Synergistic effects of Organic Manures and Biofertilizers on the Growth Performance of Cauliflower (*Brassica oleracea* L. var. botrytis) cv. Pusa Snowball-1

ABSTRACT:

The experiment entitled "Synergistic effects of Organic Manures and Biofertilizers on the Growth Performance of Cauliflower (*Brassica oleracea* L. var. botrytis) cv. Pusa Snowball-1" was carried out during *Rabi* 2023-24was carried at the Experimental, Organic Research farm Kargunwa ji, Jhansi, Department of Horticultural Sciences, Institute of Agricultural Sciences, Bundelkhand University Jhansi (Uttar Pradesh). The present experiment was design under Randomized block design with three replication with plot size- (2.4×1.8) m and number of rows per plant-5 rows per plant accommodating spacing (60×60) cm. Gross experimental area - 370 m^2. The Net experimental area - 214 $m^2$with number of treatments 7. Total number of plots - 24. The plot size - 2.4 x 1.8 m. The distance between rows - 60 cm between plants - 45 cm.The plant height was found to move significantly due to various treatments at every stage of observation of plants. Among treatments, T_6 having 50% Biofertilizer + 50% Vermicompost resulted in significantly higher plant height at every stages as compared to the remaining treatments. 50% Biofertilizer + 50% FYM (T_5) was found the second-best treatment. Accordingly, at 60 days stage, the maximum height up to 33.56 cm was recorded in case of T_1, followed by 32.31 cm in case of T_1.Among the fertilizer treatments100% recommended dose of fertilizer ($N_{100}P_{60}K_{80}$) resulted in highest net profit up to Rs.47048/ha with highest 2.51 B:C ratio. However, this was followed by T_6(50% Biofertilizer + 50% Vermicompost) with Rs. 35,254/ha net income and 1.78 B:C ratio. The treatment $T_1$and T_7 gave almost equal net profit ranging from Rs 35121 to Rs 32569/ha, the B:C ratio ranged from 1.75 to 1.62. On the other hand, the lowest net profit (Rs. 17189/ha) and B:C ratio (1.66) was recorded in case of T_6treatment.

***Key words*:**Cauliflower, biofertilizers, Manure, Organic andTomato.

INTRODUCTION

Cauliflower, scientifically known as (*Brassica oleracea* L. var. *botrytis*) is 2n = 18**,** belongs to the family Brassicaceae,commonly referred to as the mustard or cauliflower family known for its edible, white curd that is botanically classified as an inflorescence, (Yamaguchi, 1983 and Grout, 1988)). The plant is native to the Mediterranean region but is now grown worldwide due to its adaptability to various climates and soil conditions(Horne, 1952). It is a cool-season crop, requiring temperate climates with moderate rainfall or irrigation, Crozier (1891).The cauliflower head, commonly referred to as the "curd," is rich in nutrients, including vitamins C, K, and B6, folate, fiber, and antioxidants, making it an essential part of a balanced diet Swarup and Brahmi, (2005).Cauliflower is a cruciferous vegetable, and Pusa Snowball-1 is a specific cultivar known for its high yield and quality. The variety is typically chosen for its uniformity and market acceptance.Organic manures refer to natural fertilizers like compost, farmyard manure (FYM), or Vermicompost, which provide essential nutrients and improve soil structure and microbial activity Negri *et al.*,(2007).

Organic manures are considered environmentally friendly and sustainable for agriculture, offering slow-releasing nutrients that enhance long-term soil health.Biofertilizers are microbial products that enhance plant growth by promoting nutrient availability or fixing nitrogen Sastry *et al.*,(2019).

One of the critical issues in cauliflower farming is its high nutrient demand, particularly for nitrogen, phosphorus, and potassium. The conventional use of chemical fertilizers has been the standard practice to meet these nutrient needs, Maggoni*et al.*,(2010). However, excessive reliance on chemical fertilizers can lead to environmental degradation, soil nutrient imbalances, and reduced soil health. These challenges highlight the importance of exploring sustainable alternatives, such as organic manures and biofertilizers, which may offer solutions to improve soil fertility, enhance plant growth, and increase yields in a more environmentally friendly manner Lim, (2013).

Such research maycompare the impact of organic manures and biofertilizers individually or in combination against conventional chemical fertilizers.

MATERIAL AND METHODS

This chapter provides a detailed overview of the materials and methods used in the study titled "Effect of Organic Manures and Biofertilizers on Growth and Yield of Cauliflower (*Brassica oleracea* L. var. botrytis) CV. Pusa Snowball-1."

Experimental Site

The experiment was conducted at the organic research farm of the Department of Horticulture, Institute of Agricultural Sciences, Bundelkhand University, Jhansi (U.P.), during the *Rabi* season of 2023-24. The site was chosen for its conducive environment for crop growth and availability of necessary facilities for the research.

Climate and Weather Conditions

Jhansi experiences a Mediterranean hot summer climate (Csa) characterized by hot summers and mild winters. The city is located at an elevation of 0 meters above sea level, and its average annual temperature is 30.03°C (86.05°F), which is 4.06% higher than the national average. The mean annual temperature in Jhansi is recorded at 25.8°C (78.4°F), and the total annual precipitation is approximately 871 mm (34.3 inches), which supports the farming activities in the region.

Methodology

The present experiment was design and optimized under Randomized block design with three replication with plot size- (2.4×1.8) m and number of rows per plant-5 rows per plant accommodating spacing (60×60) cm. Gross experimental area - 370 m^2. The Net experimental area - 214 m^2 with number of treatments 7 including the check/control plot. The total number of plots were24 with plot size - 2.4 x 1.8 m. The distance between rows - 60 cm between plants - 45 cm.

RESULTS AND DISCUSSION

Morphological Parameters

1. **Plant height (cm)**

The data with respect to plant height recorded after 30, 45 and 60 days of transplanting are shown in Table 1. The increase in plant height, in general, was observed with the advancement of plant growth up to 45 days stage. It was, in general, enhanced steadily between 30 to 45 and 45 to 60 days period in all the treatments at 30 days stage, the plant height in various treatments ranged from lowest 21.69 cm to highest 23.86 cm, whereas at 60 days stage, it ranged from 31.75 cm to 33.56 cm.

The plant height was found to move significantly due to various treatments at every stage of observation of plants. Among treatments, T_6 having 50% Biofertilizer + 50% Vermicompost resulted in significantly higher plant height at every stages as compared to the remaining treatments. 50% Biofertilizer + 50% FYM (T_5) was found the second-best treatment. Accordingly, at 60 days stage, the maximum height up to 33.56 cm was recorded in case of T_1, followed by 32.31 cm in case of T_1. In contrast to this, the significantly lowest height only 30.83 to 30.85 cm was recorded in case of T_4 and treatments having lower dose of fertilizers. The influence of PSB biofertilizer was also found in the lowest order next to control treatment.The best treatments T_6 and T_5 proved significantly superior to T_1 having 100% NPK. FYM (T_1) proved significantly superior to vermicompost (T_2). Similar results due to effect of organic and bio-fertilizer were recorded by Peralta-Antonio*et al.*, (2019); Kayesh*et al* ., (2019); Shankar *et al* ., (2019).

2. Numberofleaves/plants

The number of leaves per plant were also counted at different growth intervals under each treatment. The mean values so obtained were subjected to statistical computation. The mean data are presented in Table 2 and exhibited through them.Thenumberof leaves, ingeneral, werefound toenhance withthe enhancement of plant growth up to 60 days stage of observation. The leaves were formed almost at the equal rate from the beginning period of plant growth up to 60 days of transplanting.At 30 days stage, the leaves ranged from lowest 6.22/plant to highest 7.61/plant in various treatments, whereas at 60 days stage, the leaves ranged from lowest 15.70 to highest 19.95/plant.

The different treatments exerted significant impact upon this parameter at every stageof observation. Out of the various treatments, T4 having all the four inputs brought about significantly higher number of leaves per plant at every stage of observation as compared to the rest of the treatments.T_1 treatment having 20 t FYM/ha was found the second best in raising this parameter. According to the maximum number of leaves (19.95/plant) were noted at 60 days stage from T_5 treatment. This was followed by T_1 treatment (18.78) leaves/plant. On the other hand, the equally lowest number of leaves formation (15.70 to 15.85plants) was observed in case of T_6 and T_7 treatments.

It was the general observation that half dose of FYM or Vermicompost when applied with biofertilizer resulted in significantly lower leaves formation as compared to the other treatments. T_1 having 20t FYM/ha proved significantly superior to Vermicompost5t/ha (T_2). Similarly, T_5 was found significantly superior to T_6 having 100 % NPK. This trend of treatments effect was observed at every stage of observation.Similar results due to effect of organic and bio-fertilizer were recorded by Jha *et al*., (2017); Kayesh*et al* ., (2019); Shankar *et al* ., (2019).

3. NetprofitandB:Cratio

The net profit and B:C ratio was estimated under each treatment based on the existing market rates of inputs and outputs. The mean data so obtained are presented in Table 3.Amongthefertilizer treatments100%recommendeddoseoffertilizer($N_{100}P_{60}K_{80}$) resulted in highest net profit up toRs.47048/hawith highest 2.51B:C ratio.However, this was followed by T_6(50% Biofertilizer + 50% Vermicompost) with Rs. 35,254/ha net income and 1.78 B:C ratio. The treatment $T_1$and T_7gave almost equal net profit ranging from Rs 35121 to Rs 32569/ha, the B:C ratio ranged from1.75 to 1.62. On the other hand, the lowest net profit (Rs. 17189/ha) and B:C ratio (1.66) was recorded in case of T_6treatment. The net profit of this T_6treatment was very low than that obtained from the other treatments. Among these applied organic sources of nutrients, then netprofitranged from the lowest (Rs 27,189) in case of Vermicompost to the highest (Rs 35,389/ha)in case of FYM. Thus, Vermicompost and FYMwere found almost in thewide rage in giving profit/ha. The treatments like T_3 and T_7further lowered down the net profit in comparison the other combinations with otherorganic sources of nutrients. There was larger differences in the netprofit obtained from the different treatments. The netprofit from 100% NPK (T_2) was higher by Rs 35,254/ha as compared to the best treatment $T_5$where all the four types of nutrient inputs were applied together. Cost economics for all the treatments was worked out on the basis of the incurred input cost and market price of the produce at the time of experimentation. Similar findings have also been reported by (Bhusan *et al.* 2010; Choudhary *et al.*2017; Jha *et al.*2017), (Akhther*et al.*2018; Patidar *et al.* 2018) and Rana *et al.*2020).

CONCLUSION

The study observed significant effects of various treatments on plant height, number of leaves, and net profit. Plant height increased steadily from 30 to 60 days across treatments, with the highest growth recorded in T_6 (50% Biofertilizer + 50% Vermicompost), followed by T5 (50% Biofertilizer + 50% FYM). Treatment T_6 also showed the lowest number of leaves, while T_4, combining all four inputs, resulted in the highest leaf count at every growth stage. Regarding cost-benefit analysis, T_1 (100% NPK) generated the highest net profit (Rs. 47,048/ha) and B:C ratio (2.51), while treatments involving organic amendments like FYM and Vermicompost resulted in moderate net profits, with T6 showing the lowest. Organic and bio-fertilizer treatments were effective but less profitable compared to traditional fertilizers.

FUTURE SCOPE

Optimizing the combination and application rates of biofertilizers, organic amendments, and chemical fertilizers to further improve plant growth and yield while reducing environmental impact. Exploring the long-term effects of integrated nutrient management (INM) practices on soil health, sustainability, and cost-effectiveness is essential. Additionally, studies could investigate the economic viability of such treatments across different crop types and regions, considering factors like climate, soil characteristics, and market prices. Further experimentation could also include the evaluation of other organic amendments, such as compost or green manures, and their synergistic effects with biofertilizers. Lastly, exploring innovative methods to enhance nutrient use efficiency and reduce input costs could lead to more sustainable farming practices.

COMPETING INTRESTS

The authors have stated that there are no conflicting interests.

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Table 1: Plant height of cauliflower at different growth stages as influenced by different treatments

Tr.No.	Treatments	Plant height(cm)DAT		
		30	**45**	**60**
T0	Control	22.12	28.81	32.02
T1	100%FYM	23.28	28.02	32.31
T2	100%Vermicompost	22.01	27.16	31.95
T3	100%PoultryManure	21.69	26.78	31.75
T4	100%Biofertilizer (*Azotobacter*+VAM)	23.02	28.31	32.47
T5	50%Biofertilizer+50%FYM	23.47	30.17	32.23

T6	50%Biofertilizer+50%Vermicompost	23.86	31.42	33.56
T7	50%Biofertilizer+50%PoultryManure	22.51	28.69	32.14
	Sem±	0.192	0.042	0.085
	C.D.(5%)	0.571	0.142	0.214

Table 2: Number of leaves/ plant of cauliflower at different growth stages as influenced by different fertility treatments

Tr.No.	Treatments	Number of leaves / plants		
		30	45	60
T0	Control	7.45	10.78	18.01
T1	100%FYM	7.58	11.41	17.00
T2	100%Vermicompost	7.16	11.32	17.85
T3	100%PoultryManure	6.78	10.85	16.85
T4	100%Biofertilizer(*Azotobacter*+VAM)	7.12	11.32	18.98
T5	50%Biofertilizer+50%FYM	7.29	10.21	17.52
T6	50%Biofertilizer+50%Vermicompost	7.76	11.88	19.45
T7	50%Biofertilizer+50%PoultryManure	6.85	10.45	16.54
	Sem±	0.008	0.016	0.052
	C.D.(5%)	0.027	0.053	0.140

Table-3 Net profit and B:C ratio from cauliflower as influenced by different fertility treatments

Tr.No.	Treatments	Netincome (Rs./ha)	B:CRatio
T0	Control	47,048	2.53
T1	100%FYM	35,121	1.75
T2	100%Vermicompost	27,196	1.51
T3	100%PoultryManure	28,175	1.54
T4	100%Biofertilizer(*Azotobacter*+VAM)	25,327	1.48
T5	50%Biofertilizer+50%FYM	26,785	1.49

T6	50%Biofertilizer+50%Vermicompost	35,254	1.78
T7	50%Biofertilizer+50%PoultryManure	32,569	1.62
	Sem±	1.23	0.11
	C.D.(5%)	3.45	1.14