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# Influence of organic manures and different bio-inoculants on production potential of turnip (*Brassica Rapa* L.) under heavy soils of Punjab

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**Abstract**
A field experiment entitled Influence of organic manures and different bio-inoculants on production potential of turnip (*Brassica rapa* L.) under heavy soils of Punjab was conducted during the Rabi season of 2024–25 at the Campus for Research and Advanced Studies, Dhablan, G.S.S.D.G.S. Khalsa College, Patiala. The experiment was laid out in a Split-Plot Design (SPD) with 3 replications and 12 treatment combinations. The statistical analysis revealed that among organic manures and their combinations, $OM_4$- FYM (10 t $ha^{-1}$) + PM (1 t $ha^{-1}$) + VC (0.5 t $ha^{-1}$) ensured greater plant height (41.31 cm), number of leaves plant $^{-1}$ (25.13), leaf length (27.87 cm), leaf width (8.87 cm), leaf area index (3.64), root length (14.32 cm), root width (11.03 cm), root yield (27.18 kg $plot^{-1}$), root yield (260.37 q $ha^{-1}$), gross return (520728.89 Rs $ha^{-1}$), net return (375765.56 Rs $ha^{-1}$) and B:C ratio (2.59). Similarly, for different bio-inoculants, $BI_3$- PSB (5kg $ha^{-1}$) performed best in terms of plant height (40.31 cm), number of leaves plant $^{-1}$ (22.53), leaf length (27.13 cm), leaf width (8.52 cm), leaf area index (3.12), root length (13.45 cm), root width (10.01 cm), root yield (24.01 kg $plot^{-1}$), root yield (213.02 q $ha^{-1}$), gross return (426008.33 Rs $ha^{-1}$), net return (274408.33 Rs $ha^{-1}$) and B:C ratio (1.81). The interaction effect between organic manures and different bio-inoculants was found to be non-significant for all parameters.

**Keywords:** Turnip, Organic manure, Bio-inoculants and Split-Plot Design

## Introduction
Turnip (2n=20) is one of the most important root vegetable crop grown worldwide. It is a cool-season vegetable crop of the Brassicaceae family. It is believed to have originated from a wild form of Eurasian origin. It is frequently referred to as turnip mustard or field mustard. It is well adapted to areas of humid tropics and sub-tropical climates. The root develops best flavour, texture and size at a temperature of 10-15°C. The short-day length and cool weather favour the proper development of roots. Turnip can be grown in all types of soils, but it grows best in sandy-loamy soil with sufficient humus. The crop has the capability to fit excellently in various multiple cropping sequences owing to its rapid maturity and short growing period. It is used for human consumption as well as feed for livestock (Javed *et al*. 2019) [12]. Turnip consists of bioactive components which are anti-cancerous, anti-diabetic, anti-microbial and anti-oxidant in nature. Bioactive component known as isothiocyanate helps in reducing the risk of cancer (Cao *et al*. 2021) [7].

Manures are used to enhance soil quality and ensure high crop yields. As organic farming is good for the environment and human health, it is growing in popularity. In addition to providing nutrients and organic matter, these manures increase the size, biodiversity, and activity of the soil's microbial population. The residue they produce makes them more important for the entire ecosystem than individual crops (Arora and Maini, 2011) [4]. Bio-inoculants are substances that are applied to seeds, plant surfaces or soil that contain live microorganisms. Through a distinct biological mechanism, microorganisms found in bio-inoculants aid in the mobilization of nutritional components from non-useable to usable forms. These are also more affordable, sustainable and environmental friendly sources of fertilizer that produce plant hormones that improve crop quality and growth (Asokan *et al*. 2000) [5].

## Material and methods

The field experiment was conducted during the Rabi season of 2024–25 at the Campus for Research and Advanced Studies, Dhablan, Postgraduate Department of Agriculture, G.S.S.D.G.S. Khalsa College, Patiala. A field experiment was carried out with 12 treatment combinations. The design used was a Split-Plot Design (SPD) with 3 replications. The growth parameters like plant height (cm), number of leaves plant $^{-1}$, leaf length (cm), leaf width (cm) and leaf area index were recorded at 20 DAS, 40 DAS, 60 DAS and at harvest. Correspondingly, yield parameters like root length (cm), root width (cm), root yield (kg plot$^{-1}$) and root yield (q ha$^{-1}$) were recorded at harvest and economic parameters were also analysed for different treatment combinations.

### Treatment Details

**Main plot - Bio-inoculants**

$BI_1$ – *Azotobacter* (5kg ha$^{-1}$)
$BI_2$ – *Azospirillium* (5kg ha$^{-1}$)
$BI_3$ - PSB (5kg ha$^{-1}$)

**Sub plot - Organic Manures**

$OM_1$ - FYM (10 t ha$^{-1}$)
$OM_2$ - FYM (15 t ha$^{-1}$) + Poultry manure (2 t ha$^{-1}$)
$OM_3$ - FYM (15 t ha$^{-1}$) + Vermicompost (1 t ha$^{-1}$)
$OM_4$ - FYM (10 t ha$^{-1}$) + Poultry manure (1 t ha$^{-1}$) + Vermicompost (0.5 t ha$^{-1}$).

| Experiment details of layout | |
|---|---|
| Design | Split Plot Design (SPD) |
| Replications | 3 |
| No. of treatments | 12 |
| No. of experimental plots | 36 |
| Seed rate | 3 kg ha$^{-1}$ |
| Gross plot size | 4.05 x 3.0 m |
| Net plot size | 3.6 x 2.9 m |
| Spacing (Row to Row) | 45x10 cm |
| Variety | Purple Top White Globe |

## Result and Discussion

**Growth parameters:** With the application of organic manures and their integration, $OM_4$: FYM (10 t ha$^{-1}$) + PM (1 t ha$^{-1}$) + VC (0.5 t ha$^{-1}$) outperforms with the plant height (41.31 cm), number of leaves plant $^{-1}$ (25.13), leaf length (27.87 cm), leaf width (8.87 cm) and leaf area index (3.64). and the lowest was recorded with $OM_1$-FYM (10 t ha$^{-1}$), with plant height (37.41 cm), number of leaves plant$^{-1}$ (18.62), leaf length (25.52 cm), leaf width (7.65 cm), and leaf area index (2.17). This outcome mirrors the patterns identified by Aradhya *et al*. (2022) [3] in turnip, Aisha *et al*. [1] (2014) and Hazarika *et al*. (2016) [11]. The findings state that an increase in plant height is due to cell elongation, cell division, chlorophyll synthesis and photosynthetic activity. It helps in root nodulation and nitrogen fixation. This can be attributed to the balanced, sustained nutrient supply provided by the $OM_4$ combination.

**Table 1:** Influence of organic manures and different bio-inoculants on growth parameters of turnip

| Treatments | Plant height (cm) | Number of leaves plant $^{-1}$ | Leaf length (cm) | Leaf width (cm) | Leaf area index |
|---|---|---|---|---|---|
| **Bio-inoculants** | | | | | |
| $BI_1$: *Azotobacter* (5kg ha$^{-1}$) | 39.16 | 21.15 | 26.46 | 8.18 | 2.72 |
| $BI_2$: *Azospirillium* (5kg ha$^{-1}$) | 39.71 | 21.97 | 26.97 | 8.34 | 3.02 |
| $BI_3$: PSB (5kg ha$^{-1}$) | 40.31 | 22.53 | 27.13 | 8.52 | 3.12 |
| SEm ± | 0.34 | 0.21 | 0.06 | 0.07 | 0.06 |
| CD 5% | 0.95 | 0.58 | 0.17 | 0.19 | 0.16 |
| **Organic Manures** | | | | | |
| $OM_1$: FYM (10 t ha$^{-1}$) | 37.41 | 18.62 | 25.52 | 7.65 | 2.17 |
| $OM_2$: FYM (15 t ha$^{-1}$) + PM (2 t ha$^{-1}$) | 39.58 | 20.39 | 26.66 | 8.28 | 2.80 |
| $OM_3$: FYM (15 t ha$^{-1}$) + VC (1 t ha$^{-1}$) | 40.60 | 23.40 | 27.34 | 8.60 | 3.20 |
| $OM_4$: FYM (10 t ha$^{-1}$) + PM (1 t ha$^{-1}$) + VC (0.5 t ha$^{-1}$) | 41.31 | 25.13 | 27.87 | 8.87 | 3.64 |
| SEm ± | 0.23 | 0.28 | 0.09 | 0.09 | 0.05 |
| CD 5% | 0.67 | 0.81 | 0.27 | 0.25 | 0.14 |

Correspondingly, with different bio-inoculants, the best plant height (40.31 cm), number of leaves plant $^{-1}$ (22.53), leaf length (27.13 cm), leaf width (8.52 cm) and leaf area index (3.12) was recorded with $BI_3$: PSB (5kg ha$^{-1}$), which was statistically at par with $BI_2$: *Azospirillium* (5kg ha$^{-1}$) plant height (39.71 cm), number of leaves plant $^{-1}$ (21.97), leaf length (26.97 cm), leaf width (8.34 cm) and leaf area index (3.02). The least values were recorded with $BI_1$-*Azotobacter* (5kg ha$^{-1}$) as plant height (39.16 cm), number of leaves plant $^{-1}$ (21.15), leaf length (26.46 cm), leaf width (8.18 cm) and leaf area index (2.72). The results are consistent with the observations of Ekta *et al*. (2017) [9], Bajpai *et al*. (2022) [6], Ali *et al*. (2023) [2] in cauliflower and Gujar *et al*. (2025) [10], who noted that PSB helps in the secretion of growth hormones, which help in the uptake and transportation of water and decomposition of nutrients. PSB produces enzymes like phosphatases and phytases, which break down the organic phosphorus. Phosphorus is essential for energy transfer, which helps plants reach their maximum height potential more quickly.

### Yield parameters

With different organic manures, the yield parameters were highest with $OM_4$: FYM (10 t ha$^{-1}$) + PM (1 t ha$^{-1}$) + VC (0.5 t ha$^{-1}$) recording root length (14.32cm), root diameter (11.03 cm), root yield (27.18 kg plot$^{-1}$) and root yield (260.37 q ha$^{-1}$) and the least results were shown by $OM_1$-FYM (10 t ha$^{-1}$) resulting in like root length (11.74 cm), root diameter (8.06 cm), root yield (13.32 kg plot$^{-1}$) and root yield (125.06 q ha$^{-1}$). The findings of Debbarma *et al*. (2018) [8], Kumar and Gupta (2018) [13] and Kumar *et al*. (2022) [14] in tomato conclude that the size of the fruit is directly influenced by the enhanced vegetative growth.

**Table 2:** Influence of organic manures and different bio-inoculants on yield parameters of turnip

| Treatments | Root length (cm) | Root diameter (cm) | Root yield (Kg plot$^{-1}$) | Root yield (q ha$^{-1}$) |
|---|---|---|---|---|
| **Bio-inoculants** | | | | |
| $BI_1$: *Azotobacter* (5kg ha$^{-1}$) | 12.92 | 9.29 | 19.19 | 183.85 |
| $BI_2$: *Azospirillium* (5kg ha$^{-1}$) | 13.34 | 9.78 | 21.62 | 205.24 |
| $BI_3$: PSB (5kg ha$^{-1}$) | 13.45 | 10.01 | 24.01 | 213.01 |
| SEm ± | 0.05 | 0.09 | 0.89 | 8.54 |
| CD 5% | 0.14 | 0.24 | 2.47 | 23.70 |
| **Organic Manures** | | | | |
| $OM_1$: FYM (10 t ha$^{-1}$) | 11.74 | 8.06 | 13.32 | 125.06 |
| $OM_2$: FYM (15 t ha$^{-1}$) + PM (2 t ha$^{-1}$) | 13.19 | 9.54 | 19.33 | 185.20 |
| $OM_3$: FYM (15 t ha$^{-1}$) + VC (1 t ha$^{-1}$) | 13.72 | 10.14 | 24.24 | 232.16 |
| $OM_4$: FYM (10 t ha$^{-1}$) + PM (1 t ha$^{-1}$) + VC (0.5 t ha$^{-1}$) | 14.32 | 11.03 | 27.18 | 260.37 |
| SEm ± | 0.09 | 0.14 | 0.63 | 6.24 |
| CD 5% | 0.25 | 0.41 | 1.83 | 18.01 |

An increase in root length can be due to the combined application of vermicompost and poultry manure. It can be attributed to improved nutrient availability and improvement in the physical condition of the soil, like soil porosity, making it easier for roots to penetrate deeper and absorb nutrients, which in turn provides a balanced nutritional environment both in the soil rhizosphere and the plant system. Similarly, between different bio-inoculants root length (13.45cm), root diameter (10.01cm), root yield (24.01 kg plot$^{-1}$) and root yield (213.01 q ha$^{-1}$) was maximal with $BI_3$: PSB (5kg ha$^{-1}$) which was statistically at par with $BI_2$: *Azospirillium* (5kg ha$^{-1}$) resulting in like root length (13.34cm), root diameter (9.78cm), root yield (21.62 kg plot$^{-1}$) and root yield (205.24 q ha$^{-1}$) and lowest results were observed with $BI_1$- *Azotobacter* (5kg ha$^{-1}$) resulting in root length (12.93 cm), root diameter (9.29 cm), root yield (19.19 kg plot$^{-1}$) and root yield (183.85 q ha$^{-1}$) A similar trend was observed by Parry *et al*. (2021) [15] and Sharma *et al*. (2023) [16]. PSB is known to synthesise Indole 3 acetic acid (IAA), which is the primary hormone responsible for root initiation and elongation. PSB boost soil microbial activity, fostering robust root development and resilience against environmental stress.

## Economic parameters

The findings of economics with different treatments reported that $OM_4$: FYM (10 t ha$^{-1}$) + PM (1 t ha$^{-1}$) + VC (0.5 t ha$^{-1}$) recorded maximum gross return of 520728.89 Rs ha$^{-1}$, net return 375765.56 Rs ha$^{-1}$ and B:C ratio of 2.59 and the minimum results were derived from $OM_1$- FYM (10 t ha$^{-1}$) for gross return of 250126.67 Rs ha$^{-1}$and net return 131163.34 Rs ha$^{-1}$ whereas $OM_2$- FYM (15 t ha$^{-1}$) + Poultry manure (2 t ha$^{-1}$) resulted in lowest B:C ratio of 1.01.

**Table 3:** Influence of organic manures and different bio-inoculants on economic parameters of turnip

| Treatments | Gross return (Rs ha $^{-1}$) | Net return (Rs ha $^{-1}$) | B:C ratio |
|---|---|---|---|
| **Bio-inoculants** | | | |
| $BI_1$: *Azotobacter* (5kg ha$^{-1}$) | 367696.67 | 217146.67 | 1.44 |
| $BI_2$: *Azospirillium* (5kg ha$^{-1}$) | 410473.33 | 259733.33 | 1.72 |
| $BI_3$: PSB (5kg ha$^{-1}$) | 426008.33 | 274408.33 | 1.81 |
| SEm ± | 17070.61 | 17070.61 | 0.12 |
| CD 5% | 47395.62 | 47395.62 | 0.32 |
| **Organic manures** | | | |
| $OM_1$: FYM (10 t ha$^{-1}$) | 250126.67 | 131163.33 | 1.10 |
| $OM_2$: FYM (15 t ha$^{-1}$) + PM (2 t ha$^{-1}$) | 370393.33 | 186430.00 | 1.01 |
| $OM_3$: FYM (15 t ha$^{-1}$) + VC (1 t ha$^{-1}$) | 464322.22 | 308358.89 | 1.98 |
| $OM_4$: FYM (10 t ha$^{-1}$) + PM (1 t ha$^{-1}$) + VC (0.5 t ha$^{-1}$) | 520728.89 | 375765.56 | 2.59 |
| SEm ± | 12472.87 | 12472.87 | 0.08 |
| CD 5% | 36024.25 | 36024.25 | 0.23 |

Correspondingly, it was recorded best with $BI_3$: PSB (5kg ha$^{-1}$) as gross return of 4206008.33 Rs ha$^{-1}$, net return 274408.33 Rs ha$^{-1}$ and B:C ratio of 1.81 which was statistically at par with $BI_2$: *Azospirillium* (5kg ha$^{-1}$) as gross return of 410473.33 Rs ha$^{-1}$, net return 259733.33 Rs ha$^{-1}$ and B:C ratio of 1.72 and least values were observed with $BI_1$- *Azotobacte*r (5kg ha$^{-1}$) as gross return of 367696.67 Rs ha$^{-1}$, net return 217146.67 Rs ha$^{-1}$ and B:C ratio of 1.44.

## Conclusion

After experimenting, the results concluded that $OM_4$: FYM (10 t ha$^{-1}$) + PM (1 t ha$^{-1}$) + VC (0.5 t ha$^{-1}$) gave higher results for all the growth, yield and economics parameters. Also, in the case of different bio-inoculants $BI_3$: PSB (5kg ha$^{-1}$) outperformed all the parameters. The combined effect of organic manure and bio-inoculants showed a non-significant influence on the growth, yield, quality and economics parameters of turnip. It is concluded that the combined application of organic manure $OM_4$: FYM (10 t ha$^{-1}$) + PM (1 t ha$^{-1}$) + VC (0.5 t ha$^{-1}$) and $BI_3$: PSB (5kg ha$^{-1}$) shows the most effective results. This combination is a sustainable approach ensuring increased nutrient uptake, better microbial activity in soil, improved soil quality and productivity.

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