



P-ISSN: 2349-8528
E-ISSN: 2321-4902
www.chemijournal.com
IJCS 2020; 8(6): 46-51
© 2020 IJCS
Received: 12-09-2020
Accepted: 21-11-2020

Megha B Nirgulkar
PG Student of Soil Science and
Agricultural Chemistry, College
of Agriculture, Nagpur,
Maharashtra, India

VP Babhulkar
Assistant Professor, College of
Agriculture, Gadchiroli,
Maharashtra, India

N Sanjuna Reddy
PG Student of Soil Science and
Agricultural Chemistry, College
of Agriculture, Nagpur,
Maharashtra, India

Kajal D Bhoyar
Research Scholar, Soil Science
and Agricultural Chemistry,
College of Agriculture, Nagpur,
Maharashtra, India

Corresponding Author:
Megha B Nirgulkar
PG Student of Soil Science and
Agricultural Chemistry, College
of Agriculture, Nagpur,
Maharashtra, India

Effect of nitrogen and phosphorus on growth parameter, flowering parameter and content of NPK in African marigold

Megha B Nirgulkar, VP Babhulkar, N Sanjuna Reddy and Kajal D Bhoyar

DOI: <https://doi.org/10.22271/chemi.2020.v8.i6a.11181>

Abstract

This research was conducted to investigate the Effect of nitrogen and phosphorus on growth parameter, flowering parameter and content of NPK in African marigold, during 'Kharif' season 2019-2020 at Horticulture Section, College of Agriculture, Nagpur. The fertilizers applied as per the treatments to evaluate the growth, flowering parameter and content of nitrogen, phosphorus and potassium in African marigold flower and plant. The Experiment was laid out in factorial randomized block design with sixteen treatment replicates thrice. The treatments comprised of four levels of nitrogen viz. N₁-0 kg ha⁻¹, N₂-80 kg ha⁻¹, N₃-100 kg ha⁻¹, N₄-120 kg ha⁻¹ and four levels of phosphorus viz. P₁-0 kg ha⁻¹, P₂-40 kg ha⁻¹, P₃-50 kg ha⁻¹, P₄-60 kg ha⁻¹. The maximum vegetative growth viz. plant height, stem diameter, plant spread and flowering parameters viz., days required for 50 per cent flowering, days required for first harvest were significantly found superior with the treatment combination of N₃P₃ (100 kg N ha⁻¹ with 50 kg P ha⁻¹). In respect of content of NPK in African marigold flower and plant increased with individual application of N₃ (100 kg N ha⁻¹) and P₃ (50 kg P ha⁻¹) and content of NPK in plant of African marigold was improved significantly with the combined application of N₃P₃ (100 kg N ha⁻¹ with 50 kg P ha⁻¹).

Keywords: African marigold, nitrogen, phosphorus, potassium, content

Introduction

African marigold is one of the important and popular commercial flowers grown mainly for making garlands, other decorative purposes and also used for religious offering, pharmaceuticals, foods supplement and coloring agent for cosmetics. So, for its cultivation balanced fertilisation are required. improper balance of nutrients in plants considered to be major factor contributing to low yields, which poses a serious problem in flower production. It has been established that the nutrient requirements of many of flower crops are not consistent. Hence, the nutrient supply should be adjusted to the specific requirements of plants during various stages of growth to attain maximum level of yields. Nitrogen is well known for its influence on the growth, flower production and quality of bloom in marigold (Naik., 2015). Nitrogen plays a vital role in metabolic activities of plants. It is one of the very important major plant nutrients which directly affect the plant growth and flowering behaviour. It is constituent of nucleic acid, protoplasm and might have increased carbohydrates synthesis, amino acid etc. from which the phyto-hormones like auxins, gibberellins and cytokines have been synthesizes resulting plant growth (Verma and Kumar 2018), whereas, phosphorus has very important role in energy storage or structural integrity. It 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 stimulating early flowering (Kumar., 2015). Suitable combination of fertilizers consequently leading to increase vegetative growth, production of healthy plants having maximum number of shoots and leaves which have a good effect on quality flower production.

Material and Methods

The present investigation was carried out during 'kharif' season 2019-2020 at Horticulture Section, College of Agriculture, Nagpur (20° 10' N and 79° 19' E, 321.26 m above MSL).

Nagpur is characterized by hot, dry summer and fairly cold winter. The area shows wide fluctuation of temperature. The soil of experimental site was medium black in colour with good drainage.

The experiment was laid out to study the effect of nitrogen and phosphorus on growth parameter, flowering parameter and content of NPK in African marigold. The research was carried out on variety African double orange. Sixteen treatment combinations with four levels of nitrogen 0, 80, 100, 120 kg ha⁻¹ and phosphorus 0, 40, 50 and 60 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 (N₁P₁), T2 – 0 kg N ha⁻¹ + 40 kg P ha⁻¹ (N₁P₂), T3 – 0 kg N ha⁻¹ + 50 kg P ha⁻¹ (N₁P₃), T4 – 0 kg N ha⁻¹ + 60 kg P ha⁻¹ (N₁P₄), T5 – 80 kg N ha⁻¹ + 0 kg P ha⁻¹ (N₂P₁), T6 – 80 kg N ha⁻¹ + 40 kg P ha⁻¹ (N₂P₂), T7 – 80 kg N ha⁻¹ + 50 kg P ha⁻¹ (N₂P₃), T8 – 80 kg N ha⁻¹ + 60 kg P ha⁻¹ (N₂P₄), T9 – 100 kg N ha⁻¹ + 0 kg P ha⁻¹ (N₃P₁), T10- 100 kg N ha⁻¹ + 40 kg P ha⁻¹ (N₃P₂), T11 -100 kg N ha⁻¹ + 50 kg P ha⁻¹ (N₃P₃), T12 -100 kg N ha⁻¹ + 60 kg P ha⁻¹ (N₃P₄), T13 – 120 kg N ha⁻¹ + 0 kg P ha⁻¹ (N₄P₁), T14 -120 kg N ha⁻¹ + 40 kg P ha⁻¹ (N₄P₂), T15 – 120 kg N ha⁻¹ + 50 kg P ha⁻¹ (N₄P₃) and T16 – 120 kg N ha⁻¹ + 60 kg P ha⁻¹ (N₄P₄). The seeds of African marigold were sown in the nursery beds in the month of July. African marigold seedlings of uniform size were transplanted 27 days after sowing at the spacing of 45 cm x 30 cm in the month of August, 2019. Half dose of nitrogen and full dose of phosphorus as per treatments were applied as a basal dose at the time of transplanting of seedlings and remaining half dose of nitrogen was given one month after transplanting and recommended dose of K 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 growth parameters i.e. plant height, stem diameter, plant spread. Whereas flowering parameters includes days required for 50% flowering and days required for first harvest were recorded. While the plant samples for NPK analysis were collected at the flag end of the crop growth (105 DAT). Leaves, stem, flowers and roots were collected separately and washed thoroughly with distilled water and the water was blotted out. The plant parts were then kept in paper bags and dried in hot air oven at 70 °C for 48 hours. The dried plant parts were finely ground in a 'Willey Mill' to a fine powder. This fine powder was again dried in oven at 60°C for a couple of hours and stored in desiccators till the samples were used for chemical analysis, estimation of total nitrogen was done by Micro kjeldhal's method, phosphorus content in plant samples was determined by 'Vanadomolybdate method' and potassium content of plant tissue was determined by flame photometer method. Data were statistically analysed in FRBD (Panse and Sukhatme, 1967)^[9].

Results and Discussion

Effect of nitrogen and Phosphorus on growth parameters

The data presented in table 1 revealed that the increase in individual application of nitrogen and phosphorus significantly influence the growth parameters i.e., plant height at last picking recorded maximum in (N₄) i.e. application of 120 kg nitrogen ha⁻¹ gives (84.32 cm), which was found at par with (N₃) i.e.100 kg nitrogen ha⁻¹ recorded (83.60 cm). Maximum stem diameter at 50% flowering was recorded highest (1.74 cm) with (N₄) i.e. application of 120 kg nitrogen ha⁻¹, which is followed by (N₃) recorded (1.71 cm). While plant spread at 50% flowering was recorded highest (52.93 cm) with treatment (N₄) i.e. application of 120 kg nitrogen ha⁻¹ followed by treatment (N₃) recorded (50.65 cm). The increase in growth parameters with maximum dose of nitrogen might be due to nitrogen increased photosynthetic activity for better vegetative and reproductive growth of the plant. Nitrogen was the main driving force behind the life processes which led to enhanced growth of plant. The similar observation was also noted by Shinde *et al.*, (2014)^[11] that application of highest level nitrogen i. e. 200 kg ha⁻¹ gives maximum plant height (105.48 cm) in African marigold, Nikam *et al.*, (2018)^[8] updated that, the application of highest dose i.e. 200 kg N ha⁻¹ recorded maximum diameter of stem (2.65 cm) in annual chrysanthemum and Singh *et al.*, (2013)^[12] recorded that, the application of nitrogen @ 150 kg ha⁻¹ found maximum plant spread in African marigold. Maximum plant height was recorded with treatment (P₄) i.e. an application of 60 kg phosphorus ha⁻¹ gave (80.93 cm), found at par with treatment (P₃) i.e. application of 50 kg phosphorus ha⁻¹ gave (78.62 cm). Whereas, maximum stem diameter (1.66 cm) of plant was recorded with treatment (P₄) where 60 kg phosphorus ha⁻¹ applied which was found at par with treatment (P₃) where 50 kg phosphorus ha⁻¹ applied recorded (1.65 cm). The maximum spread of plant (50.33 cm) was recorded with (P₄) i.e. an application of 60 kg phosphorus ha⁻¹ which was found at par with (P₃) i.e. application of 50 kg phosphorus ha⁻¹ recorded (49.84 cm). The reason for increased in growth parameters might be due to abundant availability of phosphorus in the rooting medium which affects the earlier maturation of plant that trends to develop the flower, also crop produced maximum vegetative growth, reproductive growth resulted in production of maximum growth. Similar result reported by Erbas *et al.*, (2017)^[3] also reported that, the plant height was maximum (104.3 cm) under the application of 100 kg phosphorus ha⁻¹ in Lavandin, Solanki and Ganie (2009)^[13] also reported that, the increase in stem diameter was recorded maximum under the treatment where maximum dose of phosphorus was applied in African marigold and Meheta *et al.*, (2016) reported that the application of P₂O₅ @ 200 kg ha⁻¹ recorded maximum plant spread in china aster.

Table 1: Plant height, stem diameter and plant spread of African marigold as influenced by nitrogen and phosphorus levels

Treatments	Plant height at last picking (cm)	Stem diameter at 50% flowering (cm)	Plant Spread at 50% flowering (cm)
Levels of Nitrogen (kg ha⁻¹)			
N ₁ - 0 kg N ha ⁻¹	76.86	1.43	42.13
N ₂ - 80 kg N ha ⁻¹	80.60	1.60	48.23
N ₃ - 100 kg N ha ⁻¹	83.60	1.71	50.65
N ₄ -120 kg N ha ⁻¹	84.32	1.74	52.93
'F' test	Sig.	Sig.	Sig.
SE (m) ±	0.45	0.005	0.52
CD at 5%	1.31	0.014	1.52
Levels of Phosphorus (kg ha⁻¹)			

P ₁ - 0 kg P ha ⁻¹	71.28	1.56	41.69
P ₂ - 40 kg P ha ⁻¹	76.56	1.62	46.09
P ₃ - 50 kg P ha ⁻¹	78.62	1.65	49.84
P ₄ - 60 kg P ha ⁻¹	80.93	1.66	50.33
'F' test	Sig.	Sig.	Sig.
SE (m) ±	0.45	0.005	0.52
CD at 5%	1.31	0.014	1.52
Interaction (Nitrogen X Phosphorus)			
'F' test	Sig.	Sig.	Sig.
SE (m) ±	1.11	0.081	1.09
CD at 5%	3.21	0.210	2.94

The data presented in table 2 revealed that significantly higher plant height at last picking was observed (88.91 cm) in treatment combination (N₄P₄) where, an application of 120 kg N ha⁻¹ applied with 60 kg P ha⁻¹ which was found at par with treatment combination (N₃P₃) where, 100 kg N ha⁻¹ applied with 50 kg P ha⁻¹ recorded (86.54 cm) plant height. Maximum stem diameter (1.76 cm) at 50% flowering stage was observed in treatment combination (N₄P₄) i.e. 120 kg N ha⁻¹ with 60 kg P ha⁻¹ applied which was found at par with treatment combination (N₃P₃) where, 100 kg N ha⁻¹ applied with 50 kg

P ha⁻¹ recorded (1.74 cm), while combine application of nitrogen @ 120 kg ha⁻¹ with phosphorus @ 60 kg ha⁻¹ i.e. (N₄P₄) recorded maximum (53.66 cm) spread of plant which was found at par with treatment combination (N₃P₃) i.e. application of nitrogen @ 100 kg ha⁻¹ with phosphorus @ 50 kg ha⁻¹ which recorded (51.14 cm) plant spread. Similar results were noted by Nain *et al.*, (2016) [7] updated that, application of nitrogen 30 g m⁻² and phosphorus 25 g m⁻² significantly produce various growth parameters namely plant height, plant spread.

Table 2: Interaction effect of nitrogen and phosphorus on plant height, stem diameter and plant spread of African marigold

Treatments	Phosphorus levels														
	Plant height at last picking (cm)					Stem diameter at 50% flowering (cm)					Plant spread at 50% flowering (cm)				
	0 kg ha ⁻¹ (P ₁)	40 kg ha ⁻¹ (P ₂)	50 kg ha ⁻¹ (P ₃)	60 kg ha ⁻¹ (P ₄)	Average	0 kg ha ⁻¹ (P ₁)	40 kg ha ⁻¹ (P ₂)	50 kg ha ⁻¹ (P ₃)	60 kg ha ⁻¹ (P ₄)	Average	0 kg ha ⁻¹ (P ₁)	40 kg ha ⁻¹ (P ₂)	50 kg ha ⁻¹ (P ₃)	60 kg ha ⁻¹ (P ₄)	Average
N ₁ - 0 kg N ha ⁻¹	68.48	74.12	81.03	83.84	76.86	1.36	1.43	1.48	1.50	1.43	35.36	40.60	46.51	47.08	42.13
N ₂ - 80 kg N ha ⁻¹	74.75	79.90	82.88	84.91	80.60	1.54	1.61	1.63	1.64	1.60	42.22	44.09	48.49	49.15	48.23
N ₃ - 100 kg N ha ⁻¹	80.47	82.92	86.54	87.05	83.60	1.62	1.64	1.74	1.75	1.71	45.99	50.05	51.14	52.43	50.65
N ₄ -120 kg N ha ⁻¹	81.04	85.27	84.06	88.91	84.32	1.65	1.71	1.75	1.76	1.74	47.19	50.65	53.25	53.66	52.93
Average	71.28	76.56	78.62	80.93		1.56	1.62	1.65	1.66		41.69	46.09	49.84	50.33	
	Interaction (N X P)					Interaction (N X P)					Interaction (N X P)				
'F' test	Sig.					Sig.					Sig.				
SE (m) ±	1.11					0.081					1.09				
CD at 5%	3.21					0.210					2.94				

Effect of nitrogen and Phosphorus on flowering parameter

The data presented in table 3 revealed that early 50 per cent flowering (64.93 days) was observed in treatment (N₃) where nitrogen applied @ 100 kg ha⁻¹ which was found at par with the treatment (N₄) i.e. application of nitrogen @ 120 kg ha⁻¹ recorded (66.59 days). Also early harvesting i.e. (81.33 days) was observed in treatment (N₃) where, nitrogen applied @ 100 kg ha⁻¹ in soil which found at par with the treatment (N₄) i.e. application of nitrogen @ 120 kg ha⁻¹ where (83.49 days) required for first harvest. Similar observations were also reported by Samoon *et al.*, (2018) [10] that, the application of nitrogen @ 150 kg ha⁻¹ recorded significantly minimum days to 50 per cent flowering in calendula.

Early 50 per cent flowering (66.33 days) was recorded in treatment (P₃) where phosphorus applied @ 50 kg ha⁻¹, but found at par with (P₄) i.e. 60 kg P applied ha⁻¹ requires (68.99 days). Early harvesting i.e. (82.73 days) was observed in treatment (P₃) where, P applied @ 50 kg ha⁻¹ which found at par with the treatment (P₄) i.e. application of P @ 60 kg ha⁻¹ where (84.39 days) required for first harvest. Similar observation reported by Maheta *et al.*, (2016) [6] that, the application of phosphorus @ 200 kg ha⁻¹ recorded significantly minimum days to 50 per cent flowering in china aster. Similar observations were also reported by Shinde *et al.*, (2014) [11] that, the application of nitrogen recorded

significantly minimum days to first harvest in African marigold.

Table 3: Days to 50% flowering and days to first harvest of African marigold as influenced by nitrogen and phosphorus levels

Treatments	Days to 50% flowering (days)	Days to first harvest (days)
Levels of Nitrogen (kg ha⁻¹)		
N ₁ - 0 kg N ha ⁻¹	74.79	90.19
N ₂ - 80 kg N ha ⁻¹	69.48	86.88
N ₃ - 100 kg N ha ⁻¹	64.93	81.33
N ₄ -120 kg N ha ⁻¹	66.59	83.49
'F' test	Sig.	Sig.
SE (m) ±	0.91	0.91
CD at 5%	2.64	2.64
Levels of Phosphorus (kg ha⁻¹)		
P ₁ - 0 kg P ha ⁻¹	74.51	92.64
P ₂ - 40 kg P ha ⁻¹	71.73	88.13
P ₃ - 50 kg P ha ⁻¹	66.33	82.73
P ₄ - 60 kg P ha ⁻¹	68.99	84.39
'F' test	Sig.	Sig.
SE (m) ±	0.91	0.91
CD at 5%	2.64	2.64
Interaction (Nitrogen X Phosphorus)		
'F' test	Sig.	Sig.
SE (m) ±	1.04	1.44
CD at 5%	2.49	2.94

The data presented in table 4 revealed that the treatment combination (N₃P₃) where an application of Nitrogen @ 100 kg ha⁻¹ with phosphorus @ 50 kg ha⁻¹ applied resulted in lowest days required for 50% flowering (63.33 days) however, found at par with treatment combination of (N₄P₄) where Nitrogen applied @ 120 kg ha⁻¹ with phosphorus 60 kg ha⁻¹ required (63.40 days). The treatment combination (N₃P₃) where an application of Nitrogen @ 100 Kg ha⁻¹ with phosphorus @ 50 kg ha⁻¹ applied resulted in lowest days

require to first harvest (80.73 days) however, found at par with treatment combination of (N₄P₄) where Nitrogen applied @ 120 kg ha⁻¹ with 60 kg phosphorus ha⁻¹ required (82.80 days). Similar result was also reported by Nain *et al.*, (2016) [7] that, the minimum days to 50 per cent flowering were obtained with application of 30 g m⁻² nitrogen and 25 g m⁻² phosphorus in African marigold. Tembhare *et al.*, (2016) [15] revealed that application of 200 kg nitrogen and 75 kg phosphorus ha⁻¹ improves the days required for first harvest.

Table 4: Interaction effect of nitrogen and phosphorus on days to 50% flowering and days to first harvest (days) of African marigold

Treatments	Phosphorus levels									
	Days to 50% flowering					Days to first harvest (days)				
	0 kg ha ⁻¹ (P ₁)	40 kg ha ⁻¹ (P ₂)	50 kg ha ⁻¹ (P ₃)	60 kg ha ⁻¹ (P ₄)	Average	0 kg ha ⁻¹ (P ₁)	40 kg ha ⁻¹ (P ₂)	50 kg ha ⁻¹ (P ₃)	60 kg ha ⁻¹ (P ₄)	Average
N ₁ - 0 kg N ha ⁻¹	79.66	72.33	71.86	70.33	74.79	96.06	92.73	88.26	86.73	90.19
N ₂ - 80 kg N ha ⁻¹	74.06	69.80	69.20	68.86	69.48	91.46	87.20	85.60	85.26	86.88
N ₃ - 100 kg N ha ⁻¹	72.53	66.66	63.33	63.80	64.93	89.93	85.06	80.73	81.20	81.33
N ₄ -120 kg N ha ⁻¹	71.73	67.13	65.53	63.40	66.59	87.13	83.53	80.93	82.80	83.49
Average	74.51	71.73	66.33	68.99		92.64	88.13	82.73	84.39	
	Interaction (N X P)					Interaction (N X P)				
'F' test	Sig.					Sig.				
SE (m) ±	1.04					1.44				
CD at 5%	2.49					2.94				

Effect of nitrogen and Phosphorus on content of NPK in African marigold flower

The data presented in table 5 revealed that the significantly maximum content of N (1.082%) in African marigold flower was recorded in (N₄) i.e. 120 kg nitrogen applied ha⁻¹ which was found at par with (N₃) i.e. application of 100 kg nitrogen ha⁻¹ containing (1.076%) N in flower. Whereas, maximum content of P (0.525%) in African marigold flower was recorded in (N₄) i.e. 120 kg nitrogen applied ha⁻¹, however found at par with (N₃) i.e. application of 100 kg nitrogen ha⁻¹ recorded (0.516%) P in plant, while maximum content of K (0.915%) in African marigold flower was recorded in treatment (N₄) where, 120 kg nitrogen applied ha⁻¹ which was found at par with (N₃) where, 100 kg nitrogen applied ha⁻¹ and noticed (0.896%) K in plant. Similar result noted by Joshi *et al.*, (2012) [4] that, the application of nitrogen @ 300 kg ha⁻¹ was found effective in increasing nitrogen, phosphorus content while application of nitrogen 100 kg ha⁻¹ was found effective in increasing K content in chrysanthemum flower.

Significantly maximum content of N (1.044%) in marigold flower was recorded with (P₄) i.e. an application of 60 kg phosphorus ha⁻¹ which was found at par with (P₃) i.e. application of 50 kg P ha⁻¹ noticed (1.033%) content of N in flower. Also, significantly maximum content of P (0.544%) in African marigold flower was recorded with (P₄) i.e. 60 kg phosphorus applied ha⁻¹ which was found at par with (P₃) i.e. 50 kg P applied containing (0.535%) P in flower.

Whereas, maximum content of K (0.909%) in African marigold flower was recorded with (P₄) i.e. an application of 60 kg phosphorus ha⁻¹ which was found at par with treatment (P₃) i.e. 50 kg phosphorus applied ha⁻¹ where K content in flower (0.889%) was noticed. Joshi *et al.*, (2012) that, the application of phosphorus @ 100 kg ha⁻¹ was found effective in increasing nitrogen content in chrysanthemum flower, also reported that the application of Phosphorus @ 150 kg ha⁻¹ was found effective in increasing phosphorus content in chrysanthemum flower.

Table 5: Content of nitrogen, phosphorus and potassium in flower of African marigold as influenced by nitrogen and phosphorus levels

Treatments	N content in flower (%)	P content in flower (%)	K content in flower (%)
Levels of Nitrogen (kg ha⁻¹)			
N ₁ - 0 kg N ha ⁻¹	0.900	0.489	0.835
N ₂ - 80 kg N ha ⁻¹	0.998	0.500	0.852
N ₃ - 100 kg N ha ⁻¹	1.076	0.516	0.896
N ₄ -120 kg N ha ⁻¹	1.082	0.525	0.915
'F' test	Sig.	Sig.	Sig.
SE (m) ±	0.006	0.004	0.007
CD at 5%	0.017	0.014	0.021
Levels of Phosphorus (kg ha⁻¹)			
P ₁ - 0 kg P ha ⁻¹	0.980	0.448	0.844
P ₂ - 40 kg P ha ⁻¹	1.004	0.499	0.858
P ₃ - 50 kg P ha ⁻¹	1.033	0.535	0.889
P ₄ - 60 kg P ha ⁻¹	1.044	0.544	0.909
'F' test	Sig.	Sig.	Sig.
SE (m) ±	0.006	0.004	0.007
CD at 5%	0.017	0.014	0.021
Interaction (Nitrogen X Phosphorus)			
'F' test	N.S.	N.S.	N.S.
SE (m) ±	0.015	0.032	0.017
CD at 5%	-	-	-

The data presented in table 6 revealed that the combine application of different levels of nitrogen with phosphorus

levels on content of NPK in African marigold flower was found non significant.

Table 6: Interaction effect of nitrogen and phosphorus on content of nitrogen, phosphorus and potassium in flower

Treatments	Phosphorus levels														
	N content in flower (%)					P content in flower (%)					K content in flower (%)				
Nitrogen levels	0 kg ha ⁻¹ (P ₁)	40 kg ha ⁻¹ (P ₂)	50 kg ha ⁻¹ (P ₃)	60 kg ha ⁻¹ (P ₄)	Average	0 kg ha ⁻¹ (P ₁)	40 kg ha ⁻¹ (P ₂)	50 kg ha ⁻¹ (P ₃)	60 kg ha ⁻¹ (P ₄)	Average	0 kg ha ⁻¹ (P ₁)	40 kg ha ⁻¹ (P ₂)	50 kg ha ⁻¹ (P ₃)	60 kg ha ⁻¹ (P ₄)	Average
N ₁ - 0 kg N ha ⁻¹	0.846	0.890	0.903	0.933	0.900	0.446	0.454	0.490	0.526	0.489	0.799	0.790	0.862	0.892	0.835
N ₂ - 80 kg N ha ⁻¹	0.936	1.002	1.071	0.986	0.998	0.448	0.490	0.493	0.503	0.500	0.828	0.847	0.856	0.879	0.852
N ₃ - 100 kg N ha ⁻¹	1.040	1.060	1.077	1.127	1.076	0.443	0.485	0.520	0.526	0.516	0.879	0.884	0.900	0.923	0.896
N ₄ -120 kg N ha ⁻¹	1.046	1.066	1.083	1.133	1.082	0.457	0.490	0.523	0.535	0.525	0.873	0.914	0.933	0.943	0.915
Average	0.980	1.004	1.033	1.044		0.448	0.499	0.535	0.544		0.844	0.858	0.889	0.909	
	Interaction (N X P)					Interaction (N X P)					Interaction (N X P)				
'F' test	N.S.					N.S.					N.S.				
SE (m) ±	0.015					0.032					0.017				
CD at 5%	-					-					-				

The data presented in table 7 revealed that significantly maximum content of N (1.617%) in African marigold plant was recorded in (N₄) i.e. application of 120 kg nitrogen ha⁻¹ however, found at par with (P₃) i.e. application of 100 kg nitrogen ha⁻¹ containing (1.602%) N in plant. Significantly maximum content of P (0.478%) in African marigold plant was recorded in the treatment (N₄) i.e. addition of 120 kg nitrogen ha⁻¹ but found at par with (N₃) i.e. application of 100 kg nitrogen ha⁻¹ containing (0.469%) P in plant. Significantly maximum content of K (1.942%) in African marigold plant was recorded in treatment (N₄) i.e. application of 120 kg nitrogen ha⁻¹ which was found at par with (N₃) i.e. application of 100 kg nitrogen ha⁻¹ recorded (1.930%) K content in plant. While, maximum content of N (1.571%) in African marigold plant was recorded with (P₄) i.e. an application of 60 kg phosphorus ha⁻¹ which was found at par with (P₃) i.e. 50 kg

phosphorus applied ha⁻¹ recorded (1.564%) N content in plant. Significantly maximum content of P (0.509%) in African marigold plant was recorded with an application of 60 kg phosphorus ha⁻¹ which found at par with (P₃) i.e. application of 50 kg phosphorus ha⁻¹ recorded (0.500%) P content in plant. Also, maximum content of K (1.930%) in marigold plant was recorded with an application of the treatment (P₄) i.e. application of 60 kg phosphorus ha⁻¹ which was found at par with treatment (P₃) i.e. application of 50 kg phosphorus ha⁻¹ recorded (1.913%) K content in plant. Similar findings were also reported by Joshi *et al.*, (2012) [4] that, the application of phosphorus 150 kg ha⁻¹ was found effective in increasing phosphorus content in chrysanthemum plant. Sonawane *et al.*, (2009) [14] revealed that, application of phosphorus at 75 kg ha⁻¹ had recorded maximum uptake of nitrogen, phosphorus and potassium by the china aster plant.

Table 7: Content of nitrogen, phosphorus and potassium in plant of African marigold as influenced by nitrogen and phosphorus levels

Treatments	N content in plant (%)	P content in plant (%)	K content in plant (%)
Levels of Nitrogen (kg ha⁻¹)			
N ₁ - 0 kg N ha ⁻¹	1.475	0.447	1.792
N ₂ - 80 kg N ha ⁻¹	1.518	0.453	1.863
N ₃ - 100 kg N ha ⁻¹	1.602	0.469	1.930
N ₄ -120 kg N ha ⁻¹	1.617	0.478	1.942
'F' test	Sig.	Sig.	Sig.
SE (m) ±	0.004	0.005	0.009
CD at 5%	0.016	0.016	0.026
Levels of Phosphorus (kg ha⁻¹)			
P ₁ - 0 kg P ha ⁻¹	1.513	0.381	1.832
P ₂ - 40 kg P ha ⁻¹	1.545	0.433	1.879
P ₃ - 50 kg P ha ⁻¹	1.564	0.500	1.913
P ₄ - 60 kg P ha ⁻¹	1.571	0.509	1.930
'F' test	Sig.	Sig.	Sig.
SE (m) ±	0.004	0.005	0.009
CD at 5%	0.016	0.016	0.026
Interaction (Nitrogen X Phosphorus)			
'F' test	Sig.	Sig.	Sig.
SE (m) ±	0.009	0.013	0.022
CD at 5%	0.021	0.039	0.068

The data presented in table 8 revealed that Significantly maximum N content in plant (1.636%) recorded in treatment (N₄P₄) i.e. application of nitrogen @ 120 kg ha⁻¹ with phosphorus @ 60 kg ha⁻¹ which was found at par with treatment combination (N₃P₃) i.e. application of 100 kg N ha⁻¹ with 50 kg ha⁻¹ containing (1.630%) N in plant. Significantly maximum P content in plant (0.519%) recorded at (N₄P₄) i.e.

application of nitrogen @ 120 kg ha⁻¹ with phosphorus @ 60 kg ha⁻¹ which found at par with treatment combination (N₃P₃) i.e. application of 100 kg N ha⁻¹ with 50 kg P ha⁻¹ recorded (0.509%) P content in plant. Significantly maximum K content in plant (1.964%) recorded in treatment (N₄P₄) i.e. application of @ 120 kg ha⁻¹ with phosphorus @ 60 kg ha⁻¹ which found at par with treatment combination (N₃P₃) i.e.

application of 100 kg N ha⁻¹ with 50 kg ha⁻¹ recorded (1.946%) K content in plant. Similar results were also reported by Kareem (2020) [5] that, the application of nitrogen 200 kg ha⁻¹ with phosphorus 200 kg ha⁻¹ was found effective in increasing N content in marigold. Similar results were also reported by Ahmad *et al.*, (2017) [1] that, the application of

nitrogen @ 200 kg ha⁻¹ with phosphorus 200 kg ha⁻¹ was found effective in increasing phosphorus content. Badole *et al.*, (2015) [2] revealed that, the combined application of nitrogen @ 200 kg ha⁻¹ and phosphorus @ 75 kg ha⁻¹ significantly increased in content of NPK in flower and plant.

Table 8: Interaction effect of nitrogen and phosphorus on content of nitrogen, phosphorus and potassium in plant

Treatments	Phosphorus levels														
	N content in plant (%)					P content in plant (%)					K content in plant (%)				
	0 kg ha ⁻¹ (P ₁)	40 kg ha ⁻¹ (P ₂)	50 kg ha ⁻¹ (P ₃)	60 kg ha ⁻¹ (P ₄)	Average	0 kg ha ⁻¹ (P ₁)	40 kg ha ⁻¹ (P ₂)	50 kg ha ⁻¹ (P ₃)	60 kg ha ⁻¹ (P ₄)	Average	0 kg ha ⁻¹ (P ₁)	40 kg ha ⁻¹ (P ₂)	50 kg ha ⁻¹ (P ₃)	60 kg ha ⁻¹ (P ₄)	Average
N ₁ - 0 kg N ha ⁻¹	1.447	1.466	1.482	1.505	1.475	0.388	0.423	0.483	0.495	0.447	1.739	1.772	1.781	1.876	1.792
N ₂ - 80 kg N ha ⁻¹	1.491	1.509	1.527	1.547	1.518	0.362	0.435	0.462	0.496	0.453	1.784	1.880	1.860	1.929	1.863
N ₃ - 100 kg N ha ⁻¹	1.530	1.598	1.630	1.634	1.602	0.375	0.425	0.509	0.517	0.469	1.815	1.887	1.946	1.952	1.930
N ₄ -120 kg N ha ⁻¹	1.584	1.605	1.625	1.636	1.617	0.400	0.452	0.515	0.519	0.478	1.840	1.902	1.956	1.964	1.942
Average	1.513	1.545	1.564	1.571		0.381	0.433	0.500	0.509		1.832	1.879	1.913	1.930	
	Interaction (N X P)					Interaction (N X P)					Interaction (N X P)				
'F' test	Sig.					Sig.					Sig.				
SE (m) ±	0.009					0.013					0.022				
CD at 5%	0.021					0.039					0.068				

Conclusion

The combine application of nitrogen @ 100 kg ha⁻¹ and phosphorus @ 50 kg ha⁻¹ improve the growth and flowering parameter. i.e. plant height, stem diameter, plant spread, days to 50% flowering and days to first harvest. In case of content of NPK in flower of African marigold recorded maximum with individual application of nitrogen 100 kg ha⁻¹ and phosphorus 50 kg ha⁻¹. Whereas, content of NPK in plant of African marigold recorded highest with the individual and also combine application of nitrogen @ 100 kg ha⁻¹ with phosphorus 50 kg ha⁻¹.

References

- Ahmad I, Jabeen N, Ziaf K, Dole JM, Khan MAS, Bakhtavar MA, *et al.* Macronutrient application affects morphological, physiological, and seed yield attributes of *Calendula officinalis*. *Can. J Plant Sci* 2017;97:906-916.
- Badole WP, Sanap PB, Vandana Kotangale, Pranali Bhaire. Effect of nitrogen and phosphorus on nutrient uptake, yield and quality of china aster. *J Soil and Crops* 2015;25(2):397-401.
- Erbas S, Kucukyumuk Z, Baydar H, Erdal I, Sanli A. Effects of Different Phosphorus Doses on Nutrient Concentrations as Well as Yield and Quality Characteristics of Lavandin (*Lavandula × intermedia* Emeric ex Loisel. Var. Super). *Turk. J Field Crops* 2017;22(1):32-38.
- Joshi NS, Varu DK, Barad AV. Effect of different levels of nitrogen, phosphorus and potash on quality, nutrient content and uptake of chrysanthemum cultivars. *Asian J Hort* 2012;7(2):497-503.
- Kareem AJ, Saeed M, Abdulhadi MD, Mohammed NI. Response of marigold (*Tagetes erecta* L.) Cv. Double eagle to nitrogen and phosphorus application. *Plant Archives* 2020;20(1):609-615.
- Maheta P, Polara ND, Rathod J. Effect of nitrogen and phosphorus on growth, flowering and flower yield of china aster. *The Asian J. Hort* 2016;11(1):132-135.
- Nain S, Beniwal BS, Dalal RPS, Sonu Sheoran. Effect of nitrogen and phosphorus application on growth, flowering and yield of African marigold (*Tagetes erecta* L.) under semi-arid conditions of Haryana. *Ind. Ecological Soc.: International Conference* 2016.
- Nikam BS, Badge SA, Pawar AR. Growth and Seed Yield of Annual Chrysanthemum as Influenced by Different Levels of Nitrogen and Potassium. *Int. J Curr. Microb. App. Sci* 2018;7(9):563-568.
- Panse VG, PV, Sukhatme. *Statistical methods for agricultural workers*, ICAR, New Delhi 1967, 155.
- Samoon SA, Neelofar Z, Bashir KS, Krad, Lone A. Effect of nitrogen and phosphorus levels on flowering of calendula (*Calendula officinalis* L) var. Touch of Red Mixture. *The Pharma Inno* 2018;7(5):39-41.
- Shinde M, Khiratkar SD, Ganjure S, Bahadure R. Response of nitrogen and potassium levels on growth, flowering and seed yield of African marigold. *J Soils and Crops* 2014;24(1):89 -94.
- Singh HK, Brajmohan JP, Nathiram R. Effect of inorganic fertilizer (nitrogen) and bio-fertilizer (*Azospirillum*) on growth and flowering in African marigold (*Tagetes erecta* L.) cv. Pusa Narangi Gaiinda. *Int. J Agric. Sci* 2013;9(1):189-192.
- Solanki RB, Ganie NA. Growth and flowering of african marigold as affected by nitrogen and phosphorus under varying intra-row spacing. *Asian J Hort* 2009;4(2):418-420.
- Sonawane SP, Dabke DJ, Dodke SB, Dhane SS. Effect of nitrogen, phosphorus and FYM on yield and nutrient uptake by china aster. *J Agri. Univer* 2009;(1):90-91.
- Tembhare VJ, Badge S, Panchbhai DM, Ragtate SR. Flowering, seed yield and quality of china aster as influenced by application of nitrogen and phosphorus. *Plant Archives* 2016;16 (1): 356-360.