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EFFECT OF DIFFERENT LEVELS OF NITROGEN, PHOSPHORUS AND POTASH ON GROWTH AND FLOWERING OF CHRYSANTHEMUM CULTIVARS

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ABSTRACT: Field experiments were conducted for two consecutive years on medium black calcareous soil of Horticultural Instructional Farm, Junagadh Agricultural University, Junagadh. The experiment was laid out in factorial randomized block design with twenty four treatments replicated three times. The treatments consisted of two varieties of chrysanthemum viz., IIHR-6 (V_1) and Shyamal (V_2), three levels of nitrogen (100, 200 and 300 N kg ha^{-1}), two levels of phosphorus (100 and 150 P_2O_5 kg ha^{-1}) and two levels of potash (100 and 150 K_2O kg ha^{-1}). Both the varieties significantly influenced growth and flowering parameters, where, plant height, number of branches per plant and leaf area were observed higher in the variety IIHR-6 during both the years and in pooled results; whereas higher fresh and dry weight of plant, weight of 10 flowers, flowering span and dry weight of flowers were recorded in the variety Shyamal. The later variety also took more days for first flower bud initiation and first flower open. Application of nitrogen at 300 kg ha^{-1} recorded significantly highest plant height, number of branches per plant, leaf area, fresh and dry weight of plant, flowering span, total fresh and dry weight of flower, weight of 10 flowers and diameter of flower during the first year, second year and in pooled data. The dose @ 300 N kg ha^{-1} also took less days for first flower bud initiation and first flower open. Phosphorus also played a significant role in improving all of these attributes at higher level except, leaf area, fresh weight of plant, number of days taken for first flower open and flowering span. Effect of potash was failed to influence all of these growth and flowering parameters during both the years and in pooled results also.

Keywords: *Nitrogen, phosphorus, potash, Chrysanthemum morifolium, cultivars, growth, flowering.*

Chrysanthemum (*Chrysanthemum morifolium*, Ramat) is a popular flower crop for commercial importance belonging to family Asteraceae. The bloom of the Asteraceae appears on capitulum's inflorescence. It consists of a large number of small florets in very close formation. The florets are of two types, ray florets and disc florets. The ray florets are large, attractive, and colorful and of various shapes which give beauty to head, whereas disc florets are smaller and centrally placed. The chrysanthemum is mainly grown for its cut flower for making bouquets, garlands, *veni* and for decoration during religious and social functions. Some species of chrysanthemum are also cultivated as source of pyrethrum, an important insecticide (Carter, 5; Chittenden, 6). Manure schedule of N, P and K plays a major role in successful production of chrysanthemum (Lunt and Kofranek, 15; Hansen and Lynch, 9). It is evident from the literature that very little research work has been carried out on response of chrysanthemum varieties to different levels of nitrogen, phosphorus and potash for growth and flowering parameters in Gujarat state, especially in South Saurashtra region. With this view, the present study was under taken to find out optimum level of nitrogen, phosphorus and potash on growth and flowering parameters of chrysanthemum cultivars (IIHR-6 and Shyamal).

MATERIALS AND METHODS

The field experiment was conducted during the *rabi* season of 2003-04 and 2004-05 at Horticultural Instructional Farm, Junagadh Agricultural University, Junagadh. The soil of experiment site was medium black having 7.6 and 7.5 pH, 0.27 and 0.24 dS/m E.C, 0.67 and 0.69 organic carbon, 235 and 240 kg ha^{-1} available

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nitrogen, 31.5 and 28.30 kg ha^{-1} available phosphorus and 225.78 and 231.67 kg ha^{-1} available potash content during the year 2003-04 and 2004-05, respectively. The treatments consisted of three levels of nitrogen (100, 200 and 300 kg ha^{-1}), two levels of phosphorus (100 and 150 kg ha^{-1}) and two levels of potash (100 and 150 kg ha^{-1}) in chrysanthemum cultivars viz., IIHR-6 and Shyamal were tested in factorial randomized block design with three replications. The actively growing herbaceous top portion of stem was selected for cutting. The cuttings were taken from the healthy and disease free mother plants of chrysanthemum varieties IIHR-6 and Shyamal. General recommended cultural practices were given to the experimental plot. All the observations were recorded as mentioned in results and the data obtained were averaged and computed. The experiment was repeated for second year and data of two years as well as pooled were used for analysis. Standard statistical procedure was followed for analysis of variance to interference the results.

RESULTS AND DISCUSSION

Effect of Varieties

In the variety IIHR-6 significantly more plant height, number of branches and leaf area were recorded during both the years and in pooled results also (Table 1) as compared to the Shyamal variety. Whereas, fresh and dry weight of plant, flowering span, fresh and dry weight of flowers (Table 2), weight of 10 flowers and diameter of flowers (Table 3) were significantly higher in variety Shyamal. This variety had also taken more days for flower bud initiation and for first flower open in both the years and in pooled data also (Table 2). The higher increase in plant height, branches and leaf area in variety IIHR-6 as compared to variety Shyamal might be due to difference in genetical make-up in the varieties. The significant variation in number of branches in chrysanthemum varieties is also supported by the findings of Gondhali *et al.* (8). Whereas significant difference in fresh and dry weight might be as arrangement and angle of leaves in Shyamal in such way that it remained direct to the sun and so process of photosynthesis occur more and maximum accumulation of photo-synthates occurred. Secondly it has vigorous growth and more number of secondary branches so ultimately fresh and dry weight might be increased. The result is in accordance with those of Yadav *et al.* (24) reported in tuberose.

Significant effect was also observed between both the varieties for flowering parameters such as number of days taken for flower bud initiation, for open to first flower, duration of flowering, weight of 10 flowers, diameter of flower, fresh and dry weight of flowers during the 2003-04 and 2004-05 and in pooled results (Table 1 to 3). Significantly earlier flower bud initiation and flowering were observed in IIHR-6 as compared to Shyamal, while longer flowering span was recorded in variety Shyamal in both the years and in pooled also (Table 2). The flowering characters in different varieties are dependent on proper amounts of stored carbohydrates which are necessary for inducing the plant from vegetative phase to flowering (Kosengarten and Mengel, 13). Same trend was also found by Kanamadi and Patil (11) who reported that the variety Sharad Mala took 121 days for opening of first flower. Katawale and Patil (15) reported that the variety Sharad Mala has a long flowering period and variety Vasantika had a shorter flowering period.

Variety Shyamal also recorded higher flower diameter, weight of 10 flowers, and total fresh and dry weight of flowers as compared to variety IIHR-6 in the year 2003-04, 2004-05 and in pooled data (Table 2 and 3). This might be due o difference in their genetic make-up of particular variety. Shyamal has vigorous growth, so more photosynthesis occurred at the source (leaves) and used in sink (flower), this might have been increased the weight of flowers. Likewise, higher cell expansion process in flowers of Shyamal might have increased the size of flowers. The results are in full conformity with the results of Mishra (17) who observed that the variety Shyamal followed by

Puja and Suneel produced significantly bigger flowers, whereas variety Vasantika gave the smallest flowers. Similarly in the present experiment, the weight of flowers per plant was recorded maximum in variety Shyamal. Gondhali *et al.* (8) also reported that varieties Flirt, Puja and IIHR-6 produced moderate number of flowers and gave highest weight of flowers.

Effect of Nitrogen

The results indicated that plant height, number of branches, leaf area and fresh and dry weight were significantly influenced by different levels of nitrogen. The highest dose of nitrogen (300 kg ha^{-1}) had recorded highest plant height, number of branches, leaf area, fresh and dry weight of plant during the year 2003-04, 2004-05 and in pooled results also (Table 1). The increase in plant height at the higher dose of nitrogen (N_3) might be due to the increase in transport of metabolites and rate of photosynthesis in the plant, which enables the plant to have quick and better upward vegetative growth. These results are in agreement with the findings of Belgaonkar *et al.* (2) and Lodhi and Tiwari (14).

At higher nitrogen level, early flowering occurred and terminal vegetative bud converted in to flower might have broken down the apical dominance of plant resulting in more number of auxiliary shoots. Secondly, the nitrogen supply to the roots is responsible to stimulate the production and export of cytokinin to the shoots (Wagner and Michael, 23). The increased levels of cytokinin in plants due to higher nitrogen application rate might have caused the lateral buds to sprout producing more number of lateral branches.

Leaf area at full bloom stage was increased with increasing the nitrogen level in both the years and in pooled (Table 1). In chrysanthemum leaf area was increased when nitrogen fertilizer was raised from 80-160 mg per liter (Schuch *et al.*, 21). Nitrogen, as an elementary constituent of amino acid, nucleic acid, proteins, nucleotides, chlorophyll and numerous secondary substances such as alkaloids, thus, an important constituent of the protoplasm. It also acts as constitute of enzymes. Nitrogen is implicated in all enzymatic reactions taking place in the cells and, thus, plays an active role in energy metabolism (Bergmann, 3). Photosynthates transported to site of growth are used predominately in the synthesis of nucleic acid and protein, hence during the vegetative stage, N level of plants to a large extent, controls the growth of the plant (Mengel and Kirkby, 18). Thus, increase in dose of nitrogen from 100 to 300 kg ha-1 had improved cell division, which resulted in greater plant height, number of branches per plant, leaf area and fresh weight of plant.

The highest level of nitrogen has significantly taken least days for flower bud initiation and flowering (Table 2). This might be due to that the nitrogen gave vigorous growth and so it produces maximum photosynthates that are enough for flowering and this way plant could enter early in reproductive phase. These results are in agreement with the findings of Vijayakumar and Shanmugavelu (22), who observed that the increase in nitrogen level stimulated early flowering in chrysanthemum.

In the present study, the fresh and dry weight of vegetative part of the plant was increased with increasing the levels of nitrogen. This increase in vegetative growth (fresh weight of plant) may be due to increase in plant height, number of branches and leaf area. The increase in dry weight of plant might be due to increase in the availability of nutrients with increasing nitrogen levels. These findings are in full conformity with the results reported by Gangwar *et al.* (7) and Ravindra *et al.* (20). Magnifico *et al.* (16) found that highest fresh and dry weight of chrysanthemum plants were obtained with N fertilizers applied every two weeks @ 190 kg N/100 m^2.

Highest level of nitrogen also recorded highest fresh weigh of flowers, weigh of 10 flowers and dry weight of flowers. Abundant supply of nitrogen at higher level might have accelerated the photosynthetic activities of plants and thus, more assimilates might have been available for flowers to

Table 1: Effect of different levels of nitrogen, phosphorus and potash on vegetative traits of chrysanthemum varieties.

Treatment	Plant height (cm)			Number of branches			Leaf area (cm^2)			Fresh wt. of plant (g)			Dry wt. of plant (g)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
Variety (V)															
V_1-IIHR-6	60.57	59.80	59.19	13.11	13.32	13.62	34.24	33.96	34.10	162.76	160.81	161.79	61.65	60.05	60.85
V^2-Shyamal	53.99	55.63	53.80	11.92	10.85	10.98	32.03	31.36	31.69	172.06	169.51	170.79	65.00	63.73	64.37
C.D.(P=0.05)	2.44	2.73	1.80	0.59	0.59	0.41	1.61	1.36	1.03	7.31	7.52	5.21	2.35	2.18	1.58
Nitrogen (kg N ha^{-1})															
N_1-100	52.40	53.41	52.16	11.14	10.69	10.91	31.23	31.66	31.44	152.48	150.84	151.66	54.62	54.87	54.57
N_2-200	58.14	57.42	57.04	12.44	11.90	12.17	33.18	32.25	32.72	160.09	161.63	160.76	62.90	60.34	61.62
N_3-300	61.30	62.32	60.29	13.97	13.67	13.82	35.00	34.08	34.54	189.66	183.22	186.44	72.46	70.47	71.46
C.D. (P=0.05)	2.98	3.34	2.21	0.73	0.72	0.51	1.97	1.64	1.27	8.95	9.34	6.39	2.88	2.67	1.94
Phosphorus (kg P_2O_5 ha^{-1})															
P_1-100	55.97	56.26	56.11	12.11	11.91	12.01	33.13	32.53	32.83	165.73	164.50	165.12	62.02	61.30	61.66
P_2-150	58.60	59.18	58.89	12.92	12.27	12.59	33.14	32.79	32.96	169.09	165.83	167.46	64.63	62.49	63.56
C.D. (P=0.05)	2.44	2.73	1.81	0.59	0.81	0.41	NS	NS	NS	NS	NS	NS	2.35	NS	1.58
Potash (kg K_2O ha^{-1})															
K_1-100	56.49	57.15	55.82	12.40	12.03	12.21	33.08	32.07	32.57	167.15	163.57	165.36	62.87	61.48	62.17
K_2-150	58.08	58.29	57.17	12.63	12.15	12.39	33.19	33.26	33.22	167.67	166.76	167.21	63.78	62.31	63.04
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	9.04	10.18	9.48	9.98	10.29	10.13	10.23	8.52	9.47	9.19	9.72	9.46	7.82	7.40	7.62

Table 2: Effect of different levels of nitrogen, phosphorus and potash on flowering traits of chrysanthemum varieties.

Treatment	Plant height (cm)			Number of branches			Leaf area (cm^2)			Fresh wt. of plant (g)			Dry wt. of plant (g)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
Variety (V)															
V_1-IIHR-6	55.43	53.07	54.25	73.13	73.67	73.40	66.40	68.61	67.50	6.08	6.01	6.05	65.29	63.53	64.41
V_2-Shyamal	62.18	60.16	61.17	78.32	78.83	78.58	73.42	73.71	73.56	6.45	6.38	6.42	69.22	68.01	68.70
C.D. (P=0.05)	2.82	2.18	1.76	4.16	3.70	2.75	3.72	2.93	2.34	0.26	0.24	0.17	3.14	2.76	2.07
Nitrogen (kg N ha^{-1})															
N_1-100	62.00	59.40	60.70	78.88	80.75	79.81	64.99	66.87	65.93	5.59	5.52	5.55	55.15	50.55	52.63
N_2-200	58.62	56.29	57.46	77.33	76.21	77.02	68.34	70.59	69.46	6.45	6.34	6.40	67.26	68.10	68.90
N_3-300	55.81	54.16	54.98	70.96	71.29	71.13	76.40	76.02	76.21	6.77	6.73	6.75	79.35	78.66	79.13
C.D. (P=0.05)	3.45	2.67	2.15	5.10	4.53	3.37	4.56	3.59	2.86	0.31	0.29	0.21	3.85	3.38	4.81
Phosphorus (kg P_2O_5 ha^{-1})															
P_1-100	60.35	57.07	58.89	76.28	77.64	76.96	69.02	70.27	69.64	6.01	6.01	6.01	65.55	64.64	65.01
P_2-150	57.27	56.21	56.74	75.17	74.86	75.01	70.80	72.05	71.42	6.53	6.38	6.46	68.96	66.90	68.09
S.Em.±	0.99	0.77	0.63	1.46	1.30	0.98	1.31	1.03	0.83	0.09	0.08	0.06	1.10	0.97	0.73
C.D. (P=0.05)	2.82	NS	1.76	NS	NS	NS	NS	NS	NS	0.26	0.24	0.17	3.34	NS	2.07
Potash (kg K_2O ha^{-1})															
K_1-100	58.94	56.72	57.83	76.47	77.94	77.21	68.87	69.79	69.94	6.17	6.10	6.14	67.07	65.40	66.19
K_2-150	58.68	56.52	57.60	74.97	74.56	74.76	70.95	72.53	71.12	6.36	6.29	6.33	67.44	66.14	66.91
C.D.(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV%	10.08	8.11	9.19	11.58	10.22	10.92	11.22	10.00	10.00	8.59	8.05	8.33	9.84	8.85	9.36

Table 3: Effect of different levels of nitrogen, phosphorus and potash on yield and yield attributing characters of chrysanthemum varieties.

Treatments	Weight of 10 flowers (g)			Total fresh weight of flowers/plant (g)			Dry weight of flowers/plant (g)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
Variety (V)									
V_1-IIHR-6	30.10	29.26	29.68	220.21	214.07	217.14	65.29	63.53	64.41
V_2-Shyamal	32.11	31.41	31.76	247.76	242.40	245.08	69.22	68.01	68.70
C.D. (P=0.05)	1.36	1.03	0.84	14.01	13.18	9.50	3.14	2.76	2.07
Nitrogen (kg N ha^{-1})									
N_1-100	26.28	26.03	26.16	162.64	158.70	160.67	55.15	50.55	52.63
N_2-200	30.83	29.91	30.37	232.46	227.69	230.08	67.26	68.10	68.90
N_3-300	36.20	35.07	35.64	306.85	298.31	302.58	79.35	78.66	79.13
C.D. (P=0.05)	1.66	1.26	1.03	17.16	16.14	11.63	3.85	3.38	4.81
Phosphorus (kg P_2O_5 ha^{-1})									
P_1-100	29.31	28.46	28.89	224.89	220.38	222.64	65.55	64.64	65.01
P_2-150	32.90	32.21	32.55	236.73	236.08	239.58	68.96	66.90	68.09
C.D. (P=0.05)	1.36	1.03	0.84	14.01	13.18	9.50	3.34	NS	2.07
Potash (kg K_2O ha^{-1})									
K_1-100	30.71	30.19	30.45	231.24	225.05	228.24	67.07	65.40	66.19
K_2-150	31.50	30.49	30.99	236.73	231.41	234.07	67.44	66.14	66.91
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V.%	9.19	7.12	8.25	12.61	12.61	12.39	9.84	8.85	9.36

develop, resulting in increased flower weight per plant. Butters (4) observed that high level of N application increased the size of flower in chrysanthemum. Rao *et al.* (19) obtained significantly increased weight of flowers per plant in chrysanthemum with increasing N application from 50 to 200 kg ha^{-1}. The nitrogen at N_3 level might have accelerated the photosynthetic activities by increasing the source size (number of branches and leaf area) there by providing facility to develop more flowers with more photosynthates, which might have resulted in increased cell division and cell expansion of flower tissue, the ultimate effect of which had increased in flower size the terms of flower diameter.

Effect of Phosphorus

The growth characters improved significantly with increase in phosphorus application rates, except leaf area and fresh weigh of plant (Table 1) in both the years and in pooled. Phosphorus is an essential constituent of cell component such as phosphoproteins and phospholipids, are indispensable constituents of the various cell membranes, that are also important for the maintenance of cell structure. The storage and liberation of the energy budget and energy metabolism are controlled by the alternate synthesis and break down of energy rich adenosite diphosphate and triphosphate ions. The energy level of organic compound raised by synthesis is phosphate ester and thus, prepared for subsequent reactions such as starch synthesis or respiration (Bergmann, 3).

The higher levels of phosphorus (P_2) was found to be significant on flowering parameters. The higher level of phosphorus P_2 recorded the minimum days for appearance of first flower bud in the year 2003-04 and in pooled but it was non-significant in 2004-05. (Table 2). The earliness of flower bud initiation might be due to rapid vegetative growth i.e number of branches per plant and commencement of early reproductive phase. These results are in agreement with the results of Vijayakumar and Shanmugavelu (22) in chrysanthemum and Anuradha *et al.* (1) in marigold. The highest level of phosphorus resulted in significantly maximum diameter of flower, weight of 10 flowers and total fresh weigh of flower (Table 2 and 3) in both the years and in pooled results. The improvements in these characters might be due to enhancement in vegetative growth like plant height and number of branches per plant, which are likely to be responsible for more accumulation of photosynthates, hence resulted in giving maximum value in these characters. These findings are very similar to the findings of Belgaonkar *et al.* (2) and Jhon and Paul (10) in chrysanthemum and Gangwar *et al.* (7) in tuberose.

Effect of Potash

Effect of different levels of potash was found to be non-significant on growth and flowering characters during both the years and in pooled results. The lack of response of applied potash in chrysanthemum may be due to enough availability of potash in the experimental plot (Table 1 to 3).

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