International Journal of Agricultural Sciences
Volume 9 | Issue 1| January, 2013 | 182-188

RESEARCH PAPER

Performance of varieties and chemical fertilizers on growth and flowering in chrysanthemum

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Abstract : A field experiment was conducted to investigate the performance of varieties and chemical fertilizers on chrysanthemum at Horticultural Instructional Farm, Junagadh Agricultural University, Junagadh during *Rabi* season of 2003-04 and 2004-05. The experiment was laid out in Factorial Randomized Block Design with twenty four treatments combinations, replicated three times. The treatment consisted of two varieties *viz.*, IIHR-6 (V_1), Shyamal (V_2); three levels of nitrogen (100, 200 and 300 N kg ha^{-1}), two levels of phosphorus (100 and 150 kg P_2O_5 ha^{-1}) and two levels of potash (100 and 150 kg K_2O ha^{-1}). Both the varieties significantly influenced growth and flowering parameters in which higher plant height, number of branches per plant and leaf area were observed in the variety IIHR-6 in both the years and in pooled. Similarly, higher fresh and fry weight of plant, flowering parameters like weight of 10 flowers, flowering span and dry weight of flowers were recorded in variety Shyamal. This variety also take 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 both the years and pooled. This dose (300 kg N ha^{-1}) also taken 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. Potash failed to influence all of these growth and flowering parameters during both the years and pooled.

Key Words : Nitrogen, Phosphorus, Potash, *Chrysanthemum morifolium*, Growth, Flowering, Parameters, Cultivars

View Point Article : Joshi, N.S., Varu, D.K., Barad, A.V. and Pathak, D.M. (2013). Performance of varieties and chemical fertilizers on growth and flowering in chrysanthemum. *Internat. J. agric. Sci.*, **9**(1): 182-188.

Article History : Received : 24.07.2012**; Revised :** 30.09.2012**; Accepted :** 18.11.2012

INTRODUCTION

Chrysanthemum (*Dendrathema grandiflorum* Ramat) is a popular flower crop of commercial importance belonging to family Asteraceae and native of Europe and Asia. 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 shapers which give beauty to head, where as 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 (Chittenden, 1956; Carter, 1980; Pascual, Villalobos, 1996). Manurial schedule of N, P and K plays a major role in successful production of chrysanthemum (Lunt and Kofranek, 1958; Hansen and Lynch, 1998). 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*

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season of 2003-04 and 2004-05 at Horticultural Instructional Farm, Junagadh Agricultural University, Junagadh. The soil of experiment sites 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 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 level 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, which were raised from the suckers. The cutting was obtained from the chrysanthemum var. "IIHR-6" and "Shyamal". The observations were recorded on five randomly taken competitive plants. The height of five selected plants was measured with the help of meter scale, while for number of branches, the branches emerged from the main shoot were counted at full bloom stage. In case of leaf area, it was recorded with the help of leaf area meter and average leaf area was worked out. For measurement of fresh weight of plants, five selected plants were kept for observation up to last harvest. They were uplifted from the bed and then fresh weight was taken with the help of electrical balance in gram, while for dry weight of plants, those plants are kept for fresh weight used for dry weight of plants, they were kept for sun drying, after few days they were dried and used for observation of dry weight of plant. Number of days was counted from the date of transplanting to first flower bud initiation while in case of first flower open, date of transplanting to first flower opening for first flower open. While flowering span was counted in days from opening of first flower to last picking. Flowers taken during all the plucking were used for observation of total fresh weight of the flowers, while for dry weight, those flowers kept for fresh weight in each picking, was taken for dry weight of flower under laboratory condition and later oven dried at 65 o C till constant weight was obtained. Flowering attributes, like weight of 10 flowers was measured by randomly 10 fresh flowers were taken from the previous selected five plants and weighed with the help of electrical balance. With the help of vernier calipers, diameter of five randomly selected flowers from each net plot was measured at full bloom stage. All the data obtained were averaged and computed. General recommended cultural practices were followed. Standard statistical procedure was followed for analysis of variance. The data were pooled for two years.

RESULTS AND DISCUSSION

The results of the present study as well as relevant discussions have been presented under following sub heads:

Effect of varieties :

The variety IIHR-6 recorded significantly more plant height, number of branches and leaf area in both the years and in pooled results also (Table 1) as compared to the Shyamal variety. Where as, 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 also taken more days for flower bud initiation and for first flower open in both the years and in pooled data (Table 2).

Significantly higher plant height, number of branches and leaf area were recorded in variety IIHR-6 as compared to variety Shyamal during both the years and in pooled data (Table 1). This might be due to genetically difference in the varieties. Bhati and Chitkara (1987) stated that the difference in vegetative growth in all the varieties of marigold can be attributed to differences in their genetic composition. The significant variation in number of branches in chrysanthemum varieties is also supported by the findings of Gondhali *et al.* (1998).

The fresh and dry weight per plant (Table 2) was also found significant due to different varieties and variety Shyamal recorded higher fresh weight of plant as compared to variety IIHR-6 during 2003-04, 2004-05 and in pooled results. This 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 photosynthates occurred, secondly it has vigorous growth and more number of secondary branches so ultimate fresh and dry weight was increased. This is accordance with those, reported in tuberose by Yadav *et al*. (2002). They noted that the fresh and dry weight of bulbs were higher in cv. Double. The total fresh weight was higher in cv. Single, whereas, the total dry weight was higher in cv. DOUBLE.

Both the varieties gave significant effect on 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 early flower bud initiation and flowering were observed in IIHR-6 as compared to Shyamal, while longest 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 as proper amounts of stored carbohydrates are necessary for inducing the plant from vegetative phase to flowering (Kosengarten and Mengel, 1995), as has also been found by Kanamadi and Patil (1993). They reported that the variety Sharad Mala took 121 days for opening of first flower. Katawale and Patil (1992) 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

Table 1: Response of chrysanthemum varieties and different levels of N, P and K on growth parameters

Treatments	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
S.E.±	0.86	0.96	0.64	0.21	0.21	0.15	0.57	0.47	0.37	2.57	2.68	1.85	0.82	0.76	0.56
C.D. at 5 %	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	52.15	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
S.E.±	1.05	1.17	0.78	0.25	0.25	0.18	0.69	0.57	0.45	3.14	3.28	2.27	1.01	0.94	0.69
C.D. at 5 %	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
S.E.±	0.86	0.96	0.64	0.21	0.21	0.15	0.57	0.47	0.37	2.57	2.68	1.85	0.82	0.76	0.56
C.D. at 5 %	2.44	2.73	1.81	0.59	NS	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
S.E.±	0.86	0.96	0.64	0.21	0.21	0.15	0.57	0.47	0.37	2.57	2.68	1.85	0.82	0.76	0.56
C.D. at 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	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 : Response of chrysanthemum varieties and different levels of N, P and K on flowering parameters

Treatments	No. of days taken for flower bud initiation (days)			No. of days taken for first flower open (days)			Flowering span (days)			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	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	220.21	214.07	217.14	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	247.76	242.40	245.08	69.22	68.01	68.70
S.E±	0.99	0.77	0.63	1.46	1.30	0.98	1.31	1.03	0.83	4.92	4.63	3.38	1.10	0.97	0.73
C.D. at 5 %	2.82	2.18	1.76	4.16	3.70	2.75	3.72	2.93	2.34	14.01	13.18	9.50	3.14	2.76	2.07
Nitrogen (kg N ha^{-1})5															
N_1-100	62.00	59.40	60.70	78.88	80.75	79.81	64.99	66.87	65.93	162.64	158.70	160.67	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	232.46	227.69	230.08	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	306.85	298.31	302.58	79.35	78.66	79.13
S.E±	1.21	0.94	0.77	1.79	1.59	1.20	1.60	1.26	1.02	6.02	5.66	4.13	1.35	1.19	1.69
C.D. at 5 %	3.45	2.67	2.15	5.10	4.53	3.37	4.56	3.59	2.86	17.16	16.14	11.63	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	224.89	220.38	222.64	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	243.07	236.08	239.58	68.96	66.90	68.09
S.E±	0.99	0.77	0.63	1.46	1.30	0.98	1.31	1.03	0.83	4.92	4.63	3.38	1.10	0.97	0.73
C.D. at 5 %	2.82	NS	1.76	NS	NS	NS	NS	NS	NS	14.01	13.18	9.50	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	231.24	225.05	228.24	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	236.73	231.41	234.07	67.44	66.14	66.91
S.E±	0.99	0.77	0.63	1.46	1.30	0.98	1.31	1.03	0.83	4.92	4.63	3.38	1.10	0.97	0.73
C.D. at 5 %	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	12.61	12.61	12.39	9.84	8.85	9.36

and in pooled data (Table 2 and 3). This might be due o difference in their genetically make-up of particular variety. Shyamal has vigorous growth, so more photosynthates produced at the source (leaves) and used in sink (flower), this might have been increased the weigh of flowers. Likewise, higher cell expansion process in Shyamal flower might have increased the size of flowers. The results are in full conformity with the results of Mishra (1999). He observed that the variety Shyamal followed by Puja and Suneel produced significantly bigger flowers, whereas variety Vasantika gave the smallest flowers.

In the present experiment, the weight of flowers per plant was recorded maximum in variety Shyamal. Gondhali *et al.* (1998) 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 in Table 1, that the plant height, number of branches, leaf area, fresh and dry weight were influenced by different levels of nitrogen. The higher dose of nitrogen (300 kg ha^{-1}) 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 (Table 1).

The increase in plant height due to the higher dose of nitrogen (N_3) might be due to the fact that nitrogen increases transport of metabolites and rate of photosynthesis in plants, which enables the plant to have quick and better upward vegetative growth. These results are in agreement with the findings of Lodhi and Tiwari (1993), Belgaonkar *et al.* (1996), and Patel (2004) in chrysanthemum.

At higher nitrogen level, early flowering occurred and terminal 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 roots is found to stimulate the production and export of cytokinin to the shoots (Wagner and Michael, 1971). The increased levels of cytokines in plants due to higher nitrogen application rate might have caused the lateral buds to sprout giving more number of lateral branches. Rachayanavar (1985) stated that the maximum numbers of branches were found with the application of 250 kg N per hectare in chrysanthemum. A significant improvement in number of branches per plant was also reported by Avari (1993) in the marigold crop with application of 300 kg N ha^{-1}.

In present experiment, leaf area at full bloom stage was increased with the increasing the nitrogen level in the both the years and in pooled (Table 1). In chrysanthemum leaf area was increased when nitrogen fertilizer was raised from 80-160 mg per litre (Schuch *et al*., 1998).

Nitrogen, as an elementary constituent of amino acid, nucleic acid, proteins, proteids, nucleotides, chlorophyll and numerous secondary substances such as alkaloids, is an important constituent of the protoplasm. It also acts as a constitute of enzymes. Nitrogen is implicated in all enzyme reactions taking place in the cells and, thus, plays an active role in energy metabolism (Bergmann, 1992). Photosynthetic transported to site of growth are used predominately in the

Table 3 : Response of chrysanthemum varieties and different levels of N, P and K on flowering parameters

Treatments	Weight of 10 flowers (g)			Diameter of flower (cm)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
Variety (V)						
V_1= IIHR-6	30.10	29.26	29.68	6.08	6.01	6.05
V_2= Shyamal	32.11	31.41	31.76	6.45	6.38	6.42
S.E.±	0.48	0.36	0.30	0.09	0.08	0.06
C.D. at 5 %	1.36	1.03	0.84	0.26	0.24	0.17
Nitrogen (kg N ha^{-1})						
N_1-100	26.28	26.03	26.16	5.59	5.52	5.55
N_2-200	30.83	29.91	30.37	6.45	6.34	6.40
N_3-300	36.20	35.07	35.64	6.77	6.73	6.75
S.E.±	0.58	0.44	0.37	0.11	0.10	0.07
C.D. at 5 %	1.66	1.26	1.03	0.31	0.29	0.21
Phosphorus (kg P_2O_5 ha^{-1})						
P_1-100	29.31	28.46	28.89	6.01	6.01	6.01
P_2-150	32.90	32.21	32.55	6.53	6.38	6.46
S.E.±	0.48	0.36	0.30	0.09	0.08	0.06
C.D. at 5 %	1.36	1.03	0.84	0.26	0.24	0.17
Potash (kg K_2O ha^{-1})						
K_1-100	30.71	30.19	30.45	6.17	6.10	6.14
K_2-150	31.50	30.49	30.99	6.36	6.29	6.33
S.E.±	0.48	0.36	0.30	0.09	0.08	0.06
C.D. at 5 %	NS	NS	NS	NS	NS	NS
C. V %	9.19	7.12	8.25	8.59	8.05	8.33

synthesis of nucleic acid and protein, hence, during the vegetative stage, N nutrition of plants to a large extent, controls the growth of the plant (Mengel and Kirkby, 1982). Thus higher 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.

In the both the year and in pooled analysis, the highest level of nitrogen has significantly taken less days for flower bud initiation and flowering (Table 2). This might be due to of nitrogen giving 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 Vijaykumar and Shanmugavellu (1978), 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 Ravindra *et al*. (1986) and Bapusaheb (1979) in marigold. They noted that with increasing nitrogen rate there was corresponding increase in dry weight of plant in marigold. Magnifico *et al*. (1986) found that highest fresh and dry weight of chrysanthemum plants were obtained with N fertilizers applied every two weeks to give a 190 kg N/100 m^2. Significant improvement in dry matter content of stem leaves and flowers in marigold with 200 kg ha^{-1} were reported by Bapusaheb (1979).

The flowering characters *viz.*, total fresh weigh and dry weight of flowers (Table 1) weight of 10 flowers and diameter of flower (Table 2) increased significantly with increasing the nitrogen level from 100 to 300 kg ha^{-1} in both the years and in pooled analysis.

Higher level of nitrogen also recorded highest fresh weigh of flowers, weight 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 develop, resulting in increased flower weight per plant. Butters (1971) observed that high level of N application increased the size of flower in chrysanthemum. Rao *et al.* (1992) obtained significantly increased weight of flowers per plant in chrysanthemum with increasing N application rates from 50 to 200 kg N 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 the developing flowers with more photosynthates, which might have resulted in increased cell division and cell expansion of flower tissue, the ultimate effect of which was increased in flower size in terms of flower diameter, Kumar *et al*. (2002) found that 300 kg N ha^{-1} gave positive response towards flower diameter of china aster.

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 the year 2003-04-05 and in pooled analysis. Phosphorus is an essential constituent of cell component such as phosphoproteids 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, 1992). Anuradha *et al*. (1988) found significant increase in total plant dry matter of marigold with increasing levels of phosphorus. Similarly, maximum number of branches per plant was obtained with the application of 125 kg P_2O_5 ha^{-1} in gaillardia by Singatkar (1995).

The different levels of phosphorus (P_2) were found to be significant on flowering parameters. The highest level of phosphorus P_2 recorded the minimum days for appearance of first flower bud (Table 2). The earliness of flower bud initiation might de 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 Vijaykumar and Shanmugavellu (1978) in chrysanthemum and Anuradha *et al*. (1990) 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 similar to the findings or Jhon and Paul (1999) and Belgaonkar *et al.* (1996) in chrysanthemum.

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 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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