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Effect of Nitrogen and Phosphorus Levels on Flowering Characteristics of Marigold (*Tagetes minuta* L.) var Vanfool

M. M. Sharma, O. P. Singh

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Abstract Present study was carried out during *rabi* season in 2011-12 and 2012-13 with a view to study the effect of nitrogen and phosphorus levels on flowering characteristics of marigold. Maximum number of days taken to first flower bud formation was recorded with the application of 180 kg N/ha and 120 kg P/ha whereas, a minimum number of days taken to first flower bud formation and opening of first flowers were observed in the treatment where to fertilizers were given (N_0P_0). Nitrogen significantly and phosphorus application non-significantly influenced the days taken to opening of first flowers. On further study, by increasing the levels of nitrogen, the duration of flowering increased significantly. Maximum duration of flowering was observed due to application of 180 kg N/ha followed by 120 kg N/ha and 120 kg P/ha followed by 60 kg P/ha. The interaction effect of nitrogen and phosphorus was found non-significant. However, the maximum duration of flowering was recorded with the application of 180 kg N/ha along with 120 kg P/ha.

Keywords Application, Fertilizers, Maximum, Characters.

Introduction

Genus *Tagetes* has so many important wild and cultivated plants. Among them, Wild Marigold (*Tagetes minuta* L.) var Vanfool is very important member belonging to Asteraceae family. It has tiny involucres, toxic flowers and a particular odour. Being a weed, it is able to adapt almost every temperate area. Phytogenetic study with the help of one morphological and three molecular data sets depicts that there are 40 genera and 26,000 angiosperm species included in the order Asterales. Out of which 23,000 species are included in a single family Asteraceae. Tageteae probably, originated in Mexico and then, independently introduced to South America. Approximately, 216 new world species are included in Tageteae as reported by Lookerman et al. [1]. The specific epithet of marigold is from the Latin word 'minutes' meaning small and refers to the small size of the capitula and 'glandulifera' from glandula and fare and shows glands on under surface of leaves and on bracts of involucrum as studied by Hulina [2].

Tagetes minuta is the source of a much priced marigold essential oil. All the marigolds belong to the genus *Tagetes* (family Asteraceae tribe Helinieae)

M. M. Sharma*
PhD (Horticulture), Dep of Horticulture, N. D. University of Agriculture & Technology, Kumarganj, Faizabad 224229, India

O. P. Singh
Professor (Horticulture), Dep of Horticulture, N. D. University of Agriculture & Technology, Kumarganj, Faizabad 224229, India
e-mail: sharmamalay4968@gmail.com
*Correspondence

whose members are strongly scented species. The genus *Tagetes* is named after *Tagetes*, an Etruscan deity who sprang from the earth and revealed the art of the water divining vital forming.

It is considered native to South Africa, but is now found throughout the world. The eleven economically important species of *Tagetes* are *T. minuta* (South American marigold), *T. patula* (French marigold), (French marigold), *T. erecta* (African marigold), *T. signata*, *T. biflora*, *T. arborea*, *T. elongate*, *T. lucida*, *T. tenuifolia*, *T. mendocina* and *T. parryi*. Among them, the species of immense aromatic and pharmaceutical importance is *T. minuta*. South Africa, Brazil and Australia are the main producing countries of *T. minuta* oil in the world. Although, *T. minuta* is long recorded to be grown profusely in India, especially in wild habitats of Uttar Pradesh, Himachal Pradesh and Jammu & Kashmir, the first appraisal of its essential oil composition as made during early sixties. Interests in its domestication and commercial cultivation for essential oil production have been initiated recently. Now, the production and sale of *T. minuta* oil have assumed a degree of economic importance in certain rural areas of Indian hills (between 1000 to 2500 m) as well as in plains. It is produced as an excellent adjunct to the traditional winter crops.

In view of the importance of *Tagetes minuta* L. var Vanfool, present study was conducted to find out the optimum level of Nitrogen and Phosphorus on different flowering characteristics of marigold.

Materials and Methods

Systematic experimental procedures were followed during *rabi* season in the year 2011-12 and 2012-13. The experiment was carried out at the Main Experimental Station. Department of Horticulture, Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (UP), which is located 42 km away from Faizabad district headquarter on Faizabad–Raebareli Road. The soil analysis was done in the Laboratory of Department of Soil Science & Agricultural Chemistry and Department of Horticulture of this University.

Geographically, the site of experimentation is situated at 26.47° North latitude and 82.12° east longitude at an altitude of 113 meters above the mean sea level Kumarganj, Faizabad experiences sub-tropical climate of Indo-Gangetic plains of Eastern Uttar Pradesh (India) with hot dry summers and cool winters. The mean annual rainfall was recorded 1280 mm and relative humidity 63.15%. The rainfed was erratically distributed. Both maximum and minimum temperatures were found to fluctuate throughout the crop growth period. In general, the maximum temperature declined from time of transplanting to the third week of January and thereafter, increasing trends were recorded up to the termination of crop. The fluctuations were from 19.25°C to 41.87°C. The lowest and highest minimum temperature were recorded in first week of February and first week of May. The fluctuations were from 6.02°C to 25°C. The total rainfall received during crop season 57.21 mm. The meteorological observations recorded during the course of experimentation from October, 2011-12 to April, 2012-13.

In order to determine the physic-chemical properties of the soil and its fertility status, the soil samples were collected randomly from the different places of the field with the help of soil auger in each of the three replications to a depth of 0—15 cm after the land preparation and before application of fertilizers. The soil samples from each replication were mixed together and a composite sample was drawn and analyzed. Factorial Randomized Block Design with three replications and twelve treatments having thirty six plots of the size 2.4 × 1.8 m were included in the experiment. Plant spacing was 40 × 30 cm. Variety chosen for present study was 'Vanfool'. Season of experiment was *rabi* of 2011-12 and 2012-13. Date of nursery and date of transplanting were 5th October and 11th November, respectively. Four levels of Nitrogen (N_0, N_{60}, N_{120} and N_{180} kg/ha) and three levels of Phosphorus (P_0, P_{60} and P_{120} kg/ha) were applied for conducting the research. Viewing the precious and different use of fresh and processed Wild Marigold under present study, days taken to first flower bud formation ;days taken to opening of first flower ; days taken to 50% flowering ; duration of flowering in days and number of flowers per plant were mea-

Table 1. Effect of nitrogen and phosphorus levels on days taken to first flower bud formation in *Tagetes minuta*.

Levels of nitrogen	Levels of phosphorus 2011-12				Levels of phosphorus 2012-13			
	P_0	P_1	P_2	Mean	P_0	P_1	P_2	Mean
N_0	124.93	125.93	127.40	126.08	122.93	123.93	125.40	124.08
N_1	128.07	127.00	127.87	127.64	126.07	125.00	125.87	125.64
N_2	132.40	133.87	137.33	134.53	130.40	132.20	135.00	132.53
N_3	138.07	136.73	139.07	137.95	135.73	135.07	137.07	135.95
Mean	130.86	130.88	132.91	–	128.78	129.05	130.83	–
	N		–	P		–	N × P	
	2011-12	2012-13	–	2011-12	2012-13	–	2011-12	2012-13
SEd±	1.72	1.74	–	1.49	1.51	–	2.99	3.02
CD (p = 0.05)	3.58	3.62	–	NS	NS	–	NS	NS

sured with the application of different levels of nitrogen and phosphorus.

Results and Discussion

Under flowering characteristics of marigold, five characteristics like, days taken to first flower bud formation ; days taken to opening of first flowers ; days taken to 50% flowering ; duration of flowering (days) and number of flowers per plant were studied.

Days taken to first flower bud formation

A perusal of observations recorded in Table 1 for the year 2011-12 and 2012-13 reveal that application of nitrogen significantly and phosphorus non-significantly influenced the days taken to first flower bud formation. Maximum number of days (137.95 days during 2011-12 and 135.95 days during 2012-13) taken to first flower bud formation was recorded with the application of 180 kg N/ha.

The application of phosphorus had shown non-significant effect of days taken to first flower bud formation in Marigold (*Tagetes minuto* L.). However, maximum values (132.91 days during 2011-12 and 130.83 days during 2012-13) were recorded with the application of 120 kg P/ha, followed by 60 kg P/ha (130.88 during 2011-12 and 129.05 during 2012-13). Minimum days were recorded under the control (130.86 during 2011-12 and 128.78 during 2012-13) treatment.

The interaction effect of nitrogen and phosphorus was also found non-significant. However, the

Table 2. Effect of nitrogen and phosphorus levels on days taken to opening of first flower in *Tagetes minuta*.

Levels of nitrogen	Levels of phosphorus 2011-12				Levels of phosphorus 2012-13			
	P_0	P_1	P_2	Mean	P_0	P_1	P_2	Mean
N_0	130.00	132.00	135.93	132.64	129.00	131.00	134.93	131.64
N_1	134.00	132.00	135.93	133.97	133.00	131.00	132.60	132.20
N_2	138.20	139.27	144.13	140.53	137.20	138.43	142.97	139.53
N_3	143.80	142.93	145.67	144.13	142.63	142.10	144.67	143.13
Mean	136.50	136.55	140.41	–	134.42	135.63	138.79	–
	N		–	P		–	N × P	
	2011-12	2012-13	–	2011-12	2012-13	–	2011-12	2012-13
SEd±	1.72	1.74	–	1.49	1.51	–	2.99	3.02
CD (p = 0.05)	3.58	3.62	–	NS	NS	–	NS	NS

Table 3. Effect of nitrogen and phosphorus levels on days taken to 50% flowering in *Tagetes minuta*.

Levels of nitrogen	Levels of phosphorus 2011-12				Levels of phosphorus 2012-13			
	P_0	P_1	P_2	Mean	P_0	P_1	P_2	Mean
N_0	137.13	137.67	141.93	138.91	136.13	136.67	140.93	137.91
N_1	139.80	139.53	139.60	139.64	138.80	138.53	138.60	138.64
N_2	143.67	145.40	150.40	146.49	142.67	144.57	149.23	145.49
N_3	149.93	149.20	151.33	150.15	148.77	148.37	150.33	149.12
Mean	142.63	142.95	145.81	–	141.59	142.03	144.77	–
	N		–	P		–	N × P	
	2011-12	2012-13	–	2011-12	2012-13	–	2011-12	2012-13
SEd±	1.68	1.68	–	1.46	1.45	–	2.92	2.91
CD (p = 0.05)	3.50	3.48	–	NS	NS	–	NS	NS

maximum days taken to first flower bud formation (139.07 days during 2011-12 and 137.07 days during 2012-13) was recorded with the application of 180 kg N/ha along with 120 kg P/ha. Minimum days taken to first flowers bud formation was observed in the treatment where no fertilizers were given (N_0P_0). This finding was partially supported by Sharma et al. [3].

Days taken to opening of first flowers

Data recorded in Table 2 for the year 2011-12 and 2012-13 with respect to days taken to opening of first flowers in marigold indicate that nitrogen significantly and phosphorus application non-significantly influenced the days taken to opening of first flowers.

Minimum number of days (132.64 days during 2011-12 and 131.64 days during 2012-13) taken to opening of first flowers was recorded without application of nitrogen followed by the application of N @ 60 kg/ha whereas, maximum number of days (144.13 days during 2011-12 and 143.13 days during 2012-13) taken to opening of first flowers were counted with application of 180 kg N/ha.

The phosphorus application did not significantly influence the days taken to opening of first flowers. However, maximum number of days taken to opening of first flowers (140.41 days during 2011-12 and 138.79 days during 2012-13) was noticed in the plants treated with phosphorus @ 120 kg/ha in both consecutive cropping seasons.

The interaction effect of nitrogen and phosphorus was found non-significant. However, the maxi-

Table 4. Effect of nitrogen and phosphorus levels on duration of flowering (days) in *Tagetes minuta*.

Levels of nitrogen	Levels of phosphorus 2011-12				Levels of phosphorus 2012-13			
	P_0	P_1	P_2	Mean	P_0	P_1	P_2	Mean
N_0	32.67	31.93	33.27	32.62	33.83	33.10	34.10	33.67
N_1	30.93	37.60	36.13	34.88	31.93	38.60	36.97	35.83
N_2	42.13	41.93	43.00	42.35	43.13	42.93	44.00	43.35
N_3	42.60	44.07	45.07	43.92	43.60	45.07	46.07	44.91
Mean	37.08	38.88	39.36	–	38.12	39.92	40.28	–
	N		–	P		–	N × P	
	2011-12	2012-13	–	2011-12	2012-13	–	2011-12	2012-13
SEd±	1.72	1.52	–	1.49	1.32	–	2.99	2.64
CD (p = 0.05)	3.58	3.16	–	NS	NS	–	NS	NS

Table 5. Effect of nitrogen and phosphorus levels on number of flowers per plant in *Tagetes minuta*.

Levels of nitrogen	Levels of phosphorus 2011-12				Levels of phosphorus 2012-13			
	P_0	P_1	P_2	Mean	P_0	P_1	P_2	Mean
N_0	1503.67	2023.33	1324.00	1617.00	1511.67	2031.33	1332.00	1625.00
N_1	2168.33	2584.00	2957.67	2570.00	2177.67	2590.67	2967.00	2578.44
N_2	2414.00	2455.67	3234.67	2701.00	2422.00	2462.33	3242.67	2709.00
N_3	2478.00	3522.00	3363.33	3121.11	3530.00	3371.33	4619.33	3480.22
Mean	2142.00	2646.25	2719.92	–	2613.19	2653.58	3290.25	–
	N		–	P		–	N × P	
	2011-12	2012-13	–	2011-12	2012-13	–	2011-12	2012-13
SEd±	405.39	237.01	–	351.07	205.26	–	702.15	410.52
CD (p = 0.05)	840.78	491.57	–	NS	NS	–	NS	NS

mum days taken to opening of first flowers (145.67 days during 2011-12 and 144.67 days during 2012-13) was recorded with the application of 180 kg N/ha along with 120 kg P/ha while, the minimum days taken to opening of first flower was measured in the treatment in which no fertilizers were given (N_0P_0). This study was partially supported by Sharma et al. [3] and Yadav et al. [4].

Days taken to 50% flowering

Data with respect to days taken to 50% flowering in Marigold presented in Table 3 for the year 2011-12 and 2012-13 indicate that nitrogen application significantly and phosphorus application non-significantly influenced the days taken to 50% flowering.

Minimum number of days (138.91 days during 2011-12 and 137.91 days during 2012-13) taken to 50% flowering was reported under the plots having no application of nitrogen and phosphorus followed by the lots treated with N and P at the lowest dose of 60 kg/ha whereas, maximum number of days taken to 50% flowering (150.15 days during 2011-12 and 149.15 days during 2012-13) was recorded with the application of 180 kg N/ha.

The phosphorus application did not significantly influenced the days taken to 50% flowering. However, maximum number of days (145.81 days during 2011-12 and 144.77 during 2012-13) was recorded from the plants treated with 120 kg P/ha.

The interaction effect of nitrogen and phosphorus was found non-significant. The maximum days taken to 50% flowering (151.33 during 2011-12 and 150.33 during 2012-13) was recorded with the application of 180 kg N/ha along with 120 kg P/ha. However, the minimum days taken to 50% flowering was measured in the treatment where no fertilizers were given (N_0P_0). Such results were seen in the study of Acharya and Dashora [5] and Baboo and Singh (6).

Duration of flowering (days)

Data pertaining to duration of flowering as influenced by different levels of nitrogen and phosphorus application presented in Table 4 for the year 2011-12 and 2012-13 indicate that the application of nitrogen variated significantly the duration of flowering and phosphorus and showed non-significant influence on the duration of flowering in Marigold.

By increasing the levels of nitrogen, the duration of flowering increased significantly. Maximum duration of flowering (43.92 days during 2011-12 and 44.91 days during 2012-13) was observed with the application of 180 kg N/ha followed by 120 kg N/ha (42.35 days during 2011-12 and 43.35 days during 2012-13) and with the application of 60 kg N/ha, minimum duration of flowering was recorded as (34.88 days during 2011-12 and 35.83 days during 2012-13).

Flowering duration also increased due to levels of phosphorus application. Maximum flowering du-

ration (39.36 days during 2011-12 and 40.28 days during 2012-13) was recorded with the application of 120 kg P/ha followed by 60 kg P/ha (38.88 days during 2011-12 and 39.92 days during 2012-13). However, the application of phosphorus was found non-significant.

The interaction effect of nitrogen and phosphorus was found non-significant. However, the maximum duration of flowering (45.07 days during 2011-12 and 46.07 days during 2012-13) was recorded with the application of 180 kg N/ha along with 120 kg P/ha. The minimum duration of flowering was recorded in the treatment where no fertilizers were given (N_0P_0) as supported by Yadav et al. (4).

Number of flowers per plant

The data recorded on average number of flowers per plant in Marigold is presented in Table 5 for the year 2011-12 and 2012-13, which show that application of nitrogen significantly and phosphorus non-significantly influenced the number of flowers per plant. The number of flowers per plant increased significantly with increasing the levels of nitrogen. Maximum number of flowers per plant (3121.11 during 2011-12 and 3840.22 during 2012-13) was recorded with application of 180 kg N/ha followed by 2701.00 during 2011-12 and 2709.00 during 2012-13 with the application of 120 kg N/ha and 2570.00 during 2011-12 and 2578.44 during 2012-13 was recorded with the application of 60 kg N/ha.

The application of phosphorus had shown non-significant effect on numbers of flowers per plant of Marigold and maximum values for number of flowers per plant (2719.92 during 2011-12 and 3290.25 during 2012-13) was recorded with the application of 120 kg P/ha followed by (2646.25 during 2011-12 and 2653.58 during 2012-13) was recorded with application of 60 kg P/ha and 2141.00 during 2011-12 and 2613.91 during 2012-13 under controlled plots.

The interaction effect of nitrogen and phosphorus was found non-significant. Thr maximum number of flowers per plant (3363.33 during 2011-12 and 4619.33 during 2012-13) was recorded with the application of 180 kg N/ha along with 120 kg P/ha and the minimum number of flowers per plant was observed in the treatment where no fertilizers were given (N_0P_0) as the study was partially supported by Sharma et al. [3], Yadav et al. [4] and Kumar et al. [7].

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