EFFECT OF BIO-FERTILIZERS ON GROWTH, FLOWERING, QUALITY AND YIELD OF CHRYSANTHEMUM (*DENDRANTHEMA GRANDIFLORA* T.) CV. SNOWBALL UNDER OPEN FIELDCONDITIONSOF PRAYAGRAJ

ABSTRACT

The present experiment was carried out during September, 2022 to January, 2023 inResearchField,DepartmentofHorticulture,SHUATS,Prayagraj.Theresearchwasconductedwithanaimtoidentifythemostsuitablebio-fertilizer treatmentundertheagroclimaticconditionsofPrayagrajwas carried out in Randomized Block Design (RBD), with ten treatments, replicated thrice.From the present experimental findings, it was observed that treatment T_7 (60 % NP + 100 % K + Azotobacter 0.3g/plant + PSB 0.5g/plant) found best in all the parameters like plant height (42.3cm), plant spread (22.8 cm), number of primary branches (6.7), days taken to first bud initiation (60.5), days taken to 50% flowering (97 days), bud length (0.72), bud diameter (1.22 cm), flower diameter (16.4 cm), stalk length (32.5 cm), vase life (6.1), number of cut flowers stalks per plant (4.6), number of cut flowers stalks per plot (41.5), number of cut flower stalks per hectare (511111). In terms of maximum gross returns (Rs. 2,044,444 per ha), net returns (Rs. 1,412,733 per ha) and benefit-cost ratio (3.23) is found in treatment T_7 followed by T_4 (80 % NP + 100 % K + Azotobacter 0.3g/plant + PSB 0.5g/plant), whereas minimum is recorded in treatment T_1-Control.

Keywords:*Chrysanthemum, NPK, Azotobacter, Phosphorus solubilizing bacteria,openfield*

1. INTRODUCTION

Chrysanthemum(*Dendranthemagrandiflora*T.)belongstotheAsteraceaefamily.Itis believed to be native to the northern hemisphere chiefly Europe and Asia and was believed tohave been originated in China (Carter 1990). The basic chromosome number of chrysanthemum is 9, while2nrangesfrom36to75,thoughmostofthemarehexaploidy. The wordchrysanthemum is derived from the Greek word "chryos" means gold and "anthemon" or"anthos"meansflower.

In the trade of global flower market, chrysanthemum is the second largest cut flowerafter rose (Bhattacharjee and De, 2003) and holds fifth rank as pot plant. The species is also suitable as cut flowers due to the most important characteristics ofits attractive color, long vase life, tough flowers, uniform opening, long erect stem, longinternodesand normalspraywithhighcentralbloomandeasytoopenflowerbudsatthe destination.

In the current scenario, lower productivity and inferior flower quality of chrysanthemum is due to use of chemical fertilizers, especially the quick-release nitrogenous fertilizers. In order to minimize these ill effects, biofertilizers practices involving azotobacter, phosphate solubilizing microorganisms, etc. must be adopted for sustainable production.

Bio-fertilizers or more appropriately called microbial inoculants are the preparations containing live or latent cells of efficient strains of microorganisms. These bio-fertlizers are ~~a~~ cost effective, eco-friendly, renewable energy source and plays a crucial role in reducing the inorganic fertilizer application and at the same time increasing the quality of crop products and safeguarding the soil health (Choudhary and Trivedi, 2008). Common bio-fertilizers used in horticulture crops are Azotobacter, Azospirillum, Bacillus, Phosphorous solubilizing bacteria (PSB) and Vesicular arbuscularmycorrhizal (VAM) fungi. From these common bio-fertilizers Azotobacter is an important nitrogen fixer inoculants. These bacteria utilize atmospheric nitrogen gas for their cell protein synthesis.

Comment [m1]: Now name changed to AMF not VAM

Next to nitrogen, phosphorous is also one of the master key elements for plant merely 15 to 20 per cent of applied phosphorus is recovered by the crop plants and remaining gets fixed in the soil. The fixed form does not contribute to the available phosphorous content in the soil. It has been established that there are specific groups of soil microorganisms known as "phosphobacteria" which increase the availability of phosphate (Singh *et al.*, 2014) to plants not only by mineralizing organic phosphorus compounds but also by rendering phosphorus compounds more available to them e.g., PSB, Mycorrhiza. So keeping in view of the above facts, this experiment was planned tostudy the effect of bio-fertilizers on growth,

flowering & yield of chrysanthemum and towork out the economics of different treatments.

2. MATERIALS ANDMETHODS

2.1 Geographicallocation oftheexperimentalsite

The experimental site is located at a latitude of 25.41º North and longitude of 81.84 ºEast,with an altitudeof98meters abovethemean sealevel(MSL).

2.2 Climaticconditionsoftheexperimentalarea

The area of Prayagraj comes under humid sub-tropical climate, which experienceswarm humid monsoon, hot dry summer and cold dry winter. The annual mean temperature is26.1ºCwhilemonthlymeantemperaturesare18-29ºC.Thedailyaveragemaximumtemperature is about 22ºC and the minimum temperature is 9ºC. The average annual rainfallreceived is 1042.2 mm. At this location, the temperature reaches upto 46ºC-48ºC and theminimum temperature recorded is 4ºC-5ºC. The relative humidity ranges in this locationranges between 20-94%. The meteorological data (September, 2022-January, 2023) withrespecttomaximumandminimumtemperatures,totalrainfallandrelativehumidity.

Comment [m2]: Not included with this manuscript

2.3 Experimental details

The experiment was conducted in Randomized Block Design (RBD) with 10 treatments of Bio-fertilizers with three replications in the Departmental Research Field of Department of Horticulture, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj during September, 2022 to January, 2023. Total number of treatments were ten *viz*. T_1 (Control), T_2 (80 % N + 100 % PK + Azotobacter 0.3g/plant), T_3 (80 % P + 100 % NK + PSB 0.5g/plant), T_4 (80 % NP + 100 % K + Azotobacter 0.3g/plant + PSB 0.5g/plant), T_5 (60 % N + 100 % PK + Azotobacter 0.3g/plant), T_6 (60 % P + 100 % NK + PSB 0.5g/plant), T_7 (60 % NP + 100 % K + Azotobacter 0.3g/plant + PSB 0.5g/plant), T_8 (40 % N + 100 % PK + Azotobacter 0.3g/plant), T_9 (40 % P + 100 % NK + PSB 0.5g/plant), T_{10} (40 % NP + 100 % K + Azotobacter 0.3g/plant + PSB 0.5g/plant).The treatments were supplemented with recommended dose of 25 t/ha FYM. Chrysanthemum cultivar Snowball was planted on 28th September, 2022 at a spacing of 30 cm x 30 cm.

3. RESULTSANDDISCUSSIONS

Plant height (cm) and Plant spread (cm)

Maximum plant height (42.3cm)and plant spread (22.8cm) was observed from the plants grown intreatment T_7 containing 60% NP + 100% K + Azotobacter 0.3g/plant + PSB 0.5g/plant significantly superior to rest of the treatments. The enhanced plant height may be due to the presence of more readily available form of nitrogen due to the use of Azotobacter, which might have triggered the vegetative growth of plant (Kumar *et al*., 2013). This increase in the plant spread might be due to the use of combination of RDN with Azotobactor which gave an additive effect and due to secretion of certain growth promoting substances like auxin, gibberellins, vitamins, and organic acids in soil. Asokan*et al.*(2000) also reported that phosphate solubilizing bacteria secretes some organic acids such as lactic, glycolic, fumaric& succinic acids which convert insoluble phosphates into soluble forms.

Days taken for first flower bud initiation

In terms of days to first bud initiation treatment T_7 containing 60 % NP + 100 % K + Azotobacter 0.3g/plant + PSB 0.5g/plant recorded minimum days taken to first bud initiation (60.5)whereas the maximum days were recorded in the treatment T_1-Control (74.4). The earlinessmight be due to the effect of biofertilizers*viz*., Azotobacter& PSB, creating a conducive source sink relationship and ultimately causing an increase in the synthesis of cytokinin in the root tissue and its simultaneous transport to auxillary buds would have resulted in better sink for mobilization of photo assimilates at a rapid rate and have helped in the early transformation from vegetative to reproductive phase. Similar results were observed by (Naik and Dalawai, 2004) in Carnation and (Pooja*et al*., 2012) in China aster cv. 'kamini'.

Flower diameter (cm)

Data revealed that higher flower diameter was recorded in treatment T_7 containing 60 % NP + 100 % K + Azotobacter 0.3g/plant + PSB 0.5g/plant (16.4 cm)whereas the minimum flower diameter was recorded in the treatment T_1-Control (9.9 cm). This increase in flower diameter might be due to better nutrient uptake, higher photosynthesis and excellent physiological, biological activities due to presence of Azotobacter and PSB which have resulted in rapid synthesis and translocation of photosynthates from the source to developing flower bud and finally increase in flower diameter (Kumawat*et al*., 2017).

Stalk length (cm)

Maximum flower stalk length was recorded in treatment T_7 containing 60 % NP + 100 % K + Azotobacter 0.3g/plant + PSB 0.5g/plant (32.5 cm)significantly superior to rest of the treatments.All the treatments involving in combination with various levels of phosphorus were effective considerably as compared to control due to enhanced absorption in biofertilizers inoculated plants,leading to increased availability of assimilates that needed for the improvement in flower stalk length. Laishram*et al*., (2013) reported similar results in chrysanthemum.

Vase Life (Number of days)

In terms of vase life treatment T_7 containing 60 % NP + 100 % K + Azotobacter 0.3g/plant + PSB 0.5g/plant recorded maximum vase life (6.1)whereas the minimum vase life was recorded in the treatment T_1-Control (3.5).Biofertilizers increased vase life of Chrysanthemum. The Increased vase life might be due to by triggering of such metabolic activity and Narrowing of the C:N ratio by the significant Accumulation of carbohydrates. Furthermore, ~~These~~these findings are well supported by Meshram*et al*., (2008), Palagani*et al*., (2013) and Pandey *et al*., (2018) in chrysanthemum.

Number of flower stalks per plant/hectare

Yield is an important parameter to decide the efficacy of a treatment. Data recorded on maximum number of flower stalks per plant (4.6)and maximum number of flower stalks per hectare (511111) in treatment T_7 containing 60 % NP + 100 % K + Azotobacter 0.3g/plant + PSB 0.5g/plant. This increase in number of flowers might be due to the effect of bio-fertilizers along with the recommended dose of chemical fertilizers. Azotobacter, which makes the unavailable nitrogen to available form to plants also enhances the uptake of Fe, Zn, Cu and Mo and helps in production of more number of flowers, whereas, Phosphate-Solubilizing Bacteria (PSB) species are also reported to beneficial in increasing the phosphorus availability in soil and thereby increasing yield (Shashidhara and Gopinath, 2005)

Table 1: Effects of bio-fertilizers on Plant height (cm), Plant Spread (cm), Days taken for first flower bud initiation and Flower diameter of Chrysanthemum (*Dendranthemagrandiflora*T.)

Treatment Symbols	Treatment Combinations	Plant Height (cm)	Plant Spread (cm)	Days taken for first flower bud initiation	Flower Diameter (cm)
		60 DAP	**60 DAP**		
T_1	RDN (125:100:25 kg/ha) NPK	27.3	14.6	74.4	9.9
T_2	80% N + 100% PK + Azotobacter 0.3g/plant	31.6	18.1	66.2	13.4
T_3	80% P + 100% NK + PSB 0.5g/plant	30.3	19.1	67.5	10.9
T_4	80% NP + 100% K + Azotobacter 0.3g/plant + PSB 0.5g/plant	35.2	20.2	65.4	13.8
T_5	60% N + 100% PK + Azotobacter 0.3g/plant	34.6	18.2	68.8	11.7
T_6	60% P + 100% NK + PSB 0.5g/plant	32.9	17.1	69.3	12.8
T_7	60% NP + 100% K + Azotobacter 0.3g/plant + PSB 0.5g/plant	42.3	22.8	60.5	16.4
T_8	40% N + 100% PK + Azotobacter 0.3g/plant	29.6	16.3	68.4	13.4
T_9	40% P + 100% NK + PSB 0.5g/plant	31.3	17.3	66.6	12.1
T_{10}	40% NP + 100% K + Azotobacter 0.3g/plant + PSB 0.5g/plant	30.2	16.8	71.5	12.5
F-Test		S	S	S	S
SE(d)		3.07	1.12	1.12	1.12
C.V.		11.55	7.60	7.60	10.85
C. $D_{0.05}$		6.45	2.35	2.35	2.36

Table 2: Effects of biofertilizers on Stalk Length (cm), Vase Life of flowers (no. of days), Number of flower stalks per plant and Number of flower stalks per hectare ofChrysanthemum (*Dendranthemagrandiflora*T.)

Treatment Symbols	Treatment Combinations	Stalk Length (cm)	Vase Life	Number of stalks per plant	Number of stalks per hectare
T_1	RDN (125:100:25 kg/ha) NPK	19.5	3.5	2.8	322221
T_2	80% N + 100% PK + Azotobacter 0.3g/plant	25.9	4.8	3.4	385185
T_3	80% P + 100% NK + PSB 0.5g/plant	22.5	4.5	3.2	377777
T_4	80% NP + 100% K + Azotobacter 0.3g/plant + PSB 0.5g/plant	26.7	5	3.8	422222
T_5	60% N + 100% PK + Azotobacter 0.3g/plant	21.8	4.6	3.3	370370
T_6	60% P + 100% NK + PSB 0.5g/plant	24.1	3.8	3.4	355555
T_7	60% NP + 100% K + Azotobacter 0.3g/plant + PSB 0.5g/plant	32.5	6.1	4.6	511111
T_8	40% N + 100% PK + Azotobacter 0.3g/plant	26.1	3.6	3.1	348148
T_9	40% P + 100% NK + PSB 0.5g/plant	20.9	4	2.9	325926
T_{10}	40% NP + 100% K + Azotobacter 0.3g/plant + PSB 0.5g/plant	25.3	4	3.2	355555
F-Test		S	S	S	S
SE(d)		2.80	0.48	0.33	37270.8
C.V.		13.98	13.54	12.27	12.095
C. $D_{0.05}$		5.89	1.02	0.71	78306

4. CONCLUSION

Based on the present investigation it is concluded that treatment T_7 (60 % NP + 100 % K + Azotobacter 0.3g/plant + PSB 0.5g/plant) performed better in all the parameters like plant height, plant spread, days taken to first bud initiation, flower diameter, stalk length, vase life, number of cut flowers stalks per plant, number of cut flower stalks per hectare followed by T_4 (80 % NP + 100 % K + Azotobacter 0.3g/plant + PSB 0.5g/plant), whereas minimum is recorded in treatment T_1-Control.

REFERENCE

Asokan, R., Mohandas, S. and Anand L. (2000) *Indian Horticulture*, 45, 1, 44-47.

Bhattacharjee, S.K. and De, L.C. (2003) Floriculture industry in India. *Advanced commercial floriculture Chrysanthemum*. Volume.**1** pp 240-242.

Carter, G. D. (1990) In: Introduction to Floriculture (ed. R.A. Larson), *Academic Press Inc.*

Choudhary, S. and Trivedi, P.C. (2008) Biofertilizers: Boon for Agriculture In:Biofertilizers. *Pointer Publishers*, Jaipur, pp.1-38.

Kumawat, M., Khandelwal, S.K., Choudhary, M.R., Kumawat, P.K, Sharma, G. and Panwar, P. (2017)*International Journal of Current Microbiology and Applied Sciences*, **6**(8), 60-65

Kumar, S., Singh, J.P., Mohan, B., Nathiram and Rajbeer (2013)*Theasian Journal of Horticulture***8**(1), 118-121.

Laishram, N., Dhiman, S.R., Gupta, Y.C., Bhardwaj, S.K. and Singh, A. (2013)Microbial dynamics and physico-chemical Properties of soil in the rhizosphere of chrysanthemum (*Dendranthemagrandiflora*) as influenced by integrated Nutrient management. *Indian Journal of Agricultural Sciences* **83**(4): 447-455.

Meshram, N., Badge, S.,Bhongale, S. A. and Khiratkar, S. D. (2008) Effect of Bioinoculants with graded doses of NPK On flowering, yield attributes and Economics of annual chrysanthemum. *J. Soils and Crops*, **18** (1): 147-150.

Naik, B.H. and Dalawai, B. (2014)*International Journal of Agricultural Sciences and Veterinary Medicine*,**2**(3), 18-24.

Palagani, N.,Barad, A. V.,Bhosale, N. and *Thumar, B. V. (2013)* Influence of Integrated plant nutrition on growth and Flower yield of chrysanthemum(*Chrysanthemum morifolium*Ramat.) cv. IIHR-6 under Saurashtra condition.*Asian J. Hort.*, **8** (2): 502-506.

Comment [m3]: Title of the article not mentioned

Comment [m4]: Title not mentioned

Comment [m5]: title

Pandey, S. K., Prasad, V. M., Singh, V. K., Kumar, M. and Saravanan, S. (2018) Effect of bio-fertilizers and inorganic Manures on plant growth and flowering Of chrysanthemum (*Chrysanthemum Grandiflora*) cv. Haldighati. *J. Pharmacogn. Phytochem*., SP1: 637-642.

Pooja, G., Kumari, S., Dikshit, S.N. (2012) *Annals of Biology***28**(1):66-67.

Shashidhara, G.R. and Gopinath, G. (2005)*Journal of Ornamental Horticulture*, **8**(4), 249-253

Singh, R., Kumar, M., Raj, S. and Kumar, S. (2014) Effect of integrated nutrient management (INM) on growth and flowering in gladiolus (*Gladiolus grandiflorus* L.) cv. White prosperity.*Annals of Horticulture*, **6**(2): 251-258.