Original Research Article

Profitability of Annual Chrysanthemum (*Chrysanthemum coronium* L.) flower production as influenced by application of mycorrhiza and Vermicompost.

ABSTRACT

To check the effect of mycorrhiza on growth and flowering of chrysanthemum, an open field experiment was conducted the effect of vermicompost and mycorrhizal treatments on profitability of *Chrysanthemum coronarium* L. Treatments comprises of 04 mycorrhiza treatments (No application, *Glomus mosseae*, *Acaulospora laevis*, *Gigaspora margarita*) and 04 vermicompost doses (0 g/ m^2, 500 g/ m^2, 750 g/ m^2, 1 kg/ m^2). The experiment was laid out in factorial randomized block design with three replications. Chrysanthemum plants showed improved growth and flowering with the application of vermicompost and mycorrhiza. In the present investigations, economic analysis of different treatments reveals that application of treatment M_3V_2 (*Gigaspora margarita* + Vermicompost @ 750 g/m^2) resulted in highest benefit cost ratio (5.83) closely followed by benefit cost ratio of the treatments; M_2 V_2 (*Acaulospora laevis* + Vermicompost @ 750 g/m^2) and M_1 V_2 (*Glomus mosseae* + Vermicompost @ 750 g/m^2).

Key words: Chrysanthemum, Profitability, mycorrhiza, vermicompost, gross income, B:C ratio

1. Introduction

Annual Chrysanthemum (*Chrysanthemum coronarium* L.) belongs to the family Asteraceae. It is one of the most widely cultivated garden flowers. The flower comes in yellow and white colour and is highly suitable for garland making, pot culture and bedding purposes. The production constraints in annual chrysanthemum cultivation are poor soil fertility, traditional system of crop management etc. The quality of flowers is greatly influenced by the quantity of nutrients and source of nutrients.

Current development in sustainability involves a rational exploitation of soil microbial activities and the use of less expensive source of plant nutrients which may be made available to the plants by microbiologically mediated process. Arbuscular mycorrhizal fungi have been found to increase plant growth, increase chlorophyll content, phosphorus content, increase resistance to cultural and environmental stresses.

Addition of organic amendments to soil has been reported to enhance plant biomass, mycorrhizal infectivity and proliferation of AM fungal hypahe in soil. Decomposition of many organic materials by earthworms to vermicompost has been known as a cheaper and environment friendly process. It is a rich source of different essential nutrients which improve overall soil condition and promote yield and growth of plant. Vermicompost contain different types of soil beneficial microbes that can improve plant growth through release of vitamins and hormones.

The uses of chemical fertilizers cause environmental hazards (Akhzaria *et al*. 2018), whereas use of soil microbes and organic medium such as manure and compost has been suggested as a useful method of fertilization and possess a great great potential in sustainable agriculture systems (Kumar *et al.* 2012; Pezeshkpour *et al.* 2014; Bhattacharjee *et al.* 2015, Naeeni Foroozan Nikkah 2017). Vermicompost when added to soil loosens the soil and improves the physical and biological properties of the soil including structure of the soil, aeration and water-holding capacity of the soil (Jain *et al*, 2012; Dhayal and Aravindkshan 2018). Organic manures and biofertilizers improve plant growth, overcome rivalry between vegetative and reproductive stage and increasing the yield potential (Xie and Wu, 2017).

Keeping in view the importance of the crop, the present investigation was carried out with the view to increase the profitability of annual chrysanthemum flower production by application of different mycorrhizal strains and vermicompost.

2. Material and Methods

The investigation was carried out in 2019 at the Experimental Farm, Division of Vegetable Science & Floriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Main Campus, Chatha, Jammu (J&K).

List 1 : **Experimental treatments and notations**

Experimental treatments and notations					
Factor A (Mycorrhiza treatments)			**Factor B (Vermicompost Doses)**		
1.	No application	(M_0)	1.	0 g/ m^2	(V_0)
2.	*Glomus mosseae*	(M_1)	2.	500 g/ m^2	(V_1)
3.	*Acaulospora laevis*	(M_2)	3.	750 g/ m^2	(V_2)
4.	*Gigaspora margarita*	(M_3)	4.	1 kg/ m^2	(V_3)

The experimental field was prepared to a fine tilth and beds of the required dimension were made according to the lay out plan. Healthy seedlings were transplanted on 25/10/2019 in the experimental plots at a spacing of 30 cm x 30 cm thereby accommodating 20 seedlings per bed size of 1.5 m × 1.2 m. At the time of planting, vermicompost at different doses were incorporated into the beds according to the treatment requirements. Vesicular arbuscular mycorrhiza (*Glomus mosseae*, *Acaulospora laevis* and *Gigaspora margarita*) were applied @ 2 g/plant and were incorporated in the planting pits at the time of planting. All other intercultural operations were carried out Irrigations were given as and when required during the crop growth. No disease incidence was recorded during the experiment. In each treatment, five plants were randomly selected and tagged for recording data on flowering parameters. The chlorophyll content of leaf was recorded by using SPAD - 502 chlorophyll meter and expressed in percentage. The partitioning coefficient of root and shoot was measured at peak flowering stage. It was calculated by using the formula

The data relating to each parameter were statistically analyzed by applying the technique of analysis of variance using Factorial Randomized Block Design (Gomez and Gomez 1985). The level of significance for f-test and t-test were kept at 5% (P=0.05).

3. Results and Discussion

Results indicated that irrespective of the mycorrhizal species used, inoculated plants produced highest vegetative and floral parameters of commercial importance than non-inoculated plants.

3.1 Flowering and yield parameters

Maximum number of flowers per plant (103.58), maximum flower diameter (7.30 cm) and maximum flower duration (49.33 days) was recorded with the application of *Glomus mosseae*. Maximum flower weight (7.84 g), flower yield per plant (767.69 g) and highest shelf life (7.75 days) was recorded with the application of *Gigaspora margarita*. However, the effect of mycorrhiza on days to 50% flowering was found to be non-significant. Asrar and Elhindi (2011) also reported that under well-watered conditions, mycorrhizal fungi significantly increased flower diameter and flower weight of marigold plants compared to non-mycorrhiza plants.

The promotion of flowering by mycorrhizal inoculation might be the result of improved plant nutrient concentrations like potassium and a possible hormonal effect by fungal colonization (Perner *et al*. 2007 and Meir *et al*. 2010). Mycorrhizal root systems influence the source to sink balance by utilizing recent photosynthate supplied by photosynthesis in leaves and a considerable proportion of the assimilated carbon (Douds *et al*. 2000, Smith and Read 2008). The enhanced flowering of plants associated with *G. mosseae* may be the consequence of higher carbohydrate production, especially at the beginning of flower production, and/or more efficient carbohydrate use of these plants during the reproductive phase. This confirms the earlier findings of Dufault *et al.* (1990) that mycorrhizal inoculation in gerbera improves the phosphorus and potassium uptake which results in improved flower quality.

The enhancement of flowering in plants inoculated with *G. mosseae was* independent of foliar nutrient concentration (Garmendia and Mangas 2012) similar theory was also explained by Aboul Nasr (1996) in flower production of *Tagetes* and *Zinnia* after their inoculation with *Gigaspora etunicatum.*

Salehi *et al.* (2015) and Shamshiri *et al.* (2012) reported that mycorrhizal symbiosis causes flowering acceleration in cumin and kinnow due to better plant nourishment and uptake of less mobile nutruients viz-a-viz augmenting water uptake (Ortas *et el.* 2001).

Naeni *et al*. (2017) reported highest number of capitule with the conjoint application of 75% vermicompost and *Glomus mosseae* in milk thistle (*Silybum morianum*). Garmendia and Mangas (2012) reported relatively higher flower production of rose plants with the inoculation of *Glomus mosseae* than non-mycorrhizal control. They also found that plants associated with *Glomus mosseae* inoculums exhibited early flowering and increased number of cut flowers of rose. Long *et al.* (2010) also reported increased flower number per plant with application of *Glomus mosseae* in zinnia.

Among the vermicompost doses, earliest 50% flowering (148.83 days) was recorded with the application of vermicompost @ 1kg/m^2. Maximum number of flowers per plant (102.88), flower weight (7.78 g), flower diameter (7.4 cm), flowering duration (51.92 days), flower yield per plant (799.90 g) and maximum shelf life (7.89 days) was recorded with the treatment of vermicompost @1kg/m^2.

The earliness of flowering might also be attributed to the supply of macro and micro nutrients, enzymes and growth hormones by vermicompost. These results are in line with the findings of Gayathri *et al.* (2004) in limonium. Advanced flowering due to VAM have also been reported by Gaur *et al.* (2000) in *Petunia hybrida*, *Callistephus chinensis* and *Impatiens balsamina.*

Further, vermicompost continues to decompose after application resulting in an increase in temperature in rhizosphere, which is responsible for acceleration of bloom date. Vermicompost also contains humic acid which is known to increase nutrient accumulation in conditions of limited nutrient availability and when additional nutrients were supplied (David *et al.* 1994).

More photosynthesis enhanced food accumulation which might have resulted in better plant growth and subsequently higher number of flowers per plant and hence more flower yield. Vermicompost, being the source of macro and micro nutrients like; Fe and Zn, enzymes, growth hormones and beneficial microflora might have played a secondary role in increasing the flower yield.

The higher flower yield due to application of vermicompost has also been reported in marigold (Mashaldi 2000) and golden rod (Kusuma 2001). Patil *et al.* (2004) confirmed that using organic, inorganic and *in situ* vermiculture in *Jasminum sambac* increased the number of flowers per plant by increasing the leaf area and chlorophyll content.

Interaction effect revealed least number of days for 50% flowering (146.67 days) with the application of M_0V_3 (no Mycorrhiza + vermicompost @ 1kg/m^2 days). Maximum number of flowers per plant (107.88), flower diameter and flowering duration (57.00 days) was recorded with M_1V_3 (Glomus mosseae + vermicompost @ 1 kg/m^2). Maximum flower weight (8.64 g), maximum flower yield (902.36 g) and shelf life (8.40 days) was recorded with M_3V_3 (Gigaspora margarita + vermicompost @ 1 kg/m^2).

Longer shelf life might also be attributed to the better overall food and nutrient status of the flower under these treatments.

3.2 Economic Ratio

The economic value of a crop is determined by its yield and quality. If growing conditions provide required microclimate and nutrition, plants exhibit full expression of genetic potential, yield and quality for long period. The acceptance of any package by farmers depends largely on the comparative economics of a practice and also feasibility of adoption and the effect on yield and quality as well. In the present investigations, economic analysis of different treatments reveals that application of treatment M_3V_2 (*Gigaspora margarita* + Vermicompost @ 750 g/m^2) resulted in highest benefit cost ratio (5.83) closely followed by benefit cost ratio of the treatments; M_2 V_2 (*Acaulospora laevis* + Vermicompost @ 750 g/m^2) and M_1 V_2 (*Glomus mosseae* + Vermicompost @ 750 g/m^2). This increase in monetary return may be attributed to higher yield and improved quality of flowers which fetches more prices in the market.

Conclusion: From the results of present investigation, the following conclusions have been drawn which may be beneficial for cultivation of *Chrysanthemum coronarium* L. under the Jammu agro climatic conditions.

Among the various mycorrhizal treatments tested, *Glomus mosseae* (M1) and *Gigaspora margarita* (M3) performed better in terms of better vegetative as well as floral parameters of economic importance. Vermicompost @ 1 kg/ m^2 recorded highest number of flowers per plant, flower weight, flowering duration and flower yield per plant.

The interaction effect revealed highest number of flowers per plant, flower duration, shelf life with M_1V_3 (*Glomus mosseae* + vermicompost @ 1 kg/ m^2). However, highest benefit cost ratio (5.83) was recorded with the treatment M_3V_2 (*Gigaspora margarita* + Vermicompost @ 750 g/m^2.

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Table:1. Economic profitability of *Chrysanthemum coronarium* L. flower production as influenced by mycorrhiza and vermicompost

Treatments			Flower yield (Kg/ha)	Total expenditure (Rs.)	Gross returns (Rs.)	Net returns (Rs.)	Benefit: Cost ratio
T_1	M_0 V_0	**No Mycorrhiza + Vermicompost (0 g/m^2)**	23780.50	1,76,500	713415	5,36,915	**3.04**
T_2	M_0V_1	**No Mycorrhiza + Vermicompost (500 g/m^2)**	27246.50	1,80,500	817395	6,36,895	**3.53**
T_3	M_0 V_2	**No Mycorrhiza + Vermicompost (750 g/m^2)**	32378.00	1,82,500	971340	7,88,840	**4.32**
T_4	M_0 V_3	**No Mycorrhiza + Vermicompost (1 kg/m^2)**	34896.50	2,96,500	1046895	7,50,395	**2.53**
T_5	M_1 V_0	***Glomus mosseae* + Vermicompost (0 g/m^2)**	31234.50	1,79,000	937035	7,58,035	**4.23**
T_6	M_1 V_1	***Glomus mosseae* + Vermicompost (500 g/m^2)**	33200.00	1,83,000	996000	8,13,000	**4.44**
T_7	M_1 V_2	***Glomus mosseae* + Vermicompost (750 g/m^2)**	37700.50	1,85,000	1131015	9,46,015	**5.11**
T_8	M_1 V_3	***Glomus mosseae* + Vermicompost (1 kg/m^2)**	38243.50	2,99,000	1147305	8,48,305	**2.84**
T_9	M_2 V_0	***Acaulospora laevis* + Vermicompost (0 g/m^2)**	32983.50	1,79,000	989505	8,10,505	**4.53**
T_{10}	M_2 V_1	***Acaulospora laevis* + Vermicompost (500 g/m^2)**	35056.50	1,83,000	1051695	8,68,695	**4.75**

T_{11}	$M_2 V_2$	***Acaulospora laevis* + Vermicompost (750 g/m^2)**	38938.50	1,85,000	1168155	9,83,155	**5.31**
T_{12}	$M_2 V_3$	***Acaulospora laevis* + Vermicompost (1 kg/m^2)**	41722.00	2,99,000	1251660	9,52,660	**3.19**
T_{13}	$M_3 V_0$	***Gigaspora margarita* + Vermicompost (0 g/m^2)**	29047.00	1,79,000	871410	6,92,410	**3.87**
T_{14}	$M_3 V_1$	***Gigaspora margarita* + Vermicompost (500 g/m^2)**	37231.50	1,83,000	1116945	9,33,945	**5.10**
T_{15}	M_3V_2	***Gigaspora margarita* + Vermicompost (750 g/m^2)**	42142.00	1,85,000	1264260	10,79,260	**5.83**
T_{16}	$M_3 V_3$	***Gigaspora margarita* + Vermicompost (1 kg/m^2)**	45118.00	2,99,000	1353540	10,54,540	**3.53**