**IMPACTS OF ORGANIC MANURES AND BIOFERTILIZERS ON YIELD AND ECONOMICS ANALYSIS OF BROCCOLI (*Brassica oleracea* *var. italica)* IN REGION OF KHIALA, PUNJAB**

**ABSTRACT**

The research experiment was conducted under the title “Impacts of Organic Manures and Biofertilizers on Yield and Economics analysis of Broccoli (*Brassica oleracea* *var. italica)* in Region Khiala, Punjab” was carried out at the research studies farm, Department of Agriculture, Sant Baba Bhag Singh University, Khiala, Jalandhar during Rabi season 2023-24.The experiment was laid out in a Randomized Block Design with three replications and 8 treatments comprising of T0- Control (No Organic Manure), T1- Farm Yard Manure (20 t/ha), T2- Vermicompost (5 t/hac), T3- Neem Cake (2 t/hac), T4-*Azotobacter* + *Phosphate Solubilizing Bacteria* (PSB), T5-Farm yard manure+ *Azotobacter* + PSB, T6- Vermicompost+ *Azotobacter* +PSB, T7- Neem cake + *Azotobacter* + PSB. It was observed that treatment T6 (Vermicompost+ Biofertilizers) shows a superior result in yield (Weight of primary and secondary curd, yield per plant, yield per plot and yield per hectare). Overall combined application of organic manures and biofertilizers for better yield of broccoli crop. Economics returns of the same treatment were also found best in term of gross income, net returns and benefit cost ratio.

**Keywords:** *Yield parameters, Organic manures, Biofertilizers, Economics* **Arrange key words alphabetically!**

**INTRODUCTION**

Broccoli (*Brassica oleracea* L.), which is originated from the Mediterranean region commonly known as Hari Gobhi in Hindi and a member of Cole group, belongs to the family Brassicaceae or Cruciferae (mustard family). Broccoli is an Italian vegetable which is cultivated in Italy in ancient roman times. Commercial cultivation of broccoli was started around 1923 (Decoteau, 2000) [1]. Broccoli is classified into two types: heading and sprouting. Heading broccoli produces curd, whereas sprouting broccoli comprises a bunch of green immature buds and a thick fleshy flower stem that develops a head (Dhaliwal, 2017) [2].Broccoli is called the "Crown of Jewel Nutrition" because to its high vitamin and mineral content. It has also had extra benefits, because broccoli is a great source of numerous vitamins and minerals. Approximately 130 times more vitamin A is present in it than Cabbage (Anonymous, 2006)[3], Neha & Nalini, 2025[4]. Brassica vegetables possess both antioxidant and anticarcinogenic properties (Cartea *et al*., 2008) [5] and it is well known that dietary intake of food containing antioxidants provides effective support for the body’ defensive systems and may prevent some diseases (Mc Carty, 2008) [6] (Nalini & Brar, 2017)[7].Broccoli is one of the most nutritious Cole crops and contains vitamin A (130 times and 22 times higher than the cauliflower and cabbage, respectively), thiamin, riboflavin, niacin, vitamin C and minerals like Ca, P, K and Fe (Kumar *et al*., 2011) [8]. Broccoli is a cool-loving crop and very sensitive to high temperature which cause the heads to be distorted, making it a high-risk crop.

Organic manure and biofertilizers offer an alternative source of chemical fertilizers and being increasingly used in vegetable production. Biofertilizers are important beneficial microorganisms, which have ability to mobilize the nutritionally important elements from non-unstable to stable form through biological processes and are known to increase yield in several vegetables (Kumar *et al*., 2001)[9]. Biofertilizers are cost effective and renewable source of plant nutrient. Organic manure is a source of food for the innumerable number of microorganisms and creature like earthworms who breakdown these micronutrients, which are easily absorbed by the plants. Organic manures play major role in plant growth as sources of all necessary macro and micro nutrients in available from during mineralization and improving the physical and chemical properties of soil (Chaterjee *et al*., 2005)[10]. Organic such as Farm yard manure, vermicompost and neem cake improve the soil structure, aeration, slow-release nutrient which support root development leading to higher yield of broccoli (Abou *et al*., 2006)[11] . Considering the above circumstances, this work was undertaken to investigate the performances of different organic manures and biofertilizers on yield of broccoli.

**2. MATERIALS AND METHODS**

This The study was conducted at Sant Baba Bhag Singh University, Department of Agriculture during the Rabi season 2023. It is situated at longitude 75° 81`E, latitude 31°42`N and an elevation of 228 meters above mean sea level in the central plains of Punjab. Climate is subtropical, with abundant rainfall during the Kharif season and little precipitation the rest of the year (*Rabi* season). The mean high temperature was 24.2°C to 31°C, while the mean minimum temperature was 5°C to 11.5°C. The rabi season is distinguished by an abundance of sunlight. The ideal temperature for broccoli production is 18 - 22°C. The humidity recorded 89% during November month when sowing of broccoli is done in field. The experiment was laid out in Randomized Block Design (RBD) with three replications. Welcome-141 broccoli variety was used in the study as a planting material. The total area of the plot 234m2. The size of each plot was 2.5mx 4.0m. The experimental field was ploughed completely before transplantation of seedlings. Debris of previous crop should be removed. The field was properly leveled and adequate drainage was provided (Neha & Nalini, 2025) [4].The plots were made and treatments were assigned as per the layout. Healthy seedlings that were one month old were placed in the experimental plots on October 2023, with a distance of 60 cm × 45 cm between each transplant. The measured data, at 90 days after transplanting were weight of primary and secondary curd, yield per plant, yield per plot and yield per hectare. Economics of the experiment was worked out on the basis of prevailing market prices of inputs and outputs. The data of the trial obtained were subjected to statistical analysis and the results were documented, analyzed and presented in tabular form.

**Fig.1 a) Measuring the diameter of curd b) Weighing the curd c) Yield of broccoli**

 **a) b) c)**

 **RESULTS AND DISCUSSION**

The weight of primary and secondary curd was significantly affected by different applications of organic manures and biofertilizers. The maximum weight of primary curd 412.0 g was recorded with treatment T6, which was statistically at par with treatment T5 (366.6 g), T7 (275.6 g), T2 (269.0 g) and treatment T4 (226.9 g) respectively. The minimum weight of primary curd 168.6 g was recorded under T0 Control plot, then followed by treatment T1(171.5 g) and T3 (224.9 g) respectively. A rise in head weight be brought about by longer-term, increased nutritional accessibility from organic inputs at various growth stages (Naorem *et al*., 2023) [12]. Vermicompost holds onto nutrients for an extended period of time, but ordinary compost is usable to provide plants with the necessary quantity of macro and micronutrients, including the essential NPK, in a shorter length of time. Vermicompost is proven to be a very nutrient dense organic fertilizer and a more potent growth stimulator than traditional composts, according to (Mehedi *et al*., 2018)[13]. The results are quite with findings of (Dhotra *et al*., 2018[14] , Varsha *et al*., 2022 [15] and Lal *et al*., 2012)[16]. The maximum secondary weight of curd was 156.3 g recorded with treatments T6, which is statistically at par with treatments T5 (143.3 g), T7 (136.3 g), T2 (134.9 g) and treatment T4 (137.8 g) respectively. The minimum weight of secondary curd 99.7 g was found under T0 Control plot where no application of organic manures and biofertilizers use, which is significantly followed by treatment T1 (118.4 g) and T3(105.4 g) respectively. The increase in weight of secondary head is due to combine application of FYM, Vermicompost with biofertilizers. Micro and macronutrients that are essential are provided by vermicompost. The physical and chemical qualities of soil are enhanced by organic manure, while simultaneously balancing the supply of nutrients supply and demand. Bio fertilizers are made up of microorganisms that may mobilize nutrients through biological processes from an unusable state to a useable one (Meena *et al*., 2017) [17]. The present results have close resemblance with the findings of (Ekta *et al*., 2017 [18] and Atal *et al*., 2019)[19] .

**Table 1. Effect of organic manures and biofertilizers on weight of primary and secondary curd (g) of broccoli**

|  |  |  |
| --- | --- | --- |
| **Treatments** | **Weight of primary curd (g)** | **Weight of secondary curd (g)** |
| T0 Control (no organic manure) |  168.6 ± 0.722 | 99.7 ± 0.872 |
| T1 Farm yard manure (20 t/ha) |  171.5 ± 0.757 | 118.4 ± 0.330 |
| T2Vermicompost (5t/ha) |  269.0 ± 0.819 | 134.9 ± 0.577 |
| T3 Neem cake (2 t/ha) |  224.9 ± 0.590 | 105.4 ± 0.318 |
| T4 *Azotobacter* + PSB | 226.9 ± 0.580 | 137.8 ± 1.126 |
| T5 Farm yard manure + *Azotobacter* + PSB | 366.6 ± 0.721 | 143.6± 0.512 |
| T6 Vermicompost + *Azotobacter* + PSB | 412.0 ± 0.451 | 156.3 ± 0.319 |
| T7 Neem cake + *Azotobacter* + PSB | 275.6 ± 0.578 | 136.3 ± 0.781 |
| **SE(m)±** | 0.617 | 0.627 |
| **CD (p=0.05)** | 0.873 | 1.921 |

 PSB: Phosphate solubilizing bacteria

Fig.2 Effect of organic manures and biofertilizers on weight of primary and secondary curd (g)

**Yield per plant**

Yield per plant is most crucial parameters for enhancing the total yield. The maximum yield per plant was 568.3 g recorded with treatment T6, which is statistically at par with treatment T5 (510.2 g), T7 (411.9 g), T2 (403.9 g) and T4 (364.7 g) respectively. While minimum yield per plant 268.3 g was recorded under T0 Control plot, which was followed by treatment T1 (289.9 g) and T3 (330.4 g) respectively.

The enhancement in yield per plant is due to the right amount of nitrogen, which is essential for the synthesis of many different substances, such as enzymes that help plants utilize carbohydrates and chlorophyll. Furthermore, ATP and ADP both include phosphorus, which is crucial for the intake of nutrients. Similar to how potassium promotes starch synthesis, photosynthesis, sugar translocation, and eventually plant development in broccoli, it also activates a variety of enzymes and alters energy metabolism (Kumar *et al.,*2017)[20]. In addition to releasing nutrients gradually, organic fertilizers are additionally utilized to enhance the foundation and equilibrium of the soil and to increase crop plant output and quality. These fertilizers are created from animal excrement or other agricultural wastes Gami *et al.,*2023[21]**.** Similar findings have also been recorded by Atal *et al.,*(2019)[19] and Varsha *et al.,*(2022)[15]**.**

 **Table 2. Effect of organic manures and biofertilizers on yield per plant (g) and per plot (kg) of broccoli**

|  |  |  |
| --- | --- | --- |
| **Treatments** | **Yield per plant (g)** | **Yield per plot (kg)** |
| T0 Control (no organic manure) | 268.3± 0.96 | 2.65 ± 0.49 |
| T1 Farm yard manure (20 t/ha) | 289.9 ± 0.52 | 3.23 ± 0.18 |
| T2Vermicompost (5t/ha) | 403.9 ± 1.09 | 3.76 ± 0.37 |
| T3 Neem cake (2 t/ha) | 330.4± 0.69 | 3.31 ± 0.42 |
| T4 *Azotobacter* + PSB | 364.7± 0.86 | 3.67 ± 0.38 |
| T5 Farm yard manure + *Azotobacter* + PSB | 510.2± 0.59 | 5.53 ± 0.29 |
| T6 Vermicompost + *Azotobacter* + PSB | 568.3± 0.57 | 5.66 ± 0.17 |
| T7 Neem cake + *Azotobacter* + PSB | 411.9 ± 0.60 | 4.09 ± 0.09 |
| **SE(m)±** | 0.61 | 0.29 |
| **CD (p=0.05)** | 1.76 | 0.90 |

PSB: Phosphate solubilizing bacteria mean of three replications

Fig. 3 Effect of organic manures and biofertilizers on yield per plant (g) and (kg)

**Yield per plot**

The maximum yield per plot was recorded with treatment T6 (5.66 kg), which was statistically at par with treatment T5 (5.53 kg), T7 (4.09 kg), T2 (3.76 kg) and treatment T4 (3.67 kg) respectively. The minimum yield per plot was 2.65 kg found under T0 Control plot, which was followed by treatment T1 (3.23 kg) and treatment T3 (3.31 kg) respectively. Because farmyard manure and vermicompost have a positive impact on the physical, chemical, and biological properties of soil, which in turn aid in enhancing plant absorption of nutrients, higher values for yield contributing characteristics have been achieved (Jain *et al.,*2023)[22]. The application of organic materials led to improved broccoli plant growth and yield, which may have been caused by the availability of a more readily available kind of fertilizer for plants. It also improved the soil's ability to store water and other plant nutrients, such as micronutrients. Organic material provides a favorable environment for the growth of broccoli plants' root systems. According to Indriyati *et al.* (2015)[23], applying organic materials enhanced soil organic C and considerably reduced exchangeable aluminum (Al) in acid soil at varied levels, regardless of the type of organic material applied. Greater nutrient availability and ideal soil conditions for plant growth led to the establishment of healthy vegetative plants, which in turn produced a larger yield.

**Yield per hectare**

One of the most important factors to take into account when evaluating the efficacy of different treatments and looking at a number of factors is yield per hectare. The maximum yield per hectare was 56.6 q ha-1 was obtained with treatment T6, which was statistically at par with treatment T5 (55.3 q ha-1), T7 (40.9 q ha-1), T2 (37.6 q ha-1) and treatment T4 (36.7 q ha-1) respectively. The minimum yield per hectare 26.5 q ha-1 was recorded under T0 Control Plot, which was then followed by treatment T1 (32.3 q ha-1) and T3 (33.1q ha-1) respectively. It is well known that *Azotobacter* produces antifungal and antibiotic compounds that suppress a range of soil fungus.

 Additionally, it is capable of synthesizing and secreting gibberellins, or compounds that resemble gibberellins, thiamine, riboflavin, pyridoxine, cyanocobalamin, nicotinic acid, pentatonic acid, Indole acetic acid, and gibberellins, which promote strong plant development and dry matter.

Additionally, it improved head development, fertilization, and yield in the end. Phosphorus solubilizing bacteria (PSB) release growth-promoting chemicals and vitamins into the soil, which feeds the crops. After PSB was injected, broccoli sprouts showed improved yield characteristics. This might be because the phosphorus that was previously insoluble or otherwise fixed became more soluble and more available to the plants. When combined with other nutrients, the favorable benefits of PSB may have enhanced agricultural productivity. This might have happened because various reproductive structures partitioned more quickly, leading to a larger crop yield overall (Lal *et al.,*2012)[16].

**Table 3. Effect of organic manures and biofertilizers on yield per hectare (q/ha) of broccoli**

|  |  |
| --- | --- |
| **Treatments** | **Yield per hectare (q/ha)** |
| T0 Control (no organic manure) | 26.5 ± 0.35 |
| T1 Farm yard manure (20 t/ha) | 32.3 ± 0.39 |
| T2Vermicompost (5t/ha) | 37.6 ± 0.88 |
| T3 Neem cake (2 t/ha) | 33.1 ± 0.60 |
| T4 Biofertilizers (*Azotobacter* + PSB) | 36.7 ± 0.41 |
| T5 Farm yard manure + *Azotobacter* + PSB | 55.3 ± 0.46 |
| T6 Vermicompost + *Azotobacter* + PSB | 56.6 ± 0.52 |
| T7 Neem cake + *Azotobacter* + PSB | 40.9 ± 0.99 |
| **SE(m)±** | 0.53 |
| **CD (p=0.05)** | 1.06 |

 PSB: Phosphate solubilizing bacteria mean of three replications

Fig. 4 Effect of organic manures and biofertilizers on yield per hectare (q/ha)

**4. ECONOMIC ANALYSIS**

The economics of different treatments viz., yield, cost of cultivation, gross return, net return and benefit cost ratio.

**Gross returns**

The maximum gross return Rs. 283000 ha-1 was obtained with treatment T6, which was statistically at par with treatment T5 (Rs. 276500 ha-1), T7 (Rs. 204500 ha-1), T2 (Rs.188000 ha-1) and treatment T4 (Rs.183500 ha-1) respectively. The minimum gross return Rs. 132500 ha-1 was recorded under T0 Control Plot, which was then followed by treatment T1 (Rs. 164500 ha-1) and T3 (Rs. 165500 ha-1) respectively.

Combined application of vermicompost and biofertilizers recorded to have more gross returns as compared to other treatment. The result is quite in line with those of (Mal *et al.,*2014) [24]and (Jaiswal *et al.,*2022)[25] **.**

**Net return**

The maximum net return (Rs. 212450 ha-1) was obtained with treatment T6, which was statistically at par with treatment T5 (Rs. 194050 ha-1), T7 (Rs. 129950 ha-1), T2 (Rs. 109044 ha-1) and treatment T4 (Rs. 103045 ha-1) respectively. The minimum gross return Rs. 57045 ha-1 was recorded under T0 Control Plot, which was then followed by treatment T1 (Rs. 84608 ha-1) and T3 (Rs. 85270 ha-1) respectively.

Combined application of vermicompost and biofertilizers recorded to have more net returns as compared to other treatment. The result is quite in line with those of (Changkija *et al.,*2017) [26] and (Mathukiya *et al.,*2022)[27]**.**

**Benefit cost ratio**

The maximum benefit cost ratio (3.01) was obtained with treatment T6, which was statistically at par with treatment T5 (2.35), T7 (1.74), T2 (1.38) and treatment T4 (1.28) respectively. The minimum benefit cost ratio (0.75) was recorded under T0, which was then followed by treatment T3 (1.06) and T1 (1.10) respectively. Combined application of vermicompost and biofertilizers recorded to have more benefit cost ratio as compared to other treatment. Similar observations were found by (Singh *et al.,*2021) [28]and (Ekta *et al.,*2017)[29].

**Table 4. Effect of organic manures and biofertilizers on gross return, net return and benefit cost ratio of broccoli**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Treatments** | **Cost of cultivation****(Rs ha-1)** | **Total yield** **(q ha-1)** | **Gross return (Rs ha-1)** | **Net return (Rs ha-1)** | **B:C ratio** |
| **a** | **b** | **c= b X MSP** | **d= c-a** | **e= d/a** |
| T0 Control (no organic manure) | 75455 | 26.5 | 132500 | 57045 | 0.75 |
| T1 Farm yard manure (20 t/ha) | 76892 | 32.3 | 161500 | 84608 |  1.10 |
| T2Vermicompost (5t/ha) | 78956 | 37.6 | 188000 | 109044 | 1.38 |
| T3 Neem cake (2 t/ha) | 80230 | 33.1 | 165500 | 85270 | 1.06 |
| T4 *Azotobacter* + PSB | 80455 | 36.7 | 183500 | 103045 | 1.28 |
| T5 Farm yard manure + *Azotobacter* + PSB | 82450 |  55.3 | 276500 | 194050 | 2.35 |
| T6 Vermicompost + *Azotobacter* + PSB | 70550 | 56.6 | 283000 | 212450 | 3.01 |
| T7 Neem cake + *Azotobacter* + PSB | 74550 | 40.9 | 204500 | 129950 | 1.74 |

B:C: benefit cost ratio, PSB: Phosphate solubilizing bacteria

 Fig .5 Effect of organic manures and biofertilizers on gross returns and net returns of broccoli

**Conclusion and Recommendation**

The findings of the study experiment revealed that the combination of vermicompost and biofertilizers have shown positive results on yield parameters as well as productivity of broccoli with maximum net returns. The maximum performance in yield parameters were found with treatment T6 (Vermicompost + Biofertilizers), which was statistically at par with treatment T5 (Farm yard manure + Biofertilizers). The use of vermicompost has resulted in increased growth and provide micronutrients, and improve soil conditions that facilitate the accessibility of important nutrients. Vermicomposting has decomposing diverse organic resources into environment. Biofertilizers improve the microbial biomass and soil structure, resulting in higher production. The combination of both have shown ecofriendly and sustainable response to environment.

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**Use “and” as against “&” to make uniform style and meet standard rule**