



# Effect of different Nitrogen Sources on Growth and Yield of Kasuri Methi (*Trigonella corniculata* L.)

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

Kasuri methi (*Trigonella corniculata* L.) is a slow growing plant remains in a rosette condition during vegetative growth. The flowers are orange-yellow coloured with long stalks. Being a leguminous crop, kasuri methi is highly responsive to nitrogenous fertilizer application especially in early stage. Nitrogen promotes the leaf, stem and other vegetative growth. The plant needs nitrogen for vegetative growth, resulting in higher green and seed yield. Nitrogen plays very important role in chlorophyll synthesis. The present study aimed to determine the effect of different nitrogen sources on growth and yield of Kasuri methi (*Trigonella corniculata* L.). The investigation was carried out at Vegetable Research Farm and in the laboratories of the Department of Seed Science and Technology, CCS Haryana Agricultural University, Hisar during Rabi season of 2022-23. The

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material comprised of newly developed kasuri methi variety "Hisar Kasuri Methi - 7" which was grown with eighteen treatment combinations of organic manures (FYM, Vermicompost) inorganic fertilizers and biofertilizer (*Rhizobium*). All the treatment combinations were evaluated for different growth and seed yield parameters. Experimental results revealed that significantly highest growth and yield attributes viz., plant height at 30, 60, 90 DAS and at maturity (5.53, 14.00, 76.67 and 95.14 cm), number branches/plant (6.99), number of cluster/plant (122.00), number of pods/cluster (19.62), length of pod (2.01 cm), number of pods/plant (2457.97), number of seed/pod (6.95), biological yield (3085.85 kg/ha), seed yield (730.57 kg/ha) and harvest index (23.67%) were observed under treatment T<sub>1</sub> {100 % RDN (Inorganic) + *Rhizobium*}, whereas, minimum was recorded under treatment T<sub>18</sub> (Control). Application of vermicompost promotes the lush growth of plants which may be due to the presence of plant growth promoters like auxins and cytokinin in vermicompost, which are responsible for cell division and cell elongation. Increase in plant height and number of branches due to early and abundant nitrogen availability resulting in a better nutritional environment in the root zone for growth and development of plant. The beneficial effect on yield attributes might be also due to the increased supply of all the essential nutrients which might have resulted in higher manufacture of food and its subsequent partitioning to sink. Higher seed yield may be due to *Rhizobium* and inorganic nitrogen sources, which have enhanced the availability of N in soil as major plant nutrients as well as inoculation of N<sub>2</sub> fixer benefit plants than any group of organisms alone and may have additional benefits.

**Keywords:** Kasuri methi; vermicompost; *Rhizobium*; farm yard manure; growth; yield.

## 1. INTRODUCTION

"Crop nutrients play a pivotal role in crop production, influencing plant growth, development, and overall productivity. Essential nutrients, including nitrogen, phosphorus, potassium, sulfur, calcium, magnesium, and various micronutrients, are crucial for the synthesis of proteins, enzymes, and other essential compounds within plants. Adequate nutrient availability ensures proper root development, robust vegetative growth, efficient flowering, and successful reproduction, ultimately leading to higher yields and improved crop quality" (Dongre et al., 2023). "Nitrogen is vital to plants because it is a major component in chlorophyll, amino acids and also required for the growth of the plants. Being a leguminous crop, kasuri methi is highly responsive to foliar application of nitrogenous fertilizer especially in early stage. Nitrogen promotes the leaf, stem and other vegetative growth. It also increases the protein content. Nitrogen application to legumes at lower doses in the initial stage is essential for vigorous start" (Yadav et al., 2024). "Kasuri methi (*Trigonella corniculata* L.), is a semi-arid crop belonging to family Fabaceae. It is known by different names depending on the location, including kasturi methi, marwari methi, champa methi (Hindi), pirang (Bengali), and sickle-fruited fenugreek in English. It is well known that Kasuri methi is an important source of dietary fibre, vitamins, and minerals. Kasuri methi extract is a flavouring ingredient, a baldness remedy, and a

metabolism and digestion stimulant. It is used as a vegetable, spice, and fodder in addition to some medicinal uses, such as lowering cholesterol levels, reducing skin marks and blemishes, acting as a carminative, an antipyretic tonic and an aphrodisiac, as well as being extremely helpful in treating dyspepsia and poor liver function" (Sethi et al., 1990). The seeds are used to treat gout, diabetes, arthritis, rickets, enlargement of the liver and spleen, chronic cough, diarrhoea, dysentery and dropsy. The green leaves of kasuri methi contain 86.1% water, 4.4% protein, 0.9% fat, 1.1% fibre, 6.0% other carbs, and 1.5% ash. Furthermore, leaves are rich in vitamins, including carotene (2.34 mg/100g of fresh edible portion), thiamine (0.04 mg), riboflavin (0.31 mg), nicotinic acid (0.8 mg), and vitamin C (52.0 mg/100g of edible portion), as well as a number of alkaloids, including trigonelline, choline, gentianine, and carpain (Anupama et al., 2017). Additionally, steroidal substances such as diosgenin (73.2%), trigogenin (2.5%), yuccagenin (19.9%), and gitogenin (4.4%) are known to be present in fenugreek seeds (mg/g dry weight).

India leads the globe in both area (167468 ha) and production (248203 ton) of kasuri methi. Rajasthan, Madhya Pradesh, Maharashtra, Haryana, Punjab, Gujarat and Uttar Pradesh are the primary producing states in India. More than 65 percent of the total acreage and production (971340 ha and 1161352 ton) are produced by Rajasthan alone during 2021-22. It

is being cultivated commercially in the S-W districts of Haryana, particularly in Hisar, Bhiwani, Rohtak, Sirsa, Mohindergarh, and Rewari, where both soil and climate are favourable for its growth and development (Anonymous, 2015).

“Kasuri methi (*Trigonella corniculata* L.) is a slow-growing plant that remains in a rosette condition during vegetative growth. The flowers are orange-yellow coloured with long stalks. Pods are sickle shaped 2-3 cm long and seeds are smaller in size and scented. Kasuri methi suitable for 5-8 leaf cuttings. Its seed mature in 130-140 days after sowing (DAS). The average yield of green is 150-225 q/ha” (Fageria, 2015).

Being a leguminous crop, kasuri methi is highly responsive to nitrogenous fertilizer application especially in early stage. Nitrogen promotes the leaf, stem and other vegetative growth. The plant needs nitrogen for vegetative growth, resulting in higher green and seed yield. Nitrogen plays a very important role in chlorophyll synthesis. Nitrogen is a crucial component of many substances that help plants grow, including amino acids, proteins, nucleic acids, prophyrin, flavin, pyridines, nucleotides, enzymes, coenzymes, and alkaloids. Fenugreek cultivation helps in fixing the atmospheric nitrogen because it is a legume crop. Improper nutrient management is one of the major reasons responsible for low yield and poor seed quality. The production of ample quantities of FYM has great potential for supplementing chemical fertilizers. FYM is a source of plant nutrients and has a wonderful effect on the physical, chemical and biological properties of soil. The limitations associated with its limited use in agriculture lie in its unavailability, bulkiness and prior microbial decomposition requiring time to release nutrients. On the other hand, the synthetic source of nitrogen (eg. Urea) is water soluble and gives an immediate greening effect on the crops luring the farmers to blindly apply urea as soon as symptoms of chlorosis appear.

Pushpa et al., (2022) found that the effects of vermicompost, *Rhizobium* along with other organic fertilizers increase plant height of kasuri methi, number of leaves per plant, number of branches per plant and yield parameters, including seed yield per plant, seed yield per plot as compared to control. Sahu et al., (2020) found that the application of bio-fertilizers considerably increases the yield and its characteristics in

fenugreek and that the best growth and yield parameters were recorded with the application of 50% recommended dose of fertilizer + *Rhizobium*.

“Integrated use of vermicompost and biofertilizers in fenugreek can be a more efficient, economical and judicious approach than chemical fertilizers alone” (Chaichi et al., 2015; Meena et al., 2015).

## 2. MATERIALS AND METHODS

The present experiment was carried out at Research Farm of the Department of Vegetable Science and in the laboratories of the Department of Seed Science and Technology, CCS Haryana Agricultural University, Hisar, Haryana during *Rabi* season of 2022-23. The field is located 215.2 metres above mean sea level between 29°10' North latitude and 75°46' East longitude. The soil texture of the experimental site was sandy loam with pH 8.11, E.C. of 0.39 dS/m and organic carbon of 0.39 %. Available nitrogen, phosphorus and potassium contents were 140, 20.00 and 214.00 kg/ha respectively. The variety “Hisar Kasuri Methi - 7” of kasuri methi was grown with the recommended cultural practices. The biofertilizer *Rhizobium* was used as seed treatment @ 62.5 ml/ha of seed while FYM and Vermicompost were used @ 20 t/ha and 3.125 t/ha respectively. The crop was sown on 20 November 2022 with randomised block design (RBD) having three replications with eighteen treatments in each replication and having plot size of 3 m × 2.4 m with a spacing of 30 cm × 10 cm was used to conduct the experiment. All agronomic practices were followed timely for the successful raising the crop. Crop harvesting on 5 April 2023 and threshing on 18 April 2023 was done.

Treatment details:

T<sub>1</sub>: 100% RDN (Inorganic) + *Rhizobium* (seed treatment)

T<sub>2</sub>: 75% RDN (Inorganic) + *Rhizobium* (seed treatment)

T<sub>3</sub>: 100% RDN through FYM + *Rhizobium* (seed treatment)

T<sub>4</sub>: 75% RDN through FYM + *Rhizobium* (seed treatment)

T<sub>5</sub>: 100 % RDN through Vermicompost + *Rhizobium* (seed treatment)

T<sub>6</sub>: 75% RDN through Vermicompost + *Rhizobium* (seed treatment)

T<sub>7</sub>: 75% RDN (Inorganic) + 25 % RDN through FYM + *Rhizobium* (seed treatment)

T<sub>8</sub>: 50% RDN (Inorganic) + 50 % RDN through FYM + *Rhizobium* (seed treatment)

T<sub>9</sub>: 75% RDN (Inorganic) + 25 % RDN through Vermicompost + *Rhizobium* (seed treatment)

T<sub>10</sub>: 50% RDN (Inorganic) + 50 % RDN through Vermicompost + *Rhizobium* (seed treatment)

T<sub>11</sub>: 75 % RDN through FYM + 25 % RDN through Vermicompost + *Rhizobium* (seed treatment)

T<sub>12</sub>: 50% RDN through FYM+ 50 % RDN through Vermicompost + *Rhizobium* (seed treatment)

T<sub>13</sub>: 75 % RDN through Vermicompost + 25 % RDN through FYM + *Rhizobium* (seed treatment)

T<sub>14</sub>: 100% RDN (Inorganic)

T<sub>15</sub>: 100% RDN through FYM

T<sub>16</sub>: 100 % RDN through Vermicompost

T<sub>17</sub>: *Rhizobium* (seed treatment)

T<sub>18</sub>: Control

Farm Yard Manure (FYM) and Vermicompost (VC) were applied at the time of field preparation. Inorganic fertilizer treatment combinations (50%, 75% and 100% Recommended Dose of Fertilizers (RDF) nitrogen were applied in the form of urea. Half a dose of nitrogen was given as basal dose at the time of sowing and the remaining 50% was given as top dressing at 30 days after sowing.

The parameters recorded on growth traits viz., plant height, number branches/plant, days to 50% flowering and yield traits viz., number of cluster/plant, number of pods/cluster, length of pod (cm), number of pods/plant, number of seed/pod, biological yield (kg/ha), seed yield (kg/ha) and harvest index (%).

### 3. RESULTS AND DISCUSSION

#### 3.1 Growth Parameters

The highest growth attributes viz., plant height at 30, 60, 90 DAS and at maturity (5.53, 14.00, 76.67 and 95.14 cm), number branches/plant (6.99), days to 50% flowering (94.70) was recorded under treatment T<sub>1</sub> {100 % RDN (Inorganic) + *Rhizobium*} followed by the treatment T<sub>9</sub> {75 % RDN (Inorganic) + 25 % RDN through VC + *Rhizobium*} at par with treatment T<sub>7</sub> {75 % RDN (Inorganic) + 25 % RDN through FYM + *Rhizobium*}, treatment T<sub>10</sub> {50% RDN (Inorganic) + 50 % RDN through Vermicompost + *Rhizobium*} and treatment T<sub>13</sub> {75 % RDN through Vermicompost + 25 % RDN through FYM + *Rhizobium*}.

“Significantly increased in growth attributes might be due to the increased level of vermicompost and biofertilizers in combination. Since the vermicompost is a storehouse of almost all the plant nutrients required for proper growth and development of plants, its addition in the soil enhanced the availability of nutrients. Thus the improvement in the soil environment of encouraged the proliferation of plant roots, which helped to draw more water and nutrients from larger areas and deeper layers and thus owing to the higher availability of nutrients, the synthesis of more carbohydrates and their translocation to different plant parts resulted in increased vegetative growth including the reproductive structures” (Lunagariyain et al. 2018). These findings are in agreement with the reports of Biswas and Anusuya (2014) in fenugreek, Das et al. (2016) in chickpea, Jadhav et al. (2015) in fenugreek, Sunanda et al. (2014) in kasuri methi, Singh et al. (2015), Chaichi et al. (2015), Meena et al. (2015), Badar et al. (2016), Raghuwanshi et al. (2016) and Vedpathak et al. (2016) in fenugreek and Khan et al. (2017) in cowpea.

Application of vermicompost promotes the lush growth of plants which may be due to the presence of plant growth promoters like auxins and cytokinin in vermicompost, which are responsible for cell division and cell elongation. The results of present investigation indicated higher growth characters under the influence of organic sources of fertilization are in close conformity with the findings of Vedpathak and Chavan (2016).

The combination of organic manures and inorganic fertilizers ensured sufficient availability

of nutrients while the biofertilizers improved nutrient availability and provided a better soil environment which increased nitrogen fixation and ultimately may have led to increased growth of the plant. The results are in conformity with the findings of Sahu et al. (2014) in coriander, Patil et al. (2014) in fennel and Dutta et al. (2011) in fenugreek.

Increase in plant height and number of branches due to early and abundant nitrogen availability resulting in a better nutritional environment in the root zone for growth and development of plant. The results of significant improvement in overall growth of the fenugreek crop under the influence of 100% RDF (40 kg N + 40 kg P) are in close conformity with the findings of Mehta et al. (2012).

The response of treatment combinations on plant height and number of branches may be due to more availability of nutrients through inorganic fertilizers application and more nitrogen fixation by *Rhizobium* bacteria which helped in better nutrient absorption and proper utilization in plant growth which enhanced plant height of kasuri methi. The results are in accordance with the findings of Malhotra et al. (2006), Aishwath. (2012) in coriander and in fenugreek by Soyam. (2012) in which higher plant height was observed with the application of biofertilizers along with a recommended dose of nitrogen.

### 3.2 Yield Parameters

The highest yield attributes viz., number of cluster/plant (122.00), number of pods/cluster (19.62), length of pod (2.01 cm), number of pods/plant (2457.97), number of seed/pod (6.95), biological yield (3085.85 kg/ha), seed yield (730.57 kg/ha) and harvest index (23.67 %) was recorded under treatment  $T_1$  {100 % RDN (Inorganic) + *Rhizobium*} followed by the treatment  $T_9$  {75 % RDN (Inorganic) + 25 % RDN through VC + *Rhizobium*} at par with treatment  $T_7$  {75 % RDN (Inorganic) + 25 % RDN through FYM + *Rhizobium*}, treatment  $T_{10}$  {50% RDN (Inorganic) + 50 % RDN through Vermicompost + *Rhizobium*} and treatment  $T_{13}$  {75 % RDN through Vermicompost + 25 % RDN through FYM + *Rhizobium*}.

The yield increase due to cumulative effect of more seeds per pod and maximum weight of seed through increased nutrient uptake by plant

might have stimulated the rate of various physiological processes like growth and assimilation by the balanced application of organic and inorganic nutrients along with bio-fertilizer (*Rhizobium*). Similar results were reported by Karma Chewang Bhutia. (2017) in fenugreek.

“The quick and continuous availability of the appreciable amount of essential plant nutrients from inorganic source, fixation of nitrogen by *Rhizobium*, balanced C/N ratio, synthesis of auxin, growth substances and perhaps helped to increase the seed yield of coriander” (Peerzada, 2016).

The beneficial effect on yield attributes might be also due to the increased supply of all the essential nutrients which might have resulted in higher manufacture of food and its subsequent partitioning to sink. Furthermore, the addition of biofertilizers recorded higher seed yield components, which could be owing to the activity of beneficial microorganisms like *Rhizobium*, which mediated biological process like N-fixation. The findings of present investigation are supported by those of Khoja and Gupta (2014), Rahimi. (2009), Singh (2013), Jhariya and Jain (2016) in coriander.

Higher seed yield may be due to *Rhizobium* and inorganic nitrogen sources, which have enhanced the availability of N in soil as major plant nutrients as well as inoculation of N<sub>2</sub> fixer benefit plants than any group of organisms alone and may have additional benefits. These results are in close conformity with the findings of Mehta. (2012) and Godara. (2017).

Vermicompost and biofertilizers like *Rhizobium* have much greater access to water and nutrients and thus increase the shoot dry weight, number of cluster per plant, number of pods per cluster, pod length (cm), number of pods per plant, seed yield and harvest index (%) is probably due to the increased uptake of food, improving plant water potential, improving plant growth resulting in better nutrition and increase in activity is due to photosynthesis. These results are in conformity with the study of Mathur. (2016), Mehta. (2015), Godara. (2012), Biswas and Anusuya (2014), Jadhav. (2015), Chaichi. (2015), Raghuwanshi. (2016), Godara. (2017), Verma. (2017), Khan. (2017) and Malav. (2018) in fenugreek.

**Table 1. Effect of different nitrogen sources on growth parameters of kasuri methi**

Sr. No.	Treatments	Plant height at				Maturity	No. of branches per plant	Days to 50% flowering
		30 DAS	60 DAS	90 DAS				
T <sub>1</sub>	100% RDN (Inorganic) + <i>Rhizobium</i> (seed treatment)	5.53	14.00	76.67	95.14	6.99	94.70	
T <sub>2</sub>	75% RDN (Inorganic) + <i>Rhizobium</i> (seed treatment)	4.92	11.26	68.05	85.57	5.52	92.33	
T <sub>3</sub>	100% RDN through FYM + <i>Rhizobium</i> (seed treatment)	4.80	10.17	65.22	84.71	5.48	90.00	
T <sub>4</sub>	75% RDN through FYM + <i>Rhizobium</i> (seed treatment)	4.66	10.06	61.17	82.71	5.41	89.67	
T <sub>5</sub>	100 % RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	5.01	12.18	71.17	86.10	5.75	92.00	
T <sub>6</sub>	75% RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	4.82	11.24	67.07	85.57	5.52	91.33	
T <sub>7</sub>	75% RDN (Inorganic) + 25 % RDN through FYM + <i>Rhizobium</i> (seed treatment)	5.47	13.31	74.64	90.14	6.28	91.33	
T <sub>8</sub>	50% RDN (Inorganic) + 50 % RDN through FYM + <i>Rhizobium</i> (seed treatment)	5.06	11.74	70.17	85.67	5.70	91.00	
T <sub>9</sub>	75% RDN (Inorganic) + 25 % RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	5.49	13.78	75.24	93.09	6.56	93.67	
T <sub>10</sub>	50% RDN (Inorganic) + 50 % RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	5.44	13.24	73.63	89.86	6.16	93.00	
T <sub>11</sub>	75 % RDN through FYM + 25 % RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	5.09	12.51	71.27	88.33	5.85	90.67	
T <sub>12</sub>	50% RDN through FYM+ 50 % RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	5.07	12.76	71.40	88.40	6.00	90.33	
T <sub>13</sub>	75 % RDN through Vermicompost + 25 % RDN through FYM + <i>Rhizobium</i> (seed treatment)	5.42	13.07	73.60	89.43	6.01	90.67	
T <sub>14</sub>	100% RDN (Inorganic)	5.10	11.80	70.57	86.05	5.74	92.33	
T <sub>15</sub>	100% RDN through FYM	4.72	10.16	62.24	84.19	5.35	88.67	
T <sub>16</sub>	100 % RDN through Vermicompost	5.08	11.40	68.30	85.67	5.53	91.33	
T <sub>17</sub>	<i>Rhizobium</i> (seed treatment)	4.66	9.03	57.05	82.30	5.34	87.00	
T <sub>18</sub>	Control	4.23	8.58	56.43	78.90	5.29	86.67	
SE(m)		0.10	0.30	0.10	1.60	0.20	2.00	
C.D .5%		0.41	0.95	4.68	6.43	0.47	NS	

**Table 2. Effect of different nitrogen sources on yield parameters of kasuri methi**

Sr. No	Treatments	Number of cluster per plant	Number of pod per cluster	Number of pods per plant	Pod length (cm)	Number of seeds per pod
T <sub>1</sub>	100% RDN (Inorganic) + <i>Rhizobium</i> (seed treatment)	122.00	19.62	2457.97	2.01	6.95
T <sub>2</sub>	75% RDN (Inorganic) + <i>Rhizobium</i> (seed treatment)	90.87	17.52	1745.45	1.86	6.00
T <sub>3</sub>	100% RDN through FYM + <i>Rhizobium</i> (seed treatment)	84.86	17.14	1692.06	1.84	5.95
T <sub>4</sub>	75% RDN through FYM + <i>Rhizobium</i> (seed treatment)	78.71	17.05	1547.38	1.76	5.81
T <sub>5</sub>	100 % RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	103.47	18.05	1946.35	1.91	6.24
T <sub>6</sub>	75% RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	85.71	17.19	1727.82	1.86	5.95
T <sub>7</sub>	75% RDN (Inorganic) + 25 % RDN through FYM + <i>Rhizobium</i> (seed treatment)	117.89	19.24	2166.83	1.99	6.52
T <sub>8</sub>	50% RDN (Inorganic) + 50 % RDN through FYM + <i>Rhizobium</i> (seed treatment)	94.38	17.90	1769.06	1.92	6.10
T <sub>9</sub>	75% RDN (Inorganic) + 25 % RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	121.20	19.57	2442.68	2.00	6.76
T <sub>10</sub>	50% RDN (Inorganic) + 50 % RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	116.86	18.80	2108.05	1.95	6.52
T <sub>11</sub>	75 % RDN through FYM + 25 % RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	104.05	18.06	1970.31	1.94	6.24
T <sub>12</sub>	50% RDN through FYM+ 50 % RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	104.37	18.22	2009.52	1.93	6.33
T <sub>13</sub>	75 % RDN through Vermicompost + 25 % RDN through FYM + <i>Rhizobium</i> (seed treatment)	107.27	18.59	2080.10	1.94	6.48
T <sub>14</sub>	100% RDN (Inorganic)	102.60	17.95	1914.84	1.87	6.19
T <sub>15</sub>	100% RDN through FYM	80.33	17.14	1670.63	1.76	5.90
T <sub>16</sub>	100 % RDN through Vermicompost	91.68	17.57	1757.93	1.87	6.05
T <sub>17</sub>	<i>Rhizobium</i> (seed treatment)	77.41	16.57	1517.28	1.74	5.67
T <sub>18</sub>	Control	76.09	16.24	1381.39	1.73	5.62
SE(m)		2.40	0.50	51.80	0.01	0.10
C.D .5%		6.98	1.49	149.38	0.13	0.42

**Table 3. Effect of different nitrogen sources on yield parameters of kasuri methi**

Sr. No	Treatments	Seed yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
T <sub>1</sub>	100% RDN (Inorganic) + <i>Rhizobium</i> (seed treatment)	730.57	3085.85	23.67
T <sub>2</sub>	75% RDN (Inorganic) + <i>Rhizobium</i> (seed treatment)	635.88	2928.85	21.62
T <sub>3</sub>	100% RDN through FYM + <i>Rhizobium</i> (seed treatment)	645.00	2926.24	22.04
T <sub>4</sub>	75% RDN through FYM + <i>Rhizobium</i> (seed treatment)	634.00	2916.31	21.74
T <sub>5</sub>	100 % RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	667.58	3000.11	22.16
T <sub>6</sub>	75% RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	631.72	2928.55	21.52
T <sub>7</sub>	75% RDN (Inorganic) + 25 % RDN through FYM + <i>Rhizobium</i> (seed treatment)	704.02	3050.66	23.08
T <sub>8</sub>	50% RDN (Inorganic) + 50 % RDN through FYM + <i>Rhizobium</i> (seed treatment)	646.60	2970.55	21.77
T <sub>9</sub>	75% RDN (Inorganic) + 25 % RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	719.37	3060.61	23.50
T <sub>10</sub>	50% RDN (Inorganic) + 50 % RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	699.04	3045.44	22.95
T <sub>11</sub>	75 % RDN through FYM + 25 % RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	669.54	3020.33	22.16
T <sub>12</sub>	50% RDN through FYM+ 50 % RDN through Vermicompost + <i>Rhizobium</i> (seed treatment)	681.65	3030.67	22.45
T <sub>13</sub>	75 % RDN through Vermicompost + 25 % RDN through FYM + <i>Rhizobium</i> (seed treatment)	683.12	3040.71	22.47
T <sub>14</sub>	100% RDN (Inorganic)	660.10	2980.43	22.15
T <sub>15</sub>	100% RDN through FYM	640.03	2922.45	21.89
T <sub>16</sub>	100 % RDN through Vermicompost	644.14	2950.83	21.75
T <sub>17</sub>	<i>Rhizobium</i> (seed treatment)	617.79	2911.62	21.22
T <sub>18</sub>	Control	440.50	2850.53	15.10
SE(m)		18.90	54.30	0.50
C.D .5%		54.57	156.10	1.50

#### 4. CONCLUSION

Based on the present study it can be concluded that the application of 100 per cent recommended dose of nitrogen through inorganic sources along with biofertilizer (*Rhizobium*) (T<sub>1</sub>) recorded significantly higher values for all the growth ((plant height at 30, 60, 90 DAS and at maturity (5.53, 14.00, 76.67 and 95.14 cm) number branches/plant (6.99)) and yield attributes (number of cluster/plant (122.00), number of pods/cluster (19.62), length of pod (2.01 cm), number of pods/plant (2457.97), number of seed/pod (6.95), biological yield (3085.85 kg/ha), seed yield (730.57 kg/ha) and harvest index (23.67 %).

#### DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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