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Effect of Graded Level of N and P on Growth and Yield of Calendula

Ommala D. Kuchanwar[1*], Ruchika S. Nagmote[1], Neha K. Chopde[2], Shanti Patil[3], Padmaja H. Kausadikar[1] and P. A. Panghate[1]

[1]Dept. of Soil Science & Agricultural Chemistry, [3]Dept. of Botany, College of Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Nagpur, Maharashtra (440 001), India

[2]Associate Professor of Horticulture, College of Agriculture, Sonapur, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Gadchiroli, Maharashtra (442 605), India

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Corresponding Author

Ommala D. Kuchanwar

e-mail: ommalakuchanwar@yahoo.com

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Abstract

An experiment to study the effect of graded level of N and P on growth and yield of calendula was carried out at Horticulture Section, College of Agriculture, Nagpur, during October 2018 to march 2019 with sixteen treatment combinations in factorial randomized block design. The treatments comprised of four levels of nitrogen 50, 75, 100, 125 kg ha^{-1} and phosphorus 0, 25, 50 and 75 kg ha^{-1} applied as per the treatments. The results of present investigation revealed that, application of 100 kg ha^{-1} nitrogen and 50 kg ha^{-1} phosphorus produced significantly maximum stem diameter and plant spread with respect to growth parameter, minimum days for first flower bud initiation, days for opening of first flower from bud initiation, days for 50% flowering with respect to flowering parameters and number of flowers plant^{-1}, flower yield q ha^{-1} and dry matter plant yield q ha^{-1} with respect to yield parameters which were at par with the results obtained with the application of 125 kg ha^{-1} nitrogen and 50 kg ha^{-1} phosphorus. The interaction effects revealed that, they were significant in respect number of flowers plant^{-1} and flower yield q ha^{-1}. For these parameters, the best treatment combination was 100 kg N kg ha^{-1} + 50 P kg ha^{-1}. It was followed by 125 N kg ha^{-1} + 50 P kg ha^{-1}.

1. Introduction

Floriculture is one of the most important branches of Horticulture in aesthetic, social and commercial sense. It has been closely associated with Indian culture from Vedic times. Nowadays, there is great demand for cut flowers in local and export market. The important flowers having more demand are Rose, Gerbera, Carnation, Gladiolus, Chrysanthemum, Marigold, Aster, Orchids, and Calendula etc. The total area under floriculture crops in India was estimated to be 9,43,000 hectares with approximate production 5.93 lakh metric tons of cut flowers and 1.653 lakh metric tons of loose flowers (Anonymous, 2017).

Among the various annuals calendula is one of the most commonly cultivated seasonal flower crops. It belongs to family *compositae*. It is also known as pot marigold. The name is derived from the word 'Calendae' meaning first day of the month. It is originated in South Europe. The plant prefers sunny situations and well drained rich soil. It can be grown as a winter seasonal at the places having mild climate.

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.

2. Materials and Methods

The present investigation was carried out at Horticulture section, College of Agriculture, Nagpur during October 2018 to March 2019 to study the effect of graded level of N and P on growth and yield 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 were as,

T_1 = 0 kg N ha^{-1} + 0 kg P ha^{-1} (N_0P_0),

T_2 = 0 kg N ha^{-1} + 25 kg P ha^{-1} (N_0P_1),

T_3 = 0 kg N ha^{-1} + 50 kg P ha^{-1} (N_0P_2),

T_4 = 0 kg N ha^{-1} + 75 kg P ha^{-1} (N_0P_3),

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T_5 = 75 kg N ha^{-1} + 0 kg P ha^{-1} (N_1P_0),
T_6 = 75 kg N ha^{-1} + 25 kg P ha^{-1} (N_1P_1),
T_7 = 75 kg N ha^{-1} + 50 kg P ha^{-1} (N_1P_2),
T_8 = 75 kg N ha^{-1} + 75 kg P ha^{-1} (N_1P_3),
T_9 = 100 kg N ha^{-1} + 0 kg P ha^{-1} (N_2P_0),
T_{10} = 100 kg N ha^{-1} + 25 kg P ha^{-1} (N_2P_1),
T_{11} = 100 kg N ha^{-1} + 50 kg P ha^{-1} (N_2P_2),
T_{12} = 100 kg N ha^{-1} + 75 kg P ha^{-1} (N_2P_3),
T_{13} = 125 kg N ha^{-1} + 0 kg P ha^{-1} (N_3P_0),
T_{14} = 125 kg N ha^{-1} + 25 kg P ha^{-1} (N_3P_1),
T_{15} = 125 kg N ha^{-1} + 50 kg P ha^{-1} (N_3P_2), and
T_{16} = 125 kg N ha^{-1} + 75 kg P ha^{-1} (N_3P_3).

The seeds of calendula were sown in the nursery beds in the month of October. Calendula seedlings of uniform size were transplanted 15 days after sowing at the spacing of 30 cm × 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 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 growth parameters *viz.*, stem diameter and plant spread were recorded at 50 percent flowering and flowering parameters *viz.*, minimum days for first flower bud initiation, days for opening of first flower from bud initiation and days for 50% flowering and yield parameters *i.e.*, number of flowers $plant^{-1}$, flower yield q ha^{-1} and dry matter yield q ha^{-1} were recorded on these randomly selected plants. Data were statistically analysed in FRBD (Panse and Sukhatme, 1967).

3. 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 and yield parameters of calendula.

3.1 Growth Parameters

Significantly maximum stem diameters were observed in treatment combination of 100 kg nitrogen and 50 kg phosphorus ha^{-1} (0.47 cm) which was followed by 125 kg nitrogen and 50 kg phosphorus ha^{-1} (0.46 cm). However, minimum stem diameter was recorded in control treatment (0.32 cm). Similar results were reported by Solanki and Genie (2009) that, the application of 300 kg N ha^{-1} and 200 kg P_2O_5 ha^{-1} significantly increase stem diameter of plant in African marigold.

Spread of plant at 50 percent flowering stage was recorded significantly maximum in treatment combination of 100 kg nitrogen and 50 kg phosphorus ha^{-1} (45.56 cm) which was followed by 125 kg nitrogen and 50 kg phosphorus ha^{-1} (41.35 cm). However, minimum spread of plant was recorded in control treatment (30.46 cm). This might be due to synergistic activities in all the growth nutrients which played active role in enlarging plant cells and tissues, consequently increased vegetative growth. The above results were similar to the results reported by Nath *et al.*, (2010) that, an application of 200 kg nitrogen ha^{-1} and 100 kg phosphorus ha^{-1} had recorded maximum plant spread in China aster cv. Phule Ganesh White.

3.2 Flowering Parameter

Minimum days required for opening of first flower from bud initiation in treatment combination of nitrogen @ 100 kg ha^{-1} and phosphorus @ 50 $kgha^{-1}$ (44.00 days) which was followed by 125 kg nitrogen and 50 kg phosphorus ha^{-1} (46.93 days). However, maximum days required for opening of first flower from bud initiation was recorded in treatment combination control treatment (64.60 days). The results were similar to the findings recorded by Samoon *et al.* (2018) that, the application of nitrogen 150 kg ha^{-1} with phosphorus 80 kg

Table 1: Effect of graded level of N and P on stem diameter and plant spread at 50% flowering of calendula

Treatments	Phosphorus levels (P) kg ha^{-1}					Phosphorus levels (P) kg ha^{-1}				
Nitrogen levels	Stem diameter at 50 % flowering (cm)					Plant spread at 50 % flowering (cm)				
	0 (P_0)	25 (P_1)	50 (P_2)	75 (P_3)	Avg.	0 (P_0)	25 (P_1)	50 (P_2)	75 (P_3)	Avg.
N_0- 0 kg N ha^{-1}	0.32	0.36	0.39	0.42	0.37	30.46	33.46	35.90	34.66	33.62
N_1- 75 kg N ha^{-1}	0.38	0.40	0.43	0.45	0.41	36.10	36.50	41.30	40.26	38.54
N_2-100 kg N ha^{-1}	0.44	0.45	0.47	0.45	0.45	40.43	41.00	45.56	41.13	42.03
N_3-125 kg N ha^{-1}	0.41	0.43	0.46	0.45	0.44	35.86	36.20	42.66	40.70	38.85
Average	0.39	0.41	0.45	0.44	-	35.71	36.79	41.35	39.19	
	(N)	(P)		Interaction (N × P)		(N)	(P)		Interaction (N × P)	
'F' test	Sig.	Sig.		N.S.		Sig.	Sig.		N.S.	
SE (m) ±	0.014	0.014		0.03		0.70	0.70		1.73	
CD at 5%	0.042	0.042		-		2.04	2.04		-	

Table 2: Effect of graded level of N and P on minimum days for first flower bud initiation, days for opening of first flower from bud initiation and days for 50% flowering of calendula

Treatments	Phosphorus levels (P) kg ha^{-1}					Phosphorus levels (P) kg ha^{-1}					Phosphorus levels (P) kg ha^{-1}				
Nitrogen levels	Stem diameter at 50 % flowering (cm)					Plant spread at 50 % flowering (cm)					Days for 50% flowering				
	0 (P_0)	25 (P_1)	50 (P_2)	75 (P_3)	Avg.	0 (P_0)	25 (P_1)	50 (P_2)	75 (P_3)	Avg.	0 (P_0)	25 (P_1)	50 (P_2)	75 (P_3)	Avg.
N_0- 0 kg N ha^{-1}	64.60	62.43	57.20	59.23	60.86	6.66	6.23	5.56	5.70	6.04	83.55	81.86	79.13	78.90	80.86
N_1- 75 kg N ha^{-1}	55.60	53.46	50.10	52.86	53.00	5.93	5.56	5.26	5.13	5.47	80.43	78.63	74.30	74.76	77.03
N_2-100 kg N ha^{-1}	46.10	48.03	44.00	47.16	46.32	4.86	4.86	4.30	4.63	4.60	77.10	74.83	70.93	73.40	74.06
N_3-125 kg N ha^{-1}	49.13	49.03	46.93	48.00	48.27	4.70	4.66	4.56	4.60	4.66	77.00	76.43	73.13	75.46	75.50
Average	53.85	53.24	49.55	51.81	-	5.54	5.33	4.92	5.01	-	79.52	77.94	74.37	75.63	-
	(N)	(P)		Interaction N × P		(N)	(P)		Interaction N × P		(N)	(P)		Interaction N × P	
'F' test	Sig.	Sig.		N.S.		Sig.	Sig.		N.S.		Sig.	Sig.		N.S.	
SE (m) ±	0.80	0.80		1.97		0.09	0.09		0.24		1.02	1.02		2.51	
CD at 5%	2.33	2.33		-		0.28	0.28		-		2.96	2.96		-	

Table 3: Effect of graded level of N and P on number of flowers plant^{-1}, flower yield q ha^{-1} and dry matter plant yield q ha^{-1} of calendula

Treatments	Phosphorus levels (P) kg ha^{-1}					Phosphorus levels (P) kg ha^{-1}					Phosphorus levels (P) kg ha^{-1}				
Nitrogen levels	Flower per plant					flower yield (q) ha^{-1}					Dry matter plant yield (q) ha^{-1}				
	0 (P_0)	25 (P_1)	50 (P_2)	75 (P_3)	Avg.	0 (P_0)	25 (P_1)	50 (P_2)	75 (P_3)	Avg.	0 (P_0)	25 (P_1)	50 (P_2)	75 (P_3)	Avg.
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	39.65	45.96	48.51	47.29	45.35
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	47.08	48.83	51.14	50.94	49.49
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	50.63	52.61	60.16	56.37	54.94
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	49.45	51.19	58.31	55.94	53.72
Average	42.30	45.55	49.90	48.81	-	67.20	71.85	81.05	78.19	-	46.70	49.65	54.53	52.63	-
	(N)	(P)		Interaction N × P		(N)	(P)		Interaction N × P		(N)	(P)		Interaction N × P	
'F' test	Sig.	Sig.		Sig.		Sig.	Sig.		Sig.		Sig.	Sig.		N.S.	
SE (m) ±	1.09	1.09		2.67		1.35	1.35		3.31		0.93	0.93		2.28	
CD at 5%	3.14	3.14		7.71		3.91	3.91		9.58		2.69	2.69		-	

ha^{-1} had significant influence on minimum number of days required for flower bud initiation in calendula. Minimum days required opening of first flower from bud initiation in treatment combination of nitrogen @ 100 kg ha^{-1}

and phosphorus @ 50 kg ha^{-1} (4.30 days) which was followed by 125 kg nitrogen and 50 kg phosphorus ha^{-1} (4.56 days) However, maximum days required for opening of first flower from bud initiation was recorded in treatment combination control treatment (6.66 days). Similar results were also reported by Vijay *et al*., (2015) that, the minimum days to opening of first flower from bud initiation were obtained with application of 150 kg N ha^{-1} with 80 kg P_2O_5 ha^{-1} in calendula.

Minimum days required to 50 percent flowering in treatment combination of nitrogen @ 100 kg ha^{-1} and phosphorus @ 50 kg ha^{-1} (70.93 days) which was followed by 125 kg nitrogen and 50 kg phosphorus ha^{-1} (73.13 days)However, maximum days required for opening of first flower from bud initiation was recorded in control treatment (83.55 days). Similar result were also reported by Nain *et al.,* (2016) that, the minimum days to 50 percent flowering were obtained with application of 30g m^{-2} nitrogen and 25 g m^{-2} phosphorus in African marigold.

3.3 Yield Parameter

Significantly maximum number of flower plant^{-1} in treatment combination of N_2P_2 *i.e.,* 100 kg nitrogen and 50 kg phosphorus ha^{-1} (55.16) which was followed by the treatment combination N_3P_2 *i.e.* 125 kg nitrogen and 50 kg phosphorus ha^{-1} (53.93). However, minimum number of flower plant^{-1} in treatment combination N_0P_0 *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 plats cell and tissues, consequently increased vegetative growth. The similar results were recorded by Sonawane *et al.* (2008) 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} had recorded maximum flower yield ha^{-1} (94.60 q) which was followed with the treatment combinations 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. From above finding, it was shown that, maximum flower yield ha^{-1} was recorded under the treatment 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 plats 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.

An application 100 kg nitrogen and 50 kg phosphorus ha^{-1} in treatment N_2P_2 had recorded maximum dry matter yield of plant (60.16 q ha^{-1}) which was followed with the treatment combinations N_3P_2 *i.e.* 125 kg nitrogen and 50 kg phosphorus ha^{-1} (58.31 q). However, minimum dry matter yield of plant (39.65 q ha^{-1}) was recorded in control treatment.

4. Conclusion

The combine application of nitrogen @ 100 kg ha^{-1} and phosphorus @ 50 kg ha^{-1} improve the growth parameter *i.e.*, stem diameter and plant spread, flowering parameters *i.e.*, minimum days for first flower bud initiation, days for opening of first flower from bud initiation and days required for 50 percent flowering and yield parameter *i.e.,* flower plant^{-1}, fresh flower yield and dry matter yield of plant.

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