction of photosynthesis thereby resulting in more number of leaves and branches per plant. Similar kind of observations were reporded earlier in African marigold by Sharma *et al*. (2006) and Rajbeer and Jitendra (2009). Application of potassium at the rate of 150 kg ha^{-1} recorded singificantly highest number of primary branches (23.61) and was found at par with the application of potassium at the rate of 200 kg ha^{-1}. The potassium nutrient might have enhanced the carbohydrate supply to the growing meristematic tissue thereby an increase in the cell division and cell differentiation might have taken place which would have increased the number of primary branches per plant. These results were in confirmity with the earlier findings of Pal and Ghosh (2010) and Kishore *et al*. (2010) in African marigold. Among the combinations tried, application of nitrogen at the rate of 200 kg ha^{-1} in combination with potassium at the rate of 150 kg ha^{-1} recorded singificantly highest number of primary branches produced (30.50). Nitrogen and potassium were considered the two important major nutrients among the three known to have a key role in the synthesis of amino acids and proteins, which could have increased the lateral growth in terms of branches. The above results were in close confirmity with the earlier findings of Kumar *et al*. (2003) and Gnyandev (2006) in China aster.

Significant differences were observed with respect to number of secondary branches per plant due to nitrogen, potassium as well as their interactions at 90 DAT (table 1). Siginificantly maximum number of secondary branches per plant was recorded by the application of nitrogen at the rate of 200 kg ha^{-1} (50.22) when compared with all other doses. Plants applied with higher quantities of nitrogen recorded significantly more number of secondary branches which might be due to the involvement of nitrogen in the basic reaction of photosynthesis that resulted in the formation of more number of leaves and branches. The lower rate of C:N ratio also encourages vegetative growth (Hartmann *et al*., 1981). Application of potassium at the rate of 150 kg ha^{-1} recorded singificantly highest number of secondary branches (46.55) and was found at par with the application of potassium at the rate of 200 kg ha^{-1}. Formation of number of secondary branches increased with an increase in the level of potassium application. It could be due to increased supply of carbohydrates to the growing meristematic and cambial tissue. Armstrong *et al.* (1988) reported an increase in the cell number and cell elongation particularly in the primary branches led to an increase in the formation of more number of secondary branches. Pal and Ghosh (2010) also reported similar findings in African marigold. Among the combinations, application of nitrogen at the rate of 200 kg ha^{-1} in combination with potassium at the rate of 150 kg ha^{-1} recorded singificantly highest number of secondry branches (53.67). Nitrogen and potassium are the two most important major nutrients known to have a key role in the synthesis of amino acids and proteins which could increase the lateral growth in terms of branches. The above findings were in confirmity with the earlier findings of Kumar *et al*. (2003) and Gnyandev (2006) in China aster.

The effect of nitrogen, potassium as well as their interactions were found significant on plant spread at 90 DAT (table 2). Significantly maximum plant spread was recorded by the application of nitrogen at the rate of 200 kg ha^{-1} (46.94 cm) when compared with all other doses of nitrogen. Plant spread has been found increased with increased dose of nitrogen application. Nitrogen is considered as an elementary constituent of many amino acids, nucleic acids, proteins, nucleotides, chlorophyll and numerous secondary metabolites such as alkaloids which are the important constituents of the protoplasm. Application of potassium at the rate of 150 kg ha^{-1} recorded singificantly maximum plant spread (45.82 cm). Photosynthetically produced carbohydrates are transported to the site of growth are used predominantly in the synthesis of nucleic acids and proteins hence, application of nitrogenous fertilizers during the vegetative growth phase to the plants controls the growth of the plant to a larger extent (Mengel and Kirkby, 1980). Plant spread was found increased with increased level of potassium application which might be due to an increase in the formation of number of primary and secondary branches per plant by enhanced supply of photosynthates to the growing meristematic and cambial tissues which ultimately improved the vegetative growth of the plant. Potassium fertilization may have a stimulating effect on the photosynthesis, phloem loading and translocation of carbohydrates as well as synthesis of large molecular weight substances. Similar observations were recorded in their earlier studies by Pal and Ghosh (2010) and Kishore *et al*. (2010) in African marigold. Application of nitrogen at the rate of 200 kg ha^{-1} in combination with potassium at the rate of 150 kg ha^{-1} recorded singificantly maximum plant spread (51.04 cm). Nitrogen and potassium are the two important constituents of chlorophylls, proteins and amino acids hence increased level of nitrogen enhanced the rate of photosynthesis thereby increased cell division and cell elongation took place which ultimately enhanced the vegetative growth. Further, there was a better utilization of nitrogen in the presence of potassium as reflected in increasing the plant spread. The above results were in confirmity with the earlier findings of Kumar *et al*. (2003) and Gnyandev (2006) in China aster.

Effect of nitrogen, potassium and their interactions on number of leaves per plant were found significant (table 2). Significantly highest number of leaves per plant was observed with the application of nitrogen at the rate of 200 kg ha^{-1} (92.02). Application of higher quantity of nitrogen showed the ability to increase cell division and cell differentiation in the growing meristematic tissue thereby increased the overall leaf production. Sharma *et*

Table 1 : Growth parameters of garland chrysanthemum as influenced by nitrogen and potassium levels during rabi season.

Treatment	90 DAT														
	Plant height (cm)					Number of primary branches					Number of secondary branches				
	K_{50}	K_{100}	K_{150}	K_{200}	Mean	K_{50}	K_{100}	K_{150}	K_{200}	Mean	K_{50}	K_{100}	K_{150}	K_{200}	Mean
N_{50}	74.00	77.02	78.50	79.17	**77.17**	16.44	17.83	18.59	19.27	**18.03**	38.33	42.00	43.26	41.46	**41.26**
N_{100}	81.00	81.98	82.53	83.84	**82.34**	20.40	21.13	21.70	21.92	**21.29**	42.98	43.29	43.61	43.69	**43.39**
N_{150}	84.50	84.55	86.75	86.60	**85.60**	22.47	23.03	23.67	24.04	**23.30**	44.83	45.19	45.64	46.00	**45.42**
N_{200}	86.50	87.88	91.50	89.50	**88.85**	25.00	26.17	30.50	26.80	**27.12**	46.70	49.00	53.67	51.49	**50.22**
Mean	**81.50**	**82.85**	**84.82**	**84.78**	**83.49**	**21.08**	**22.04**	**23.61**	**23.01**	**22.44**	**43.21**	**44.87**	**46.55**	**45.66**	**45.07**

Factors	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
N	0.45	1.32	0.24	0.63	0.38	1.11
K	0.45	1.32	0.24	0.63	0.38	1.11
N × K	0.86	2.50	0.48	1.26	0.66	2.11

Table 2 : Growth parameters of garland chrysanthemum as influenced by nitrogen and potassium levels during rabi season.

Treatment	90 DAT														
	Plant spread (cm)					Number of leaves					Dry weight of the plant (g)				
	K_{50}	K_{100}	K_{150}	K_{200}	Mean	K_{50}	K_{100}	K_{150}	K_{200}	Mean	K_{50}	K_{100}	K_{150}	K_{200}	Mean
N_{50}	38.00	40.25	41.89	40.80	**40.24**	53.25	61.33	65.81	68.67	**62.27**	11.25	11.87	13.00	13.00	**12.28**
N_{100}	39.80	41.80	44.86	42.50	**42.24**	75.33	76.40	77.99	78.93	**77.16**	13.75	14.25	14.75	15.10	**14.46**
N_{150}	41.25	44.00	45.50	44.20	**43.74**	81.60	82.07	83.83	83.53	**82.76**	15.22	15.70	16.20	16.70	**15.96**
N_{200}	42.80	46.00	51.04	47.90	**46.94**	88.57	89.50	98.00	92.00	**92.02**	17.00	17.50	20.20	18.25	**17.96**
Mean	**40.46**	**43.01**	**45.82**	**43.85**	**43.29**	**74.69**	**77.33**	**81.41**	**80.78**	**78.55**	**14.31**	**14.91**	**16.03**	**15.76**	**15.17**

Factors	SEm ±	CD at 5%	SEm ±	CD at 5%	SEm ±	CD at 5%
N	0.18	0.53	0.24	0.63	0.20	0.58
K	0.18	0.53	0.24	0.63	0.20	0.58
N × K	0.37	1.07	0.48	1.26	0.40	1.10

al. (2006) recorded maximum number of leaves (162.50) per plant with the application of nitrogen at the rate of 200 kg ha^{-1} in African marigold. Application of potassium at the rate of 150 kg ha^{-1} recorded significantly highest number of leaves per plant (81.41) when compared with all other doses. The number of leaves per plant was found increased with the application of graded levels of potassium. The reason may be attributed to an increase in the rate of photosynthetic activity and translocation of photo assimilates to the growing meristematic and cambial tissue thereby increasing the number of leaves per plant due to cell differentiation. The present results were in agreement with the earlier findings of Shah *et al.* (2014) who reported an increase in the level of potassium application led to increased number of leaves in *Zinnia elegans*. Application of nitrogen and potasssium in combination each at the rate of 200 kg ha^{-1} and 150 kg ha^{-1} have significantly increased the number of leaves per plant (98.00) when compared with all other combinations. Application of higher doses of nitrogen and potassium increased plant height and number of branches thereby increased more vegetative buds and ultimately increased number of leaves per plant. The present results were found in close confirmity with the earlier findings of Javid *et al*. (2005), who reported that a combined application of NPK at the rate of 30:20:20 g m^{-2} produced more number of leaves per plant in zinnia.

The data on influence of nitrogen, potassium and their interactions were found significant on dry weight of the plant (table 2). Significantly maximum dry weight of the plant was recorded by the application of nitrogen at the rate of 200 kg ha^{-1} (17.96 g) when compared with all other doses. Application of potassium at the rate of 150 kg ha^{-1} has recorded significantly highest dry weight of the plant (16.03) and was at par with the application of potassium at the rate of 200 kg ha^{-1} (15.76 g). Among the interactions, application of nitrogen at the rate of 200 kg ha^{-1} in combination with the application of potassium at the rate of 150 kg ha^{-1} has recorded significantly highest dry weight of the plnat (20.20 g). The increase in dry weight of the plant might be due to an increase in plant spread, number of branches per plant and leaf area per

Table 3 : Flower yield parameters of garland chrysanthemum as influenced by nitrogen and potassium levels during rabi season.

Treatment	90 DAT														
	Flower yield per plant (g)					Flower yield per plot (kg)					Flower yield per hectare (q)				
	K_{50}	K_{100}	K_{150}	K_{200}	Mean	K_{50}	K_{100}	K_{150}	K_{200}	Mean	K_{50}	K_{100}	K_{150}	K_{200}	Mean
N_{50}	12.50	16.73	17.07	17.38	**15.92**	0.21	0.35	0.38	0.39	**0.33**	3.80	6.50	7.33	7.70	**6.58**
N_{100}	17.53	17.97	15.60	18.50	**17.50**	0.44	0.46	0.49	0.52	**0.48**	8.10	8.40	9.48	9.90	**8.97**
N_{150}	18.37	19.57	20.57	21.00	**20.61**	0.60	0.62	0.63	0.64	**0.62**	9.95	11.83	12.30	12.74	**11.71**
N_{200}	25.05	24.21	36.00	30.00	**25.38**	0.72	0.78	1.08	0.88	**0.87**	13.50	14.00	25.25	20.75	**18.38**
Mean	**18.36**	**19.62**	**22.31**	**21.72**	**19.85**	**0.49**	**0.56**	**0.64**	**0.61**	**0.57**	**8.09**	**10.18**	**13.59**	**12.77**	**11.41**

Factors	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
N	0.38	1.10	0.02	0.06	0.46	1.35
K	0.38	1.10	0.02	0.06	0.46	1.35
N × K	0.78	2.09	0.04	0.11	0.88	2.56

plant. The present findings were in close confirmity with the earlier results reported by Ravindran *et al*. (1986) in marigold and Joshi *et al*. (2013) in chrysanthemum.

The data pertaining to flower yield of annual chrysanthemum was presented in Table-3. Among the individual treatments, application of nitrogen at the rate of 200 kg ha^{-1} has recorded significantly highest yield per plant (25.38 g), per plot (0.87 kg) and per hectare (18.38 q) when compared with all other doses of nitrogen application. Application of potassium at the rate of 150 kg ha^{-1} has recorded significantly highest flower yield per plant (22.31 g), per plot (0.64 kg) and per hectare (13.59 q) and was found at par with the application of potassium at the rate of 200 kg ha^{-1}. Among the interactions, application of nitrogen at the rate of 200 kg ha^{-1} in combination with the potassium at the rate of 150 kg ha^{-1} has recorded significantly highest flower yield per plant (30.00 g), per plot (1.08 kg) and per hectare (25.25 q) when compared with all other combinations of nitrogen and potassium. Based on the results obtained, it may be concluded that number of flowers per plant increased with the application of graded levels of nitrogen and potassium in different combinations. The yield of flowers per plant increased with the application of nitrogen mainly because of increased carbohydrate reserve for the development of floral primordia apart from the structural development of the plant. The present results were in confirmation with the earlier findings of Agarwal *et al*. (2002), Sharma *et al*. (2006), Rajbeer and Jitendra (2009) in African marigold.

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