

Influence of chemical, organic and biofertilizers on growth, yield attributes and yield of Indian mustard (*Brassica juncea* L.)

Abstract

A field experiment was conducted at the Agriculture Research Farm, School of Agricultural Sciences and Technology, RIMT University, Mandi Gobindgarh, Punjab in India during rabi season 2023-24 to study the "Influence of chemical, organic and biofertilizer on growth, yield attributes and yield of Indian mustard (*Brassica juncea* L.)". The experimental field was laid out in a randomized block design (RBD) with 8 treatments and replicated thrice. The treatment combinations are T1- control, T2- 100% RDN and T3- 75% RDN + 5t FYM ha^{-1} , T4- 75% RDN + 5t FYM ha^{-1} + *Azotobacter* 20 ml ha^{-1} , T5- 75% RDN+ *Azotobacter* 20 ml ha^{-1} , T6- 50% RDN + 10t FYM ha^{-1} , T7- 50% RDN + 10t FYM ha^{-1} + *Azotobacter* 20 ml ha^{-1} , T8- 50% RDN + *Azotobacter* 20 ml ha^{-1} . The result of present study revealed that the treatment T4 (75% RDN + 5t FYM ha^{-1} + *Azotobacter* 20 ml ha^{-1}) has shown significant result on plant population m^{-2} (at harvest) (14.5), plant height (cm) (153.2cm), number of branches $plant^{-1}$ (20.5), chlorophyll content ($\mu mole m^{-2}$) (SPAD) (45.10), no. of siliqua $plant^{-1}$ (300.10), no. of seeds siliqua $^{-1}$ (18.0), siliqua length (cm) (5.90cm), test weight (g) (3.36g), seed yield $q ha^{-1}$ (22.98 $q ha^{-1}$), stover yield $q ha^{-1}$ (56.07 $q ha^{-1}$), biological yield $q ha^{-1}$ (79.06 $q ha^{-1}$) and harvest index (%) (28.80%).

Comment [JT1]: The summary lacks conclusion

Key words: Mustard, nitrogen, FYM, Bio-fertilizer, growth, yield, India-

Introduction

Indian mustard (*Brassica juncea* L.) is an important rabi season oilseed crop of the world which belongs to the family Brassicaceae. The ideal temperature for the growth of mustard is 15°C – 25°C and prefers a pH range of 6.0-7.5. The suitable soils are sandy loam to clay loam soil but thrive best on light loam soils and well drained soils. India is the third largest rapeseed-mustard producer country in the world after China and Canada. This crop accounts for nearly one-third of the oil produced in India, making it the country's key edible oilseed crop (Kumar *et al.*, 2013). Mustard seed, in general, contains 30-33% oil, 17-25% proteins, 8-10% fibre, 6-10% moisture and 10-12% extractable substances (Pandey *et al.*, 2013). Indian mustard is commonly known as "raya", and is considered a vital oil producing

crop among Brassica in India (Meena *et al.*, 2018). Globally, the estimated area, production and yield of mustard during 2018-19 was 36.59 million hectares (mha), 72.37 million tonnes (mt) and 1980 kg ha⁻¹, respectively (Anonymous, 2020). In India, it is grown in an area of 6.1 mha with a production of 8.3 mt and 1349 kg ha⁻¹ productivity during 2018-19 (Anonymous, 2021). It is mainly grown in northern part of India and Rajasthan is the largest producing state followed by Uttar Pradesh (Sodani *et al.*, 2017). In Punjab state, it is grown on 43.9 thousand hectares with a production of 69.3 thousand tonnes during 2021-22 (Anonymous 2023-24). The average yield was 15.79 quintals ha⁻¹ (6.39 q acre⁻¹).

Comment [JT2]: Highlight the current yield and potential to see the gap without good fertilization

Oilseeds are energy rich crops and obviously the requirement of major nutrient is very high. Chemical fertilizers played a major role in agricultural production and changed the country from a region of food scarcity to food sufficiency. But chemical fertilizers have also contributed significantly towards the pollution of water, air and soil and it alone cannot sustain the soil productivity. So the current trend is to explore the possibility of supplementing chemical fertilizers with organic ones, which are eco-friendly and cost-effective (Datta *et al.*, 2009). The use of chemical fertilizers in combination with organic manure is essentially required to improve soil health (Prasad *et al.*, 2017). *Brassica juncea* requires a relatively large amount of nutrients for realization of yield potential but inadequate supply often leads to low productivity (Tripathi *et al.* 2010). The nutrient management is one of the most important agronomic factors that affect the Indian mustard (Hadiyal *et al.*, 2017). Independent use of neither the chemical fertilizers nor the organic sources can sustain the fertility of soil and productivity of the crops in high input production system (Thaneshwar *et al.*, 2017). Under such situation, balance combinations of chemical fertilizers with organic resources such as farmyard manure (FYM) and bio-fertilizers like *Azospirillum* and phosphate solubilizing bacteria (PSB) which are also eco-friendly and cost effective can be used to boost the production and also to improve fertilizer use efficiency (Singh and Sinsinwar, 2006).

Nitrogen is considered to be the most important nutrient, which determines the growth of the mustard crop and increases the amount of protein and yield. Nitrogen also affects the uptake of other essential nutrients and it helps in the better partitioning of photosynthates to reproductive parts which increase the seed: stover ratio (Singh and Meena, 2004). Farmyard manure supplies the essential plant nutrients N, P and K in available form to the plant through mineralization as it contains 0.5% N, 0.2% P and 0.5% K and it also improves the soil structure through aggregation (Kumawat *et al.*, 2018), nutrient use efficiency, microbial

action and ensures better availability of nutrients in soil. Bio fertilizers such as *Azotobacter* promotes seed germination and give initial vigor of plant by producing growth promoting substances (Yadav *et al.*, 2010). Integrated nutrient management is essential in sustaining high crop production over the years and also improves soil health by ensuring a safer environment (Pal and Pathak, 2016). So the integrated nutrient supply system involving a combination of chemical fertilizers with organic sources and bio fertilizers has been quite promising in sustaining the soil health and productivity of Indian mustard.

Materials and methods

The present experiment entitled, "Influence of chemical, organic and bio-fertilizer on growth, yield attributes and yield of Indian mustard (*Brassica juncea* L.)" was conducted during rabi season 2023-24 at the Agriculture Research Farm, School of Agricultural Sciences and Technology, RIMT University, Mandi Gobindgarh, Punjab in north of India. The experimental site (Mandi Gobindgarh) is situated at 30.6642° N latitude and 76.2914° E longitude at an altitude of 268 meters above mean sea level. The experiment comprised of 8 treatment combinations in randomized block design (RBD) with three replications. The treatment combinations are T1- control, T2- 100% RDN and T3- 75% RDN + 5t FYM ha⁻¹, T4- 75% RDN + 5t FYM ha⁻¹ + *Azotobacter* 20 ml ha⁻¹, T5- 75% RDN+ *Azotobacter* 20 ml ha⁻¹, T6- 50% RDN + 10t FYM ha⁻¹, T7- 50% RDN + 10t FYM ha⁻¹ + *Azotobacter* 20 ml ha⁻¹, T8- 50% RDN + *Azotobacter* 20 ml ha⁻¹. Kesari 5111 variety of mustard with a seed rate of 3.75 kg ha⁻¹ were used in the treatment. It was hand sown at a depth of 4-5 cm with row to row spacing of 45 cm and plant to plant spacing of 15 cm. Nitrogen was applied through urea in splits as chemical source of nutrient. Half dose of nitrogen was applied as basal dose at the time of sowing and remaining half dose of nitrogen was applied 30 days after sowing as per treatment. As per treatment, the seeds were inoculated with bio fertilizer (*Azotobacter*) at the time of sowing and sown to the plots according to treatment wise. The data on growth parameters (plant population m⁻², plant height (cm), branches plant⁻¹ and chlorophyll content), yield attributes (no. of siliqua plant⁻¹, no. of seeds siliqua⁻¹, siliqua length and test weight) and yield (grain yield, stover yield, biological yield and harvest index) were observed.

Results and discussion

Growth parameters

Data regarding Growth parameters viz., plant population m⁻², plant height (cm), no. of branches plant⁻¹ and chlorophyll content (µmole m⁻²) (SPAD) are mentioned in Table 1.

Comment [JT3]: If it is possible, a first point must be made for the material (description of the study area, other materials used, if possible produce the map of the study area, etc.) and the methodology for the next point which will specify the method of work and data analysis.

Comment [JT4]: Please define these terms at least once at the beginning for ease of understanding

Comment [JT5]: The method does not present the data analysis tools and the different tests applied for data analysis

Plant population m^{-2} (at harvest)- The results revealed that significantly higher plant population per m^2 was observed at treatment T4- 75% RDN + 5t FYM ha^{-1} + *Azotobacter* 20 ml ha^{-1} (14.5) over T7- 50% RDN + 10t FYM ha^{-1} + *Azotobacter* 20 ml ha^{-1} (12.7), T6- 50% RDN + 10t FYM ha^{-1} (12.4), T5- 75% RDN+ *Azotobacter* 20 ml ha^{-1} (12.0), T8- 50% RDN + *Azotobacter* 20 ml ha^{-1} (11.8) and T1- control (11.0), but it was statistically at par with the treatments T2- 100% RDN (13.3) and T3- 75% RDN + 5t FYM ha^{-1} (13.0). The lower plant population per m^2 (11.0) was observed at treatment T1- Control. With the judicious combined application of organic and inorganic source of nutrient, which contributed favourable condition for plant growth by increasing the availability of nutrients to plant significantly enhanced the plant population m^{-2} . The results obtained from the present experiment are in close conformity with the findings of Gupta *et al.*, (2023).

Plant height (cm)- Results revealed that significantly higher plant height (153.2 cm) was recorded in treatment T4-75% RDN + 5t FYM ha^{-1} + *Azotobacter* 20 ml ha^{-1} but was statistically at par with the treatments T2 -100% (RDN) (148.0 cm), T3-75% RDN + 5t FYM ha^{-1} (145.0 cm) and T7- 50% RDN + 10t FYM ha^{-1} + *Azotobacter* 20 ml ha^{-1} (141.1 cm). The increase in plant height might be due to availability of nutrients throughout the crop growth by decomposition of FYM and supplying adequate amount of nitrogen and other nutrients, which encourage taller plant height. Integrated nutrient management increased the uptake of nutrients by crop contributed to higher vegetative growth. Nitrogen may influence the different physiological processes such as a cell elongation cell division, and chlorophyll production which resulted in better growth attributes. *Azotobacter* fixes atmospheric nitrogen in the soil and FYM improve the soil physio-chemical property. This results were also recorded by Saha *et al.*, (2015), Yadav *et al.*, (2023).

Number of branches $plant^{-1}$ - Results has shown that significantly higher number of branches $plant^{-1}$ (20.5) was recorded in treatment T4- 75% RDN + 5t FYM ha^{-1} + *Azotobacter* 20 ml ha^{-1} and it was statistically at par with the treatments T2 -100% RDN (20.0), T3- 75% RDN + 5t FYM ha^{-1} (19.6) and T7- 50% RDN + 10t FYM ha^{-1} + *Azotobacter* 20 ml ha^{-1} (19.1). The beneficial effects might have resulted due to combined application of inorganic fertilizer, organic manure and biofertilizers which satisfied the immediate nutrient requirements and also improved soil's environment for better plant growth. One of the normal effect of nitrogen on growth is to increase the branching of the inflorescence. The growth and yield characteristics were also enhanced by the additional *Azotobacter* application. This results were also recorded by Indira *et al.*, (2021 a), Saha *et al.*, (2015).

Comment [JT6]: The discussion is not provided, please explain what could justify the result obtained with the T4 treatment unlike other treatments

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Comment [JT7]: Please specify the results obtained by these authors and the conditions under which their study was carried out.

Comment [JT8]: Avoid these ways of comparison, you really need to present the results of others and put them in your context

Chlorophyll content ($\mu\text{mole m}^{-2}$) (SPAD)- Treatment T4- 75% RDN + 5t FYM ha^{-1} + *Azotobacter* 20 ml ha^{-1} recorded significantly higher chlorophyll content (45.10) and it was statistically at par with rest of the treatments T2- 100% RDN (43.91), T3-75% RDN + 5t FYM ha^{-1} (42.34), T7- 50% RDN + 10t FYM ha^{-1} + *Azotobacter* 20 ml ha^{-1} (41.93) and T6- 50% RDN + 10t FYM ha^{-1} (41.00). Nitrogen is an integral part of chlorophyll which is the primary absorber of light energy needed for photosynthesis in addition to its role in the formation of proteins. Chlorophyll content is maximum under integrated nutrient management treatments over control. It is established fact that FYM improve physical, chemical and biological properties of soil and supplies essential plant nutrients for long term as entire crop period with slow pace while the inorganic fertilizer ensures readily available nutrients for a short period. The present findings have been supported by Bijarnia *et al.*, (2017).

Comment [JT9]: Apparently you have difficulty in discussing with the authors

Table 1: Effect of chemical, organic and bio-fertilizer on plant population m^{-2} , plant height (cm), no. of branches plant-1 and chlorophyll content ($\mu\text{mole m}^{-2}$) (SPAD)

Treatment		Plant population m^{-2}	Plant height (cm)	No. of branches plant-1	Chlorophyll content ($\mu\text{mole m}^{-2}$) (SPAD)
T1	Control	11.0	116.2	15.4	35.29
T2	100% RDN	13.3	148.0	20.0	43.91
T3	75% RDN + 5t FYM ha^{-1}	13.0	145.0	19.6	42.34
T4	75% RDN + 5t FYM ha^{-1} + <i>Azotobacter</i> 20 ml ha^{-1}	14.5	153.2	20.5	45.10
T5	75% RDN + <i>Azotobacter</i> 20 ml ha^{-1}	12.0	130.5	18.0	40.10
T6	50% RDN + 10t FYM ha^{-1}	12.4	135.0	18.7	41.00
T7	50% RDN + 10t FYM ha^{-1} + <i>Azotobacter</i> 20 ml ha^{-1}	12.7	141.1	19.1	41.93
T8	50% RDN + <i>Azotobacter</i> 20 ml ha^{-1}	11.8	125.4	17.0	38.85
C.D. (p=0.05)		1.7	17.0	2.3	4.66
SE(m)		0.5	5.55	0.77	1.52
SE(d)		0.7	7.86	1.09	2.15
RESUME.		7.6	7.03	7.2	6.42

Comment [JT10]: What statistical test was done? The results do not present statistical tests. This does not allow us to fully understand the significance of the difference in effects between the different treatments.

Yield Attributes

Data regarding yield attributes viz., number of siliqua plant^{-1} , number of seeds siliqua $^{-1}$, Siliqua length (cm) and Test weight (g) are mentioned in Table 2.

Number of siliqua plant^{-1} - Maximum number of siliqua plant^{-1} (300.10) was recorded in treatment T4- 75% RDN + 5t FYM ha^{-1} + *Azotobacter* 20 ml ha^{-1} but was statistically at par with the following treatments T2- 100% RDN (289.30), T3- 75% RDN + 5t FYM ha^{-1} (280.50) and T7- 50% RDN + 10t FYM ha^{-1} + *Azotobacter* 20 ml ha^{-1} (278.90). The increase in nitrogen supply results in greater cell size and more cell division, which in turn produces more number of branches and eventually more siliqua can develop. Application of *Azotobacter* and FYM in addition to inorganic fertilizer promoted the growth and yield attributes and controls the availability of nutrients to the crop. As a result, it promotes flowering and produces more siliqua per branches. Significant enhancement in overall growth of the plant as a result of increased photosynthetic efficiency. Thus, increased availability of photosynthates, metabolites and nutrients to develop reproductive structures seems to have resulted in increased no. of siliquae per plant. The present findings are confirmed with the findings of Saha *et al.*, (2015), Yadav *et al.*, (2023).

Number of seeds siliqua $^{-1}$ - revealed that significantly maximum number of seeds siliqua $^{-1}$ (18.00) was recorded in treatment T4- 75% RDN + 5t FYM ha^{-1} + *Azotobacter* 20 ml ha^{-1} over T6- 50% RDN + 10t FYM ha^{-1} , T5- 75% RDN+ *Azotobacter* 20 ml ha^{-1} and T8- 50% RDN + *Azotobacter* 20 ml ha^{-1} (16.1, 15.7 and 15.00) respectively, but it was statistically par with the remaining treatments T2-100% RDN, T3- 75% RDN + 5t FYM ha^{-1} and T7- 50% RDN + 10t FYM ha^{-1} + *Azotobacter* 20 ml ha^{-1} (17.3, 17.00 and 16.8) respectively. In contrast, the treatment T1- Control (13.6) exhibit the minimum number of seeds siliqua $^{-1}$ among all the treatments. The number of seeds siliqua $^{-1}$ in mustard was significantly influenced by the balanced nutrient management techniques. The higher numbers of seeds per siliqua appear to be the result of increased availability of photosynthates, metabolites, and nutrients to establish reproductive structures. The present findings were supported with the findings of Indira *et al.*, (2021 b), Saha *et al.*, (2015), Yadav *et al.*, (2023).

Comment [JT11]: Same discussion problem

Siliqua length (cm)- indicated that significantly higher siliqua length (5.90) was recorded in treatment T4-75% RDN + 5t FYM ha^{-1} + *Azotobacter* 20 ml ha^{-1} over T7-50% RDN + 10t

FYM ^{ha-1} + *Azotobacter* 20 ml ^{ha-1} (5.00 cm), T6-50% RDN + 10t FYM ^{ha-1} (4.60 cm), T5-75% RDN+ *Azotobacter* 20 ml ^{ha-1} (4.30 cm), T8-50% RDN + *Azotobacter* 20 ml ^{ha-1} (4.00 cm) and T1-Control (3.50 cm) but was at par with treatments T2-100% RDN (5.60 cm) and T3-75% RDN + 5t FYM ^{ha-1} (5.40 cm). The lowest siliqua length (3.50 cm) was observed in T1- control among all the treatments. The combined application of FYM, nitrogen and *Azotobacter* might increase plant nutrient availability, which result into better nourishment of plants and thus, results in the increase in length of siliquae in mustard. Similar results were recorded by Indira et al., (2021 b), Yadav et al., (2023), Singh et al., (2022).

Test weight (g)- Maximum test weight was recorded in treatment T4 - 75% RDN + 5t FYM ^{ha-1} + *Azotobacter* 20 ml ^{ha-1} (3.36 g) over treatment T6 - 50% RDN + 10t FYM ^{ha-1} (2.95 g), T5 - 75% RDN + *Azotobacter* 20 ml ^{ha-1} (2.87 g), T8 - 50% RDN + *Azotobacter* 20 ml ^{ha-1} (2.72 g) and T1 - Control (2.56 g) but was at par with treatments T2- 100% Recommended dose of Nitrogen (RDN) (3.25 g), T3 - 75% RDN + 5t FYM ^{ha-1} (3.16 g) and T7 - 50% RDN + 10t FYM ^{ha-1} + *Azotobacter* 20 ml ^{ha-1} (3.00 g). From the different treatments, the least test weight is observed in treatment T1 – Control (2.56 g). Judicious combination of FYM, bio-fertilizers and chemical, fertilizers promotes profitable and sustainable production. The bio-fertilizers plays a significant role in improving the nutrient's supplies by way of nitrogen fixation and their availability in crop production have a positive impact on crop growth. It improves flowering thus, results in more siliqua per branches and raised the weight of 1000 seeds. The results obtained from the present experiment are in close conformity with the findings of Saha et al., (2015) and Indira et al., (2021 b).

Table 2: Effect of chemical, organic and bio-fertilizer on number of siliqua ^{plant-1}, number of seeds siliqua-1, Siliqua length (cm) and Test weight (g)

Treatment	No. of siliqua ^{plant-1}	No. of seeds siliqua-1	Siliqua length (cm)	Test weight (g)
T1 Control	239.50	13.6	3.50	2.56
T2 100% RDN	289.30	17.3	5.60	3.25
T3 75% RDN + 5t FYM ^{ha-1}	280.50	17.0	5.40	3.16
T4 75% RDN + 5t FYM ^{ha-1} + <i>Azotobacter</i> 20 ml ^{ha-1}	300.10	18.0	5.90	3.36
T5 75% RDN + <i>Azotobacter</i> 20 ml ^{ha-1}	255.30	15.7	4.30	2.87

T6	50% RDN + 10t FYM ^{ha-1}	260.50	16.1	4.60	2.95
T7	50% RDN + 10t FYM ^{ha-1} +	278.90	16.8	5.00	3.00
	Azotobacter 20 ml ^{ha-1}				
T8	50% RDN + Azotobacter 20 ml ^{ha-1}	245.60	15.0	4.00	2.72
C.D. (p=0.05)		38.21	1.7	0.97	0.42
SE(m)		12.47	0.5	0.31	0.13
SE(d)		17.64	0.8	0.44	0.19
RESUME.		8.04	6.0	11.4	8.02

Comment [JT12]: What statistical test was done? The results do not present statistical tests. This does not allow us to fully understand the significance of the difference in effects between the different treatments. Repeat the analyzes to show significant differences

Yield

Data regarding yield viz., Seed yield (q^{ha-1}), Straw yield (q^{ha-1}), Biological yield (q^{ha-1}) and Harvest index (%) - are mentioned in Table 3.

Seed yield (q^{ha-1}) - results revealed that the treatment T4- 75% RDN + 5t FYM^{ha-1} + Azotobacter 20 ml^{ha-1} recorded significantly higher seed yield (22.98 q^{ha-1}) of *Brassica juncea* over T7- 50% RDN + 10t FYM^{ha-1} + Azotobacter 20 ml^{ha-1} (19.24q^{ha-1}), T6- 50% RDN + 10t FYM^{ha-1} (17.57q^{ha-1}), T5- 75% RDN+ Azotobacter 20 ml^{ha-1} (16.48q^{ha-1}), and T8- 50% RDN + Azotobacter 20 ml^{ha-1} (15.29q^{ha-1}) but was statistically par with T2-100% RDN (21.48q^{ha-1}) and T3- 75% RDN + 5t FYM^{ha-1} (20.24q^{ha-1}). In contrast, the lowest seed yield (13.52q^{ha-1}) was observed in T1- control among all the treatments. This might be due to delayed release of nutrient from FYM, which reduces nitrogen loss and efficient use of macro and micronutrients. The production of growth promoting and antifungal substances by *Azotobacter* and nitrogen fixation was perhaps the cause for maximum yields. Organic fertilizer, releasing their own nutrients might have increase the nutrient use efficiency of applied inorganic fertilizer in Indian mustard. Adequate supply of available nutrients to crop resulting in better growth and development ultimately reflected into better grain yields. Similar reports have also been reported by Indira *et al.*, (2021 b), Singh V (2020), Nagdive *et al.*, (2007).

Comment [JT13]: Same discussion problem

Straw yield (q^{ha-1}) - Results shows that the treatment T4- 75% RDN + 5t FYM^{ha-1} + Azotobacter 20 ml^{ha-1} recorded significantly higher grain yield (56.07 q^{ha-1}) of *Brassica juncea* over T5- 75% RDN+ Azotobacter 20 ml^{ha-1} (46.48q^{ha-1}) and T8- 50% RDN + Azotobacter 20 ml^{ha-1} (44.92q^{ha-1}) but it was statistically par with 100% RDN (54.94q^{ha-1}), T3- 75% RDN + 5t FYM^{ha-1} (54.82q^{ha-1}) and T7- 50% RDN + 10t FYM^{ha-1} + Azotobacter

20 ml^{ha-1} (52.77q^{ha-1}) and T6- 50% RDN + 10t FYM^{ha-1} (49.20q^{ha-1}). In comparison with all the other treatments, T1- control (41.21 q^{ha-1}) exhibits the lowest straw yield. Significant increase in straw yield is due to the beneficial effects of inorganic N, FYM and *Azotobacter* on the growth and yield attributes in plant. Higher yield attributes may be due to the more nutrient contribution by its incorporation towards the nutrition, since FYM is a source of various primary, secondary and micronutrients and when applied with inorganic fertilizer N, it acts as a slow releasing source of N, which could reduce the Nitrogen losses. The increase in yields with biofertilizers was mainly due to the increase in almost all growth and yield contributing characters, which eventually lead to a significant increase in stover yields. These results were supported with the findings of Singh V (2020), Nagdiveet al., (2007).

Comment [JT14]: Same discussion problem

Biological yield (q^{ha-1})- The treatment with application of T4- 75% RDN + 5t FYM^{ha-1} + *Azotobacter* 20 ml^{ha-1} recorded significantly higher biological yield (79.06q^{ha-1}) over T5- 75% RDN+ *Azotobacter* 20 ml^{ha-1} (62.95q^{ha-1}), T6- 50% RDN + 10t FYM^{ha-1} (66.78q^{ha-1}), T7- 50% RDN + 10t FYM^{ha-1} + *Azotobacter* 20 ml^{ha-1} (72.02q^{ha-1}) and T8- 50% RDN + *Azotobacter* 20 ml^{ha-1} (60.22q^{ha-1}) and T1 -Control (54.74) but was statistically par with T2- 100% RDN (76.42q^{ha-1}), T3- 75% RDN + 5t FYM^{ha-1} (75.07q^{ha-1}) and T7- 50% RDN + 10t FYM^{ha-1} + *Azotobacter* 20 ml^{ha-1} (72.02q^{ha-1}). This might be mainly due to increase in dry matter and number of branches and leaves, which was the result of increase in yield. In addition, N is an essential nutrient which promotes the cell development, cell division and photosynthesis activity and thus, it increases the yield as well as quality of the crop. The results obtained in present experiment are in close conformity with the findings of Saha et al., (2015), Singh et al., (2022).

Harvest index (%)- Results shows that the treatment T4- 75% RDN + 5t FYM^{ha-1} + *Azotobacter* 20 ml^{ha-1} recorded significantly higher harvest index (28.80%) of *Brassica juncea* over T6- 50% RDN + 10t FYM^{ha-1} (26.45%), T5- 75% RDN+ *Azotobacter* 20 ml^{ha-1} (26%), T8- 50% RDN + *Azotobacter* 20 ml^{ha-1} (25.19%) and T1- control (24.51%) but it was statistically par with T2- 100% RDN (27.87), T3- 75% RDN + 5t FYM^{ha-1} (27.32%) and T7- 50% RDN + 10t FYM^{ha-1} + *Azotobacter* 20 ml^{ha-1} (26.81%). This might be due to the slow released of nutrient from FYM, reducing nitrogen loss and maximizing the usage of macro- and micronutrients. The production of growth promoting and antifungal substances by *Azotobacter* and nitrogen fixation was perhaps the reason for higher yields. Similar results were also reported by Indira et al., (2021b), Singh et al., (2022).

Comment [JT15]: Same discussion problem

Table 3: Effect of chemical, organic and bio-fertilizer on Seed yield ($q\ ha^{-1}$), Straw yield ($q\ ha^{-1}$), Biological yield ($q\ ha^{-1}$) and Harvest index (%)

Treatment		Seed yield ($q\ ha^{-1}$)	Stover yield ($q\ ha^{-1}$)	Biological yield ($q\ ha^{-1}$)	Harvest index (%)
T1	Control	13.52	41.21	54.74	24.51
T2	100% RDN	21.48	54.94	76.42	27.80
T3	75% RDN + 5t FYM ha^{-1}	20.24	54.82	75.07	27.32
T4	75% RDN + 5t FYM ha^{-1} + Azotobacter 20 ml ha^{-1}	22.98	56.07	79.06	28.80
T5	75% RDN + Azotobacter 20 ml ha^{-1}	16.48	46.48	62.95	26.00
T6	50% RDN + 10t FYM ha^{-1}	17.57	49.20	66.78	26.45
T7	50% RDN + 10t FYM ha^{-1} + Azotobacter 20 ml ha^{-1}	19.24	52.77	72.02	26.81
T8	50% RDN + Azotobacter 20 ml ha^{-1}	15.29	44.92	60.22	25.19
C.D. (p=0.05)		2.97	7.66	9.70	2.56
SE(m)		0.97	2.50	3.16	0.83
SE(d)		1.37	3.54	4.48	1.18
RESUME.		9.17	8.66	8.02	5.45

Comment [JT16]: Same problem in producing statistical tables, the tables lack understanding and do not allow you to see the statistical differences

Conclusion

On the basis of the present experiment, it was concluded that among the various treatment, the application of 75% RDN + 5t FYM ha^{-1} + Azotobacter 20 ml ha^{-1} was found to be beneficial for growth and yield of mustard.

Comment [JT17]: The conclusion is very short and can be completed with suggestions or recommendations. It would also be good to repeat the study to confirm the results.

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