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Effect of N, P and bio-fertilizer on growth and flowering of annual chrysanthemum (*Chrysanthemum coronarium* L.)

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Abstract
The Present investigation to study effect of N, P and Bio-fertilizer on growth and flowering 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 two Bio-Fertilizers, viz., Azotobacter and Phosphate Solubilizing Bacteria (PSB) each at 5 kg/ha were tried to determine the most suitable & economical dose for maximization of flower production. After three months of planting, plants with maximum height (99.40 cm) and basal stem diameter (9.04 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 (58.06 cm) in E-W direction, number of compound leaves (572 nos.) and primary branches (29.0 nos.) per plant remaining at par with T8 in respect of these parameters. The weight of individual flowers was not significantly influenced by various fertilizer treatments although application of 150 kg N+50 kg P+100 kg K+5 kg each of Azotobacter and PSB/ha (N2P1KB1 i.e.T6 recorded the maximum weight (2.71 g). Application of 150 kg N +100 kg P +100kg K +5 kg each of Azotobacter and PSB (N2P2KB1 i.e.T8) recorded maximum number (97 nos.) of flowers per plant and per plot (2910 nos.), as well as per hectare (4041667 nos.) and T12 (N3P2KB1) receiving 200 kgN+100 kg P+100 kg K+B1 was next to this treatment with respect to these parameters without showing significant variation from the former. Application of 150 kg N, 100 kg P and 100 kg K along with soil application of 5 kg each Azotobacter and PSB/ha (N2P2KB1 i.e.T8) was found optimum which exhibited better performance with respect to growth and flower production in Annual Chrysanthemum cv. Local which may be recommended to the flower growers for its commercial cultivation.

Keywords: Azotobacter, phosphate solubilizing bacteria (PSB), plant height, plant spread, Individual flower weight, number of flowers per plant, Number of flowers per plot, number of flowers per hectre

Introduction
Annual chrysanthemum is a member of family Asteraceae, commonly known as Crown Daisy or Garland Chrysanthemum; scientifically designated as *Chrysanthemum coronarium* recently known as *Glebionis coronaria* is native to the Mediterranean region and 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 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 health benefits 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 effect 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 find out the most suitable and economical dose of chemical fertilizers in combination with bio fertilizers 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, Chhatabara, Institute of Agricultural sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar during 2021-2022. The experiment was conducted to study the effect 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, 150 and 200 kg/ha, (N1, N2, N3 respectively), two levels of phosphorus viz., 50 and 100 kg/ha (P1, P2 respectively) and a common dose of potassium 100 kg/ha (K) along with or without two Bio-Fertilizers, viz., Azotobacter and Phosphate Solubilizing Bacteria (PSB) each at 5 kg/ha (B1, and B0 respectively) were applied 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 three 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 PSB (N2P2KB1 i.e.T8) per hectare recorded significantly taller plants, which was 99.40 cm high during the observation. 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 90.0 cm and 88.86 cm respectively. However, no significant difference in plant height was noticed among T12, T7, T6, T5 treatments. On the other hand plants with lower height was recorded with T1 (N1P1KB0), T3 (N1P2KB0), T4 (N1P2KB1), T9 (N3P1KB0) and T11 (N3P2KB0) for this parameter. 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 biofertilizer. 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 (T8) was regarded as the optimum dose. The possible reason for increase in plant height is that combined application of bio fertilizer along 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) [9].

Plant spread (East-West)

Significant difference in plant spread in E-W direction was noticed after three months of planting during the present investigation. Treatment T10 (N3P1KB1) receiving 200 kg of N, 50 kg of P and 100 kg of K/ha in combination with biofertilizer recorded maximum spread of 58.06 cm. Besides, higher plant spread was also recorded by T6 (58.0 cm) receiving150 kg N+ 50 kg P+ 100 kg K+5 kg each of Azotobacter and PSB/ha(N2P1KB1) and T12(54.93 cm) receiving 200 kg N+100 kg P+100 kg K+5 kg each of Bio-fertlizers were next to T10 without showing significant variation from each other. Similarly, no significant difference was observed in plant spread under T12, T4 (54.4 cm), T8 (54.26 cm) and T2 (53.0 cm) treatments. On the other hand, lowest spread of 48.2 cm was also recorded under T11. 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) [9]. 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) [7]. The result of the present study is in conformity with the findings

of Panchal *et al.*, (2010) [6].

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 9.04 cm during the observation. However, it was at par with T6 (N2P1KB1), T2 (N1P1KB1), T10 (N3P1KB1) and T12 (N3P2KB1) which recorded a basal stem diameter of 8.76cm, 8.72 cm, 8.68 cm, and 8.57 cm respectively after three months of planting. On the other hand T1 comprised of N1P1KB0 recorded the lowest diameter of 7.66 cm. 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 T10 (N3P1KB1) recorded the maximum number of branches (29.0) and was followed by T8 (N2P2KB1) and T6 (N2P1KB1) which recorded 28.53 and 28.26 branches without showing significant variation from each other. On the other hand, T3 (N1P2KB0) recorded the minimum number of branches (24.26) per plant during the observation recorded. It was seen that among T10, T8 and T6 treatments, T8 (receiving 150kg of N, 100 kg of P, 100 of K with 5 kg each of Azotobacter and PSB) which was next to T10 (200 kg N + 50 kg P+100 kg K + 5 kg each of biofertilizers) may be considered as the optimum dose as this treatment was found superior in respect of some of the other growth parameters. The result of the present study is in conformity with Pandey *et al.* (2018b) [8] 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. During the observation T10 (N3P1KB1) recorded maximum number (572.0) which was statistically comparable with T8 (N2P2KB1), T6 (N2P1KB1) and T2 (N1P1KB1) which recorded 561.26, 561.0 and 542.93 leaves respectively. On the other hand T3 (N1P2KB0) recorded the lowest number of leaves (471.86) and was at par with T7 (N2P2KB0) which produced 482.86 leaves. It was observed that combined application of higher doses of N i.e., 150 or 200 kg, 50 to 100 kg of P and100 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) [8] in Chrysanthemum, who observed that significantly higher number of leaves per plant was recorded with application of biofertilizers (*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 biofertilizers applied in different treatment combinations.

Weight of Individual flower

As indicated in Table-2, after three months of planting T6 (N2P1KB1) comprising of 200 kg N+ 50 kg P+ 100 kg K+ Biofertilizer recorded the maximum weight (2.71 g) of flower which was closely followed by T10 (N3P1KB1) and T12 (N3P2KB1) which recorded 2.70 g and 2.52 g respectively. On the other hand, T9 (N3P1KB0), T11 (N3P2KB0) and T7 (N2P2KB0) produced the lower weight of individual flowers which recorded 2.18, 2.26, 2.26 g respectively. It was noticed that higher levels of nitrogen with lower levels of phosphorus i.e., 150 or 200 kg nitrogen with 50 kg phosphorus along with a fixed dose of K exhibited better performance as compared to higher dose of nitrogen i.e., 150 or 200 kg of N with higher dose of P i.e., 100 kg/ha. It was further noticed that combined application of biofertilizer and inorganic fertilizer had better effect as compared to application of respective dose of inorganic fertilizer alone. However, in the present study, combined application of various doses of inorganic fertilizer i.e., N, P and K with or without biofertilizer i.e., Azotobacter and PSB could not influence the weight of flowers significantly. Earlier reports by Pandey *et al.* (2018a) [7] indicated that application of 150:100:100 kg NPK/ha with biofertilizers (*Azospirillum* + PSB) recorded maximum average weight of flowers in Chrysanthemum. Application of biofertilizer with inorganic fertilizer had better effect as compared to application of respective dose of inorganic fertilizer alone. This finding of the present study agrees with the findings of Kumar *et al.* (2009) [4] in Marigold and Kumar *et al.* (2003) [5] in China Aster.

Number of flowers per plant

Data presented in Table-2 revealed that significant difference was observed in number of flowers per plant due to various fertilizer treatments. T8(N2P2KB1) receiving 150 kg N, 100 kg P and 100 kg K along with 5 kg each of Azotobacter and PSB per hectare produced maximum number of flowers (97.0) per plant. However, it was statistically comparable with T12 (N3P2KB1 receiving 200 kg N, 100 kg P and 100 kg K/ha with biofertilizers) and T10 (N3P1KB1 receiving 200 kg N, 50 kg P and 100 kg K with biofertilizer) which recorded 94.93 and 89.4 flowers per plant respectively. Production of more number of primary branches and number of leaves per plant might have resulted in production of more photosynthates which ultimately contributed for production of more flowers per plant. The result obtained in the present study is in agreement with Sowmya and Prasad (2017) who recorded higher number of flowers in China Aster with 75 to 100% of recommended dose of NPK with biofertilizers *Azospirillum* and PSB. Kirar *et al.* (2009) [3] also reported higher number of flowers per plant in China Aster with

application of 75% NPK + Vermicompost + Azotobacter + PSB as compared 100-125% NPK alone. On the other hand, T1 (N1P1KB0) receiving 100 kg of N, 50 kg of P and 100 kg of K with no biofertilizer recorded minimum number of flowers (66.93) per plant. However, it was at par with T9 (N3P1KB0), T3 (N1P2KB0), T2 (N1P1KB1), T4 (N1P2KB1) and T5 (N2P1KB0) which recorded 70.13, 73.53, 74.73, 75.13 and 76.4 flowers per plant respectively. The result indicated that treatment receiving no biofertilizer recorded less number of flowers as compared to the treatments receiving respective doses of chemical fertilizers (N, P, K) with biofertilizer. Further, the treatments receiving low nitrogen even in presence of biofertilizers also had less number of flowers.

Number of flowers per plot

The data in Table-2 indicated that significant difference was observed among various treatments with respect to number of flowers per plot. Treatment T8(N2P2KB1) receiving 150 kg of N, 100 kg of P and 100 kg K/ha along with 5 kg each of Azotobacter and PSB recorded 2910 flowers per plot (8.91 m^2). It was followed by and at par with T12 (N3P2KB1) and T10 (N3P1KB1) which recorded 2848 and 2682 flowers per plot respectively. On the other hand, T1 (N1P1KB0) recorded the lowest number of flowers (2008 NOS). However, it was statistically comparable with T9 (N3P1KB0), T3 (N1P2KB0), T2 (N1P1KB1), T4 (N1P2KB1) and T5 (N2P1KB0) which recorded 2104, 2206, 2242, 2254 and 2292 flowers respectively. In the present investigation, it was observed N at 150 kg or 200 kg along with 100 kg P and100 kg K in combination with biofertilizers exhibited better performance. The beneficial effect of higher doses of nitrogen and phosphorus along with biofertilizer was noticed with respect to production of more number of flowers per plant which might have resulted in production of more number of flowers per plot.

Number of flowers per hectare

As indicated in Table-2 the maximum number of flowers per ha (4041667 NOS) was produced under Treatment T8 (N2P2KB1) receiving 150 kg of N, 100 kg of P, 100kg of K and 5 kg each of Azotobacter and PSB/ha which was followed by and at par with T12 (N3P2KB1) and T10 (N3P1KB1) which produced 3955556 and 3725000 flowers per hectare respectively. On the other hand, minimum number of flowers (2788889 NOS) per hectare was recorded with T1 (N1P1KB0) receiving 100 kg N, 50 kg P and 100kg of K/ha without application of biofertilizer. However, it was statistically comparable with T9 (N3P1KB0), T3 (N1P2KB0), T2 (N1P1KB1), T4 (N1P2KB1) and T5 (N2P1KB0) which produced 2922222, 3063889, 3113889, 3130556 and 3183333 flowers respectively. Production of more number of flowers per plot receiving 150-200 kg N, 100 kg of P and 100 kg of K/ha along with biofertilizer as observed in the present study might have resulted in recording higher yield of flowers per hectare.

Table 1: Effect of N, P and Bio-Fertilizer on various vegetative parameters of annual chrysanthemum after 3 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)	82.53	48.53	7.66	27.53	537.13
T2(N1P1KB1)	84.46	53.00	8.72	27.73	542.93
T3(N1P2KB0)	82.60	51.06	7.98	24.26	471.86
T4(N1P2KB1)	84.80	54.40	8.48	26.93	528.93
T5(N2P1KB0)	87.53	49.93	8.20	27.53	536.93
T6(N2P1KB1)	88.73	58.00	8.76	28.26	551.00
T7(N2P2KB0)	88.86	50.53	8.18	24.80	482.86
T8(N2P2KB1)	99.40	54.26	9.04	28.53	561.26
T9(N3P1KB0)	81.53	50.33	7.70	26.93	529.46
T10(N3P1KB1)	86.33	58.06	8.68	29.00	572.00
T11(N3P2KB0)	84.66	48.20	7.77	26.86	530.93
T12(N3P2KB1)	90.00	54.93	8.57	27.73	535.26
SE(m) ±	1.69	1.12	0.14	0.33	10.58
CD at 5%	4.96	3.30	0.41	0.97	31.05

N1-100 kg/ha, N2-150 kg/ha, N3-200 kg/ha,
P1-50 kg/ha, P2-100 kg/ha, K-100 kg/ha
B0-No bio-fertilizer, B1-Azotobacter +PSB @ 5 kg each/ha

Table 2: Effect of N, P and Bio-Fertilizer on various flowering components and yield of annual chrysanthemum after 3 months of planting

Treatments	Individual flower weight (g)	Number of flowers per plant	Number of flowers per plot	Number of flowers per ha
T1(N1P1KB0)	2.40	66.93	2008	2788889
T2(N1P1KB1)	2.48	74.73	2242	3113889
T3(N1P2KB0)	2.41	73.53	2206	3063889
T4(N1P2KB1)	2.44	75.13	2254	3130556
T5(N2P1KB0)	2.47	76.40	2292	3183333
T6(N2P1KB1)	2.71	81.20	2436	3383333
T7(N2P2KB0)	2.26	85.33	2560	3555556
T8(N2P2KB1)	2.34	97.00	2910	4041667
T9(N3P1KB0)	2.18	70.13	2104	2922222
T10(N3P1KB1)	2.70	89.40	2682	3725000
T11(N3P2KB0)	2.26	82.20	2466	3425000
T12(N3P2KB1)	2.52	94.93	2848	3955556

SE(m) ±	0.11	3.83	114.90	159583.60
CD at 5%	NS	11.23	336.96	468000.70

N1-100 kg/ha, N2-150 kg/ha, N3-200 kg/ha,
P1-50 kg/ha, P2-100 kg/ha, K-100 kg/ha
B0-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 Azotobacter and PSB/ha exhibited better performance with respect to growth and flower production in Annual Chrysanthemum cv. Local. Plants with maximum height (99.40 cm) and basal stem diameter (9.04 cm), were observed under application of 150 kg N+100 kg P+100 kg K +5 kg each of Azotobacter and PSB/ha (T8). Application of 200 kg N+50 kg P +100 kg K + 5 kg each of Azotobacter and PSB/ha(T10) resulted in production of maximum plant spread (58.06 cm) in E-W direction, number of compound leaves (572 nos.) and primary branches (29.0 nos.) per plant. The weight of individual flowers were not significantly influenced by various fertilizer treatments although T6 recorded the maximum weight (2.71 g). Application of 150 kg N +100 kg P +100kg K +5 kg each of Azotobacter and PSB (T8) recorded maximum number (97) of flowers per plant and per plot (2910 nos.), as well as per hectare (4041667 nos.) and T12 (N3P2KB1) was next to this treatment with respect to these parameters. In general, application of a specific dose of N, P and a fixed dose of K along with Bio-Fertilizers exhibited better performance with respect to almost all growth and flowering parameters as compared to application of chemical fertilizers alone without application of Bio -Fertilizers. Application of 150 to 200 kg N along with 50 to 100 kg P and 100 kg of K in combination with Bio-Fertilizers favourably influenced most of the growth and flowering characters and application of 150 kg N+100 kg P +100kg K+ 5 kg each of Azotobacter and PSB was the most suitable dose in this respect. Hence, 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 was the most suitable dose for maximizing growth and flower yield 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. Kumar P, Raghava SPS, Mishra RL. Effect of biofertilizers on growth and yield of China aster. Journal of. Ornamental Horticulture. 2003;6:85-88.
6. Panchal RV, Parekh NS, Parmar AB, Patel HC. Effect of biofertilizers and nitrogenous fertilizer on growth, flowering and yield of annual white chrysanthemum (*Chrysanthemum coronarium* L.) under middle Gujarat agro climatic conditions. The Asian Journal of Horticulture. 2010;5(1):22-25.
7. 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.
8. 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; c2018b. p. 637-642.
9. Slathia Divya, Khan FU, Masoodi NH, Khan FA, Wani JA, Iqbal Umar, *et al*. Effect of Different Combinations of NPK and Biofertilizers on Zinnia (*Zinnia elegans* J.). Current Journal of Applied Science and Technology. 2019;34(6):1-7.
10. Sowmya KA, Prasad VM. Effect of NPK and Bio-Fertilizers on Growth, Yield, 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.