

# 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 was carried out during *Rabi* 2023-24 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 carried out using Randomized block design with three replication to study the effect of organic manures i.e. (farmyard manure (FYM), vermi compost and poultry manure) and biofertilizers individually or in combination on the growth performance of cauliflower. The obtained results can be summarized as follow:

The plant height was found to move significantly due to various treatments at every observation stage of plants. Among treatments, T<sub>6</sub> (50% Biofertilizer + 50% Vermicompost) treatment resulted in significantly higher plant height at every stages as compared to the remaining treatments.

Application of 50% Biofertilizer + 50% FYM treatment (T<sub>5</sub>) 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<sub>1</sub> (100% FYM) treatment, followed by 32.31 cm in case of T<sub>1</sub> (100% FYM) treatment. Economically, the results confirmed the fact that, organic and bio-fertilizer treatments were effective but less profitable compared to traditional fertilizers where, treatment T<sub>0</sub> (N<sub>100</sub>P<sub>60</sub>K<sub>80</sub>) recorded the highest B:C ratio (2.53) and followed by T<sub>6</sub> (50% Biofertilizer + 50% Vermicompost) treatment with 1.78 B:C ratio.

**Key words:** Cauliflower, biofertilizers, Manure and Organic

## 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 Brahmī, (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 Shankar *et al.*, (2019).

Organic manures are considered environmentally friendly and sustainable for agriculture, offering slow-releasing nutrients that enhance long-term soil health Sastry *et al.*, (2019). 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).

Farmyard manure (FYM), consist of Nitrogen (N): 0.5%, Phosphorus (P): 0.2% and Potassium (K): 0.5%. FYM is an excellent soil amendment for cauliflower, contributing to higher yields, better plant health, and enhanced soil sustainability. FYM is generally applied in larger quantities compared to chemical fertilizers, but it offers a more balanced and slow-release nutrient supply, supporting sustainable soil health. Bopcha and Agarwal (2024). Vermicompost typically contains a balanced amount of NPK (Nitrogen, Phosphorus, Potassium) and various micronutrients. Vermicompost content is N: 1–2%, P: 1–1.5% and K: 1–2%. Buyukarslan and Demir (2024). Poultry manure generally contains high amounts of nutrients, especially nitrogen, and its NPK composition can be around: N: 2–4%, P: 1.5–3% and K: 1–2%, Singh *et al.*,(2023). Azotobacter is a free-living nitrogen-fixing bacterium that can fix atmospheric nitrogen into a form usable by plants. VAM (*Vesicular Arbuscular Mycorrhiza*) VAM refers to a group of beneficial fungi that form a symbiotic relationship with plant roots Zbar *et al.*,(2021). These fungi are crucial for nutrient and water uptake. These amendments can work synergistically to promote healthy crop growth, particularly for nutrient-hungry crops like Cauliflower. Vermicompost and Poultry Manure provide organic matter and essential nutrients for the crop, Yadav *et al.*,(2022). Azotobacter ensures a steady nitrogen supply through biological nitrogen fixation. Naorem *et al.*,(2024). VAM enhances nutrient and water uptake, promoting strong root development and better resilience. By using a combination of these organic and biological amendments, farmers can improve soil health, reduce chemical fertilizer dependency, and promote sustainable farming practices.

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

## **MATERIAL AND METHODS**

### **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.). Jhansi is situated at latitude 25<sup>0</sup>27 N, longitude 78<sup>0</sup>35 E and at an altitude of 271 meters above the mean sea level 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 with total number of plots 24. The number of rows per plant-5 rows per plant accommodating spacing (60×60) cm. Gross experimental area - 370 m<sup>2</sup>. The Net experimental area - 214 m<sup>2</sup> with number of treatments 7 including the check/control plot. The distance between rows - 60 cm between plants - 45 cm. The Organic manure and biofertilizers were procured from the University campus.

### **Economic studies :**

#### **Cost of cultivation**

The cost of cultivation was calculated based on the expenses incurred in cultivating in given area of cauliflower here it was cultivated. The cost of cultivation was worked out by input wise and

operation wise together with their percentage to the total.

**Gross income (Rs/ha)**

Gross income was worked out based on aggregate of all direct cost applied in cultivation of cauliflower.

**Net income (Rs/ha)**

The overall income was worked out based on aggregate of all direct cost applied in cultivation of brinjal.

**Statistical analysis**

Analysis of variance (Anova) The total variations amongst the treatment for different attributes were tested for significance by ‘F’ test using analysis of variance technique. The degrees of freedom, mean sum of squares and ‘F’ values were calculated as follows:

Sources of variation	df	S.S	M.S.S	F
Replication	(r-1)	Sr	Msr	MSr / MSe
Treatments	(t-1)	St	Mst	MSt / MSe
Error	(r-1)(t-1)	Se	Mse	
Total	rt-1	St		

Where r = number of replication

t = number of treatments.

Each sum of square (S.S) was divided by the corresponding degrees of freedom to get the MSS. To find out the ‘F’ values from the table (Fisher and Yates, 1953) the mean square values were tested, against the error mean squares. The standard error of difference between any two genotype means is expressed by the formula –

$$S.E (m) = \sqrt{\frac{2MSe}{r}}$$

Where, MSe = Error mean square  
r = Number of replication.

The test of significance of difference between means of two genotypes for a character was done by t test and critical difference (CD) was calculated as follows: C.D. = S.E (m) × ‘t’ Where ‘t’ is the table value at 5% level of significance for the error degree of freedom.

**Fig 1: Physical and Chemical composition of the soil sample of the experimental site –**

Particulars	Value obtained	Method
Physical character		
Fine sand %	42 %	By international pipette method
Silt %	38 %	

Clay%	20 %	(Pipper, 1950)
Texture	Sandy-loam	
<b>Chemical composition</b>		
Soil pH	7.5	Method no. 4 USDA handbook no. 60 (Richard 1954)
Electrical conductivity(dsm)	0.45	EC meter
Available nitrogen (kg N/ha)	214.0	Alkaline KMno <sub>4</sub> (Subbiah & Asija, 1956)
Available potash (kg K <sub>2</sub> O <sub>5</sub> /ha)	203.20	Flame-photometer method (Metson, 1956)
Available phosphorus (Kg P <sub>2</sub> O <sub>5</sub> /ha)	18.10	Olsen extraction method(Olsen <i>et al.</i> 1954)

## RESULTS AND DISCUSSION

### Morphological Parameters

#### 1. Plant height (cm)

The data with respect to plant height at 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<sub>6</sub> 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<sub>5</sub>) 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<sub>1</sub>, followed by 32.31 cm in case of T<sub>1</sub>. In contrast to this, the significantly lowest height only 30.83 to 30.85 cm was recorded in case of T<sub>4</sub> 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<sub>6</sub> and T<sub>5</sub> proved significantly superior to T<sub>1</sub> having 100% NPK. FYM (T<sub>1</sub>) proved significantly superior to vermicompost (T<sub>2</sub>). 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. Number of leaves/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. The number of leaves, in general, were found to enhance with the 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 stage of observation. Out of the various treatments, T<sub>4</sub> 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<sub>1</sub> 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<sub>5</sub> treatment. This was followed by T<sub>1</sub> 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<sub>6</sub> and T<sub>7</sub> 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<sub>1</sub> having 20t FYM/ha proved significantly superior to Vermicompost5t/ha (T<sub>2</sub>). Similarly, T<sub>5</sub> was found significantly superior to T<sub>6</sub> 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. Net profit and B: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. Among the fertilizer treatments 100% recommended dose of fertilizer (N<sub>100</sub>P<sub>60</sub>K<sub>80</sub>) resulted in highest net profit up to Rs.47048/ha with highest 2.51B:C ratio. However, this was followed by T<sub>6</sub>(50% Biofertilizer + 50% Vermicompost) with Rs. 35,254/ha net income and 1.78 B:C ratio. The treatment T<sub>1</sub>and T<sub>7</sub>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<sub>6</sub>treatment. The net profit of this T<sub>6</sub> treatment was very low than that obtained from the other treatments. Among these applied organic sources of nutrients, then net profit ranged from the lowest (Rs 27,189) in case of Vermicompost to the highest (Rs 35,389/ha)in case of FYM. Thus, Vermicompost and FYM were found almost in the wide range in giving profit/ha. The treatments like T<sub>3</sub> and T<sub>7</sub>further lowered down the net profit in comparison the other combinations with other organic sources of nutrients. There was larger differences in the net profit obtained from the different treatments. The net profit from 100% NPK (T<sub>2</sub>) was higher by Rs 35,254/ha as compared to the best treatment T<sub>5</sub>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<sub>6</sub> (50% Biofertilizer + 50% Vermicompost), followed by T<sub>5</sub> (50% Biofertilizer + 50% FYM). Treatment T<sub>6</sub> also showed the lowest number of leaves, while T<sub>4</sub>, combining all four inputs, resulted in the highest leaf count at every growth stage. Regarding cost-benefit analysis, T<sub>1</sub> (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 T<sub>6</sub> 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 INTERESTS**

The authors have stated that there are no conflicting interests.

#### **Disclaimer (Artificial intelligence)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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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% Poultry Manure	21.69	26.78	31.75
T4	100% Biofertilizer ( <i>Azotobacter</i> +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% Poultry Manure	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% Poultry Manure	6.78	10.85	16.85
T4	100% Biofertilizer( <i>Azotobacter</i> +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% Poultry Manure	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**

<b>Tr.No.</b>	<b>Treatments</b>	<b>Net income (Rs./ha)</b>	<b>B:CRatio</b>
T0	Control	47,048	2.53
T1	100% FYM	35,121	1.75
T2	100% Vermicompost	27,196	1.51
T3	100% Poultry Manure	28,175	1.54
T4	100% Biofertilizer ( <i>Azotobacter</i> +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% Poultry Manure	32,569	1.62
	Sem±	1.23	0.11
	C.D.(5%)	3.45	1.14