Indian J. Hort. 70(3), September 2013: 442-447

Short communication

Effect of nitrogen, phosphorus and potassium on growth and flowering of *Barleria cristata* Linn.

Priyanka Sharma*, Priyanka Thakur, Y.C. Gupta and S.R. Dhiman
Department of Floriculture and Landscaping, Dr Y.S. Parmar University of Horticulture and Forestry, Solan 173230, Himachal Pradesh

ABSTRACT

A field study was conducted to investigate the response of *Barleria cristata* Linn. to various levels of nitrogen, phosphorus and potassium, *i.e.* 0, 15, 30 g/ m^2. Vegetative characters like plant height, plant spread, number of primary branches, secondary branches and number of leaves per plant were recorded maximum at 30 g/ m^2 each of N, P and K and flowering characters like earlier bud formation, flowering, number of flowers per cluster, flower clusters per plant, and duration of flowering was recorded maximum at 15 g/ m^2 of N and 30 g/ m^2 each of P and K.

Key words: *Barleria cristata*, nitrogen, phosphorus, potassium.

Barleria is a diverse and popular genus belonging to family Acanthaceae. *Barleria cristata* Linn. is commonly known as 'Bluebell Barleria' or 'Phillipine Violet'. Its vernacular name in Hindi is *Jhate* and in Kannada, it is called *spatika* or *mullu jaji* or *gorate*. Barlerias are the popular flowering shrubs being loaded with beautiful bell shaped flowers in axillary or terminal racemes. Flowers are violet, purple, pink, blue or white, sometimes with spots and stripes. It is a perennial, erect, compact, bushy, strongly branched, leafy shrub which grows to the height of 1.5 m and tolerates regular pruning. Flowers are borne on spiny, hairy calyx, which are persistent even after the flowering is over and can be utilized for making gift items after drying and value addition. In India, *Barleria* is grown commercially for loose flower production in South India (Bhattacharjee, 4) and used for making garlands, adorning the hair of women, and religious and ceremonial offerings. In Himachal Pradesh, it is found growing profusely between altitude of 600-2000 m amsl and flowers in late monsoon (August-September). Its peak flowering in groups and also as an individual brightens up the landscape during rainy season. It can be used as a hedge, in shrubbery borders, as a pot plant and in foundation plantings in hilly slopes.

In order to enhance its growth and flowering performance an experiment was carried out at the experimental farm of the Department of Floriculture and Landscaping, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan. In this study, straight terminal stem cuttings were taken from healthy plants for vegetative propagation. To promote rooting, the basal end of cuttings was dipped in 500 ppm naphthalene acetic acid (NAA) solution for 30 sec. Cocopeat was used as medium for rooting of the cuttings. The rooted plants were transplanted in well prepared field on 16th July. Planting was done on raised beds of 1.0 m x 1.0 m size accommodating nine plants with a spacing of 30 cm x 30 cm. After 20 days of planting, pinching of plants was done in order to produce uniform side shoots. Experiment was carried out in Randomized Block Design with three levels each of nitrogen (0, 15, 30 g/ m^2), phosphorus (0, 15, 30 g/ m^2) and potassium (0, 15, 30 g/ m^2) having 27 treatment combinations and three replications. Nitrogen was applied as calcium ammonium nitrate, phosphorus as single super phosphate and potassium as muriate of potash.

Results showed significant effect of nitrogen on vegetative and flowering characters of *Barleria cristata*. Application of 30 g N/ m^2 resulted in maximum plant height (40.82 cm), number of primary (6.05), and secondary side shoots (20.43), plant spread (44.86 cm) and number of leaves per plant (129.54) (Table 1). This might be attributed to the fact that nitrogen is an essential part of chlorophyll and nucleic acid, which might have played major role in promoting plant growth. Furthermore, it encourages the above ground growth of the plants. The results in general are in agreement with the findings of Barman and Pal (3). They observed significant increase in plant height and number of leaves per plant in chrysanthemum cv. Chandrama with 30 g N/ m^2. Increasing dose of nitrogen increased plant height and number of branches per plant in *Barleria cristata* and found to be maximum with an application of 4 g nitrogen (as ammonium sulphate) per plant (Abou-Dahab and Habib, 1).

*Corresponding author's E-mail: priyankafls@gmail.com

Table 1. Effect of nitrogen, phosphorus and potassium on growth and flowering of *Barleria cristata*.

Treatment	Plant height (cm)	No. of primary side shoots per plant	No. of secondary side shoots/ plant	Plant spread (cm)	No. of leaves per plant	Days to bud formation	Days to flowering	No. of flowers per cluster	No. of flowering clusters per plant	Duration of flowering (days)
N_0 (control)	32.73	4.91	15.02	34.65	104.89	63.67	67.91	3.75	13.13	20.51
N_1 (15 g/m^2)	38.18	5.80	20.40	40.26	121.01	65.58	69.18	5.61	20.00	22.42
N_2 (30 g/m^2)	40.82	6.05	20.43	44.86	129.54	67.12	71.16	5.55	19.70	22.41
P_0 (control)	36.13	5.29	18.04	38.67	117.12	64.54	68.57	4.29	16.42	21.44
P_1 (15 g/m^2)	37.30	5.51	18.61	39.82	117.60	65.25	69.53	5.05	17.31	22.40
P_2 (30 g/m^2)	38.30	5.95	19.19	41.28	120.70	66.58	70.15	5.57	19.10	23.58
K_0 (control)	34.81	4.98	17.24	36.88	115.03	65.03	68.89	4.23	16.24	20.41
K_1 (15 g/m^2)	37.39	5.59	18.67	39.72	118.70	65.34	69.38	4.96	17.55	23.12
K_2 (30 g/m^2)	39.50	6.18	19.93	43.16	121.70	65.99	69.96	5.72	18.79	23.88
N × P Interaction										
N_0P_0	31.84	4.58	14.55	34.60	100.36	62.83	66.83	3.27	11.98	20.27
N_0P_1	33.11	4.79	14.79	34.15	104.49	62.86	67.76	3.74	12.46	19.73
N_0P_2	33.25	5.38	15.72	35.21	109.81	65.33	69.12	4.23	14.94	21.53
N_1P_0	36.24	5.42	20.18	38.19	121.76	64.21	68.19	4.74	18.79	22.53
N_1P_1	38.17	5.72	20.39	40.14	119.06	65.79	69.74	5.67	20.02	23.61
N_1P_2	40.12	6.27	20.63	42.45	122.19	66.74	69.61	6.42	21.20	24.18
N_2P_0	40.31	5.88	19.41	43.23	129.19	66.57	70.68	4.86	18.51	21.45
N_2P_1	40.63	6.03	20.65	45.17	129.25	67.11	71.09	5.72	19.44	23.45
N_2P_2	41.52	6.22	21.23	46.17	130.10	67.69	71.70	6.07	21.16	25.04
P × K Interaction										
P_0K_0	34.03	4.65	16.65	36.05	114.05	64.43	68.35	3.62	14.91	20.03
P_0K_1	36.45	5.26	18.39	38.41	117.87	64.45	68.47	4.32	16.39	21.88
P_0K_2	38.84	5.96	19.09	41.56	119.45	64.75	68.88	4.92	17.98	22.40
P_1K_0	34.44	4.86	17.23	36.51	112.78	64.82	69.10	4.22	16.02	19.31
P_1K_1	37.08	5.59	18.66	39.46	118.13	65.04	69.34	5.12	17.87	23.82
P_1K_2	39.38	6.09	19.94	43.49	121.90	65.90	70.15	5.79	18.04	24.06
P_2K_0	35.96	5.43	17.84	38.10	118.27	65.84	69.24	4.83	17.81	21.90

Contd...

Contd...

Treatment	Plant height (cm)	No. of primary side shoots per plant	No. of secondary side shoots/ plant	Plant spread (cm)	No. of leaves per plant	Days to bud formation	Days to flowering	No. of flowers per cluster	No. of flowering clusters per plant	Duration of flowering (days)
P_2K_1	38.65	5.93	18.96	41.30	120.09	66.58	70.34	5.44	18.40	23.65
P_2K_2	40.29	6.51	20.77	44.43	123.74	67.33	70.86	6.45	20.01	25.19
N × K Interaction										
N_0K_0	29.77	4.23	13.95	31.78	101.18	63.03	67.09	3.16	11.53	16.71
N_0K_1	32.87	4.93	14.89	34.67	104.31	63.48	67.98	3.70	13.54	22.87
N_0K_2	35.48	5.58	16.21	37.51	109.17	64.51	68.65	4.36	14.31	21.66
N_1K_0	35.27	5.25	18.74	37.42	117.89	65.52	68.97	4.61	18.79	21.34
N_1K_1	38.55	5.78	20.65	40.51	122.01	65.44	68.95	5.63	19.92	23.22
N_1K_2	40.71	6.37	21.80	42.86	123.12	66.78	69.61	6.59	21.22	24.79
N_2K_0	39.38	5.45	19.03	41.46	126.03	66.53	70.62	4.91	18.42	23.48
N_2K_1	40.75	6.08	20.47	43.99	129.78	67.15	71.22	5.55	19.20	24.28
N_2K_2	42.33	6.60	21.79	49.12	132.80	67.69	71.63	6.20	20.86	23.89
$CD_{0.05}$										
N	0.51	0.06	0.23	0.63	1.88	0.39	0.46	0.13	0.30	0.32
P	0.51	0.06	0.23	0.63	1.88	0.39	0.46	0.13	0.30	0.32
K	0.51	0.06	0.23	0.63	1.88	0.39	0.46	0.13	0.30	0.32
N × P	0.87	0.10	0.40	1.09	3.22	0.68	0.79	0.22	0.53	0.56
P × K	0.87	0.10	0.40	1.09	NS	NS	NS	0.22	0.53	0.56
N × K	NS	0.10	0.40	NS	NS	NS	NS	0.22	0.53	0.56

Vegetative parameters also increased with phosphorus application and maximum plant height (38.30 cm), number of primary side shoots per plant (5.95), number of secondary side shoots per plant (19.19), plant spread (41.28 cm) and number of leaves per plant (120.70) was registered with application of 30 g P/ m^2. It has well been documented that phosphorus plays significant role in photosynthesis, cell division, development of meristematic tissues, metabolism of carbohydrates, proteins and fats etc. Since phosphorus is found in nucleic acids and is involved through ATP in the activation of amino acids for the synthesis of proteins, that plays effective role in growth of plants. This factor may have contributed to the increased plant growth with phosphorus application (30 g/ m^2). The results are in accordance with the findings of Acharya and Dashora (2), who found taller plants with maximum spread and branches in African marigold using 200 kg/ ha (*i.e.* 20 g/ m^2) phosphorus.

Like nitrogen and phosphorus, vegetative growth of *Barleria cristata* increased with potassium application and recorded maximum plant height (39.50 cm), number of primary (6.18), number of secondary side shoots (19.93) per plant, plant spread (43.16 cm) and number of leaves per plant (121.70) was recorded with application of 30 g K/ m^2. This might be due to the fact that potassium plays essential role in plants; it is an activator of enzymes responsible for such plant processes as energy metabolism, starch synthesis, nitrate reduction and sugar degradation. Furthermore, it helps to regulate the opening and closing of stomata in the leaves and water uptake by the root cells. The results can be explained in light of observations made by Barman and Pal (3). They recorded maximum plant height, number of leaves and number of suckers per plant in chrysanthemum cv. Chandrama with application of 20 g K/ m^2.

Plants took more number of days for bud formation (67.12) and flowering (71.16) with application of nitrogen (Table 1). It is quite obvious that an increase in nitrogen encouraged vegetative development and kept plants in vegetative phase for longer period which delayed bud formation and flowering. The results are in accordance with the findings of Monish *et al*. (7), who found that days to flowering in China aster was delayed with increasing levels of nitrogen. Significant response of nitrogen on number of flowers per cluster, numbers of flower clusters per plant have been observed in present studies. Maximum number of flowers per cluster (5.61) and number of flower clusters per plant (20.00) have been observed with 15 g N/ m^2, whereas, there was slight decrease at 30 g N/ m^2 and this decrease was non-significant. This decrease may be due to the fact that at 30 g N/ m^2 vegetative growth was more which retarded the flower number of flowers per cluster and flower clusters per plant. The present results get support from the findings of Dorajeerao *et al*. (5). They also reported maximum number of flowers per plant in garland chrysanthemum with application of 150 kg/ ha (15 g N/ m^2), which was statistically significant over higher level. Duration of flowering was found to be maximum (22.42 days) with application of 30 g N/m^2, which was at par with 15 g N/ m^2.

Plants receiving 30 g P/ m^2 resulted in more time for bud formation (66.58 days) and flowering (70.15 days). Like nitrogen, phosphorus might have resulted in longer vegetative phase period which might have delayed bud formation and flowering. Plants receiving 30 g P/ m^2 also resulted in maximum number of flowers per cluster (5.57) and flower clusters per plant (19.10). Mohanty *et al*. (6) reported maximum number of flowers per plant in marigold with application of 30 g P/ m^2. Duration of flowering also increased with application of phosphorus.

Plants of *Barleria cristata* took more number of days to bud formation (65.99 days) and flowering (69.96 days) with 30 g K/ m^2 and duration of flowering (23.88 days) was also found to be maximum at this level. Plants responded significantly to potassium application and maximum number of flowers per plant (5.72) and flower clusters per plant (18.79) have been observed with 30 g K/ m^2. The present results get support from the findings of Barman and Pal (3), they observed that number of flowers per plot increased with increasing levels of potassium in chrysanthemum cv. Chandrama.

In case of interaction N × P, plant height (41.52 cm), number of primary side shoots (6.22), number of secondary side shoots (21.23), plant spread (46.17 cm) and number of leaves per plant (130.12) were found to be maximum at N_2P_2, *i.e.*, 30 g/ m^2 each of nitrogen and phosphorus (Table 1). More number of days to bud formation (67.69) and flowering (71.70) were taken by plants when combined dose of 30 g/m^2 each of nitrogen and phosphorus was applied. This treatment also resulted in maximum duration of flowering (25.04 days). Whereas, number of flowers per plant (6.42), flowering clusters per plant (21.20) was found to be maximum in plants treated with 15 g/m^2 of nitrogen and 30 g/ m^2 phosphorus (N_1P_2). Phosphorus stimulates the root system through efficient translocation to roots of certain growth stimulating compounds formed in plants, which enhanced the absorption of nutrients thus resulting in a vigorous growth when applied in combination with nitrogen.

Interaction P × K was found to show significant effect on plant height, number of primary side shoots per plant, number of secondary side shoots per plant and plant spread. Vegetative parameters like plant height (40.29 cm), number of primary side shoots

(6.51), number of secondary side shoots (20.77) and plant spread (44.43 cm) were found to be maximum with combined application of 30 g/ m^2 each of phosphorus and potassium (Table 1). This interaction was found to show significant effect on flowering parameters and number of flowers per plant (6.45), number of flower clusters per plant (20.01) and duration of flowering (25.19) was found to be maximum with application of 30 g/m^2 each of phosphorus and potassium (P_2K_2).

In case of interaction N × K, number of primary side shoots (6.60) and number of secondary side shoots (21.79) were found to be maximum at N_2K_2, *i.e.*, 30 g/ m^2 each of nitrogen and potassium. Number of flowers per plant (6.59), flowering clusters per plant (21.22) and duration of flowering (24.79 days) was found to be maximum in plants treated with 15 g/ m^2 of nitrogen and 30 g/ m^2 potassium (N_1K_2) (Table 1).

Interaction N × P × K showed significant results on plant height, number of primary side shoots per plant, plant spread, number of leaves per plant, number of flowers per cluster, number of flower clusters per plant and duration of flowering (Table 2). Maximum plant height (42.59 cm), number of primary side shoots per plant (6.83), plant spread (50.32 cm) and number of leaves per plant (135.26) was registered in plants that received 30 g/ m^2 each

Table 2. Effect of nitrogen, phosphorus and potassium on growth and flowering of *Barleria cristata*.

Treatment	Plant height (cm)	No. of primary side shoots/plant	Plant spread (cm)	No. of leaves/plant	No. of flowers/ cluster	Flower clusters per plant	Duration of flowering (days)
$N_0P_0K_0$	28.60	3.93	32.94	95.59	2.55	10.30	15.50
$N_0P_0K_1$	32.26	4.51	33.83	102.63	3.46	12.48	22.44
$N_0P_0K_2$	35.02	5.29	37.02	102.66	3.80	13.16	22.87
$N_0P_1K_0$	31.01	4.01	30.49	100.00	3.20	10.26	13.28
$N_0P_1K_1$	32.64	4.83	34.53	100.63	3.70	13.52	21.25
$N_0P_1K_2$	35.41	5.52	37.43	112.86	4.32	13.60	24.67
$N_0P_2K_0$	30.04	4.76	31.90	107.95	3.73	14.02	21.33
$N_0P_2K_1$	33.72	5.44	35.66	109.69	3.96	14.63	20.33
$N_0P_2K_2$	36.00	5.93	38.08	111.79	5.00	16.18	22.92
$N_1P_0K_0$	32.66	4.80	34.82	121.84	4.11	17.05	23.17
$N_1P_0K_1$	36.63	5.32	38.68	120.85	4.68	18.77	21.08
$N_1P_0K_2$	39.44	6.13	41.37	122.60	5.43	20.54	23.56
$N_1P_1K_0$	35.68	5.13	37.97	111.62	4.45	19.17	22.67
$N_1P_1K_1$	38.42	5.81	40.13	123.00	5.60	20.55	23.58
$N_1P_1K_2$	40.41	6.21	42.31	122.58	6.78	20.35	24.58
$N_1P_2K_0$	37.48	5.83	39.75	120.22	5.29	20.24	22.78
$N_1P_2K_1$	40.59	6.21	42.71	122.18	6.42	20.54	25.00
$N_1P_2K_2$	42.08	6.76	44.90	124.18	7.56	22.82	24.75
$N_2P_0K_0$	38.41	5.24	40.68	124.73	4.21	17.38	21.42
$N_2P_0K_1$	40.46	5.96	42.73	130.14	4.82	17.91	22.11
$N_2P_0K_2$	42.06	6.45	46.30	132.88	5.54	20.23	20.83
$N_2P_1K_0$	39.37	5.44	41.06	126.72	5.02	18.62	21.98
$N_2P_1K_1$	40.18	6.13	43.71	130.78	5.82	19.54	26.63
$N_2P_1K_2$	42.33	6.53	50.73	130.27	6.28	20.17	22.92
$N_2P_2K_0$	40.35	5.69	42.65	126.64	5.48	19.87	21.58
$N_2P_2K_1$	41.62	6.14	45.53	128.41	5.96	21.45	25.61
$N_2P_2K_2$	42.59	6.83	50.32	135.26	6.78	22.16	27.92
$CD_{0.05}$	1.51	0.18	1.82	5.60	0.70	0.92	0.96

of nitrogen, phosphorus and potassium ($N_2P_2K_2$). Maximum number of flowers per cluster (7.56) and flower clusters per plant (22.82) were recorded with application of 15 g/ m^2 of nitrogen and 30 g/ m^2 each of phosphorus and potassium ($N_1P_2K_2$). Duration of flowering was recorded maximum (27.92 days) in plants receiving 30 g/m^2 each of nitrogen, phosphorus and potassium ($N_2P_2K_2$).

Studies on the response nitrogen, phosphorus and potassium on growth and flowering of *Barleria cristata* Linn. revealed that 30 g/ m^2 each of nitrogen, phosphorus and potassium had an optimal response on vegetative characters, while 15 g/ m^2 nitrogen, 30 g/ m^2 each of phosphorus and potassium had optimal response on flowering characters.

REFERENCES

1. Abou-Dahab, T.A.M. and Habib, A.M.A. 2005. Production of *Barleria cristata* L. as a dwarf flowering pot plant. *Ann. Agric. Sci.* **43**: 727-46.
2. Acharya, M.M. and Dashora, L.K. 2004. Response of graded levels of nitrogen and phosphorus on vegetative growth and flowering of African marigold (*Tagetes erecta* Linn.). *J. Orn. Hort.* **7**: 179-83.
3. Barman, D. and Pal, D. 1999. Effect of nitrogen, potassium and spacing on growth and flowering of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cv. Chandrama. *Hort. J.* **12**: 51-59.
4. Bhattacharjee, S.K. 1980. Grow barleria for profitable flower production. *Indian Farmers' Digest*, **13**: 43-44.
5. Dorajeerao, A.V.D., Mokashi, A.N., Patil, V.S., Venugopal, C.K., Lingaraju, S. and Koti, R.V. 2012. Effect of graded levels of nitrogen and phosphorus on growth and yield of garland chrysanthemum (*Chrysanthemum coronarium* L.). *Karnataka J. Agric. Sci*. **25**: 224-28.
6. Mohanty, C.R., Mishra, N.K. and Patnaik, P. 2002. Effect of nitrogen and phosphorus on flower production in marigold. *J. Orn. Hort.* **5**: 67-68.
7. Monish, M., Umrao, V.K., Tyagi, A.K. and Meena, P.M. 2008. Effect of nitrogen and phosphorus levels on growth, flowering and yield of China aster. *Agric. Sci. Digest*, **28**: 97-100.

Received : March, 2012; Revised : October, 2012;
Accepted : January, 2013