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Studies on the Effect of Nitrogen and Potassium on Flowering in Crossandra (*Crossandra infundibuluformis* L.)

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A B S T R A C T

An experiment was carried out to study the effect of NK on flowering in crossandra. The experiment consists of sixteen treatment combinations of nitrogen and potassium. The results showed that the maximum number of spikes/plant (39.81), number of florets/spike (576.29), flower yield/plant (582.03g), weight of 100 flowers (19.19g), Shelf life (11.95 days) was recorded with 150 kg/ha N along with 60 kg/ha K.

Introduction

Fire cracker plant (*Crossandra infundibuliformis* L.) is native of India. It is an important group of flowering plants cultivated on a commercial scale (orange varieties) and is being grown extensively in South India. The plants are quite hardy and can be grown for flowerbeds and /or for loose flowers. The word crossandra is derived from Greek words 'krossoi' meaning fringe and 'aner' meaning male, thus word crossandra means fringed stamens. This flower is also a valuable ornamental pot flower in Sweden, Denmark and Hungary (Ottosen and Christensen, 1986). It is an evergreen shrub of minor importance. It belongs to the family Acanthaceae. It consists of five cultivars, namely, orange, yellow, red, deep orange and bluish flowered forms. The bright orange coloured flowers are widely used in temple offerings and for making gajras and venis to use as hair adornments.

Materials and Methods

The experiment was carried out during the *kharif* season of 2013-2014 at Horticultural College and Research Institute, Venkataramannagudem, West Godavari District of Andhra Pradesh. The experiment was laid out in a Randomized Block Design (RBD) with factorial concept replicated thrice. T_1 (0 kg nitrogen ha^{-1} + 0 kg potassium ha^{-1}) T_2 (0 kg nitrogen ha $^{-1}$ + 60 kg potassium ha^{-1}), T_3 (0 kg nitrogen ha $^{-1}$ + 120 kg potassium ha^{-1}), T_4 (0 kg nitrogen ha^{-1} + 180 kg potassium ha^{-1}), T_5 (50 kg nitrogen ha $^{-1}$ +

0 kg potassium ha^{-1}), T_6 (50 kg nitrogen ha^{-1} + 60 kg potassium ha^{-1}), T_7 (50 kg nitrogen ha^{-1} + 120 kg potassium ha^{-1}),T_8 (50 kg nitrogen ha^{-1} + 180 kg potassium ha^{-1}) T_9 (100 kg nitrogen ha^{-1} + 0 kg potassium ha^{-1}), T_{10} (100 kg nitrogen ha^{-1} + 60 kg potassium ha^{-1}) T_{11} (100 kg nitrogen ha^{-1} +120 kg potassium ha^{-1}),T_{12} (100 kg nitrogen ha^{-1} + 180 kg potassium ha^{-1}), T_{13} (150 kg nitrogen ha^{-1} + 0 kg potassium ha^{-1}) T_{14} (150 kg nitrogen ha^{-1} + 0 kg potassium ha^{-1}) T_{15} (150 kg nitrogen ha^{-1} + 120 kg potassium ha^{-1}) T_{16} (150 kg nitrogen ha^{-1} +180 kg potassium ha^{-1}). The obtained data was statistically analysed (ANOVA) and presented.

Results and Discussion

Number of spikes/plant

The data recorded on number of spikes/plant as influenced by nitrogen, potassium & their interactions at 120 and 180 DAT were presented in (Table 1). It was observed that, number of spikes/plant was significantly influenced by different levels of nitrogen at 120 DAT and at 180 DAT. Significantly maximum number of spikes/plant (32.11 at 120 DAT and 36.39 at 180 DAT) were recorded with the application of nitrogen @ 150 kg ha^{-1} (N_3) followed by 100 kg N ha^{-1}.Maximum number of spikes/plant (20.43 at 120 DAT and 22.09 at 180 DAT) were recorded with the application of potassium @ 60 kg ha^{-1} (K_1). Interactions had showed a significant influence on number of spikes/plant at both the stages. At 120 DAT, significantly maximum number of spikes/plant (39.81) were recorded with 150 kg N + 60 kg K ha^{-1} (N_3K_1). At 180 DAT, maximum number of spikes/plant (41.17) were observed with 150 kg N+ 60 kg K ha^{-1} (N_3K_1).Number of spikes/plant was found to increase with every increase in the nitrogen level up to 150 kg ha^{-1}. Supply of potassium could bring about an improvement in this parameter up to 60 kg ha^{-1} only. It is evident that better number of spikes per plant were recorded by nitrogen at 150 kg and potassium at 60 kg individually and also in combination. This combination could have encouraged the plant to put up more dry matter by increased photosynthetic surface or leaf area leading to better outturn of photosynthates which might have stimulated more floral buds and leading to a better number of spikes per plant. Similar results were reported by Dalvi *et al.*, (2008), Khan *et al.*, (2012) and Shaukat *et al.*, (2012) in gladiolus.

Number of florets/spike

The data recorded on number of florets/spike as influenced by nitrogen, potassium & their interactions at 120 DAT and 180 DAT were presented in (Table 2). Maximum number of florets/spike (538.47 at 120 DAT, 552.36 at 180 DAT) were recorded with 150 kg ha^{-1} (N_3), followed by 100 kg N ha^{-}1, Maximum number of florets/spike (351.39 at 120 DAT and at 180 DAT 378.67) were recorded with potassium application @ 60 kg ha^{-1} (K_1) which was followed by 120 kg ha^{-1} (K_2). The interactions showed a significant influence on florets/spike was at 120 DAT, significantly maximum number of florets/spike (576.29) were recorded with 150 kg N + 60 kg K ha^{-1} (N_3K_1), followed by 100 kg N + 120 kg K ha^{-1} (N_2K_2). At higher nitrogen levels, more vegetative growth and more accumulation of food reserves are diverted to flower bud differentiation and resulted in more number of florets per spike. Elevated potassium level accelerated many bio-chemical reactions and led to the more number of florets per spike. The mechanism of flower bud initiation and development is closely related to the well flourished vegetative growth. Similar results were reported by Patel *et al.*, (2010), Lehri *et al.*, (2011) and Khan *et al.*, (2012) in gladiolus. The increased number of florets under higher dose of nitrogen may be attributed to more number of floret bearing branches per plant. Similar increase in flower number with higher fertilizer levels was also noticed by Kumar *et al.,* (2003) and Gnyandev (2006) in China aster, Saud and Ramachandra (2004) and Acharya and Dashera (2004) in marigold.

Flower yield per plant (g)

The data recorded on flower yield/plant (g) as influenced by nitrogen, potassium & their interactions at 120 DAT and 180 DAT were presented in (Table 3). maximum flower yield of 480.49 g at 120 DAT and 858.69 g at 180 DAT was recorded with nitrogen @ 150 kg ha^{-1} (N_3), followed by 100 kg N ha^{-1}. Maximum flower yield (436.46 g at 120 DAT and 816.27 g at 180 DAT) was recorded with potassium application @ 60 kg ha^{-1} (K_1) which was on par with 120 kg ha^{-1} (K_2). Interactions had showed a significant influence on flower yield.

Table.1 Effect of different levels of nitrogen and potassium on number of spikes/plant in crossandra

Treatment	120 DAT						180 DAT				
	K_0	K_{60}	K_{120}	K_{180}	Mean		K_0	K_{60}	K_{120}	K_{180}	Mean
N_0	2.94	4.43	7.02	10.08	**6.12**		8.70	10.67	10.83	12.18	**10.59**
N_{50}	11.07	14.40	16.91	17.44	**14.95**		13.93	15.06	15.61	17.08	**18.42**
N_{100}	22.82	23.09	32.76	26.79	**25.58**		18.35	21.33	31.98	25.05	**30.94**
N_{150}	27.83	39.81	28.04	29.61	**32.11**		27.03	41.17	27.21	29.20	**36.39**
Mean	**17.39**	**21.29**	**19.64**	**20.43**			**17.54**	**22.09**	**19.63**	**22.07**	
Source	**N**	**K**	**N×K**					**N**	**K**	**N×K**	
SE m±	0.26	0.26	0.32					0.49	0.49	0.98	
CD at 5%	0.76	0.76	1.52					1.42	1.42	2.84	

Table.2 Effect of different levels of nitrogen and potassium on number of florets/spike in crossandra

Treatment	120 DAT						180 DAT				
	K_0	K_{60}	K_{120}	K_{180}	Mean		K_0	K_{60}	K_{120}	K_{180}	Mean
N_0	20.02	44.11	97.24	151.65	**78.25**		161.32	175.51	205.40	226.27	**192.12**
N_{50}	172.70	244.92	283.81	286.74	**247.04**		231.47	243.00	290.30	291.85	**264.15**
N_{100}	362.04	418.35	562.01	473.44	**423.32**		369.59	422.73	573.36	486.45	**434.11**
N_{150}	439.45	576.29	521.82	493.74	**538.47**		457.67	581.27	544.72	510.10	**552.36**
Mean	**279.19**	**351.39**	**335.58**	**320.92**			**333.94**	**378.67**	**374.52**	**355.62**	
Source	**N**	**K**	**N×K**					**N**	**K**	**N×K**	
SE m±	0.67	0.67	1.34					3.65	3.65	7.30	
CD at 5%	1.95	1.95	3.90					10.54	10.54	21.18	

Table.3 Effect of different levels of nitrogen and potassium on flower yield /plant (g) in crossandra

Treatment	120 DAT					180 DAT				
	K_0	K_{60}	K_{120}	K_{180}	Mean	K_0	K_{60}	K_{120}	K_{180}	Mean
N_0	311.18	338.33	342.25	351.34	**335.77**	721.14	733.71	745.93	759.52	**740.07**
N_{50}	363.36	372.49	385.88	394.37	**379.02**	767.37	776.00	785.97	799.13	**782.11**
N_{100}	399.09	429.11	566.44	456.69	**462.83**	838.83	848.45	866.80	853.98	**852.05**
N_{150}	432.28	582.03	451.29	456.38	**480.49**	850.05	876.18	856.06	852.48	**858.69**
Mean	**335.77**	**436.46**	**430.49**	**414.69**		**794.34**	**816.27**	**813.69**	**808.58**	
Source	**N**	**K**	**N×K**				**N**	**K**	**N×K**	
SE m±	0.70	0.70	1.40				0.32	0.32	0.64	
CD at 5%	2.04	2.04	4.08				0.93	0.93	1.86	

Table.4 Effect of different levels of nitrogen and potassium on weight of 100 flowers (g) in crossandra

Nitrogen	Potassium				
	K_0	K_{60}	K_{120}	K_{180}	Mean
N_0	4.70	5.43	6.79	7.31	**6.06**
N_{50}	8.34	9.21	10.86	11.43	**9.96**
N_{100}	12.52	13.40	14.41	15.92	**14.06**
N_{150}	16.10	19.19	18.17	17.54	**17.75**
Mean	**10.41**	**13.05**	**12.55**	**11.81**	
Source	**N**	**K**	**N×K**		
SE m±	0.12	0.12	0.24		
CD at 5%	0.36	0.36	0.73		

Table.5 Effect of different levels of nitrogen and potassium on shelf life (days) in crossandra

Nitrogen	Potassium				
	K_0	K_{60}	K_{120}	K_{180}	Mean
N_0	4.72	5.49	5.65	5.83	**5.42**
N_{50}	5.85	6.22	6.53	7.39	**6.49**
N_{100}	7.47	7.77	9.35	8.27	**8.21**
N_{150}	8.36	11.95	8.37	9.00	**9.42**
Mean	**6.60**	**7.85**	**7.47**	**7.62**	
Source	**N**	**K**	**N×K**		
SE m±	0.27	0.27	0.54		
CD at 5%	NS	NS	NS		

At 120 DAT, maximum flower yield (582.03 g) was recorded with 150 kg N + 60 kg K ha^{-1} (N_3K_1), followed by 100 kg N + 120 kg K ha^{-1} (N_2K_2). The favourable growing environment and climatic factors will contribute for expression of maximum yield potential in the flowers (Betonia, 1996, Praneetha *et al.*, 2002 and Talia *et al.*, 2003).

Weight of 100 flowers (g)

The data recorded on weight of 100 flowers (g) as influenced by nitrogen, potassium & their interactions were presented in (Table 4). The data showed that the weight of 100 flowers increased with increasing levels of nitrogen. The maximum weight of 100 flowers (17.75 g) was obtained with 150 kg N ha^{-1} (N_3), followed by 100 kg N ha^{-1} (N_2) with 14.06 g. Among the different levels of potassium, the maximum weight of 100 flowers (13.05 g) was found with 60 kg K ha^{-1} (K_1) which was significantly superior to other treatments. The maximum weight of 100 flowers (19.19 g) was recorded with 150 kg N + 60 kg K ha^{-1} (N_3K_1) treatment combination, followed by application of 150 kg N + 120 kg K ha^{-1} (N_3K_2) The role of potassium in plants includes cation transport across membrane, water economy, energy metabolism and enezyme activity as stated by Mengel and Kirby (1980). Potassium increases carbon exchange and enhances carbohydrate movement (Collins and Duke, 1981) and consequently stimulates vegetative growth and decreases the translocation of photosynthates into storage organs. This result may also be due to the role of nitrogen in stimulating vegetative growth as supported by other researcher's viz., Padaganur *et al.,* (2005) in tuberose, Pandey and Mishra (2005) in marigold.

Shelf life (days)

The data recorded on shelf life (days) as influenced by nitrogen, potassium and their interactions were presented in (Table 5). The data indicated that the levels of nitrogen, potassium and their interactions did not have significant effect on the shelf life of florets. However, maximum shelf life (9.42 days) of florets was recorded with 150 kg N ha^{-1} (N_3). Among the different levels of potassium, the maximum shelf life (7.85 days) of florets was recorded with 60 kg K ha^{-1} (K_1) The maximum shelf life (11.95 days) of florets was recorded with 150 kg N + 60 kg K ha^{-1} (N_3K_1) treatment combinations and the minimum shelf life (4.72 days) was recorded with 0 kg nitrogen and potassium (N_0K_0). Similar findings have been obtained by Clark and Burge (1997) and Srinivas (1994) in china aster.

It can be concluded that application of 150 kg/ha N along with 60 kg/ha K would be effective in improving flowering of crossandra.

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