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Research Article

Effects of different rates of nitrogen and pinching on yield and yield attributes of African marigold (*Tagetes erecta* L.)

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ABSTRACT

Proper pinching practice and the optimum rate of nitrogen (N) enhance the production of marigold. An experiment was conducted at a farmer's field in Gadawa-4, Gangaparaspur, Dang, Nepal from July 2018 to November 2018 to investigate the effects of different rates of nitrogen and pinching on yield and yield attributes of African marigold (cv. Kolkata Local). Two factorial experiment was laid in the Randomized Complete Block Design (RCBD) with three replications. There were eight treatments, consist of four rates of nitrogen (0, 50, 100 and 150 kg/ha) and two levels of pinching (pinching and non-pinching). The maximum plant height (89.70 cm), the diameter of flower (4.29 cm) and the fresh weight per flower (4.32 g) and early days to 50% flowering (61.58) were obtained at non- pinching. The highest number of flowers (60.66), yield per plant (237.49 g) and yield per hectare (9.89 t/ha) were obtained with pinching. The highest plant height (92.20 cm) was recorded at 150 kg/ha of N but the highest yield per plant (238.18 g) and yield per ha (9.91 t/ha) was obtained at 50 kg/ha of nitrogen application. No significant effect was noted on the days to 50% flowering, number of flowers per plant, fresh weight per flower and diameter of flowers by different rates of nitrogen. The interaction of pinching and different rates of nitrogen showed non- significant effect on yield per plant and yield per ha. But, the combination of pinching and nitrogen rates at 50 kg/ha recorded the maximum yield per plant (249.20 g) and yield per ha (10.36 t/ha). Hence it is suggested to use pinching practice with optimum application of nitrogen @ 50 kg/ha to obtain high yield of marigold.

Keywords: Marigold, nitrogen rate, pinching, quality, yield

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INTRODUCTION

Marigold (*Tagetes spp*.) belongs to the family compositae. Generally, two main species of marigold i.e. *Tagetes erecta* L. and *Tagetes patula* L. are popularly grown over the world. *Tagetes erecta* L. is of Mexican origin and *Tagetes patula* L.is African origin. *Tagetes erecta*

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L. is commonly known as "African marigold". Generally, African marigold is grown in Nepal. Due to the wider acceptance of edaphic and climatic variations, it is easier to cultivate marigold than other flowers. Marigold can produce larger flower sizes and more in number due to the wider capacity of adaptation. The color of the flower varies from yellow or orange. In Nepal, marigold flowers have an important position during the 'Tihar'- a Hindu festival, puja and other ceremonies. Oil extracted from marigold is used in perfumes preparation and insect repellent. Ladybugs, parasitic wasps, hoverflies and other beneficial insects that protect our plants from aphids and other harmful pests are attracted by marigold. As a trap crop in agriculture, marigolds are used to control nematode. Flavonoids present in marigold flowers have been found to exhibit cytotoxic, anti-inflammatory and inhibitory activities against colon cancer, leukemia and melanoma cells.

Pinching is the practice of removing the apical part of a plant. The yield of the flower depends upon the number of branches that bear flowers which can be manipulated by inhibiting the vertical growth and encouraging side shoots of plants with the help of pinching (Baskaran & Abirami, 2017). The side shoots provide more scope to produce a large number of flowers. The pinching practice is done because it stimulates the early emergence of side branches which ultimately produces more flowers with good quality and uniform flower size (Nain *et al*., 2017). When nitrogen is used at optimum rates and at the appropriate time, nitrogen helps in the optimal growth of plants (Gadagi *et al*., 2004). Nitrogen deficiency causes a reduction in plant growth and yields *(Shrestha et al., 2018).* Nitrogen helps to promote vegetative growth and helps the plants in the flower opening process during the blooming period (Ullah *et al*., 2018). However, high nitrogen is also not good as high nitrogen promotes excessive vegetative plant growth and delayed flowering (Zewide *et al*., 2012).

In Nepal, marigold can be one of the best commercial agricultural products. Nepal is bestowed with suitable climate, soil and environment required for marigold production but there is a lack of knowledge on improved practices. Researches related effect of pinching and nitrogen in yield and yield attributes of marigold is not documented and available. Due to lack of research backup, marigold growers are unaware on pinching and optimum level of nitrogen application for maximization of yield. It is necessary to conduct various research related to pinching and nitrogen application in marigold to enhance yield and quality of the marigold flower. Therefore, this research was conducted to evaluate the effect of pinching and different rates of nitrogen on yield and yield attributes of marigold production in Dang conditions.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at Gadawa rural municipality ward no 4, Gangaparaspur, Dang, Nepal. Dang is one of the pocket areas of cut flower production. It is located at 27.80^0 N latitude and 82.53^0 E longitudes with an elevation of 567 masl. The experimental site has a subtropical climate. The climatic data of the site during the experiment is shown in Figure 1. The soil of the experimental site was slightly acidic with pH 6.40. Further, the soil of the experimental site had 3.90% available organic matter, 0.18% total nitrogen, 50 kg/ha available P_2O_5 and 210 kg/ha available K_2O.

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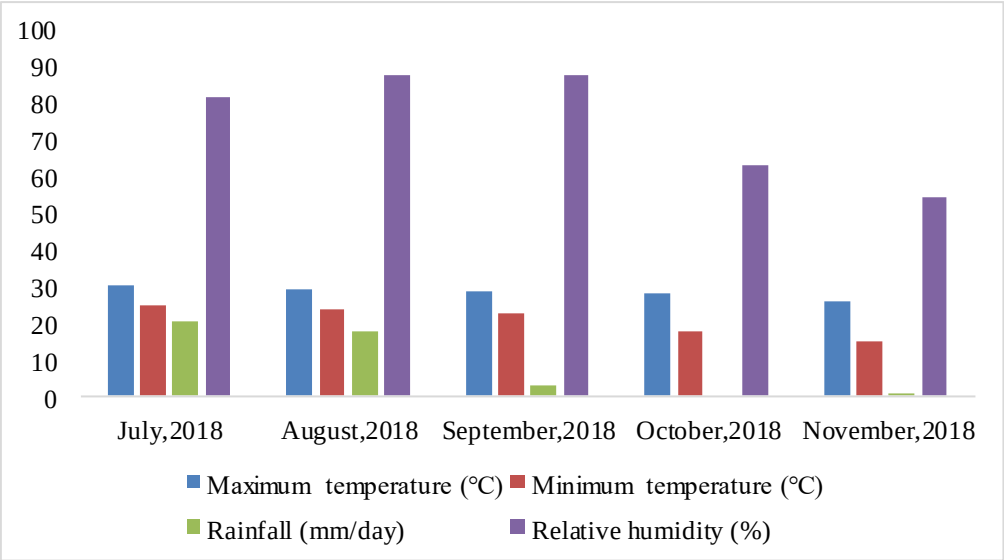

Figure 1: Monthly climatic data of the experimental site during the experiment (Source: NASA Power, 2018)

Experimental details

The variety of marigold used in the experiment was Kolkata Local. Two factorial Randomized Complete Block Design (RCBD) was used with 3 replications in 8 treatments. The total area of the experimental field was 256.5 m^2 (28.5 m × 9 m) in which the individual plot measured 6 m^2 (3 m × 2 m). The spacing between replication and plot was 1m and 0.5 m respectively. Seedlings were transplanted on 10th July, 2018. One month old healthy seedlings were transplanted at the spacing of 60 cm x 40 cm (row x plant). Irrigation was done with a watering can after transplanting. There were 5 rows in each plot and 5 plants were planted in each row. There were altogether 25 plants in each plot. Urea was applied at two splits (i.e. 1/2 as basal dose, 1/2 after 30 days). A full dose of single super phosphate and muriate of potash were applied as a basal dose. The same rate of phosphorus (P) and potash (K) was applied in all treatments i.e. 50 kg/ha and 50 kg/ha respectively. But the rates of nitrogen were 0 kg/ha, 50kg/ha, 100 kg/ha and 150 kg/ha. The crop was irrigated on regular basis as per the requirement of the crop. The plot was kept weed free by regular hand weeding. Pinching was done after one month of transplanting with the help of clean scissors, the top 3-4 cm of the plant was removed. Harvesting was done manually.

Table 1: Factors and treatments of the experiment

S.No.	Factors
	Factor A: Pinching
1	Pinching
2	Non-Pinching
	Factor B: Nitrogen rates
1	0 kg/ha
2	50 kg/ha
3	100 kg/ha
4	150 kg/ha

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Data recorded

Five represented plants from the inner rows of each plot were selected and tagged in each replication for recording data. Data on different parameters like plant height, days to 50% flowering, number of flowers per plant, fresh weight per plant, diameter of flower, yield per plant, yield per hectare were recorded. The height of tagged plants was measured from the base of the plant to the tip of the main stem using a long scale until harvesting. The average height was calculated and expressed in centimeter (cm). The number of days taken for 50% flowering in each plot was recorded by counting the days from the date of transplanting and expressed as days to 50% flowering. Similarly, the number of flowers harvested from the tagged plants was averaged and recorded as the number of flowers per plant. After recording the number of flowers harvested, ten flowers were randomly selected and their total weight was calculated in gram and the average fresh weight of per flower was obtained. Further, ten fully opened flowers were selected randomly from the tagged plants and the diameter of the flower was measured using vernier caliper and expressed in centimeter (cm). The flower yield of sampled plants was recorded and the average was calculated as yield per plant and expressed in gram (g). Further, the flower yield of the net plot area was calculated and based on total net plot yield, yield per ha was calculated and expressed in t/ha.

Statistical analysis

Collected data was tabulated in Microsoft excel and recorded data was analyzed using R software. The analysis of variance (ANOVA) in Randomized Complete Block Design (RCBD) was used to determine the level of significance. The significant differences between treatments were determined using Duncan's Multiple Range Test (DMRT). The treatment means were compared by the Least Significant Difference (LSD) test at 1% and 5% level (Gomez & Gomez, 1984; Shrestha, 2019).

RESULTS AND DISCUSSIONS

Effect of pinching on growth and yield attributes of marigold

Factor A showed a significant effect on the plant height, days to 50% flowering, number of flowers per plant, fresh weight per flower, diameter of flower, yield per plant and yield per ha Table 2. The maximum plant height (89.70 cm) was recorded at non-pinching. The maximum height of non-pinched plants as compared to pinched plants was mainly due to the reason that the non-pinched plant grew without any disturbance and achieved maximum height. Baskaran & Abirami (2017) recorded similar findings on the height of African marigold. Days to 50% flowering was earlier (61.58) in non-pinching while pinching took more days (67.09) for 50% flowering. B.C. *et al*. (2020) also stated that pinching delayed flowering. Similar finding was accorded by Khan *et al*. (2018). Further, the highest number of flowers (60.66) was recorded at pinching while the lowest was recorded at non-pinching (49.25). As the plant is pinched, the apical dominance is broken and the extra energy is diverted into the production of more branches and flowers which might be the reason for more number of flowers in pinched plants. Similar results were observed by Pushkar & Singh (2012) on the number of flowers of African marigold. Similarly, the highest fresh weight per flower (4.32 g) was recorded at non- pinching while the lowest was recorded at pinching (3.93 g). The minimum fresh weight at pinching might be due to an increased number of flowers at pinching that causes a lesser supply of plant bioregulators and food reserve to developing flower which ultimately decreases the fresh weight of the flower (Nain *et al*., 2017). Singh *et al*. (2017) reported a similar type of results on marigold. Similarly, the highest diameter of the flower (4.29 cm)

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was recorded at non-pinching while the lowest diameter of the flower (3.94 cm) was recorded at pinching. After pinching a greater number of branches raised and the number of flowers also increased but the diameter of the flower is decreased because the nutrients and other mineral content are used in promoting the vegetative growth due to which flower diameter in non-pinching is more than at pinching (Cicevan *et al*., 2016). Nain *et al*. (2017) obtained the highest flower diameter at non-pinching while the lowest at pinching on African marigold. Further, the highest yield per plant (237.49 g) and yield per ha (9.89 t/ha) was obtained at pinching while the lowest yield per plant (213.35 g) and yield per ha (8.88 t/ha) was obtained at non-pinching. Badge *et al*. (2015) in African marigold recorded the maximum yield per plant at pinching. Mohanty *et al*. (2015) and Sarkar *et al*. (2018) recorded the maximum yield per ha at pinching in African marigold.

Effect of nitrogen on growth and yield attributes of marigold

Similarly, nitrogen application showed a significant effect on the plant height, yield per plant and yield per ha but nonsignificant effect was noted on the days to 50% flowering, number of flowers per plant, fresh weight per flower and diameter of flower Table 2. The plant height varied from 81.30 cm to 92.20 cm. Among different rates of nitrogen, 150 kg/ha of nitrogen recorded the highest plant height (92.20 cm) while the lowest plant height (81.30 cm) was recorded at 0 kg/ha of nitrogen. Nitrogen rates 0 kg/ha and 50 kg/ha showed similar effects on plant height. Further, nitrogen rates 100 kg/ha and 150 kg/ha showed no different effect on plant height. Nitrogen enhances vegetative growth so plant height increased with the application of nitrogen. Ullah *et al*. (2018) also reported an increase in plant height with an increase in nitrogen rates in marigold. The highest yield per plant (238.18 g) and yield per ha (9.91 t/ha) was recorded at the nitrogen level 50 kg/ha. The nitrogen level 0 kg/ha, 50 kg/ha and 100 kg/ha behaved equally without any significant differences among each other on yield per plant and yield per ha. The lowest yield per plant (201.03 g) and yield per ha (8.36 t/ha) was recorded at the nitrogen rate 150kg/ha.

Table 2: Effect of pinching and different nitrogen rates on marigold in 2018:

Treatments	Plant height (cm)	Days to 50% flowering	Number of flowers per plant	Fresh weight per flower (g)	Diameter of flower (cm)	Yield per plant (g)	Yield per ha (t/ha)
Pinching							
Pinching	83.00b	67.09a	60.66a	3.93b	3.94b	237.49a	9.89a
Non-Pinching	89.70a	61.58b	49.25b	4.32a	4.29a	213.35b	8.88b
LSD (0.05)	3.30*	3.56**	4.15***	0.30*	0.23**	18.63*	0.77*
Nitrogen rates (kg/ha)							
0	81.30b	64.30	58.66	3.98	3.96	232.35a	9.68a
50	82.40b	64.00	56.33	4.25	4.18	238.18a	9.91a
100	89.50a	64.50	52.83	4.41	4.20	230.13a	9.58a
150	92.20a	64.50	52.00	3.86	4.11	201.03b	8.36b
LSD (0.05)	4.6***	NS	NS	NS	NS	26.35*	1.10*
CV %	4.30	6.32	8.63	8.38	6.42	9.44	9.48
Grand mean	86.30	64.33	54.95	4.12	4.11	225.42	9.38

*Means within the column followed by the same letter for lines are not significantly different at 5% level of significance by DMRT. CV= Coefficient of variation, LSD= Coefficient of variation, *= Significant at P≤0.05, **= Significant at P≤0.01, ***= Significant at P≤0.001 and NS= Non significant at 5% level of significance.*

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The decrease in yield per plant and yield per ha with the high rate of nitrogen might be due to high N absorption which decreases yield and losses of nitrogen increases (Gutierrez *et al*., 2006). Singh *et a*l. (2017) also recorded similar findings in marigold. Other parameters i.e. days to 50% flowering, number of flowers per plant, fresh weight per flower, diameter of flower were non- significant.

Interaction effect of pinching and nitrogen on yield of marigold

The interaction effect of pinching and different rates of nitrogen was non-significant for yield per plant (Table 3). But, the highest yield per plant (249.20 g) was observed in the combination of pinching with nitrogen 50 kg /ha (Table 3). The lowest yield per plant (184.53 g) was observed in non- pinching along with nitrogen 150 kg/ha. Similarly, the interaction effect of pinching and different rates of nitrogen was also non-significant for yield per ha (Table 4). But, the highest yield per ha (10.36 t/ha) was observed in the combination of pinching with nitrogen 50 kg/ha treatment Table 4 whereas the lowest yield per ha (7.66 t/ha) was observed in non-pinching along with nitrogen 150 kg/ha treatment. Singh *et al*., (2017) reported similar findings on marigold. They obtained more yield at a combination of pinching and nitrogen than non-pinching and control rates of nitrogen. They also reported a decrease in the yield of the flower with high nitrogen rates.

Table 3: Interaction effect of pinching and nitrogen application on yield per plant (g) of marigold in 2018:

	Nitrogen rates (kg/ha)			
	0	50	100	150
Pinching				
Pinching	242.06	249.20	241.16	217.53
Non-Pinching	222.63	227.16	219.10	184.53
LSD (0.05)	NS			
CV (%)	9.44			
Grand mean	225.42			

CV= Coefficient of variation, LSD= Coefficient of variation, NS= Non-significant at 5% level of significance

Table 4. Interaction effect of pinching and nitrogen application on yield per ha (t/ha) of marigold in 2018:

	Nitrogen rates (kg/ha)			
	0	50	100	150
Pinching				
Pinching	10.10	10.36	10.03	9.06
Non-Pinching	9.26	9.46	9.13	7.66
LSD (0.05)	NS			
CV (%)	9.48			
Grand mean	9.38			

CV= Coefficient of variation, LSD= Coefficient of variation, NS= Non-significant at 5% level of significance.

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CONCLUSION

Based on findings of this experiment, it is concluded that African marigold cv. Kolkata Local performed well in terms of yield per plant and yield per ha at a nitrogen rate 50 kg/ha along with pinching. Therefore, this practice can be suggested to increase yield of marigold at subtropical conditions of Dang, Nepal.

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Authors' Contributions

M. Pandey, S. Subedi designed, performed the experiment, recorded data, analyzed data. P. Khanal, P. Chaudhary and A. Adhikari collected data. P. Khanal, M. Pandey and S. Subedi wrote and edited the manuscript. T.P. Sharma supervised the experiment. J. Shrestha guided in analyzing data and writing the manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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