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Study on Effect of Phosphorus on Growth and Flowering of Marigold (*Tagetes Erecta*)

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Abstract

A field experiment to study "Effect of phosphorus on growth and flowering of Marigold (Tageteserecta)was conducted at the Mid-Western Academy and Research Institute Campus of live sciences Tulsipur, Dang. The variety used in this experiment was Karma orange. The experiment was laid out Randomized Complete Block Design (RCBD) with three replications of each treatment. Data were collected using simple random sampling without replacement. In the experiment marigold plants were fertilized with seven different doses of phosphorous (0, 20, 40, 60, 80, 100, 120 kg/ha). Dose of nitrogen (200kg/ha) and potash (90kg/ha) was constant throughout the filed. Result revealed that application of phosphorous significantly affected the various yield governing parameters like number of branches, number of flowers per plant, flower diameter and flower weight but other factors like plant height, days of first bud appearance, days of flowering were not significantly affected. The result obtained were maximum plant height (54.06cm) at 20 kg/ha, maximum number of branches at 100kg/ha, maximum number of flowers per plant at peak bloom stage was 42 at 80kg/ha, fresh flower diameter (7.55cm) at 100kg/ha and fresh flower weight (15.96gm) at 100kg/ha. Maximum yield obtained in three successive harvesting was (622.39gm/plant) at 100kg/ha and the minimum yield was (349.43gm/plant) at control treatment. From this experiment we can conclude that (100 kg/ha) dose of phosphorus might be best for obtaining maximum yield at Tulsipur, Dang condition.

Keywords: Phosphorus; Growth; Flowering; Marigold; Xanthophylls; Antioxidants; Floriculture; Agro-ecological; Photosynthesis; Farmers

Abbreviations: NAPA: Nepalese Agriculture Professionals of America; DAP: Diammonium Phosphate; GDP: Gross Domestic Product; RCBD: Randomized Complete Block Design; MOP: Muriate of Potash; LSD: Least Significant Difference

Introduction

Tageteserecta, the Mexican marigold is a species of the genus Tagetes and family Asteraceae or Compositae, native to Mexico. Despite it's being native to Maxico and Central Americas, it is often called African marigold. There are two basic types of Marigold the large-flowered American (also referred to as African) Marigold *Tageteserecta* and the smaller-flowered French marigold *(Tagetespatula)*. Marigold is a potential commercial flower that is gaining popularity on account of its easy culture, wide adaptability, and increasing demand in the subcontinent [1]. The flowers are grown for market value and is sold in market as a cut flower and garland. For yellow color xanthophylls is present. Xanthophylls comprising 90% of the petals identified pigments. Marigold flowers are available in a variety of colors, including yellow, orange mixed colors. Marigold Flowers will bloom from mid-summer all the way until frost. Marigolds are highly valued for their ornamental appeal as well as medicinal properties. Tagetesis a multipurpose plant having ornamental, ritual, medicinal, anthelmintic, insecticidal, colorant, food, and forage applications. Oil extract of Tagetessppare used against fly repellent and grown as a trap crop. Marigold contains antioxidants in flower oil that is used against blood fat, inflammation intestine and immunity.

The floriculture has been becoming one of the prominent sectors in Nepalese economy contributing 0.05% of the total national Gross Domestic Product (GDP). Although, the annual growth rate of flowers production is 24%, the import value was 0.4 million in 2014/015 [2]. The quantity of importing flower products has been increasing annually because of higher demand than that of domestic production. In addition, the floriculture is constrained by higher cost of production that led to importing larger quantity of flower products. Although, there is a Flower Promotion Policy,

(2069) the flower producers and concerned stakeholders in floriculture are not fascinated and encouraged to enhance the production and productivity. There is higher potentiality for expanding of floriculture and enhancing flower products because of diversified agro-ecological settings in the country. Despite being flourishing with greater possibility, this sector is still at very earlier stage of establishment. This sector has been facing several constraints such as inputs, technology development and transfer, credit access, and flower market, and etc. Such constraints hindered the floriculture and led to higher quantity of imports of the flower products estimated to be Rs. 40 million in 2014 [2].

Excessive amounts of phosphorus hinder micronutrient absorption. Excessive phosphorus results in deficiency of iron and zinc. However, reduced phosphorus quantities stunt plant growth. Because the plant cannot photosynthesis correctly, sugars are not turned into energy and cause purple coloring to appear across the plant. It is crucial to maintain a balanced amount of phosphorus in the soil by fertilizing correctly. This study was done to find out the dose which is below the toxic level and above the deficiency level. Findings of this result may provide the optimum dose of Phosphorus which may provide maximum profitable yield and may meet the market demand and ultimately improve the economic condition of farmers.

Materials and Method

The research was carried out at the horticulture research farm of MARIColS, Tulsipur Dang in the year 2018. The experiment was laid out in RCBD (Randomized Complete Block Design) with 7 different treatment doses of phosphorus (0, 20, 40, 60, 80,100,120) kg/ha and each treatment being replicated three times. 21 plots were made, and each plot has 20 plants and data was taken from 5 random plants after tagging. The research field was divided in 3 replications and each replication having seven plots. Gaps between the plot was maintained 1.5m and gap between replication was 50cm for easy access to management practices. Each plot was maintained of 2.5*2m^2 size. The seedling of African marigold variety karma orange was raised in germination tray. Coco peat was used as growing substrate. After emergence of 2 true leaf seedlings were transplanted. Before transplanting the plots were applied with fertilizer and ridge and bund were made. Planting was done in 50*50 cm^2 distance.

Dose of nitrogen and potash was constant in each plot and the phosphorus was varied among the treatment. FYM was incorporated initially during field preparation @ of 15ton/ha. Nitrogen was supplied in ammonium (NH4 +) form through urea and Diammonium Phosphate (DAP). Dose of nitrogen supplied through urea and DAP was at the rate of 200kg/ha. Half dose of nitrogen was applied before transplanting with full dose of potash and phosphorus and the remaining doses of nitrogen was applied in two splits after 30 and 60 days of transplanting. Phosphorus was supplied in the form of P2O5 through DAP. Potash was supplied in the form of k2O through Muriate of Potash (MOP). Dose of Potash was at the rate of 90kg/ha in each 21 plots. The varying dose of phosphorus was our treatment. The different doses were (20, 40, 60, 80, 100, 120) kg/ha. Data collection was started after 14 days of transplanting and continued up to final harvesting 95 day of transplanting. After data collection data were entered in Microsoft excel then R-studio software was used for data analysis. Significance of data were observed by ANOVA table at 5% level of significance. After finding significance difference in some of the parameters further Least Significant Difference (LSD) was calculated in R-studio using the package agricolae.

Result and Discussion

Plant height and number of branches per plant

Analysis of variation showed that there was not significant different in final plant height of plant in different treatment. Table and figure below show the result which is not significantly different but little variation among the treatment. Maximum plant height was 56cm in 20kg/ha phosphorus dose. Minimum plant height was 46 cm at control treatment. In this research maximum plant height was 54.06 cm recorded at T2 (20kg/ha phosphorus). The result revealed that there is not significant effect of phosphorus on plant height. Other factors than like nitrogen and plant gene is responsible for not significant difference in height. Nitrogen is mainly responsible for vegetative growth, chlorophyll content and protein contain in plants and phosphorus is mainly responsible for root growth, resistance and early maturity. Increase in plant height due to increased nitrogen application is closely related with the findings of Singh & Rao [3] in marigold (*Tagetesminuta L*). Since the dose of nitrogen was constant is each plot the significant difference in height was not seen.

Table 1: Effect of Different Doses of Phosphorus on Plant Height(cm) and Number of Branches in Marigold at Tulsipur, Dang.

Treatment	Phosphorus Dose (kg/ha)	Plant Height (cm)	No. of Branches Per Plant
T1	0	49.66^{ab}	16.00^{d}
T2	20	54.06^{a}	18.33^{c}
T3	40	49.20^{b}	19.67^{bc}
T4	60	52.67^{ab}	20.33^{b}

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T5	80	51.00[ab]	22.67[a]
T6	100	52.67[ab]	24.00[a]
T7	120	51.34[ab]	23.00[a]
CV %		4.8	3.92
LSD		4.4	1.43
P (0.05)		0.262	4.31e-07***

ANOVA showed that there was significant difference in number of branches due to the different levels of phosphorus treatment. Maximum number of branches was seen 24 in (100) kg/ha and the minimum number of branches were found to be 15 in control treatment. The most effective and economic dose was found to be 100kg/ha. The detail result is shown in following figure and table. The maximum number of branches per plant was recorded in increased dose of phosphorus (80.100,120) kg/ha, while the minimum number of branches was found in T1 (control dose). Phosphorus at increasing levels also showed increase in number of primary branches. These results are in accordance with the findings of [4] in *(Tagetespatula L)* cv. PusaArpita and the findings of [5] in Tageteserecta cv. Pusa Narangi (Table 1)

Days to bud appearance and flower opening

Table 2: Effect of Different Doses of Phosphorus on Days of Bud Appearance and First Flower Opening in Marigold at Tulsipur, Dang.

Treatment Dose (kg/ha)	Phosphorus Appearance (DAS)	Days to Bud Opening (DAS)	Days to Flower Opening DAS)
T1	0	49.00[a]	65.33[a]
T2	20	50.67[a]	63.33[a]
T3	40	49.00[a]	62.00[a]
T4	60	47.67[a]	64.00[a]
T5	80	48.00[a]	63.66[a]
T6	100	48.34[a]	64.66[a]
T7	120	49.67[a]	62.00[a]
CV %		4.52	3.77
LSD		3.93	4.26
P (0.05)		0.69	0.571

Days to bud appearance was not found to be significant different in different doses of phosphorus. Maximum mean days taken to first bud appearance in plant were recorded 50.67 days in T5 and minimum mean days for first bud appearance was recorded 47.67 days in T7. The effect of phosphorous on days of flowering was statistically non-significant. From table below we can observe the maximum days of flowering (65.33DAS) in T1. While the minimum days of flowing (62DAS) was observed same in T3 and T7. Although the difference was not significant, but we can see that increase in phosphorus level had decreased the time taken for first flower opening. The significant difference might have not seen because the character (days of flowering) might have been governed by other factors like plant gene and other environmental factor other than plant nutrient. Which is similar with the result of [6] The result showed that increasing N and P rates in African marigold reduced the number of days required for 50% flowering (Table 2).

Number of flowers per plant, fresh flower diameter, flower weight and yield

Different doses of phosphorus treatment significantly affected the numbers of flowers per plant. Maximum mean numbers of flowers were recorded in treatment 5 (80kg/ha phosphorus) and the minimum number of flowers were recorded in control treatment. Here the result showed that increased dose of phosphorus increased the number of flowers per plant. The Significant increase in number of flower and marigold yield and its attributes with the application of increased level of phosphorus have been reported in African marigold by [7]. The effect of phosphorous on flower diameter was statistically non-significant. From the table below we can observe the flower diameter varies from 6.38 to 7.55. The maximum flower diameter (7.55mm) was observed in T6 followed by T7 and T5 respectively. Minimum flower diameter was observed in T1 and T3. Almost equal size flower was obtained from the different phosphorus level, but slightly increasing size

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was seen in increase dose of phosphorus. Significant difference was not found because flower diameter might have been governed by plant gene but not the environmental factor or phosphorus level. The increase in phosphorus is found to be involved in the initiation of flower primordial formation leading to increase in number of flower and size as well as the attributes of yield [7].

Data analysis revealed that there was significant different in weight of fresh flower due the different treatment levels of phosphorus. It was found that maximum mean weight of flower was 15.95 in T6 (100kg/ha phosphorus) and the minimum mean weight was 12.53 in T3 (40kg/ha phosphorus). Here the control treatment, treatment 2 and treatment 3 had similar type of result and in further increase in phosphorus level lead to increased weight of fresh flowers. The maximum weight was found in T6 [6]. also observed that increasing N and P rates in African marigold increased the individual weight of a single flower. Yield of fresh flower per plant was found to be significantly different due the different treatment levels of phosphorus. It was found that maximum mean yield of flower was 622.39gm in T6 (100kg/ha phosphorus) and the minimum mean weight was 349.43 in T3 (40kg/ha phosphorus). The result is shown below in table and figure. The findings revealed that flower yield per plant varied from different doses of phosphorus treatments and the result was also significantly different among treatment. The maximum flower yield per plant was recorded under the treatment T6 (100kg/ha phosphorus) followed by treatment T5 (80kg/ha phosphorus) and the minimum flower Yield per plant was recorded in the T1(control). The increase in flower yield might be attributed to increased supply of major nutrients like N, K and P which played their unique functions in the growth and development of plants [8]. These results are in close conformity with those of Baboo & Gaikwad et al, [9,10]. The significant increase in marigold yield and its attributes with the increased level of phosphorus have been reported in African marigold by [7] (Table 3).

Table 3: Effect of Different Doses of Phosphorus on Number of Flowers Per Plant, Fresh Flower Diameter, Flower Weight and Yield in Marigold at Tulsipur, Dang.

Treatment Dose	Phosphorus (kg/ha)	No. of Flowers Per Plant	Flower Diameter(cm)	Flower Yield Per	
				weight(gm)	plant(gm)
T1	0	25.00^{c}	6.90^{ab}	12.81^{bc}	361.33^{b}
T2	20	26.33b^{c}	7.37^{ab}	12.68^{c}	365.93^{b}
T3	40	27.33^{bc}	6.38^{b}	12.53^{c}	349.43^{b}
T4	60	32.00^{b}	6.72^{ab}	14.55^{abc}	529.39^{ab}
T5	80	42.00^{a}	7.27^{ab}	14.76^{ab}	621.55^{a}
T6	100	41.33^{a}	7.55^{a}	15.95^{a}	622.39^{a}
T7	120	40.66^{a}	7.44^{a}	15.09^{a}	531.72^{ab}
CV %		10.1	8.32	8.13	25.1
LSD		6.02	1.05	2.03	215.78
P (0.05)	5.61e-05 ***	0.223	0.0156*	0.0478*	

Conclusion

From this research it can be concluded that the phosphorus play an important role on yield of African marigold. The application of T6 (Phosphorus 100 kg/ha) was observed to be the best with respect of most of the parameters examine under this research i.e. plant height, number of branches per plant, flower size, fresh flower weight and yield. For number of flowers T5 (80 kg/ha phosphorus) was found best and with respect to early flower opening T7 (120 kg/ha phosphorus). Economic analysis revealed that T5 and T6 gives the best economic return. It is recommended to use 100 kg of phosphorus per hectare land for commercial cultivation of marigold in Tulsipur, Dang conditions.

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