

# Impact of organic manures and bio-fertilizers on yield and quality attributes of broccoli (*Brassica oleracea* L. var. *italica*) cv-N.S.-50

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## ABSTRACT

Broccoli is known as the 'Crown of jewel nutrition' because it contains vitamin A (130 times higher than cauliflower and 22 times higher than cabbage), niacin, thiamin, vitamin C, riboflavin and also minerals like Fe, P, K and Ca. It aids in the battle against lung and breast cancer. Organic production of broccoli is the need of the hour to enjoy the excellent health benefit of broccoli with better test avoiding the health hazard of chemical fertilizer residues. Keeping this in mind, the experiment was carried out in the year 2019-20 at the Agricultural Research Farm, Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur. The experiment was laid out in a randomized block design (RBD) for the experimentation at spacing of 60 × 30 cm with 3 replications and 8 treatments with 24 plots. The current experiment clearly demonstrated that the quality, yield, and yield-attributing characteristics of broccoli are significantly improved by the use of organic manures and bio-fertilizers. Among all the treatments, use of Farm Yard Manure (FYM) + Phosphate Solubilizing Bacteria (PSB) + Azospirillum i.e., T<sub>7</sub> in sprouting broccoli was found to be the most effective treatment for obtaining highest yield as well as better quality under UP conditions.

**Key words :** Broccoli, FYM, PSB, Azospirillum, quality and yield.

## Introduction

Despite of being an essential member of the cruciferae family, broccoli is a relatively new crop in India and grown in a very small region. Due to its adaptability and rich source of vitamins, minerals, and phytochemicals, it has gained more attention in hotels and restaurants in modern metro-cities like Kolkata, Delhi, Mumbai, and Chennai. It is truly acquainted as the, 'Crown of jewel nutrition' because

it contains vitamin A (130 times higher than cauliflower and 22 times higher than cabbage), niacin, thiamin, vitamin C, riboflavin and also minerals like Fe, P, K and Ca. It aids in the battle against lung and breast cancer.

Increased health awareness through food safety and environmental concerns is the reason behind the demand of organic product to sky-high day by day (Worthington, 2001). Due to their superior flavor and lower chemical residues, organically grown

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vegetables are also becoming more popular (Patil *et al.*, 2016). Excessive use of nitrogenous fertilizers is the main cause of nitrate leaching, which pollutes water (Moss, 2008) as well as is a rich source of greenhouse gases whose share is continuously rising, which exacerbates climate change (De Carvalho Macedo, I. 2015). Bio-fertilizers are organic fertilizers that are alive microbiological inoculants of bacteria, fungi, and algae that can be used alone or in combination to increase the availability of nutrients to plants. Due to the current high cost of chemical fertilizer and its detrimental impact on soil health, the use of bio-fertilizers in agriculture assumes considerable significance. So, organic production of broccoli is the need of the hour to enjoy the excellent health benefit of broccoli with better test avoiding the health hazard of chemical fertilizer residues. But, research on broccoli production and quality utilizing organic manures and bio-fertilizers are very scanty in India. Keeping this in mind, the objective of this study was to evaluate the impact of combined effect of organic manures and bio-fertilizers on quality attributes and yield attributes of broccoli.

## Materials and Methods

The experiment was carried out in the year 2019-20 at the Agricultural Research Farm, Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur. The experiment was laid out in a randomized block design (RBD) for the experimentation at spacing of 60 × 30 cm with 3 replications and 8 treatments with 24 plots. The soil texture of the experimental field was well-drained sandy loam having good water holding capacity with pH value of 6.5. The experimental site has subtropical and sub humid climatic conditions, with an average day temperature of 24 °C and a relative humidity of 46%. Seedlings of Broccoli cv- N.S-50 was collected on 4<sup>th</sup> November 2019 from the Chandra Shekhar Azad

University of Agriculture and Technology, Kanpur for the present study. The seedling of broccoli was transplanted on the same day of collection in the main field. The treatment comprised of four levels of each growth substances i.e., Farmyard manure, Vermicompost, PSB and Azospirillum. Observations were recorded from five random healthy plants of each treatment on growth; yield and its attributing characters. By removing the terminal head at the point of marketable maturity, measurements of head diameter (cm) and head length (cm) were taken using measuring scales. Head weight was measured using weighing balances and expressed in gram. The yield per plot was recorded in kg/plot and latter calculated in q/ha. TSS was measured with the help of an Erma hand refractometer and was corrected using standard reference table and expressed in terms of (°Brix) at 20 °C temperature. Ascorbic acid content was determined by diluting the known volume of juice with 3% meta-phosphoric acid and titrating with 2, 6-dichlorophenol-indophenol solution till the faint pink colour was obtained (AOAC, 1960). Acidity content of fruit was estimated by following the standard methods (AOAC, 2006). The experimental data recorded were subjected to statistical analysis using analysis of variance technique suggested by (Panse and Sukhatme, (1967).

## Results and Discussion

Among various treatment combinations, significant variations were recorded for yield and its attributing characters (Table 2 and Fig. 1). Late curd initiation (66.24 days) was recorded in T<sub>0</sub> (control) and earliest curd initiation was found in T<sub>3</sub> (F.Y.M + vermicompost) (59.31 days) followed by T<sub>7</sub> (F.Y.M + Vermicompost + Azospirillum) (60.25 days) and T<sub>5</sub> (Vermicompost + PSB) (60.52 days). Head diameter was observed highest (13.78 cm) in T<sub>7</sub> (F.Y.M +

**Table 1.** Details of treatments used in present study

Sl No.	Treatments	Treatment Combinations
1.	Treatment0	control
2.	Treatment 1	F.Y.M (100%)
3.	Treatment2	Vermicompost (100%)
4.	Treatment 3	F.Y.M (50%) + Vermicompost (50%)
5.	Treatment 4	F.Y.M (50%) + PSB (50%)
6.	Treatment 5	Vermicompost (50%) + PSB (50%)
7.	Treatment 6	F.Y.M (50%) +Azospirillum (50%)
8.	Treatment 7	F.Y.M (25%) + Vermicompost (50%) + Azospirillum (25%)

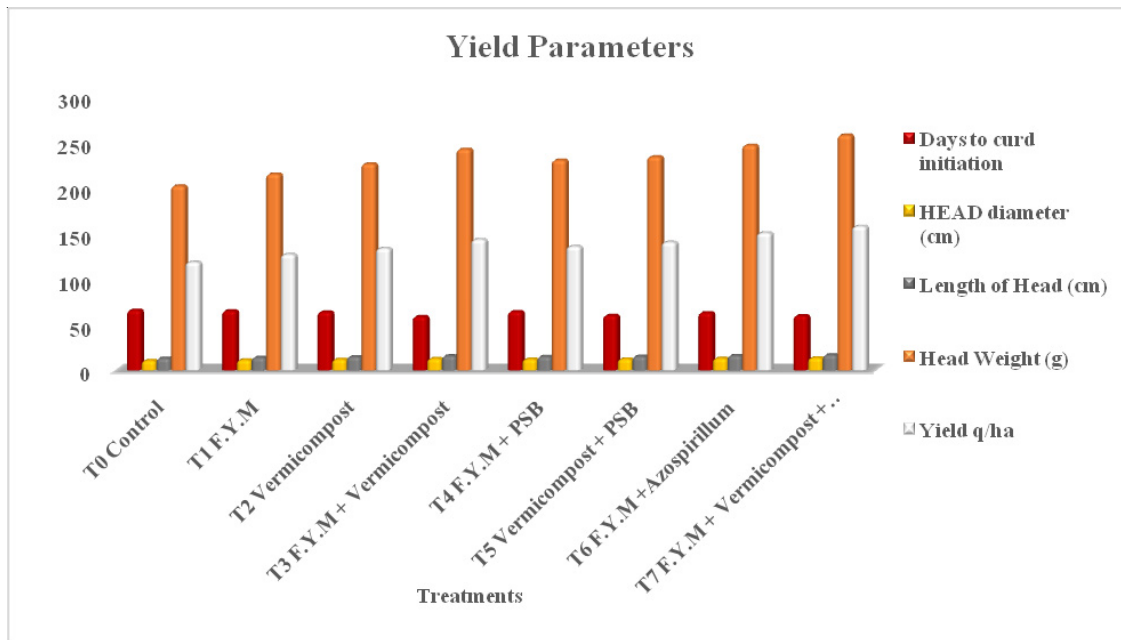


Fig. 1. Graphically shown the yield parameters taken from the broccoli

Vermicompost + Azospirillum) followed by (13.21 cm) T<sub>6</sub> (F.Y.M + Azospirillum) and (12.97 cm) in T<sub>3</sub> (F.Y.M + vermicompost) and the lowest head diameter was observed in T<sub>0</sub> (Control) 10.82 cm. The head length was recorded highest 17.03 cm in T<sub>7</sub> (F.Y.M + Vermicompost + Azospirillum) followed by 16.30 cm in T<sub>6</sub> (F.Y.M + Azospirillum) and 16.01 cm in T<sub>3</sub> (F.Y.M + Vermicompost) and the lowest head length was recorded in T<sub>0</sub> (Control) 13.35 cm, in T<sub>1</sub> (F.Y.M) 14.20 cm and in T<sub>2</sub> (Vermicompost) 14.95 cm respectively. Similarly, we have measured the highest weight of head 259.15g. in T<sub>7</sub> (F.Y.M + Vermicompost + Azospirillum) followed by 248.04g. in T<sub>6</sub> (F.Y.M + Azospirillum) and 243.63g. in T<sub>3</sub>

(F.Y.M + Vermicompost) respectively. Some lower readings in terms of head weight were found like- 203.15 g. in T<sub>0</sub> (Control), 216.27 g. in T<sub>1</sub> (F.Y.M) and 227.50 g. in T<sub>2</sub> (Vermicompost). The maximum yield, (158.70q/ha), with an increasing rate of (33.19%) was obtained with the treatment T<sub>7</sub> (F.Y.M + Vermicompost + Azospirillum) followed by (27.02%) in T<sub>6</sub> (F.Y.M + Azospirillum) and (20.89%) in T<sub>3</sub> (F.Y.M + Vermicompost) as compared to control. Higher values for yield contributing characteristics were obtained as a result of the favorable effects of farmyard manure and vermicompost in boosting the physical, chemical, and biological aspects of soil, which in turn help in improving the

Table 2. Effect of organic manures and bio-fertilizers on yield characters in broccoli

Tr.No.	Treatments	Days to curdinitiation	HEAD diameter (cm)	Length of head (cm)	Head weight(g)	Yield q/ha
Treatment 0	Control	66.24	10.820	13.350	203.150	119.150
Treatment 1	F.Y.M	65.58	11.510	14.200	216.270	127.650
Treatment 2	Vermicompost	64.28	12.120	14.950	227.500	134.330
Treatment 3	F.Y.M + Vermicompost	59.31	12.970	16.010	243.630	144.050
Treatment 4	F.Y.M + PSB	64.73	12.340	15.220	231.610	136.460
Treatment 5	Vermicompost + PSB	60.52	12.530	15.460	235.260	141.160
Treatment 6	F.Y.M +Azospirillum	63.48	13.210	16.300	248.040	151.350
Treatment 7	F.Y.M + Vermicompost + Azospirillum	60.25	13.780	17.030	259.150	158.700
C.D.at 5%	2.38	N/A	N/A	0.91	1.45	
SEM±	0.77	0.85	0.80	0.29	0.47	

nutrient absorption by plants. During the research it is clearly revealed that various yield parameters (Table 2) have shown much lower reading when organic manures are not used (treatment T<sub>0</sub>), which signifies the importance of organic manures in combination with bio-fertilizers for improving yield characters in sprouting broccoli. Similar results were previously reported by (Meena *et al.*, 2017).

Result of Table 3 and Figure 2 clearly state that among all the combination of treatments there was an increase in curd quality in respect to TSS, Vit-C and Acidity as compared to the control. Highest TSS improvement was observed in T<sub>7</sub> (F.Y.M +

Vermicompost + Azospirillum) with (33.18%) followed by T<sub>6</sub> (F.Y.M + Azospirillum) (27.07%), T<sub>3</sub> (F.Y.M + Vermicompost) (20.96%), T<sub>5</sub> (Vermicompost + PSB) (18.48%), T<sub>4</sub> (F.Y.M + PSB) (14.55%), T<sub>2</sub> (Vermicompost) (12.80%) and T<sub>1</sub> (F.Y.M) (7.13%). Significant increasing amount of vit-c was found in all the treatments with a range of 7.13 to 14.12 %. The highest Vitamin-C content (90.56 mg/100g) was found with the treatment T<sub>7</sub> (F.Y.M + vermicompost+ Azospirillum) at an increasing rate of 14.12% followed by T<sub>5</sub> (Vermicompost + PSB) (13.92%), T<sub>3</sub> (F.Y.M + vermicompost) (13.39%) and T<sub>2</sub> (Vermicompost) (12.80%) as compare to control.

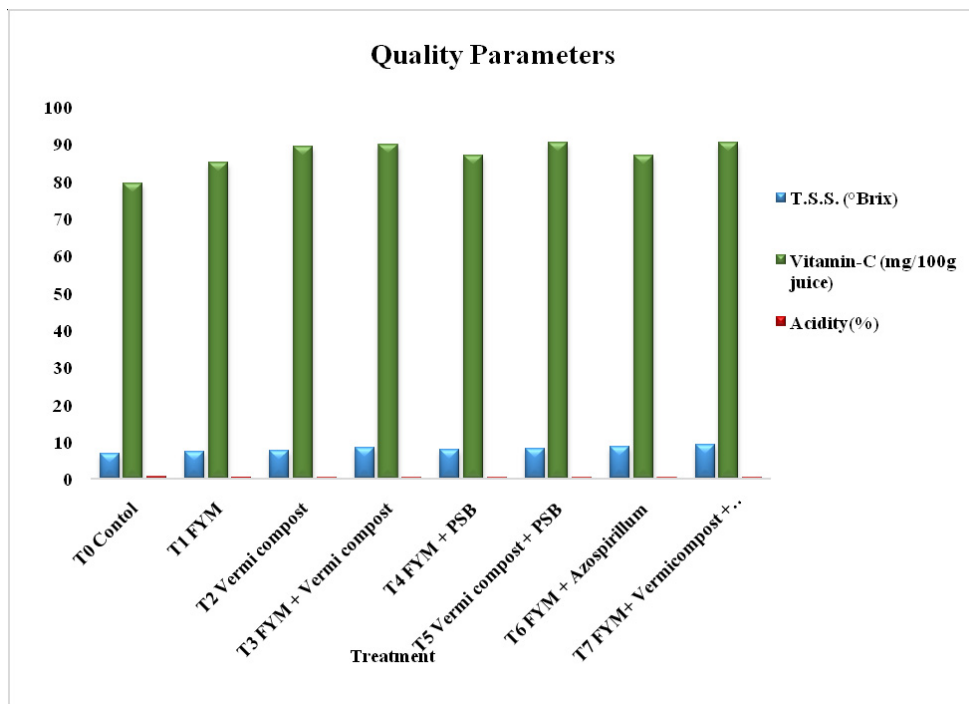


Fig. 2. Graphically shown the quality parameters of broccoli

Table 3. Effect of organic manures and bio-fertilizers on quality characters in broccoli

Treatment No.	Treatments	T.S.S. (°Brix)	Vitamin-C (mg/100g juice)	Acidity (%)
Treatment0	Control	6.87	79.35	0.58
Treatment1	F.Y.M	7.36	85.01	0.48
Treatment2	Vermicompost	7.75	89.51	0.39
Treatment3	F.Y.M + Vermicompost	8.31	89.98	0.34
Treatment4	F.Y.M + PSB	7.87	86.90	0.43
Treatment5	Vermicompost + PSB	8.14	90.40	0.38
Treatment6	F.Y.M +Azospirillum	8.73	87.08	0.41
Treatment7	F.Y.M + Vermicompost + Azospirillum	9.15	90.56	0.37
CD at 5%	1.09	1.16	0.08	
SEM±	0.35	0.38	0.02	

In terms of vit. C content, T<sub>1</sub>(F.Y.M.) experienced the least improvement (7.13%) followed by T<sub>4</sub> (F.Y.M + PSB) (9.51%) and T<sub>6</sub> (F.Y.M + Azospirillum) (9.74%). The lowest Acidity content (0.34%) was found in the treatment T<sub>3</sub> (F.Y.M + vermicompost) at a decreasing rate of (41.37%) followed by T<sub>7</sub> (F.Y.M + vermicompost + Azospirillum) (36.20%), T<sub>5</sub> (Vermicompost + PSB) (34.48%), and T<sub>2</sub> (Vermicompost) (32.75%) as compared to control. Whereas, T<sub>1</sub>(F.Y.M.) experienced the least improvement (17.24%) followed by T<sub>4</sub> (F.Y.M + PSB) (25.86%) and T<sub>6</sub> (F.Y.M + Azospirillum) (29.31%).

It means that among all the manures and bio-fertilizers used FYM and vermicompost played a significant role for higher ascorbic acid accumulation in the heads of broccoli. Due to better development of water-conducting tissue and increased nutrient uptake by the plants, the use of organic manures and bio-fertilizers boosted the growth, nutrient quality and yield of broccoli. These observations are achieved in agreement with (Meena *et al.*, 2017) and (Reger *et al.*, 2018).

## Conclusion

The current experiment clearly demonstrated that the quality, yield, and yield-attributing characteristics of broccoli are significantly improved by the use of any combination of organic manures and bio-fertilizers. Among all the treatments, use of Farm Yard Manure (FYM) + Vermicompost + Azospirillum i.e., T<sub>7</sub> in sprouting broccoli was found to be the best for obtaining highest yield as well as better quality in UP conditions.

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## Conflict of interest

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript. There is no conflict of interest.

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