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Enhanced Flower Yield and Reduction in Fertilizer Application in Chrysanthemum (*Chrysanthemum morifolium* Ramat.) through Inoculation of Biofertilizers under Field Condition

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A B S T R A C T

There is a need to reduce the use of chemical fertilizers for sustaining soil health and to reduce the cost of cultivation and that without compromising the yield of crop. The present study deals with the effect of different biofertilizers along with reduced levels of recommended dose of NPK fertilizers on flower yield and economics of chrysanthemum (*Chrysanthemum morifolium* Ramat. Syn. *Dendranthema grandiflora*) variety 'White Star'. This experiment was carried out during 2019-2020 and was laid out in Randomized Block Design (RBD) under field condition with three replications, using eleven treatments comprising of combinations of three levels of recommended dose of NPK (100% RDF, 80% RDF and 60% RDF) and four biofertilizers (*Azotobacter*, PSB, KMB and NPK consortia). The results revealed that among various treatments, maximum number of flowers per plant (10.40), number of flowers per plot (82.92) and number of flowers per hectare (11.51 lakh) were recorded in treatment 80% RDF + NPK consortia which was higher compared to the treatment with recommended dose of chemical fertilizers. Maximum gross income (Rs.17, 27,499), net income (Rs.12, 58,491) and benefit cost ratio (2.68) was obtained in the same treatment.

Introduction

Chrysanthemum is one of the most important commercial flowers grown mainly for loose and cut flower production, which are used in floral arrangements, making garlands, veni and bouquet. In many countries it is next only to rose in value of crop produced. Sustainable flower production requires optimal fertilizer management to attain a high ornamental value of plant and to reduce production cost (Zhang *et al.*, 2012). Nitrogen, phosphorus and potassium play a vital role in the production of good quality flowers. Nitrogen is considered to be the most crucial because it is a

constituent of protein and nucleic acid which is helpful in plant growth (Haque, 2001). To fulfill the increasing demand of these flowers, farmers use high quantities of chemical fertilizers. Optimal availability of nutrients assumes immense importance for flower production. But due to rising cost, indiscriminate and continuous use of chemical fertilizers in intensive cropping system, there is imbalance of nutrients in soil which has an adverse effect on soil health, yield and quality of crop (Sunitha and Hunje, 2010). In contrast, biofertilizers are prepared by the combination of microbial inoculants, which stimulates the plant growth and soil fertility. The use of biofertilizers not only helps in the balancing nutrients supply but also reduces the cost of cultivation, which is supported by several reports on integrated use of biofertilizers and chemical fertilizers on horticultural crops. Since, limited information is available on the use of biofertilizers in chrysanthemum and this crop is being cultivated by farmers in Gujarat therefore the present investigation was undertaken to reduce chemical fertilizer doses with the use of biofertilizers and to find out the optimum and economic dose of NPK along with bioferltilizers for maximizing yield of chrysanthemum.

Materials and Methods

The present investigation was conducted during 2019-20 at College Farm, College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, Mehsana, Gujarat. One month old rooted cuttings of chrysanthemum cv. "White Star" having uniform size and vigour were used for the experiment. *Azotobacter* and PSB were procured from Navsari Agricultural University (NAU) and KMB and NPK consortia were procured from Anand Agricultural University, Anand (AAU). For inoculating *Azotobacter*, PSB, KMB and NPK consortia, solutions were prepared by dissolving 10 ml of each in 2 litres of water separately. Rooted cuttings were dipped in the solution for 30 minutes and transplanted in the field immediately at a spacing of 30 cm x 30 cm on raised beds of 1.2 m x 1.8 m size. Nitrogen was applied in five equal split doses at thirty days interval and full doses of phosphorus and potassium (as per treatments) were incorporated in soil as basal dose. There were total eleven treatments *viz.*; T_1:100% RDF (NPK @ 250:50:50 kg/ha); T_2:80% RDF (NPK @ 200:40:40 kg/ha); T_3: 80% RDF + *Azotobacter*; T_4:80% RDF + PSB; T_5:80% RDF + KMB; T_6:80% RDF + NPK consortia; T_7:60% RDF (NPK @ 150:30:30 kg/ha); T_8: 60% RDF + *Azotobacter*; T_9: 60% RDF + PSB; T_{10}: 60% RDF + KMB and T_{11}: 60% RDF + NPK consortia. The experiment was laid out in Randomized Block Design (RBD) with three replications. Observations on different yield parameters were recorded and analyzed statistically. Net return and benefit: cost ratio was calculated by using the formulas given below (Reddy and Ram, 1996).

Net returns (₹/ha) = Gross returns (₹/ha) − Total cost of cultivation (₹/ha)

$$\text{Benefit Cost ratio} = \frac{\text{Net returns (₹/ha)}}{\text{Total cost of cultivation (₹/ha)}}$$

Results and Discussion

Yield Characters

Significant influence of different treatment combinations of reduced doses of inorganic fertilizers along with biofertilizers was recorded on various yield characters *viz.*, number of flowers per plant, number of flowers per plot and number of flowers per hectare. It is evident from the data (Table 1) that treatment T_6 (80% RDF + NPK consortia) resulted in maximum number of flowers per plant (10.40), number of flowers per plot (82.92) and number of flowers per hectare (11.51 lakh) followed by T_3 (80% RDF + *Azotobacter*).

Table.1 Effect of NPK levels and biofertilizers on yield characters of chrysanthemum

Treatments		Number of flowers per plant	Number of flowers per plot	Number of flowers per hectare (Lakh)
T_1	100% RDF	8.17	65.06	9.03
T_2	80% RDF	8.00	62.22	8.64
T_3	80% RDF +*Azotobacter*	9.53	75.05	10.42
T_4	80% RDF + PSB	9.20	72.44	10.06
T_5	80% RDF + KMB	8.37	67.88	9.42
T_6	80% RDF + NPK consortia	10.40	82.92	11.51
T_7	60% RDF	6.94	54.55	7.57
T_8	60% RDF + *Azotobacter*	8.04	64.21	8.91
T_9	60% RDF + PSB	7.97	62.46	8.67
T_{10}	60% RDF + KMB	7.67	60.17	8.35
T_{11}	60% RDF + NPK consortia	8.32	66.54	9.24
	S.Em. ±	0.29	1.97	0.27
	C.D. at 5%	0.84	5.80	0.81

Table.2 Effect of NPK levels and biofertilizers on economics of chrysanthemum

Treatments	Yield (flower/ha)	Gross return (₹/ha)	Total cost of cultivation (₹/ha)	Net returns (₹/ha)	Benefit Cost Ratio
T_1	9,03,611	13,55,417	4,69,615	8,85,802	1.89
T_2	8,64,167	12,96,251	4,68,208	8,28,043	1.77
T_3	10,42,361	15,63,542	4,68,448	10,95,094	2.34
T_4	10,06,111	15,09,167	4,68,408	10,40,759	2.22
T_5	9,42,777	14,14,165	4,68,448	9,45,717	2.02
T_6	11,51,666	17,27,499	4,69,008	12,58,491	2.68
T_7	7,57,638	11,36,457	4,66,799	6,69,658	1.43
T_8	8,91,806	13,37,709	4,67,039	8,70,670	1.86
T_9	8,67,500	13,01,250	4,66,999	8,34,251	1.79
T_{10}	8,35,694	12,53,541	4,67,039	7,86,502	1.68
T_{11}	9,24,167	13,86,251	4,67,599	9,18,652	1.96

The increase in number of flowers might be due to the proper nitrogen, phosphorus and potassium assimilation from 80% RDF in association with more nitrogen fixing and phosphorus solubilizing proficiency and secretion of hormones by the NPK consortia. The possible role of *Azotobacter, Azospirillum and Bacillus* spp. in atmospheric nitrogen fixation, increased availability of phosphorus and its greater uptake and better root proliferation. More photosynthesis enhanced food accumulation which might have resulted in vigourous plant growth and subsequently higher flower yield. These results also corroborate the findings of Verma *et al.,* (2011) in perennial chrysanthemum and Meshram *et al.,* (2008) and Panchal *et al.,* (2010) in annual chrysanthemum.

Economics

The economic feasibility of each treatment regarding the gross income, total cost of cultivation, net income and benefit cost ratio have been worked out.

On perusal of the data presented in the (Table 2), it was found that maximum gross income (₹17,27,499), net income (₹12,58,491) and benefit cost ratio (2.68) was obtained in T_6 (80% RDF + NPK consortia).

This might be due to the reason that inoculation of NPK consortia along with 80% recommended dose of fertilizers helped in achieving significantly higher flower yield per hectare as well as reduced the cost of production compared to RDF.

Thus, reducing 20% of recommended dose of fertilizers by integration with biofertilizers is advantageous. Similar findings on economic aspects have also been reported by Airadevi (2014) in annual chrysanthemum and Kumar *et al.*, (2009) in marigold.

The present study revealed the efficiency of application of 80% RDF (chemical fertilizers) with NPK consortia for better yield and reduction in cost of production than 100% RDF.

There is possibility of reducing the dose of chemical fertilizers with the combined use of chemical fertilizers and biofertilizers.

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