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Original Research Article

Effect of Different Levels of Nitrogen and Potassium on Growth, and Seed Yield of African Marigold

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A B S T R A C T

An investigation was carried out to study the "Effect of different levels of nitrogen and potassium on growth and seed yield of African marigold". The experiment was laid out in factorial randomized block design (FRBD) with sixteen treatment combinations with four levels of nitrogen, viz., 0 kg N ha^{-1} (N1), 100 kg N ha^{-1} (N2), 150 kg N ha^{-1} (N3), 200 kg N ha^{-1} (N_4), and potassium 0 kg K_2O ha^{-1} (K_1), 50 kg K_2O ha^{-1} (K_2), 75 kg K_2O ha^{-1} (K_3) and 100 kg K_2O ha^{-1} (K4). The treatments were replicated three times. Maximum height of $plant^{-1}$, number of branches $plant^{-1}$ and seed yield in respect of number of dry flower $plant^{-1}$, seed yield $plant^{-1}$, seed yield $plot^{-1}$ and $hectare^{-1}$ in African marigold were recorded with an application of 200 kg N ha^{-1} (N4), and 100 kg K2O ha^{-1} (K4). In interaction of nitrogen and potassium treatment combination (N4K4) by the application of 200 kg N ha^{-1} (N4) and 100 kg K_2O ha^{-1} (K4) were found maximum in terms of yield parameters. Thus, the experiment proved that, for getting the maximum production of better quality seed of African marigold with an application of 200 kg nitrogen ha^{-1} and 100 kg potassium ha^{-1} was found beneficial.

Introduction

Marigold is one of the commercially exploited flower crop that belong to the family *Asteraceae* and genus *Tagetes*. The name *Tagetes* was given after Tages known for its beauty. There are about 33 species of genus *Tagetes*. The two main popularly grown species in marigold are *Tagetes erecta* L. and *Tagetes patula* L. which have their origin in Mexico and South Africa, respectively. *Tagetes erecta* L. is popularly known as "African marigold" while *Tagetes patula* L. as "French marigold". It is propagated by seed.

Marigold is grown for loose flowers, making garlands, decoration during pooja and several religious functions especially in the Dasera and Diwali festivals besides its use in landscape gardening. The aromatic oil extracted from marigold, is called as "tagetes oil". Flower of marigold can be used for extraction of 1-lemoene, ocomene 1-linalylaetate, 1-linauol. Marigold petals are used for extraction of xanthophyll. It is used in preparation of high grade perfumes and also as an insect fly repellant. Recently dried flower petals of marigold are used as poultry feed in order to improve the colour of egg yolk as well as broiler's skin.

Marigold is a heavy feeder of nutrients, at present these nutrients are supplied through chemical fertilizers. The indiscriminate and continuous use of chemical fertilizers in intensive cropping system has led to an imbalance of nutrients in soil which has an adverse effect on soil health and affecting the seed yield. Therefore, use of nutrients is the need of the ours. The use of chemical fertilizers improves the physico-chemical properties of soil. In marigold, the fertilizer has great importance for manipulating plant growth, flowering behavior and seed yield. Therefore, balanced supply of nutrients is important for obtaining higher seed yield. Nitrogen is well known for its influence on the growth, flower production and quality of bloom in marigold (Noggle and Fritz, 1979).

In Vidharbha region of Maharashtra State, marigold is cultivated on a large scale but productivity is low and there is no proper recommendation based on latest technology to increase the yield potential. Non availability of high quality seeds of marigold is one of the major constraints to its cultivation. Hence keeping of these views in mind an experiment entitled "Effect of different levels of nitrogen and potassium on growth and seed yield of African marigold" was undertaken at Horticulture Section, College of Agriculture, Nagpur.

Materials and Methods

The experiment was conducted at experimental field of Horticulture section, College of Agriculture, Nagpur during the kharif season of the year 2012-2013. The soil used for the experiment was medium black in colour with good drainage. Soil samples were collected before applying manures at a depth of 20 cm from the experimental area from randomly selected spots. The composite sample was analysed for its chemical characteristics, nitrogen, phosphorus and potassium content. Chemical analysis of soil indicated that the soil was high in nitrogen and low in phosphorus and high in available potash and alkaline in nature. African marigold cv. African Double Orange" was selected for the study. Raised nursery beds were prepared well in advance for sowing seeds. African marigold seedlings were raised on beds at nursery. The beds were prepared thoroughly by mixing garden soil, farm yard manure and linden powder. The beds were applied with 200 g single super phosphate and 100 g urea per bed before sowing of seeds. Seeds were treated with Bavistin fungicide (0.1%) for healthy growth of seedlings. Thirty days old uniform, well developed and healthy seedlings of marigold were selected and transplanted in each plot according to treatment. Seedlings were planted at the distance of 45x30 cm and a light irrigation was given immediately after transplanting. The application of nitrogen was done in two split doses; first dose was applied at the time of transplanting of African marigold seedlings, whereas remaining half dose of nitrogen was applied at 45 days after transplanting. However, full dose of phosphorus (50 kg P_2O_5 ha^{-1}) and potassium was applied as a basal dose as per the treatment. All other field operations were performed as per recommended package of practices.

The treatments comprised four levels of nitrogen, viz., 0 kg N ha^{-1} (N1), 100 kg N ha^{-1} (N2), 150 kg N ha^{-1} (N_3), 200 kg N ha^{-1} (N_4) and potassium (0 kg K_2O ha^{-1} (P_1) , 50 kg K_2O ha^{-1} (P2), 75 kg K2O ha-1 (P3) *and* 100 kg K2O ha-1 (P4). The experiment was laid out in Factorial Randomized Block Design (FRBD) with sixteen treatment combinations and three replications. Data on growth parameter such as plant height, number of branches and flower seed yield were recorded and analyzed.

Results and Discussion

During the course of experiment various observations were recorded such as height of plant^{-1} (90 DAT), number of branches^{-1} (90 DAT) and some seed yield parameter such as number of dry flowers plant$^{-1,}$ number of seeds flower$^{-1,}$ seed yield plant^{-1} (g), seed yield plot^{-1} (g), seed yield ha^{-1} (q) recorded after final harvesting.

Growth parameter

Effect of nitrogen

In table 1, at the stage of 90 DAT, treatment N4 (200 kg N ha^{-1}) was significantly superior over all other treatment in case of plant height (105.48 cm) which was followed by the treatment N3 (102.75 cm). However, minimum plant height (95.67 cm) was recorded in treatment N1 (0 kg N ha^{-1}). Significant increases in the plant height at all the stages were observed with the increasing levels of nitrogen. This may be due to general improvement in growth and development of plant by nitrogenous fertilizer as the nitrogen is involved in various metabolic processes of plants. The results obtained during the investigation are in close accordance with the finding of Sharma *et al.,* (2006), Baboo *et al.,* (2005), and Acharya and Dashora (2004) in African marigold and Khan *et al.,* (2004) in petunia.

At the stage of 90 DAT, significantly maximum number of branches (13.56) was recorded in treatment N4 (200 kg N ha^{-1}) which was at par with the treatment N3 (13.13). However, minimum number of branches (11.78) was recorded in treatment N1 (control). The increase in plant height might be due to increased uptake of the nutrient. Nitrogen being constituent of protein, component of protoplasm and chlorophyll there all factor contributed to cell multiplication, cell enlargement and cell differentiation resulted in increased photosynthesis and translocation, which enhance number of branches in marigold plant. The similar results are in conformity with the findings of Agarwal *et al.,* (2002), Acharya and Dashora (2004), Sharma *et al.,* (2006) in African marigold.

Effect of potassium

In table 1, at the stage of 90 DAT, significantly the maximum plant height (103.44 cm) was recorded in treatment K4, which was found to be at par with the treatments K3 (101.62 cm) and K2 (101.54 cm). Whereas, the minimum plant height (97.29 cm) was recorded in the treatment K1. Potassium increases protein synthesis which might have been responsible for the significant increase in height of the plant at all the growth stages with the increasing levels of potassium. The similar results were also obtained by Agrawal *et al.,* (2002) and Das and Mishra (2005) in African marigold.

At the stage of 90 DAT, significantly the maximum number of branches (13.46) was recorded under the treatment K4 (100 kg K2O ha^{-1}), which was found to be at par with the treatment K3 (13.00). Whereas, the minimum number of branches (12.11) was recorded in the treatment control (K1). The similar results were also obtained by Agrawal *et al.,* (2002) in African marigold in Chattisgarh region and Khan *et al.,* (2004) in petunia.

Yield parameters

Effect of nitrogen

The data presented in Table 2, revealed that different levels of nitrogen and potassium had significant effect on yield parameters of African marigold. Significantly, an maximum number of dry flowers plant^{-1} were recorded in treatment N4 (27.87) followed by

treatment N3 (25.60). Whereas, the treatment N1 had minimum (16.08) number of dry flowers plant^{-1}.The more number of dry flowers plant^{-1} produced with increased levels of nitrogen might be due to vigorous growth and better photosynthesis which was favorable for development of flowers. Similar results were reported by Acharya and Dashora (2004) in marigold, Singh and Baboo (2003) in chrysanthemum.

Significantly, an maximum number of seed flower^{-1} was recorded in treatment N4 (319.05) whichwere followed bytreatment N3 (313.52). Whereas, the treatment N1 (0 kg N ha^{-1}) had minimum number of seed flower^{-1} (291.31). The maximum number of marigold seed flower^{-1} was recorded under the higher dose at nitrogen whereas, the lowest levels of nitrogen produced minimum number of seed flower^{-1}. The increased in number of seed flower^{-1} may be the result of increased flower size due

to various growth of individual plants with higher nitrogen doses. The similar results were recorded by Natrajan and Vijaykumar (2002) in African marigold, Khan *et al.*, (2004) in petunia.

Significantly, an maximum seed yield plant^{-1} (31.03 g) was recorded in treatment N4, followed by treatment N3 (27.55 g). Whereas, the treatment N1 had minimum seed yield plant^{-1} (15.54 g). The maximum seed yield plant^{-1} was recorded under the higher dose of nitrogen whereas, the lowest levels of nitrogen produced minimum seed yield plant^{-1}. The increased in seed yield plant^{-1} may be the result of increased in flower size and heavy flower weight due to various growth of individual plants with higher nitrogen dose. The similar results were recorded by Natrajan and Vijaykumar (2002) in African marigold, Singh and Baboo (2003) in chrysanthemum.

Significantly, an maximum seed yield plot^{-1} was recorded in treatment N4 (1582.78 g) followed by treatment N3 (1405.26 g). Whereas, the treatment N1 had minimum seed yield plot^{-1} (792.56 g). The maximum seed yield plot^{-1} was recorded under the higher dose at nitrogen whereas, the lowest levels of nitrogen produced minimum seed yield plot^{-1}. The increased in seed yield plot^{-1} may be the result of increased flower size and heavy flower weight due to various growth parameters of individual plants with higher nitrogen dose. The similar results were recorded by Natrajan and Vijaykumar (2002) in African marigold.

Significantly, an maximum seed yield ha^{-1} was recorded (15.63 q) in treatment N4 (200 kg N ha^{-1}) which was followed by treatment N3 (13.88 q). Whereas, the treatment N1 had minimum seed yield ha^{-1} (7.82 q). The maximum seed yield ha^{-1} was recorded under the higher dose at nitrogen whereas, the lowest level of nitrogen produced minimum seed yield ha^{-1}. The increased in seed yield ha^{-1} may be the result of big size flowerwith heavy weight due to various growth parameters of individual plants with higher nitrogen dose. The similar results were recorded by Natrajan and Vijaykumar (2002), Swaroop *et al.*, (2007) in African marigold.

Effect of potassium

Significantly, an maximum number of dry flowers plant^{-1} were recorded in treatment K4 (25.52) which was found to be at par with treatment K3 (24.59). Whereas, the treatment K1 had minimum number of dry flowers plant^{-1} (19.40). The increased in number of dry flowers plant^{-1} with increasing levels of potassium might be due to potassium. Potassium is a constituent of many energy rich compounds in plants and also involved in active root growth and helps in uptake of other nutrients results in increased in number

of dry flowers. Above the findings are close in conformity with the findings of Natrajan and Vijaykumar (2002) in marigold and Singh and Baboo (2003) in chrysanthemum. Khan *et al.*, (2004) in petunia.

Significantly, an maximum number of seeds flower^{-1} were recorded in treatment K4 (316.30) which was found to be at par with the treatment K3 (314.35). Whereas, the treatment K1 had minimum number of seed flower^{-1} (294.13). The above findings are close in conformity with the findings of Natrajan and Vijaykumar (2002) in marigold, Khan *et al.*, (2004) in petunia.

Significantly, an maximum seed yield plant^{-1} were recorded in treatment K4 (28.47 g) which was followed by treatment K3 (26.54 g). Whereas, the treatment K1 had minimum seed yield plant^{-1} (19.16 g). Above the findings are close conformity with the findings of Natrajan and Vijaykumar (2002) in marigold, Singh and Baboo (2003) inchrysanthemum.

Table.1 Effect of nitrogen, potassium and their interactions on growth parameter of marigold

Treatments	Height of plant^{-1} (cm)	Number of branches^{-1} (no.)
	90 DAT	90 DAT
A) Nitrogen levels (N)		
N_1 (0 kg N ha^{-1})	95.67	11.78
N_2 (100 kg N ha^{-1})	100.01	12.95
N_3 (150 kgNha^{-1})	102.75	13.13
N_4 (200 kg N ha^{-1})	105.48	13.56
SE (m) ±	1.039	0.194
CD at 5%	2.999	0.561
B) Potassium levels (K)		
K_1 (0 kg K_2O ha^{-1})	97.29	12.11
K_2 (50 kg K_2O ha^{-1})	101.54	12.83
K_3 (75 kg K_2O ha^{-1})	101.62	13.00
K_4 (100 kg K_2O ha^{-1})	103.44	13.46
SE (m) ±	1.039	0.194
CD at 5%	2.999	0.561
Interaction effect (N x K)		
SE (m) ±	2.079	0.389
CD at 5%	--	--

Table.2 Effect of nitrogen, potassium and their interactions on yield parameter of marigold

Treatments	Number of dry flower plant^{-1}	Number of seeds flower^{-1}	Seed yield plant^{-1} (g)	Seed yield plot^{-1} (g)	Seed yield ha^{-1} (q)
	After final harvesting				
A) Nitrogen levels (N)					
N_1 (0 kg N ha^{-1})	19.40	294.31	19.16	977.18	9.64
N_2 (100 kg N ha^{-1})	21.38	306.58	22.30	1137.30	11.22
N_3 (150 kg N ha^{-1})	24.59	314.35	26.54	1353.75	13.36
N_4 (200 kg N ha^{-1})	25.52	316.30	28.47	1452.06	14.33
B) Potassium levels (K)					
K_1 (0 kg K_2O ha^{-1})	16.08	291.31	15.54	792.56	7.82
K_2 (50 kg K_2O ha^{-1})	21.35	307.51	22.35	1139.72	11.25
K_3 (75 kg K_2O ha^{-1})	25.60	313.52	27.55	1405.26	13.88
K_4 (100 kg K_2O ha^{-1})	27.87	319.05	31.03	1582.78	15.63
Interaction effect (N x K)					
SE (m) ±	0.645	3.820	0.780	39.809	0.393
CD at 5%	1.862	-	2.251	114.84	1.134

Significantly, an maximum seed yield plot^{-1} were recorded in treatment K4 (1452.06 g) followed by treatment K3 (1353.75 g). Whereas, the treatment K1 had minimum seed yield plot^{-1} (977.18 g). The above findings are close in conformity with the findings of Natrajan and Vijaykumar (2002) in marigold.

Significantly, a maximum seed yield ha^{-1} (14.33 q) were recorded in treatment K4, followed by treatment K3 (13.36 q). Whereas, the treatment K1 had minimum seed yield ha^{-1} (9.64 q). Above the findings are close conformity with the findings of Natrajan and Vijaykumar (2002) in marigold.

It can be concluded that application of 200 kg nitrogen ha^{-1} and 100 kg potassium ha^{-1} improved the growth of plant and seed yield of African marigold cv. African Double Orange under agro-climatic conditions of Nagpur.

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