

## 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 2023-24 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 design under carried out using 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<sup>2</sup>. The Net experimental area 214 m<sup>2</sup> 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 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 observation 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.

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 2.51 B: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.

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, Organic and Tomato.

### 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

Comment [s1]: Please , mention the name of the stage

Comment [s2]: This can be summed up in one sentence , preferably written in the Explanation

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).

**Comment [s3]:** It is preferable to use recent references with in the last ten years

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).

**Comment [s4]:** It is preferable to add a paragraph about each organic fertilizer used , along with adding recent references

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).

**Comment [s5]:** Add a recent reference

Such research may compare 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.

**Comment [s6]:** Please, specify the astronomical location for the experiment as follow ( (positioned at ??????? latitude, ?????? longitude)

### 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<sup>2</sup>. The Net experimental area - 214 m<sup>2</sup> with number of treatments 7 including the check/control plot. The total number of plots were 24 with plot size - 2.4 x 1.8 m. The distance between rows - 60 cm between plants - 45 cm.

????????????????????

**Comment [s7]:** 1-Add a table for soil analysis before planting  
2-Add a table for analyzing the used organic fertilizers and mention where they were obtained  
3-Mention , the treatments application , the dates of the adding them , and the quantity of seeds used  
4-Mention the data that were recorded  
5-Mention the statistical analysis used  
6-Mention the economic feasibility study  
Taking in to account writing references in their places .

## 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

**Comment [s8]:** Mention name of growth stages

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 15.85 plants) 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 Vermicompost 5t/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:C ratio

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 2.51 B: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 to 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>3</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.

#### **REFERENCES**

1. Akhther, A. M., Jabeen, N., Bhat, T. A., Parray, E. A., Hajam, M., Wani, M. A. and Bhat, I. A. (2018). Effect of organic manures and bio-fertilizers on growth and yield of lettuce. *The Pharma Innovation Journal*, 7(5): 75-77. 1861-1875.
2. Bhusan A, Sharma AK, Sharma JP. (2010). Integrated nutrient management in knolkhol under Jammu and Kashmir condition. *J Res., SKUAST-J*. 9(2):240-243.
3. Choudhary, M., Jat, R. K., Chand, P and Choudhary, R. (2017). Effect of bio-fertilizers on growth, yield and quality of knol-khol. *Pharmacogn Phytochem*, 6:2234-2237.
4. Crisp, P. (1982). The use of an evolutionary scheme for cauliflowers in the screening of genetic resources. *Euphytica*, 31(3), 725-734.
5. Crozier, A. A. (1891). *The Cauliflower*. Register Publishing Company.
6. Grout, B. W. W. (1988). Cauliflower (*Brassica oleracea* var. botrytis L.). In *Crops II* (pp. 211-225). Berlin, Heidelberg: Springer Berlin Heidelberg.
7. Home, F. R. (1952). Winter Cauliflower: History & Breeding In The South West. *Scientific Horticulture*, 11, 128-139.
8. Jha, M. K., Jha, B and Sahu, M. R. U. (2017). Effect of organic, inorganic and biofertilizers

- on quality attributes of cabbage (*Brassica oleracea* var. capitata L.). *Journal of Pharmacognosy and Phytochemistry*, **6**: 502-504.
9. Kayesh, E., Sharker, M. S., Roni, M. S and Sarker, U. (2019). Integrated nutrient management for growth, yield and profitability of broccoli. *Bangladesh Journal of Agricultural Research*, **44**(1), 13-26.
  10. Lim, T. K. (2013). *Brassica oleracea* (Botrytis group). In *Edible Medicinal And Non-Medicinal Plants: Volume 7, Flowers* (pp. 571-593). Dordrecht: Springer Netherlands.
  11. Maggioni, L., Von Bothmer, R., Poulsen, G., & Branca, F. (2010). Origin and domestication of cole crops (*Brassica oleracea* L.): linguistic and literary considerations. *Economic botany*, **64**, 109-123.
  12. Negri, V., Branca, F., & Castellini, G. (2007). Integrating wild plants and landrace conservation in farming systems: a perspective from Italy. In *Crop wild relative conservation and use* (pp. 394-404). Wallingford UK: CABI.
  13. Patidar, P and Bajpai, R (2018). Effect of integrated nutrient management (INM) on yield parameters of Brinjal, *International Journal of Chemical Studies.*, **6**(3): 1158-1160.
  14. Peralta-Antonio, N., Watthier, M., Santos, R. H. S., Martinez, H. E. P and Vergutz, L. (2019). Broccoli nutrition and changes of soil solution with green manure and mineral fertilization. *Journal of Soil Science and Plant Nutrition*, **19**(4), 816-829.
  15. Rana, S., Thakur, K. S., Bhardwaj, R. K., Kansal, S and Sharma, R. (2020). Effect of biofertilizers and micronutrients on growth and quality attributes of cabbage (*Brassica oleracea* var. capitata L.). *IJCS*, **8**(1): 1656-1660.
  16. Sastry, K. S., Mandal, B., Hammond, J., Scott, S. W., Briddon, R. W., Sastry, K. S., ... & Briddon, R. W. (2019). *Brassica oleracea* var. botrytis (Cauliflower). *Encyclopedia of Plant Viruses and Viroids*, 302-305.
  17. Shankar, A., Kumar, S., Kumar, R., & Kumar, P. (2019). Efficacy of organic manures and bio-fertilizers on growth, yield and quality of broccoli (*Brassica oleracea* . var. *italica plenck*). *Plant Archives*, **19** (2):2608-2612
  18. Smyth, D. R. (1995). Flower development: origin of the cauliflower. *Current Biology*, **5**(4), 361-363.
  19. Srichandan, S., Mangaraj, A. K., Behera, K. K., Panda, D., Das, A. K., & Rout, M. (2015). Growth, yield and economics of broccoli (*Brassica oleracea* var. *Italica*) as influenced by organic and inorganic nutrients. *International Journal of Agriculture, Environment and Biotechnology*, **8**(4), 965.
  20. Swarup, V., & Brahma, P. (2005). Cole crops. *Plant Genetic Resources: Horticultural Crops*. New Delhi: Narosa Publishing House Pvt. Ltd, 75-88.
  21. Yamaguchi, M., & Yamaguchi, M. (1983). Crucifers. *World Vegetables: Principles, Production and Nutritive Values*, 218-238.

**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

Comment [s9]: Modify in all tables to farmyard manure

**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**

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( <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%PoultryManure	32,569	1.62
	Sem±	1.23	0.11
	C.D.(5%)	3.45	1.14