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Short communication

Influence of nitrogen and phosphorus on flowering in African marigold (*Tagetes erecta* L.) var. Cracker Jack

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ABSTRACT

An investigation was conducted during the year 2000 to study the effect of nitrogen and phosphorus on flowering in African marigold. Results revealed that among the four levels of nitrogen tested, highest level of nitrogen (N_3) led to minimum number of days for the first flower-bud to become visible (31.66 days), days to flower-break (38.55 days), days to full-flowering (50.66 days). Plants receiving N_2 recorded significantly high number of flower heads per plant (28.42) and yield (11.11 t/ha). Among the three levels of phosphorus tested, days taken to appearance of the first flower-bud, flower-break and full-flowering were significantly earlier in a treatment with no phosphorus (P_0). However, number of flower heads per plant was significantly higher in P_2 (28.3). As for interaction effect, a combination of the highest level of nitrogen with no phosphorus (N_3P_0) recorded early flowering. Number of flower heads per plant was higher in N_3P_2 (31.83). Highest flower-yield (11.65 t/ha) was recorded in N_3P_2. Thus, it is concluded that nitrogen application advances flowering, while, phosphorus application delays flowering.

Key words: Marigold, nitrogen, phosphorus, flowering

Marigold is one of the most important commercially exploited flower crops of India. Among crop production technologies, balanced N and P fertilization are essential for better plant-spread and flower yield per unit area. Nitrogen and phosphorus are required in adequate quantity to attain ideal growth and to promote flowering (Pandey and Mishra, 2005). Adequate supply of N results in vigorous plant growth, consequently superior yield of flowers of better quality. Phosphorus is needed for normal growth and development of the plant due to its vital role in chlorophyll synthesis and physiological / metabolic processes of the plant. Nutrient supply needs to be adjusted to specific requirement by the plant during various stages of its growth, to attain maximum yield (Mengal, 1969). Nitrogen is well known for its influence on plant growth, flower production and quality of bloom in marigold (Noggle and Fritz, 1979).

In the absence of precise recommendations for some areas, growers impose manurial schedules of their own accord, resulting in improper nutrition to the crop. This upsets nutrient balance in the plant and is a major factor for low yield in many flower crops, posing a serious problem in flower production. Therefore, an attempt was made to improve flowering in marigold by applying various levels of nitrogen and phosphorus fertilizers to the plant.

The experiment was conducted at Horticultural Garden, Sri Venkateswara Agricultural College, Tirupati, during year 2000. Soil in the experimental plot was red sandy-loam with good drainage and a low water-holding capacity. Soil samples were collected before applying the manure from a depth of 20cm in the experimental area from some randomly selected spots. The composite sample was analyzed for chemical characteristics and content of nitrogen, phosphorus and potassium. Chemical analysis of the soil indicated that it was low in nitrogen and available phosphorus, high in available potash, and was alkaline in nature (Table 1). Raised nursery beds of 3m and 0.5m size

Table 1. Chemical analysis of soil in Horticultural Garden at S.V. Agricultural College, Tirupati

Particulars	Quantity
pH	7.4
EC	0.39 m. mhos per cm
Organic carbon	Low (below 0.5)
Available Nitrogen	201 kg/ha
Available P_2O_5	9.2 kg/ha
Available K_2O	130 kg/ha

were prepared well in advance for seed sowing. Seeds were treated with 0.3% Captan prior to sowing on 20-07-2000. Two hundred kilograms of farm yard manure was applied as a basal dose and mixed well into the soil at the last ploughing. N and P were applied in the form of urea (46.4%) and superphosphate (16.0% P_2O_5), respectively. The entire quantity of phosphorus and potash, and 50% of total nitrogen was applied as the basal dose. The remaining 50% of the nitrogen was applied as top-dressing three weeks after transplantation to the main field. Thirty-day-old, healthy seedlings of uniform growth were used for transplanting, and, planted at 40cm x 40cm spacing. All the other field operations were performed as per the recommended package of practices.

Treatments comprised four N levels [0 (N_0), 100 (N_1), 150 (N_2) and 200 (N_3) kg N per ha] and three P levels [0 (P_0), 100 (P_1) and 200 (P_2) kg P_2O_5 per ha]. The experiment was laid out in Factorial Randomized Block Design, with three replications. Data on days taken to appearance of the first flower-bud, days to flower-break, days to full-flowering, number of flower heads per plant, and yield (t/ha) were recorded. Fischers' (1963) method of analysis of variance was followed for analysis, and data was interpretation. F and t tests were applied and the results were tabulated.

Table 2. Influence of nitrogen, phosphorus and their interactions, on flower characters in marigold var. Cracker Jack

Treatment	Days to visibility of first flower-bud	Days to flower-break	Days to full flowering	Number of flower heads /plant	Yield t/ha
Nitrogen					
N_0	34.66	41.88	53.66	23.04	9.23
N_1	33.66	40.33	52.33	26.20	9.98
N_2	32.44	39.33	51.66	28.42	11.11
N_3	31.66	38.55	50.66	26.02	10.38
S.Em	0.19	0.31	0.49	0.11	0.35
CD *(P=0.05)*	0.58	0.93	1.44	0.34	0.10
Phosphorus					
P_0	32.33	39.58	51.41	24.22	9.60
P_1	32.58	39.99	51.83	25.23	10.12
P_2	34.41	40.49	52.99	28.30	10.80
S.Em	0.17	0.27	0.42	0.09	0.03
C.D *(P=0.05)*	0.5	0.80	1.25	0.29	0.09
Nitrogen x Phosphorus					
N_0P_0	34.00	42.33	53.00	21.43	8.75
N_0P_1	34.33	42.00	54.00	22.46	9.23
N_0P_2	35.66	41.33	54.00	25.23	9.71
N_1P_0	33.00	40.00	51.66	25.33	9.51
N_1P_1	33.33	40.33	52.00	26.06	9.90
N_1P_2	34.66	40.66	53.33	27.20	10.52
N_2P_0	31.66	39.00	51.00	27.96	10.83
N_2P_1	31.33	38.66	51.33	28.33	11.18
N_2P_2	34.33	40.33	52.66	28.96	11.31
N_3P_0	30.66	37.00	50.00	22.16	9.31
N_3P_1	31.33	39.00	50.00	24.06	10.18
N_3P_2	33.00	39.66	52.00	31.83	11.65
S.Em	0.34	0.54	0.85	0.19	0.061
C.D *(P=0.05)*	1.00	1.61	2.50	0.58	0.181

Days taken to visibility of first flower-bud

Results revealed significant variation among the four levels of nitrogen for days taken to visibility of the first flower-bud (Table 2). Number of days taken got progressively and significantly reduced with increasing levels of nitrogen. Plants receiving the highest dose of nitrogen (N_3) took the least number of days (31.66) for appearance of the first flower-bud, whereas, plants treated with the lowest level of nitrogen (N_0) took more number of days (34.66). However, levels of nitrogen were seen to be independent of each other, and were significantly superior over the treatment without nitrogen.

As the level of phosphorus increased, time taken for appearance of the first flower-bud also increased. However, treatments P_0 and P_1 were of the same order and took nearly similar number of days (32.33, 32.58), but were significantly different from P_2 treatment.

Interaction between nitrogen and phosphorus with regard to appearance of the first flower-bud was significant. Minimum number of days (30.66) were required for this trait under the treatment of the highest level of nitrogen with no phosphorus (N_3P_0), closely followed by N_2P_1, N_3P_1 and N_2P_0, which were all of the same order.

Days to flower-break

Data presented in Table 2 show that Control plants (N_0) took significantly higher number of days (41.88) than nitrogen treatments for flower-break. With increase in level of nitrogen, time taken for flower-break decreased significantly. However, treatments N_3 and N_2 were at par, but, significantly different from N_1. A contrary influence of phosphorus level was observed on this trait. As the level of phosphorus increased, time taken for flower-break too increased. Treatments P_0, P_1 and P_1, P_2 were of the same order, but P_0 and P_2 were statistically different. Plants receiving the highest level of nitrogen with no phosphorus (N_3P_0) showed the earliest flower-break (37.00 days). This was significantly superior to all other treatments. Control plants (N_0P_0) receiving neither nutrient flowered late (42.33 days), closely followed by N_0P_1 (42.00 days). Difference between the early-flowering plants and the late flowering plants was found to be 5 days.

Days to full flowering

A perusal of data (Table 2) indicates that among the four nitrogen levels tested, the highest level resulted in the shortest duration (50.66 days) for full flowering, closely followed by next highest N level (51.66 days), which was on par. A similar trend was observed in N_2 and N_3. Highest level (N_3) and lowest level (N_0) of nitrogen differed significantly in their effect. Various levels of phosphorus too exhibited a significant effect. As the level of phosphorus increased, the duration of full flowering reduced significantly. Treatments P_0, and P_1 and P_2 were of the same order, but P_0 was statistically different from others. Highest level of applied nitrogen with no phosphorus (N_3P_0) significantly reduced the number of days to full flowering (50.00 days), while this was highest in the treatment with the highest level of phosphorus with no nitrogen, and, both were independent.

Number of flower-heads per plant

Information in Table 2 shows that increase in number of flower heads did not corroborate with increase in levels of nitrogen. Highest number of flower heads (28.42) was recorded in plants receiving an intermediate level of nitrogen (N_2). The highest dose of nitrogen (N_3) resulted in fewer flower heads (26.02). The two were independent of each other. Number of flowers was lowest (24.22) under no phosphorus treatment, (P_0), and maximum (28.30) under the highest level of phosphorus (P_2). Production of flowers was significantly influenced by various combination treatments of nitrogen and phosphorus. N_3P_2 was superior to all other treatments.

Table 3. Nitrogen and phosphorus content (percentage) of the plant in marigold var. Cracker Jack as influenced by nitrogen, phosphorus and interaction thereof.

Treatment	Nitrogen content (%)	Phosphorus content (%)
Nitrogen		
N_0	1.17	0.22
N_1	2.40	0.25
N_2	2.85	0.26
N_3	3.25	0.28
S.Em	0.04	0.006
C.D *(P=0.05)*	0.13	0.017
Phosphorus		
P_0	2.36	0.24
P_1	2.40	0.25
P_2	2.49	0.26
S.Em	0.04	0.005
C.D *(P=0.05)*	0.11	0.015
Nitrogen x Phosphorus		
N_0P_0	1.06	0.21
N_0P_1	1.17	0.23
N_0P_2	1.30	0.22
N_1P_0	2.16	0.24
N_1P_1	2.53	0.25
N_1P_2	2.53	0.26
N_2P_0	2.72	0.25
N_2P_1	2.83	0.27
N_2P_2	3.00	0.27
N_3P_0	3.20	0.28
N_3P_1	3.25	0.29
N_3P_2	3.31	0.28
S.Em	0.08	0.01
C.D *(P=0.05)*	0.23	0.03

Flower yield

Highest flower-yield (11.11 t/ha) was recorded in plants receiving an intermediate level of nitrogen (N_2), while, the highest dose of nitrogen (N_3) produced 10.38 t/ha yield. Treatment P_2 recorded significantly high flower yield (10.80 t/ha). This was significantly superior to that in the other P treatments. N_3P_2 was superior to all other treatments with reference to flower yield (11.65 t/ha).

Effect of nitrogen on flowering

Table 2 indicates that flowering was earlier in plants receiving nitrogen, compared to those receiving no nitrogen. However, the difference between highest level of nitrogen and no- nitrogen was just 3 days and, from a practical point of view, this is not appreciable. Number of days taken to appearance of the first flower-bud decreased progressively with increase in nitrogen level. Number of days taken to 50% flowering was observed to be reduced with increasing level of nitrogen (0-90 kg N/ha) in marigold on sandy-loamy soil by Anuradha *et al* (1988, 1990). Chadha *et al* (1999) obtained earliest bud-initiation in plants treated with 30 kg N/ha. Thus, result of the present experiment is in line with the above findings, however, our results differ from the findings of Arora and Khanna (1986) who reported delayed commencement of flowering in marigold with application of graded doses of nitrogen (0-40g/m^2). No probable explanation for this was given. Views are divergent on the effect of nitrogen on flowering. Increased vegetative growth may help production of greater amount of photosynthates, leading to flowering stimulus, thus inducing early flowering. Increased nitrogen levels stimulating early-flowering may sound contradictory to the general belief that plants normally remain vegetative, thus delaying flowering, due to high nitrogen; But, this does not seem to be true in all the cases. Butters (1971) and Vijaykumar and Shanmugavelu (1978) reported early flowering in chrysanthemum with application of increased levels of nitrogen.

Effect of phosphorus on flowering

Plants receiving phosphorus took more number of days for appearance of the first flower-bud, flower bud break and full-flowering, while, Control plants receiving no phosphorus came to flowering earlier. In other words, application of phosphorus delayed flowering. However, no statistical difference was seen between Control plants and plants receiving 100kg P_2O_5 / ha (P_1) with regard to date of appearance of the first flower-bud, flower-break and full-flowering. Except for appearance of the first flower-bud, the two levels of phosphorus tested were found to be at par with each other. These observations indicate that application of phosphorus does not favour early flowering in marigold. However, these results are not in line with findings reported by others. For instance, Anuradha *et al* (1990) and Dahiya *et al* (1998) reported that the number of days required for 50% flowering reduced with application of phosphorus in marigold. Reasons for early flowering due to phosphorus application, however, were not elucidated by them.

Interaction between nitrogen and phosphorus for flower induction

Flowering in marigold responded significantly to treatment combinations of nitrogen and phosphorus. Plants treated with the highest dose of nitrogen with no phosphorus (N_3P_0) were the earliest in the appearance of first flower-bud (30.66 days), closely followed by N_3P_1, N_2P_1 and N_2P_0 which were of equal order statistically, but differed from the other treatments. Nitrogen is known to promote vegetative growth and advances the reproductive phase in plants. This may have occurred in the present case too. Phosphorus with no nitrogen (N_0P_2) delayed appearance of the flower-bud (35.66 days), and was of same order as N_1P_2. Days to flower bud-break were the least (37 days) under N_3P_0, which differed significantly from the others. For full flowering, fewer days were recorded in N_3P_0 and N_3P_1 (50 days), while this value was highest (54 days) in phosphorus applied with no nitrogen (N_OP_1 & N_0P_2). Our data indicate that flowering is influenced greatly with treatment combinations having nitrogen; flowering was delayed in the absence of nitrogen, whatever the rate of phosphorus applied.

Increase in the content of nitrogen and phosphorus, singly or in combination, helped the plant in terms of better growth and production, as ,these two nutrients play a very important role in the plant. Yield is the net result of several contributing traits like number of flowers per plant, weight of the flower and the nutrient content in the plant and exhibited a positive correlation (Table 3).

Thus, it is concluded that nitrogen application advances flowering, while, phosphorus application delays flowering in marigold.

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