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Influence of N, P and bio-fertilizer on growth and flower production of annual chrysanthemum (*Chrysanthemum coronarium* L.)

Samanweeta Satapathy and Chitta Ranjan Mohanty

Abstract
The Present investigation to study the influence of N, P and Bio-fertilizer on growth and flower production of Annual Chrysanthemum (*Chrysanthemum coronarium*) cv. Local was carried out in form of a field trial at the Agricultural Research Station, Binjhagiri, Chhatabar, Institute of Agricultural Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar during 2021-22. Three levels of Nitrogen *viz*., 100 (N1), 150 (N2) and 200 (N3) kg/ha, two levels of Phosphorus *viz*., 50 (P1) and 100 (P2) kg/ha and a common dose of Potassium 100 (K) kg/ha along with or without (B1 and B0) two Bio-Fertilizers, *viz*., Azotobacter and Phosphate Solubilizing Bacteria (PSB) each at 5 kg/ha were tried to determine the most appropriate & economical dose for maximization of flower production. Significantly taller plants with maximum height (92.86 cm) and maximum basal stem diameter (8.9 cm), were observed under application of 150 kg N+100 kg P+100 kg K +5 kg each of Azotobacter and PSB/ha (N2P2KB1 i.e.T8). Application of 200 kg N+50 kg P +100 kg K + 5 kg each of Azotobacter and PSB/ha (N3P1KB1 i.e.T10) resulted in production of maximum plant spread (52.80 cm) in E-W direction. Application of 150 kg N+50 kg P+100 kg K+ 5kg each of Azotobacter & PSB/ha (N2P1KB1 i.e.T6) resulted in production of maximum number of compound leaves (451.66 nos.) and primary branches (22.20 nos.) per plant. However, except plant height, no significant difference existed among T6, T8, T10 and T12 with respect to other growth parameters reported. The size/diameter of individual flowers was significantly influenced by various fertilizer treatments. Although T10 recorded the maximum size/diameter (4.81 cm) of individual flower, it was followed by and at par with T8. Application of 150 kg N +100 kg P +100kg K +5 kg each of Azotobacter and PSB (T8) recorded maximum weight (177.66 g) of flowers per plant and per plot (5.33 kg), as well as per hectare (7.40 t) and T12 (N3P2KB1) & T10 (N3P1KB1) were next to this treatment with respect to these parameters without showing significant variation. Considering all growth and flowering parameters, it was concluded that application of 150 kg N, 100 kg P and 100 kg K along with soil application of 5 kg each Azotobacter and PSB/ha (T8) which exhibited better performance with respect to growth and flower production in Annual Chrysanthemum cv. Local may be recommended to the flower growers for its commercial cultivation.

Keywords: Azotobacter, phosphate solubilizing bacteria (PSB), plant height, basal stem diameter, plant spread, number of compound leaves, number of primary branches, individual flower diameter, weight of flowers per plant, weight of flowers per plot, weight of flowers per hectare

Introduction
Annual chrysanthemum (*Chrysanthemum coronarium*) belongs to the family Asteraceae. It is commonly known as Crown Daisy or Garland Chrysanthemum; which is native to the Mediterranean region. It was cultivated and naturalized in East Asia and in scattered locations of North America. In India, it is commercially grown for production of loose flowers in certain pockets of Maharashtra, Karnataka, Bihar, Punjab, Haryana, Uttar Pradesh, Madhya Pradesh and West Bengal (Jena *et al.*, 2021) [2]. It is a hardy, vigorous, taller and relatively short duration plant which produces attractive flowers in the shades of yellow and white having single or double forms (Desai, 1962) [1]. Apart from its ornamental value, Garland chrysanthemum is also used as a leafy vegetable. The leaves are either eaten fresh in a salad or as cooked greens besides, it has several medicinal values which includes antioxidant protection, reduced risk of lung cancer, protection against kidney stones, cardiovascular problems, bloating and bone loss. Chlorogenic acid, which is found in coffee beans, is also abundant in garland chrysanthemum. In Odisha it is mostly grown as a garden plant in beds and borders.

Among different crop management practices for maximization of production of quality flowers in various flowering annuals including annual chrysanthemum, nutrient management plays a

vital role. Therefore, it is required to apply adequate quantity of nutrients through proper nutrient sources. In addition to use chemical fertilizers, it is also required to use sufficient quantity of organic manure to maintain soil health besides improving crop production. However, there are certain limitations in use of chemical fertilizers. Now a days these are becoming costlier day by day for which poor farmers face difficulty to afford for the same. Besides, another problem, its indiscriminate use has resulted in deterioration of soil health. More over long term use of chemical fertilizers causes soil structure degradation. On the other hand use of organic manure to meet the entire nutrient requirement of the crop including commercial floriculture is also not possible since the availability of organic manure in such huge quantities is also a constraint. In this situation it is necessary to include low cost bio fertilizers in nutrient management programme to sustain both soil health and crop production on a long term basis.

In the present trial an attempt was made to investigate the influence of different levels of nitrogen, phosphorus and a fixed dose of potassium without or with combination of bio fertilizers *viz*., Azotobacter and Phosphate solubilizing bacteria (PSB) on vegetative growth and different flowering parameters and yield of flowers of annual Chrysanthemum (*Chrysanthemum coronarium* L.) to determine the most ideal nutrient management practices for maximization of flower production.

Materials and Methods

The present investigation was undertaken in form of a field experiment at the Agricultural Research Station, Binjhagiri, Chhatabar, Institute of Agricultural sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar during 2021-2022. The experiment was conducted to study the influence of N, P and Bio-fertilizer on growth and flowering of Annual Chrysanthemum (*Chrysanthemum coronarium*) cv. Local following Randomized Block design. Three levels of nitrogen *viz*., 100 (N1), (N2) and 200 kg (N3)/ha, two levels of phosphorus *viz*., 50 (P1) and 100 kg (P2)/ha and a common dose of potassium 100 kg (K)/ha along with (B1) or without (B0) two Bio-Fertilizers, *viz*., Azotobacter and Phosphate Solubilizing Bacteria (PSB) each at 5 kg/ha were tried which were replicated thrice. All the data concerning various growth parameters, flowering components and flower characters were analysed statistically. The analysis of variance table was prepared. The treatment effects were tested by 'F' test at 5% level of significance. The critical difference at 5% level was calculated for comparing treatment means.

Result and Discussion

Plant height

Observations on plant height of Annual chrysanthemum plants as influenced by application of various doses of nitrogen, phosphorus and a fixed dose potassium with or without bio-fertilizers like Azotobacter and Phosphate solubilizing bacteria (PSB) were recorded after two months of transplanting and the analysed data are presented in Table 1. The data revealed that application of 150 kg of N, 100 kg of P and 100 kg of K in combination with 5 kg each of Azotobacter and Phosphate solubilising bacteria (PSB) (N2P2KB1) per hectare recorded significantly taller plants of 92.86 cm among all the treatment combinations. It was followed by the treatments receiving N3P2KB1 i.e.T12 (200 kg N+100 kg P+100 kg K+ 5 kg each of Azotobacter and PSB /ha) and N2P2KB0 i.e. T7 (150 kg N+100 kg P+ 100 kg K) treatments which registered the value of 84.73 cm and 82.8 cm respectively. However, no significant difference in plant height was noticed among T12, T7, T6 and T5 treatments. On the other hand plants with lower height was recorded with T1, T3, T4, T9 and T11. It was noticed that in general application of a specific dose of nitrogen and phosphorus along with bio-fertilizers like Azotobacter and PSB exhibited better performance as compared to the same dose of nitrogen and phosphorus without application of bio-fertilizer. Hence, a dose of 150 kg of N with 100 kg of P, 100 kg of K and 5 kg each of Azotobacter and PSB was regarded as the optimum dose. The possible reason for increase in plant height is that combined 49 application of bio-fertilizer and with N:P 150:100 kg/ha or 200:100 kg/ha resulted in better nutrition which lead to increased photosynthetic activity, enhanced cell division and enlargement as nitrogen is important constituent of nucleic acid and it might have increased the synthesis of carbohydrates, amino acid, etc. from which phytohormones like auxins, gibberellins and cytokinins might have been synthesized and phosphorus being an essential component of protoplasm and chlorophyll, might have caused conversion of photosynthates into phospholipids resulting in adequate vegetative growth thus increased plant height. Bio-fertilizers produce several growth promoting hormones (auxins, gibberellins, and cytokinins) in addition to increasing the availability of nitrogen, phosphorus and potash to the plants resulting in better plant growth (Slathia *et al.*, 2019) [12].

Plant spread (East-West)

Significant difference in plant spread in E-W direction was noticed during the observation. Treatment T10 (N3P1KB1) receiving 200 kg of N,50 kg of P and 100 kg of /ha in combination with bio-fertilizer recorded maximum spread of 52.80 cm during the observation. It was followed by T6 (N2P1KB1), T12 (N3P2KB1), T8 (N2P2KB1) and T4 (N1P2KB1) which recorded 52.13 cm, 49.46 cm, 49.26 cm and 49.26 cm respectively during the observation without showing significant variation from each other, while T11 (N3P2KB0) recorded the lowest of 43.13 cm spread and was at par with T1 (N1P1KB0), T9 (N3P1KB0), T7 (N2P2KB0), T5 (N2P1KB0) and T3 (N1P2KB0) 51 which had 43.26 cm, 43.73 cm, 44.46 cm, 44.86 cm and 43.4 cm spread respectively. The result indicated that combined application of 150-200 kg N+50-100 kg P+ 100 kg of K and 5 kg each of Azotobacter and PSB proved beneficial for better growth in term of plant spread as compared to other treatments. This might be attributed to the possible role of nitrogen in improving structural parameters as it is an important constituent of protein and the role of phosphorus in structural component as in phospholipid and in absorbing and in translocation of food material. Further, application of bio-fertilizers *viz*; Azotobacter and PSB proved to be beneficial. Azotobacter is a free-living N fixing bacterium and also secrets growth promoting substances like Auxins which stimulates the plant metabolic activity and photosynthetic efficiency leading to better growth of plant (Slathia *et al.*, 2019) [12]. PSB are a group of bacteria, capable of hydrolysing organic and inorganic phosphorus from insoluble compounds. Besides, use of PSB as inoculants simultaneously increases P uptake by the plant and crop yield (Pandey *et al.*, 2018a) [9]. The result of the present study is in conformity with the

findings of Panchal *et al.*, (2010) [8].

Basal stem diameter

The data recorded in Table-1 revealed that significant variation was noticed in basal stem diameter due to different doses of fertilizer applied with or without bio fertilizers. Plants receiving T8 i.e., N2P2KB1 comprised of 150 kg N, 100kg P and 100 kg of K in combination with 5 kg each of Azotobacter and PSB recorded maximum stem diameter of 8.9 cm. However, it was at par with T6 (N2P1KB1), T2 (N1P1KB1), T10 (N3P1KB1) and T12 (N3P2KB1) which recorded a basal stem diameter of 7.89cm, 7.87cm, 7.79cm and 7.64cm respectively after two months of planting. On the other hand T1 comprised of N1P1KB0 recorded the lowest diameter of 6.67 cm during the observation recorded. It was found that treatments receiving moderate dose of N i.e., 150 kg with 100 kg P and 100 kg of K/ha in combination with bio-fertilizers (5 kg each of Azotobacter and PSB) exhibited best performance. Similar results have been reported by Kirar *et al.* (2009) [3] in China aster cv. Princess who observed that application of 75% NPK+ Vermicompost+ Azotobacter+ PSB exhibited superior performance as compared 50%. NPK with Vermicompost and Bio-fertilizers which recorded greater diameter of main stem.

Number of primary branches

As indicated in Table-1, significant difference in number of primary branches per plant was noticed due to various fertilizer treatments applied. It was found that T6 (N2P1KB1) recorded maximum number of branches (22.20) and it was closely followed by and at par with T10 (N3P1KB1), T5 (N2P1KB0), T8 (N2P2KB1), T9 (N3P1KB0), T2 (N1P1KB1), T4 (N1P2KB1) and T12 (N3P2KB1) which produced 22.13, 22.06, 22.0, 21.86, 21.73, 21.13, and 21.06 branches respectively. On the other hand, T3 (N1P2KB0) recorded the minimum number of branches 18.13. However, it was at par with T11 (N3P2KB0) which recorded 19.33 branches per plant. It was seen that combined application of higher doses of N at the rate of 150 to 200 kg, 50 to 100 kg of P/ha and 100 kg of K/ha along with 5 kg each of Azotobacter and PSB performed better. The result of the present study is in conformity with Pandey *et al.* (2018b) [10] who noticed that significantly higher number of primary branches per plant was recorded in Chrysanthemum with the application of bio-fertilizers (Azospirillum + PSB) with 150 kg of N, 100 kg of P and 100 kg of K per hectare. It was also observed that various combination of inorganic fertilizer with bio-fertilizer had better effect as compared to the same dose of inorganic fertilizer without bio-fertilizers.

Number of Compound Leaves per plant

The data presented in Table-1 revealed that significant difference existed among different treatments with respect to number of leaves per plant. Maximum number of leaves (451.66 NOS) were produced in plants receiving T6 i.e., N2P1KB1 comprised of 150 kg N, 50 kg P and 100 kg K along with 5 kg each of Azotobacter and PSB per hectare during the observation recorded after second month of transplanting. It was followed by T10 (N3P1KB1), T8 (N2P2KB1), T2 (N1P1KB1), T5 (N2P1KB0) and T9 (N3P1KB0) which recorded 448.26, 441.33, 432.40, 425.66 and 425.20 leaves respectively. On the other hand, the minimum number of leaves (366.26) was recorded under T3 (N1P2KB0) and it was at par with T1 (N1P1KB0) and T11 (N3P2KB0) which had 377.26 and 386.46 leaves per plant respectively. It was observed that combined application of higher doses of N i.e., 150 or 200 kg, 50 to 100 kg of P and 100 kg of K/ha with 5 kg each of Azotobacter and PSB per hectare *viz*., T6 (N2P1KB1), T8 (N2P2KB1), T10 (N3P1KB1) performed better as compared to other treatments. However, among these, T8 i.e., N2P2KB1 may be considered as an optimum dose since this treatment also exhibited better performance with respect to other growth parameters. Similar results have been reported by Pandey *et al.* (2018b) [10] in Chrysanthemum, who observed that significantly higher number of leaves per plant was recorded with application of bio-fertilizers (Azospirillum +PSB) + 150 kg N, 100 kg P and 100 kg K per hectare. Increase in number of leaves per plant maybe due to balanced availability of macro and micronutrients and growth promoting hormones produced by different bio-fertilizers applied in different treatment combinations.

Size/Diameter of individual flower

As indicated in (Table 2) after two months of planting, significant difference existed in diameter of flowers in Annual Chrysanthemum due to various fertilizer treatments. Flowers with maximum diameter (4.81 cm) was recorded under T10 (N3P1KB1) receiving 200 kg of N, 50 kg of P and 100 kg of K along with 5 kg each of Azotobacter and PSB per hectare. It was closely followed by T8 (N2P2KB1) which received 150 kg of nitrogen, 100 kg of phosphorus and 5 kg each of Azotobacter and PSB per hectare without showing significant variation from each other. On the other hand, T3 (N1P2KB0) recorded the lowest value (3.49 cm) in respect of flower diameter. However, it was at par with T1 (N1P1KB0) and T11 (N3P2KB0) which recorded 3.74 cm and 3.76 cm diameter respectively. Higher flower diameter with application of 100% NPK + Azospirillum + PSB has been reported by Sowmya and Prasad (2017) [13] in China aster. Panchal *et al.*, (2010) [8] also reported that application of 175 kg of N/ha with Azospirillum and Azotobacter recorded maximum flower diameter in Annual Chrysanthemum. On the basis of the present investigation, treatment with 150 kg of N,100 kg of P and 100 kg of K and 200 kg of N, 50 kg of P and 100 kg of K per hectare along with Azotobacter + PSB were found to be viable treatment combinations which improved flower diameter. The treatments promoted the rhizosphere colonization. Azotobacter and PSB resulted in enhanced nutrient uptake, which increased growth yield and quality of flowers. In the present investigation although T10 and T8 had more or less similar effect, T8 was regarded as the optimum dose since it influenced several other parameters.

Weight of flowers per plant

Data presented in Table-2 revealed that significant difference existed among various fertilizer treatments in respect of weight of flowers per plant. It was found that T8 (N2P2KB1) comprising of 150 kg N, 100 kg P and 100 kg K/ha in combination with 5 kg each of Azotobacter and PSB recorded maximum weight (177.66 g) of flowers per plant. However, it was at par with T7 (N2P2KB0), T12 (N3P2KB1), T11 (N3P2KB0), T10 (N3P1KB1), T6 (N2P1KB1) and T4 (N1P2KB1) which recorded 176.2 g, 174.2 g, 165.06 g, 163.60 g, 161.9 g and 161.4 g flowers respectively. It was noticed that in general higher doses of N with higher dose of

P along with bio-fertilizers exhibited better performance as compared to same dose of N and P without application of bio-fertilizers. Between the two higher doses of N i.e., 150 kg and 200 kg/ha, no additional benefit was obtained due to application of 200 kg N/ha. Hence, 150 kg N along with 100 kg of P and 100 of K in combination with bio-fertilizer adjudged to be optimum dose for obtaining higher yield of flowers. On the other hand, lowest yield of flowers (134.93g) was recorded under T5 (N2P1KB0), which was at par with T9 (N3P1KB0), T1 (N1P1KB0), T3 (N1P2KB0) and T2 (N1P1KB1) which recorded 146.13 g, 146.8 g, 148.66 g and 154.6 g respectively. It was seen that the treatments receiving different doses of N along with low dose of P and no bio-fertilizer recorded lower yield of flowers. Increase in flower number per plant and ultimately increase in weight of flowers per plant might be attributed to production of more number of leaves which might have resulted in production and accumulation of more photosynthates resulting in production of more number of flowers (Kumari *et al.*, 2019) [5] per plant which recorded maximum weight of flowers under these treatments. Further, these results also got support from Mittal *et al.*, (2010) [7] in African Marigold and Meshram *et al.*, (2008) [6] in Annual Chrysanthemum.

Weight of flowers per plot

The data in Table-2 indicated that significant difference was observed among various fertilizer treatments with respect to weight of flowers per plot. Treatment T8 (N2P2KB1) comprising of 150 kg of N, 100 kg of P and 100 kg of K along with 5 kg each of Azotobacter and PSB per hectare recorded maximum weight (5.33 kg) per plot. However, it was followed by and at par with T7 (N2P2KB0), T12 (N3P2KB1), T11 (N3P2KB0), T10 (N3P1KB1), T6 (N2P1KB1) and T4 (N1P2KB1) which recorded 5.28 kg, 5.22 kg, 4.95 kg, 4.90 kg, 4.85 kg and 4.84 kg per plot respectively. On the other hand, T5 (N2P1KB0) recorded the lowest weight (4.04 kg/plot) per plot among all the treatments. However, it was at par with T9 (N3P1KB0), T1 (N1P1KB0), T3 (N1P2KB0) and T2 (N1P1KB1) which produced 4.38 kg, 4.40 kg, 4.46 kg and 4.63 kg of flowers per plot respectively. It was noticed that higher doses of N i.e., 150-200 kg/ha in combination with higher dose of P i.e., 100 kg/ha exhibited better performance and between the two higher doses of N, 150 kg was found superior. It was also noticed that application of bio-fertilizer along with inorganic fertilizer gave better result in terms of flower yield per plot as compared to inorganic fertilizer treatment receiving no bio-fertilizer. Production of more weight of flowers per plant receiving 150-200 kg of N and 100 kg of P/ha along with bio-fertilizer as observed in the present study might have contributed for recording higher yield of flowers per plot.

Weight of flowers per hectare

As indicated in Table-2 the treatment T8 (N2P2KB1) receiving 150 kg of N, 100 kg of P and 100 kg of K /ha along with bio-fertilizer Azotobacter and PSB each at 5 kg recorded the maximum weight of flowers (7.40 t/ha) and it was followed by and at par with T7 (N2P2KB0), T12 (N3P2KB1), T11 (N3P2KB0), T10 (N3P1KB1), T6 (N2P1KB1) and T4 (N1P2KB1) recording flower yield of 7.34 t, 7.25 t, 6.87 t, 6.81 t, 6.74 t and 6.72 t per hectare respectively. On the other hand T5 (N2P1KB0) recorded the lowest and was at par with T9 (N3P1KB0), T1 (N1P1KB0), T3 (N1P2KB0) and T2 (N1P1KB1) which recorded 5.62 t, 6.08 t, 6.11 t, 6.19 t and 6.44 t flowers per hectare respectively. In the present investigation it was observed that higher doses of N i.e., 150-200 kg with higher dose of P i.e., 100 kg/ha and 100 kg of K/ha exhibited better result and between the two higher doses of N, nitrogen 150 kg/ha was found superior with respect to yield of flowers. It was also observed that application of bio-fertilizer i.e., Azotobacter and PSB @ 5 kg/ha each along the inorganic fertilizer gave better yield per plant and per plot as well as per hectare as compared to inorganic fertilizer alone. Increase in flower yield in the above treatments might be due to higher N and P assimilation from higher doses of N and P in association with more nitrogen fixing and phosphorus solubilizing proficiency and secretion of hormones by the cultures (Kumar *et al.*, 2009) [4]. These findings corroborate with that of Shashidhara and Gopinath (2002) [11] in Calendula.

Table 1: Influence of N, P and Bio-Fertilizer on various vegetative growth parameters of annual chrysanthemum cv. Local after 2 months of planting

Treatments	Plant height (cm)	Plant spread (E-W) (cm)	Basal stem diameter (cm)	Number of primary branches	Number of compound Leaves
T1 (N1P1KB0)	78.93	43.26	6.67	20.20	377.26
T2 (N1P1KB1)	82.46	47.80	7.87	21.73	432.40
T3 (N1P2KB0)	77.46	45.40	7.00	18.13	366.26
T4 (N1P2KB1)	78.33	49.26	7.62	21.13	414.86
T5 (N2P1KB0)	80.73	44.86	7.27	22.06	425.66
T6 (N2P1KB1)	81.73	52.13	7.89	22.20	451.66
T7 (N2P2KB0)	82.80	44.46	7.34	20.40	401.60
T8 (N2P2KB1)	92.86	49.26	8.09	22.00	441.33
T9 (N3P1KB0)	75.33	43.73	6.78	21.86	425.20
T10 (N3P1KB1)	80.93	52.80	7.79	22.13	448.26
T11 (N3P2KB0)	79.53	42.13	6.91	19.33	386.46
T12 (N3P2KB1)	84.73	49.46	7.64	21.06	418.86
SE(m) ±	1.71	1.70	0.15	0.43	11.18
CD at 5%	5.03	5.01	0.46	1.27	32.79

N1-100 kg/ha, N2-150 kg/ha, N3-200 kg/ha
P1-50 kg/ha, P2-100 kg/ha, K-100 kg/ha
BO-No bio-fertilizer, B1-Azotobacter +PSB @ 5 kg each/ha

Table 2: Influence of N, P and Bio-Fertilizer on various flowering components and yield of annual chrysanthemum cv. Local

Treatments	Individual flower diameter (cm)	Weight of flowers per plant (g)	Weight of flowers per plot (kg)	Weight of flowers per ha (tonne)
T1 (N1P1KB0)	3.74	146.80	4.40	6.11
T2 (N1P1KB1)	4.00	154.60	4.63	6.44
T3 (N1P2KB0)	3.49	148.66	4.46	6.19
T4 (N1P2KB1)	4.18	161.40	4.84	6.72
T5 (N2P1KB0)	3.90	134.93	4.04	5.62
T6 (N2P1KB1)	4.29	161.90	4.85	6.74
T7 (N2P2KB0)	4.41	176.20	5.28	7.34
T8 (N2P2KB1)	4.55	177.66	5.33	7.40
T9 (N3P1KB0)	4.26	146.13	4.38	6.08
T10 (N3P1KB1)	4.81	163.60	4.90	6.81
T11 (N3P2KB0)	3.76	165.06	4.95	6.87
T12 (N3P2KB1)	4.30	174.20	5.22	7.25
SE(m) ±	0.11	7.96	0.23	0.33
CD at 5%	0.33	23.37	0.70	0.97

N1-100 kg/ha, N2-150 kg/ha, N3-200 kg/ha
P1-50 kg/ha, P2-100 kg/ha, K-100 kg/ha
BO-No bio-fertilizer B1-Azotobacter +PSB @ 5 kg each/ha

Conclusion

Based on the result of the study it was concluded that application of 150 kg N, 100 kg P and 100 kg K along with soil application of 5 kg each of Azotobacter and PSB/ha was found optimum which exhibited better performance with respect to various vegetative growth parameters and flowering components as well as yield of flowers in Annual Chrysanthemum cv. Local which may be recommended to the flower growers for its commercial cultivation.

References

1. Desai BL. Chrysanthemum. In: Seasonal flowers, ICAR, New Delhi; c1962. p. 64-65.
2. Jena Subhendu, Mohanty CR, Patra Chakradhar, Dash Rudra Madhab. Effect of pinching on growth and flowering of annual chrysanthemum (*Chrysanthemum coronarium* L.). Journal of Pharmacognosy and Phytochemistry. 2021;10(2):1042-1045.
3. Kirar KPS, Lekhi R, Sharma Satyakumari, Sharma Rahul. Effect of Integrated Nutrient Management Practices on Growth and Flower Yield of China Aster [*Callistephus chinensis* (L.) Ness] cv Princess. Agriculture: Towards a New Paradigm; c2009. p. 234-237.
4. Kumar Dhiraj, Singh BP, Singh Viveka Nand. Effect of integrated nutrient management on growth, flowering behaviour and yield of African marigold (*Tagetes erecta* L.) cv. African Giant Double Orange. Journal of Horticultural Sciences. 2009;4(2):134-137.
5. Kumari Anju, Sharma BP, Gupta YC, Sharma Uday, Sharma Shweta. Effect of Biofertilizers applications on Growth and Flowering of African Marigold cv. 'Pusa Narangi Gainda' during Different Season of the Year under Mid-Hills Conditions of Himachal Pradesh. International Journal of Current Microbiology and Applied Sciences. 2019;8(09):234-240.
6. Meshram N, Badge S, Bhongle SA, Khiratkar SD. Effect of bioinoculants with graded doses of NPK on flowering, yield attributes and economics of annual chrysanthemum. Journal of Soils and Crops. 2008;18:217-220.
7. Mittal R, Patel HC, Nayee DD, Sitapara HH. Effect of integrated nutrient management on growth and yield of African marigold (*Tagetes erecta* L.) cv. 'Local'. The Asian Journal of Horticulture. 2010;5(2):347-349.
8. Panchal RV, Parekh NS, Parmar AB, Patel HC. Effect of bio-fertilizers and nitrogenous fertilizer on growth, flowering and yield of annual white chrysanthemum (*Chrysanthemum coronarium* L.) under middle Gujarat agroclimatic conditions. The Asian Journal of Horticulture. 2010;5(1):22-25.
9. Pandey Satish Kumar, Prasad VM, Saravanan S, Kumar Anil Effect of Bio-fertilizers and Inorganic Manures on Flowering and Yield of Chrysanthemum (*Dendranthema grandiflora* Tzvelev) cv. Haldighati. International Journal of Current Microbiology and Applied Sciences. 2018a;7(12):1696-1703.
10. Pandey Satish Kumar, Prasad VM, Singh Vivek Kumar, Kumar Madhur, Saravanan S. Effect of bio-fertilizers and inorganic manures on plant growth and flowering of chrysanthemum (*Chrysanthemum grandiflora*) cv. Haldighati. Journal of Pharmacognosy and Phytochemistry, SP1: 2018b. p. 637-642.
11. Shashidhara GR, Gopinath G. Effect of nutrients and bioinoculants in calendula. In: Floriculture Research Trends in India. Published by Indian Society of Ornamental Horticulture. ICAR, New Delhi. 2002. p. 206-208.
12. Slathia Divya, Khan FU, Masoodi NH, Khan FA, Wani JA, Iqbal Umar Neelofar, *et al*. Effect of Different Combinations of NPK and Bio-fertilizers on Zinnia (*Zinnia elegans* J.). Current Journal of Applied Science and Technology. 2019;34(6):1-7.
13. Sowmya KA, Prasad VM. Effect of NPK and Bio-Fertilizers on Growth, Yield and Quality of China Aster (*Callistephus chinensis*) cv. Shashank for Cut Flower Production under Agro Climatic Conditions of Allahabad. International Journal of Current Microbiology and Applied Sciences. 2017;6(10):3204-3210.