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Effect of graded level of nitrogen and phosphorus on yield, quality and total uptake of calendula

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Abstract

This research was conducted to investigate the effect of graded level of N and P on yield, quality and uptake of calendula, during winter season at Horticulture Section, College of Agriculture, Nagpur. Using different levels and combination of nitrogen and phosphorus for evaluate the yield, quality and uptake of calendula. The Experiment was laid out in factorial in randomized block design with sixteen treatments (each treatment with 3 replications). The results of present investigation revealed that, application of 100 kg ha⁻¹ N and 50 kg ha⁻¹ P produced significantly maximum shelf life, vase life of flower and oil content in flower with respect to quality parameters which were at par with the results obtained with the application of 125 kg ha⁻¹ N and 75 kg ha⁻¹ P. Total uptake of nitrogen, phosphorus, potassium in flower and plant of calendula maximum in treatment combination N₃P₃ i.e. 125 kg ha⁻¹ N and 75 kg ha⁻¹ P. The interaction effects revealed that, they were significant in respect to number of flowers plant⁻¹, flower yield q ha⁻¹, oil content in flower and total NPK uptake of calendula. For these parameters, the best treatment combination was 100 kg N kg ha⁻¹ + 50 P kg ha⁻¹ and 125 N kg ha⁻¹ + 75 P kg ha⁻¹.

Keywords: Calendula, Nitrogen, Phosphorus, yield, quality, uptake

Introduction

Calendula is very important ornamental plant which growing as winter annual for landscaping. It belongs to family, *Compositae*. It is considered as a valuable medicinal plant which contains oleanolic acid and other compounds, which have considerable interest for potential health benefits, including protective effects against development of cancer, inhibition of existing tumour cells, protection against several diseases (Dharmananda and Subhuti, 2003). Pigment of calendula flower is used in food colouring. It has a long flowering period bearing large yellow or orange single or double flowers with many petals. This hardy annual prefers well drained, light and sandy soil and grows to a height on about 21-65 cm. Nitrogen and phosphorus are essential nutrients for any plant growth. These nutrients are sometime deficient in soil which fulfilled by application of fertilizers based on soil analysis and crop requirement. Nitrogen is responsible for synthesis of protein, amino acids, nucleic acids, chlorophyll and protoplasm of cell which help in harvesting solar energy through chlorophyll compounds. Phosphorus is a structural component of the cell constituent. Phosphorus plays a vital role in photosynthesis, respiration, energy storage and cell division. It promotes early root formation and growth. Phosphorus improves the quality of flower. It also brings early seed formation by stimulating early flowering.

Material and methods

The present investigation was carried out at Horticulture section, Nagpur during October 2018 to March 2019 to study the effect of graded level of N and P on growth, flower, yield and quality of calendula. The research was carried out on the local variety. Sixteen treatment combinations with four levels of 50, 75, 100, 125 kg ha⁻¹ and phosphorus 0, 25, 50 and 75 kg ha⁻¹ were tested in factorial randomized block design with three replications. The different combinations of nitrogen and phosphorus as : T₁ – 0 kg N ha⁻¹ + 0 kg P ha⁻¹ (N₀P₀), T₂ – 0 kg N ha⁻¹ + 25 kg P ha⁻¹ (N₀P₁), T₃ – 0 kg N ha⁻¹ + 50 kg P ha⁻¹ (N₀P₂), T₄ – 0 kg N ha⁻¹ + 75 kg P ha⁻¹ (N₀P₃), T₅ – 75 kg N ha⁻¹ + 0 kg P ha⁻¹ (N₁P₀) T₆ – 75 kg N ha⁻¹ + 25 kg P ha⁻¹ (N₁P₁), T₇ – 75 kg N ha⁻¹ + 50 kg P ha⁻¹ (N₁P₂), T₈ – 75 kg N ha⁻¹ + 75 kg P ha⁻¹ (N₁P₃), T₉ – 100 kg N ha⁻¹

+ 0 kg P ha⁻¹ (N₂P₀), T₁₀- 100 kg N ha⁻¹ + 25 kg P ha⁻¹ (N₂P₁), T₁₁-100 kg N ha⁻¹ + 50 kg P ha⁻¹ (N₂P₂) T₁₂-100 kg N ha⁻¹ + 75 kg P ha⁻¹ (N₂P₃), T₁₃ - 125 kg N ha⁻¹ + 0 kg P ha⁻¹ (N₃P₀), T₁₄-125 kg N ha⁻¹ + 25 kg P ha⁻¹ (N₃P₁), T₁₅ - 125 kg N ha⁻¹ + 50 kg P ha⁻¹ (N₃P₂) and T₁₆ - 125 kg N ha⁻¹ + 75 kg P ha⁻¹ (N₃P₃). The seeds of calendula were sown in the nursery beds in the month of October, 2018. Calendula seedlings of uniform size were transplanted 15 days after sowing at the spacing of 30 cm x 30 cm in the month of October, 2018. Full doses of nitrogen and phosphorus as per the treatments and recommended dose of 50 kg K kg ha⁻¹ were applied at the time of transplanting.

Package of practices including irrigation were adopted as per recommendation. Five plants were selected randomly from

each plot for recording various yield parameters i.e., number of flowers plant⁻¹, flower yield q ha⁻¹, shelf life, vase life of flower and oil content in flower with respect to quality parameters and total uptake of NPK by calendula were recorded on these randomly selected plants. Data were statistically analysed in FRBD (Panse and Sukhatme, 1967) [5].

Results and discussion

The data presented in table 1, 2 and 3 revealed that, different levels of nitrogen and phosphorus had significant effect on all growth, flowering, yield and quality parameters of calendula.

Table 1: Effect of graded level of N and P on number of flowers plant⁻¹, flower yield q ha⁻¹ of calendula

Treatment	Phosphorus levels (P) kg ha ⁻¹					Phosphorus levels (P) kg ha ⁻¹				
	Flower per plant					flower yield (q) ha ⁻¹				
Nitrogen level	0 (P ₀)	25 (P ₁)	50 (P ₂)	75 (P ₃)	Average	0 (P ₀)	25 (P ₁)	50 (P ₂)	75 (P ₃)	Average
N ₀ - 0 kg N ha ⁻¹	37.73	40.96	42.50	42.06	40.81	54.26	61.23	67.13	65.50	62.03
N ₁ - 75 kg N ha ⁻¹	41.46	45.06	48.03	47.43	45.50	62.43	67.40	72.00	70.46	68.07
N ₂ -100 kg N ha ⁻¹	45.13	48.30	55.16	53.23	50.45	76.43	79.93	94.60	89.70	85.16
N ₃ -125 kg N ha ⁻¹	44.90	47.90	53.93	52.53	49.81	75.66	78.83	90.50	87.10	83.02
Average	42.30	45.55	49.90	48.81		67.20	71.85	81.05	78.19	
	(N)	(P)	Interaction N X P			(N)	(P)	Interaction N X P		
'F' test	Sig.	Sig.	Sig.			Sig.	Sig.	Sig.		
SE (m) ±	1.09	1.09	2.67			1.35	1.35	3.31		
CD at 5%	3.14	3.14	7.71			3.91	3.91	9.58		

Table 2: Effect of graded level of N and P on shelf life, vase life and oil content in calendula

Treatment	Phosphorus levels (P) kg ha ⁻¹					Phosphorus levels (P) kg ha ⁻¹					Phosphorus levels (P) kg ha ⁻¹				
	Shelf life of flower (days)					Vase life of flower (days)					Oil content in flower (%)				
Nitrogen level	0 (P ₀)	25 (P ₁)	50 (P ₂)	75 (P ₃)	Average	0 (P ₀)	25 (P ₁)	50 (P ₂)	75 (P ₃)	Average	0 (P ₀)	25 (P ₁)	50 (P ₂)	75 (P ₃)	Average
N ₀ - 0 kg N ha ⁻¹	1.13	1.23	1.33	1.26	1.24	2.93	3.10	3.46	3.36	3.21	0.22	0.23	0.24	0.24	0.23
N ₁ - 75 kg N ha ⁻¹	1.36	1.43	1.53	1.46	1.45	3.40	3.66	3.76	3.70	3.63	0.24	0.25	0.25	0.26	0.25
N ₂ -100 kg N ha ⁻¹	1.66	1.73	1.86	1.80	1.76	3.76	3.80	4.00	3.86	3.85	0.25	0.26	0.29	0.28	0.28
N ₃ -125 kg N ha ⁻¹	1.63	1.70	1.83	1.76	1.73	3.70	3.76	3.93	3.83	3.80	0.25	0.26	0.28	0.27	0.26
Average	1.45	1.52	1.64	1.57		3.45	3.58	3.79	3.69		0.24	0.25	0.27	0.26	
	(N)	(P)	N X P			(N)	(P)	N X P			(N)	(P)	N X P		
'F' test	Sig.	Sig.	N.S.			Sig.	Sig.	N.S.			Sig.	Sig.	Sig.		
SE (m) ±	0.03	0.03	0.08			0.04	0.04	0.11			0.004	0.004	0.01		
CD at 5%	0.09	0.09	-			0.13	0.13	-			0.012	0.012	0.03		

Table 3: Effect of graded level of N and P on total uptake of NPK by calendula (plant and flower)

Treatments	Phosphorus levels (P) kg ha ⁻¹					Phosphorus levels (P) kg ha ⁻¹					Phosphorus levels (P) kg ha ⁻¹				
	Total uptake of N by calendula plant and flower (kg ha ⁻¹)					Total uptake of P by calendula plant and flower (kg ha ⁻¹)					Total uptake of K by calendula plant and flower (kg ha ⁻¹)				
Nitrogen levels	0 (P ₀)	25 (P ₁)	50 (P ₂)	75 (P ₃)	Average	0 (P ₀)	25 (P ₁)	50 (P ₂)	75 (P ₃)	Average	0 (P ₀)	25 (P ₁)	50 (P ₂)	75 (P ₃)	Average
N ₀ - 0 kg N ha ⁻¹	79.46	85.67	89.04	95.52	87.42	42.63	48.34	52.15	56.74	49.96	102.91	103.96	116.50	118.71	110.52
N ₁ - 75 kg N ha ⁻¹	86.79	92.08	97.47	104.71	95.26	52.40	58.40	65.46	67.95	61.05	114.77	116.97	119.43	121.05	118.05
N ₂ -100 kg N ha ⁻¹	96.06	97.76	103.13	108.09	101.26	56.50	65.31	69.25	79.12	67.54	118.53	120.77	123.34	126.02	122.16
N ₃ -125 kg N ha ⁻¹	103.60	107.57	111.69	119.80	110.68	66.38	70.94	75.27	84.62	75.30	124.76	126.76	130.66	135.80	129.50
Average	91.46	95.80	100.33	107.03		54.47	60.75	65.53	72.11		115.24	117.11	122.48	125.39	
	(N)	(P)	N X P			(N)	(P)	N X P			(N)	(P)	N X P		
'F' test	Sig.	Sig.	Sig.			Sig.	Sig.	Sig.			Sig.	Sig.	Sig.		
SE (m) ±	0.90	0.90	2.21			0.78	0.78	1.91			1.25	1.25	3.06		
CD at 5%	2.60	2.60	6.39			2.26	2.26	5.53			3.61	3.61	8.85		

Yield parameter

Significantly maximum number of flower plant⁻¹ in treatment combination of N₂P₂ i.e. 100 kg N and 50 kg P ha⁻¹ (55.16) which was followed by the treatment combination N₃P₂ i.e. 125 kg N and 50 kg P ha⁻¹ (53.93). However, minimum number of flower plant⁻¹ in treatment combination N₀P₀ i.e. control treatment (37.73). Interaction effect of nitrogen and phosphorus might due to synergistic activities of all the

growth nutrients which played active role in enlarging plants cell and tissues, consequently increased vegetative growth. Similar results were recorded by Sonawane *et al.*, (2008) [8] that, the application of nitrogen 200 kg ha⁻¹ with phosphorus 75 kg ha⁻¹ recorded maximum numbers of flowers plant⁻¹ in china aster.

An application 100 kg nitrogen and 50 kg phosphorus ha⁻¹ (N₂P₂) had recorded maximum flower yield ha⁻¹ (94.60 q)

which was followed with the treatment combinations N_3P_2 i.e. 125 kg nitrogen and 50 kg phosphorus ha^{-1} (90.50 q). However, minimum flower yield ha^{-1} (54.26 q) was recorded in control treatment (N_0P_0). From above finding, it was shown that, maximum flower yield ha^{-1} was recorded under the treatment N_2P_2 i.e. application 100 kg nitrogen and 50 kg phosphorus ha^{-1} . Interaction effect of nitrogen and phosphorus might due to synergistic activities of all the growth nutrients which played active role in enlarging plants cell and tissues, consequently increased vegetative growth. Similar result were noted by Saman and Kirad (2013) that, the application of nitrogen 150 kg ha^{-1} and phosphorus 80 kg ha^{-1} had maximum flower yield ha^{-1} in calendula.

Quality parameter

An application 100 kg N and 50 kg P ha^{-1} had recorded maximum shelf life of calendula flower (1.86 days) which was followed with the treatment combinations 125 kg N and 50 kg P ha^{-1} (1.83 days). However, minimum shelf life of calendula flower (1.13 days) was recorded in control treatment

Maximum vase life of flower was observed in treatment combination N @ 100 kg ha^{-1} and P @ 50 kg ha^{-1} (4.00 days) which was followed by 125 kg N and 50 kg P ha^{-1} (3.93 days). However, Minimum vase life of flower was recorded in treatment combination N_0P_0 i.e. control treatment (2.93 days). The similar result were also observed by Navyashree *et al.*, (2017) reported that, application of nitrogen 62.5 g plant⁻¹ with 25 g P_2O_5 plant⁻¹ resulted significantly maximum vase life of flower in bird of paradise.

An application 100 kg N and 50 kg P ha^{-1} had recorded maximum oil content in flower (0.29%) which was followed with the treatment combinations 125 kg N and 50 kg P ha^{-1} (0.27%). However, minimum oil content in flower (0.22%) was recorded in control treatment. The similar result were also reported by Shirsat *et al.*, (2015) [7] that, application of nitrogen 180 kg ha^{-1} with phosphorus 120 kg ha^{-1} resulted significantly increase the oil per cent in marigold flower.

Total uptake of calendula plant and flower

Significantly maximum total uptake of N in calendula plant and flower was observed in treatment combination N_3P_3 i.e. 125 kg N and 75 kg P ha^{-1} (119.80 kg ha^{-1}) which was followed by N_3P_2 i.e. 125 kg N and 50 kg P ha^{-1} (111.69 kg ha^{-1}). However, minimum total uptake of N in calendula plant and flower was recorded in treatment control (79.46 kg ha^{-1}). The results were similar with results updated by Nagaich *et al.*, (2003) [3] that, an application of N 120 kg ha^{-1} and P 60 kg ha^{-1} had recorded maximum uptake of N by plant in marigold. Significantly maximum total uptake of P in calendula plant and flower was observed in treatment combination N_3P_3 i.e. 125 kg N and 75 kg P ha^{-1} (84.62 kg ha^{-1}) which was followed by N_2P_3 i.e. 100 kg N and 75 kg P ha^{-1} (79.12 kg ha^{-1}). However, minimum total uptake of P in calendula plant and flower was recorded in control treatment (42.63 kg ha^{-1}). From above results, it is shown that, the phosphorus uptake by different parts as well as total uptake, increased significantly with every step increase in the phosphorus levels. This might be attributed to increased availability and absorption of phosphorus from soil and also increased dry matter production. Similar finding were reported by Polara *et al.*, (2014) [2] updated that, an application of N at 200 kg ha^{-1} and P 150 kg ha^{-1} recorded maximum uptake of P by the plant in marigold cv. Pusa Narangi Gaında.

Significantly maximum total uptake of K in calendula plant and flower in treatment combination N_3P_3 i.e. 125 kg N and 75 kg P ha^{-1} (135.80 kg ha^{-1}) which was followed by N_2P_3 i.e. 100 kg N and 75 kg P ha^{-1} (130.66 kg ha^{-1}). However, minimum total uptake of K in calendula plant and flower was recorded in control treatment (102.91 kg ha^{-1}). The results were similar with the finding of Badole *et al.*, (2015) [1] that, the combined application of N @ 200 kg ha^{-1} and P @ 75 kg ha^{-1} significant increase in uptake of K in china aster.

Conclusion

The combine application of nitrogen @ 100 kg ha^{-1} and phosphorus @ 50 kg ha^{-1} improve the yield parameter i.e., flower plant⁻¹, fresh flower yield, quality parameter i.e. shelf life, vase life and oil content in calendula and combine application of nitrogen @ 125 kg ha^{-1} and phosphorus @ 75 kg ha^{-1} significantly improve the total uptake of calendula plant and flower

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