**Original Research Article**

**Effect of different nitrogen sources on seed quality and economics of Kasuri methi (*Trigonella corniculata* L.)**

**Abstract**

The present 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 to assess the effect of different nitrogen sources on seed quality and economics of kasuri methi. The material comprised of newly developed kasuri methi variety “Hisar KasuriMethi - 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 seed quality parameters. Experimental results revealed that significantly highest seed quality attributes *viz.,* test weight (1.70 g), standard germination (89.67 %), seedling length (9.10 cm), seedling dry weight (3.98 mg), vigour index-I (807.33) and vigour index- II (357.17) were observed under treatment T5 (100 % RDN through Vermicompost + *Rhizobium* (seed treatment)**,** whereas, minimum was recorded under treatment T18 (Control). From the economic point of view, the treatment combination having 100 % RDN (Inorganic) + *Rhizobium* (T1) gave maximum net returns (Rs 47607.20) and minimum net returns was found under control (Rs.18950.00). The benefit - cost ratio (1.87) was found maximum under treatment T1 (100 % RDN (Inorganic) + *Rhizobium)* and minimum was found under control (0.75).

**Keywords:** Kasuri methi, vermicompost, *Rhizobium,* FYM, seed quality, germination, economics

**Introduction**

Kasuri methi (*Trigonella corniculata* L.) is member of the Fabaceae family and it is a semi-arid crop. Depending on the region, it is referred to as kasturi methi, Marwari methi, champa methi (Hindi), pirang (Bengali), and sickle-fruited fenugreek in English. It is a significant source of vitamins, minerals, and dietary fiber. Its extract is used as a flavoring, baldness treatment, and digestive and metabolic enhancer. According to Sethi *et al*. (1990), it has a number of therapeutic purposes, including lowering cholesterol levels, eliminating skin blemishes and markings, serving as a carminative, an antipyretic tonic, and an aphrodisiac, as well as being incredibly effective in treating dyspepsia and impaired liver function. The seeds are used to cure a variety of conditions, including dropsy, chronic cough, diarrhea, dysentery, diabetes, rickets, enlargement of the liver and spleen, and gout. The green leaves of kasuri methi contains 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 kasuri methi’s production (248203 ton) and area (167468 ha). Rajasthan, Madhya Pradesh, Maharashtra, Haryana, Punjab, Gujarat, and Uttar Pradesh are the primary kasuri methi producing states in India. More than 65 % of the total acreage and production (971340 ha and 1161352 ton) are produced by Rajasthan alone during 2021-22. It is mostly cultivated commercially in the south-western 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).

It is a slow growing plant and remains in a rosette condition during vegetative growth and bears bright orange-yellow flowers which borne on long stalks, it’s pods are 2-3 cm long and sickle shaped, seeds are smaller and scented. Its seed mature in 130-140 days after sowing. The average yield of green is 150-225 q/ha (Fageria, 2015).

Kasuri methi is highly responsive to nitrogenous fertilizer application especially in early stage. Nitrogen supports the leaf, stem and roots growth and development. The plant needs nitrogen for vegetative growth, resulting in higher green and seed yield. Nitrogen plays very important role in chlorophyll synthesis in plants. Nitrogen is crucial component of many substances that helps plant to synthesize many amino acids, proteins, nucleic acids, prophyrin, flavin, pyridines, nucleotides, enzymes, coenzymes, and alkaloids. Kasuri methi cultivation helps in fixing the atmospheric nitrogen because it is a legume crop and improper nutrient management leds poor seed quality. The production of sufficient quantity of FYM has a great potential for supplementing the chemical fertilizers. Besides being a source of plant nutrients, it has wonderful effect on the physical, chemical and biological properties of the soil. The limitations associated with its minimum 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 immediate greening effect on the crops attracting the farmers to blindly apply urea as soon as symptoms of chlorosis appear.

Seed quality of kasuri methi are known to be influenced by different factors such as nutrition, cultural practices, etc. Among these, nutrition plays an important role and which has great influence on seed quality (Sharma *et al.,* 2006).

 Use of organic manures (vermicompost, FYM) and biofertilizers such as nitrogen fixing bacteria (*Rhizobium*) has led to a decrease in application of chemical fertilizers and has provided high quality seeds free from harmful agrochemicals for human safety (Migahed *et al.,* 2004; Khalid *et al.,* 2005).

Seeds are important component of agricultural production in India. Quality seed is must for successful crop production programme. The quality seed plays an important role in the agricultural production as well as in national economy. Therefore always use good quality seed for sowing and that enhanced the production and productivity of crops. Availability of viable and vigorous seed at the sowing time is must for achieving targets of agricultural production because good quality seed acts as a catalyst for realizing the full potential of other inputs. With time the total cultivable area is decreasing due to over growing population, so the increased agricultural productivity is the only option that we have. Good seed in good land always yield abundant. The use of good quality seeds increased the productivity of crop by 15-20%.

Because seeds are the basis of agriculture, yields and crop quality would suffer significantly without a consistent supply of high-quality seed. Planting quality seed is one technique to boost productivity without significantly expanding the area of land already under cultivation. Seed quality is most important and necessary for crop development. The desired outcome after using quality seeds are the increase in the crop production, resistance to insect-pests and diseases.

Hooda and Tehlan (2014) found that the maximum test weight (18.6 g) and germination percentage (85%) were obtained with the seed treatment with *Rhizobium +* N 45 kg/ha, while maximum seed vigour index (2465) was found in treatment *Rhizobium +* FYM 20 t/ha in coriander.

Sen *et al.,* (2022), found that in treatment T12, when 100% RDF + FYM + bio-fertiliser was used, the highest and nearly double gross return (Rs 2,56,200/-) was recorded in coriander.

According to Somdutt *et al*., (2019), the conditions that produced the highest net return (Rs 70,781.15/ha) and the highest BC ratio (1.96 /ha) were 100% RDF + vermicompost 2.5 t/ha + *Rhizobium* in fenugreek.

**Materials and Methods**

The present experiment was carried out at Research Farm, 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 m above mean sea level between 29°10' North latitude and 75°46' East longitude. The soil texture of 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 samples were analyzed for quality characters viz., test weight (g), standard germination (%), seedling length (cm), dry weight ( mg), seedling vigor index-I and seedling vigor index-II. The crop was sown on 20 November 2022 with randomised block design (RBD) having three replications with eighteen treatment in each replication and having plot size of 3 m × 2.4 m with spacing of 30 cm × 10 cm was used to conduct the experiment.All agronomic practices were followed timely for successful raising the crop. Crop harvesting on 5 April 2023 and threshing on 18 April 2023 was done.

Treatment details:

T1: 100% RDN (Inorganic) + *Rhizobium* (seed treatment)

T2: 75% RDN (Inorganic) + *Rhizobium* (seed treatment)

 T3: 100% RDN through FYM + *Rhizobium* (seed treatment)

 T4: 75% RDN through FYM + *Rhizobium* (seed treatment)

 T5: 100 % RDN through Vermicompost + *Rhizobium* (seed treatment)

 T6: 75% RDN through Vermicompost + *Rhizobium* (seed treatment)

 T7: 75% RDN (Inorganic) + 25 % RDN through FYM + *Rhizobium* (seed treatment)

 T8: 50% RDN (Inorganic) + 50 % RDN through FYM + *Rhizobium* (seed treatment)

 T9: 75% RDN (Inorganic) + 25 % RDN through Vermicompost + *Rhizobium* (seed treatment)

 T10:50% RDN (Inorganic) + 50 % RDN through Vermicompost + *Rhizobium* (seed treatment)

 T11: 75 % RDN through FYM + 25 % RDN through Vermicompost + *Rhizobium* (seed treatment)

 T12: 50% RDN through FYM+ 50 % RDN through Vermicompost + *Rhizobium* (seed treatment)

 T13: 75 % RDN through Vermicompost + 25 % RDN through FYM + *Rhizobium* (seed treatment)

 T14: 100% RDN (Inorganic)

 T15: 100% RDN through FYM

 T16: 100 % RDN through Vermicompost

T17: *Rhizobium* (seed treatment)

T18: Control

For Test weight 1000 seeds replicated thrice in each treatment were counted, weighed and average seed weight of each treatment was calculated and expressed in grams. 100 seeds in three replications and each of treatment were taken and weight on electrical balance. Seed germination (%) was calculated by the no. of seeds germinated/no. of seeds sown × 100. The seeds from each treatment combination were tested for germination by using between paper towel method kept at optimum conditions of temperature (250C). The no. of normal seedling was counted at the end of 14 days and the seed germination (%) was calculated by using the above formula. The seedling length (cm) was recorded at the end of 14th day by randomly selecting 10 seedlings which were averaged. The seedling used for measuring length were kept in a paper bag and dried in hot air oven at a constant temperature of 8000C for 3 days and then the seedling were cooled in dessicator and the weight was recorded by using electronic balance and expressed in mg. Seedling vigor index-1 and II was calculated by multiplying seed germination (%) with seedling length (cm) and seedling dry weight (mg) respectively.

Net returns of each treatment were calculated by deducting the total cost (TC) of cultivation from the gross return (GR). The Benefit Cost Ratio (BCR) was calculated by dividing gross returns with cost of cultivation. The collected data for various parameters were statistically analysed using OPSTAT and the treatments were compared at 5% level of significance.

**Results and Discussion**

**Seed quality parameters:**

The highest seed quality attributes *viz.,* test weight (1.70 g), standard germination (89.67 %), seedling length (9.10 cm), seedling dry weight (3.98 mg), vigour index-I (807.33) and vigour index- II (357.17) were observed under treatment T5 (100 % RDN through Vermicompost + *Rhizobium* (seed treatment) ) followed by treatment T13 (75 % RDN through VC + 25 % RDN through FYM + *Rhizobium)*, which was at par with the treatment T10 (50 % RDN (Inorganic) + 50 % RDN through VC + *Rhizobium)* and treatment T12 (50% RDN through FYM+ 50 % RDN through Vermicompost + *Rhizobium*).

According to Deshmukh *et al.,* (2020), application of 80 kg N + *Rhizobium*, had the highest quality parameters in fenugreek in terms of seedling length, seedling dry weight, vigour index I, vigour index II and test weight.

Choudhary *et al.,* (2019), evaluated the effects of various nitrogen sources on fenugreek and found that FYM 5 t/ha + *Rhizobium*  application and the 100% recommended dose of inorganic fertiliser resulted in significantly higher test weight, seedling length, seedling dry weight, vigour index I, vigour index II in seeds. With FYM 5 t/ha + *Rhizobium* and vermicompost 2.5 t/ha + *Rhizobium*, respectively, the absorption of nitrogen and phosphorus by the seed was greater.

In their research on the impact of integrated nutrient management on fennel seed quality, Kumar *et al.,* (2019), found that both organic and inorganic fertilisers had a substantial impact on the fennel crop's seed quality. Maximum standard germination was observed to be 91.43 % which was 21.7% higher than control.

According to Sharma *et al.,* (2016), higher coriander seed test weight was achieved with using nitrogen doses of 90–120 kg/ha and 30 cm row spacing.

 Highest vigour index-I and II were recorded in the seeds which received the treatment 100 percent RDN through vermicompost along with biofertilizers due to release of certain enzymes by the metabolites responsible for conversion of macromolecules into micromolecules within seed and increase in mobilization efficiency led to improved vigor index.(Maruthi and Paramesh, 2016).

The higher germination percentage also might be due to the bolder seeds that contain greater metabolites for resumption of embryonic growth during germination and better accumulation of food reserves like protein and carbohydrates as reported by Anitha *et al.* (2015) in fenugreek.

Anitha *et al*., (2015) also reported the increase in vigour index with combined application of inoraganic and organic manure which might be due to the availability of macro nutrients from inorganic sources and positive effect of bio-inoculants on germination and seed quality (bold seeds) that directly improves vigour index..

Chaudhary and Tehlan (2014) found that increase in seedling length of fenugreek seed might be due to release of certain enzymes by metabolites which are responsible for the conversion of macromolecules into micromolecules within the seed and increase in mobilization efficiency.

Tripathi *et al.* (2013) also reported increase in test weight by supplementing inorganic fertilizers with organic source which improved the general soil environment, physio-chemical and biological conditions, helped in improving the test weight in kasuri methi.

**Economics:**

The treatment combination of 100 % RDN (Inorganic) + *Rhizobium* (T1) gave maximum net returns (Rs 47607.20/ha) followed by the treatment having 75 % RDN (Inorganic) + 25 % RDN through VC + *Rhizobium* (T9) and 75 % RDN (Inorganic) + 25 % RDN through FYM + *Rhizobium* (T7) and minimum net returns was found under control (Rs. 18950.00/ha). The benefit - cost ratio (1.87) was found maximum under treatment with 100 % RDN (Inorganic) + *Rhizobium* (T1) followed by T9 (1.67) and minimum was found under control (0.75).

According to Pushpa *et al*., (2022) found that in fenugreek treatment T15 Vermicompost + *Rhizobium*  produced the highest net profit of Rs. 100113.00 with a B:C ratio of 1.58, followed by treatment T14 (Vermicompost + *Rhizobium* ), which produced a net return of Rs. 94212 and a B:C ratio of 1.13 compared to the control's Rs. 41939.00 and 0.74, respectively.

Sen *et al.,* (2022), found that in treatment T12, when 100% RDF + FYM + bio-fertiliser was used, the highest and nearly double gross return (Rs 2,56,200/-) was recorded in coriander. According to Somdutt *et al*., (2019), the conditions that produced the highest net return (Rs 70,781.15/ha) and the highest BC ratio (1.96 /ha) were 100% RDF + vermicompost 2.5 t/ha + *Rhizobium* in fenugreek.

According to a study by Desai *et al*., (2020), in alfalfa and found that 50% RDN through vermicompost + *Rhizobium* + 50% RDN through fertiliser (T9) was the treatment that produced the highest gross return of Rs 83817/ha, followed by 50% RDN through castorcake + 50% RDN through fertiliser + *Rhizobium* (T10) and 50% RDN through FYM + 50% RDN through fertiliser + *Rhizobium*  (T8). Under 100% RDN treatment using FYM + *Rhizobium* (T2), the lowest gross realisation (Rs 60640/ha) was noted.

Shivran *et al.,*(2017), reported that among the different nutrient management practices, significantly higher mean values were recorded for seed yield (474 kg/ ha), gross monetary returns (75840 Rs /ha), net monetary returns (57861 Rs/ha) and benefit - cost ratio (3.22) in treatment with 50% recommended dose fertilizers through vermicompost + 50% RDF through chemical fertilizers in cumin. Therefore, in cumin it can be recommended to apply 50% recommended dose of fertilizers through vermicompost + 50 % recommended dose of fertilizers through fertilizers, which will reduce the load of chemical fertilizers up to 50%.

Vineetha *et al.,* (2013), found that dill plants fertilised with 30 t of FYM /ha had the highest net return /ha (Rs 36,145) and B:C ratio (1:1.57).

Tripathi *et al.,*(2013), found that the application of 50% recommended dose of fertilizers + FYM @ 5 t/ha recorded maximum seed yield (16.8 q/ha), net returns (Rs.37280 /ha) and B-C ratio (4.38) over remaining treatments in coriander. Singh (2015) observed that the treatment FYM (15 t/ha) + RDF (50N : 40P : 30K kg/ha) was found best in improving the growth attributes of coriander and increased the yield 105.26 per cent over control and gave the highest net returns of Rs.68,370 (/ha) with benefit-cost ratio of 2.67.

**Table: 1 Effect of different nitrogen sources on seed quality of kasuri methi**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Sr. No | Treatments | Test weight (g) | Standard germination (%) | Seedling length(cm) | Seedling dry weight (mg) | Vigour index-I | Vigour index-II |
| T1 | 100% RDN (Inorganic) + Rhizobium (seed treatment) | 1.57 | 83.33 | 7.90 | 3.36 | 658.33 | 280.00 |
| T2 | 75% RDN (Inorganic) + Rhizobium (seed treatment) | 1.45 | 80.00 | 7.50 | 3.24 | 600.00 | 259.47 |
| T3 | 100% RDN through FYM + Rhizobium (seed treatment) | 1.50 | 81.33 | 7.66 | 3.29 | 623.28 | 267.86 |
| T4 | 75% RDN through FYM + Rhizobium (seed treatment) | 1.40 | 78.67 | 7.43 | 3.11 | 584.49 | 244.92 |
| T5 | 100 % RDN through Vermicompost + Rhizobium (seed treatment) | 1.70 | 89.67 | 9.10 | 3.98 | 807.00 | 357.17 |
| T6 | 75% RDN through Vermicompost + Rhizobium (seed treatment) | 1.49 | 80.67 | 7.50 | 3.29 | 605.27 | 265.12 |
| T7 | 75% RDN (Inorganic) + 25 % RDN through FYM + Rhizobium (seed treatment) | 1.53 | 81.67 | 7.75 | 3.32 | 633.19 | 270.86 |
| T8 | 50% RDN (Inorganic) + 50 % RDN through FYM + Rhizobium (seed treatment) | 1.50 | 81.33 | 7.67 | 3.30 | 623.56 | 268.13 |
| T9 | 75% RDN (Inorganic) + 25 % RDN through Vermicompost + Rhizobium (seed treatment) | 1.58 | 84.00 | 7.93 | 3.39 | 665.84 | 284.48 |
| T10 | 50% RDN (Inorganic) + 50 % RDN through Vermicompost + Rhizobium (seed treatment) | 1.62 | 88.33 | 8.53 | 3.73 | 750.64 | 326.48 |
| T11 | 75 % RDN through FYM + 25 % RDN through Vermicompost + Rhizobium (seed treatment) | 1.56 | 82.00 | 7.88 | 3.35 | 646.43 | 274.70 |  |
| T12 | 50% RDN through FYM+ 50 % RDN through Vermicompost + Rhizobium (seed treatment) | 1.60 | 86.00 | 8.50 | 3.40 | 733.83 | 293.25 |  |
| T13 | 75 % RDN through Vermicompost + 25 % RDN through FYM + Rhizobium (seed treatment) | 1.66 | 88.67 | 9.00 | 3.74 | 798.00 | 328.95 |  |
| T14 | 100% RDN (Inorganic) | 1.44 | 79.67 | 7.49 | 3.17 | 596.97 | 252.28 |  |
| T15 | 100% RDN through FYM | 1.43 | 79.67 | 7.48 | 3.16 | 595.91 | 251.48 |  |
| T16 | 100 % RDN through Vermicompost | 1.52 | 81.67 | 7.73 | 3.31 | 631.56 | 270.59 |  |
| T17 | Rhizobium (seed treatment) | 1.35 | 78.33 | 7.43 | 3.05 | 581.76 | 238.92 |  |
| T18 | Control | 1.34 | 74.00 | 6.97 | 2.94 | 515.78 | 217.31 |  |
| SE(m) | 0.01 | 1.80 | 0.22 | 0.10 | 17.70 | 8.90 |
| C.D .5% | 0.11 | 5.09 | 0.64 | 0.25 | 51.03 | 20.58 |

**Table : 2 Economics of different treatment combinations**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sr.No.** | **Treatments** | **Cost of Cultivation** | **Gross Returns** | **Net returns** | **B:C Ratio** |
| T1 | 100% RDN (Inorganic) + *Rhizobium* (seed treatment) | 25450 | 73057.20 | 47607.20 | 1.87 |
| T2 | 75% RDN (Inorganic) + *Rhizobium* (seed treatment) | 25368 | 63588.10 | 38220.10 | 1.51 |
| T3 | 100% RDN through FYM + *Rhizobium* (seed treatment) | 35125 | 64500.00 | 29375.00 | 0.84 |
| T4 | 75% RDN through FYM + *Rhizobium* (seed treatment) | 32625 | 63400.00 | 30775.00 | 0.94 |
| T5 | 100 % RDN through Vermicompost + *Rhizobium* (seed treatment) | 31375 | 66757.50 | 35382.50 | 1.13 |
| T6 | 75% RDN through Vermicompost + *Rhizobium* (seed treatment) | 29812 | 63171.80 | 33359.80 | 1.12 |
| T7 | 75% RDN (Inorganic) + 25 % RDN through FYM + *Rhizobium* (seed treatment) | 27868 | 70402.23 | 42534.23 | 1.53 |
| T8 | : 50% RDN (Inorganic) + 50 % RDN through FYM + *Rhizobium* (seed treatment) | 30287 | 64660.28 | 34373.28 | 1.13 |
| T9 | 75% RDN (Inorganic) + 25 % RDN through Vermicompost + *Rhizobium* (seed treatment) | 26930 | 71936.72 | 45006.72 | 1.67 |
| T10 | 50% RDN (Inorganic) + 50 % RDN through Vermicompost + *Rhizobium* (seed treatment) | 28412 | 69904.28 | 41492.28 | 1.46 |
| T11 | 75 % RDN through FYM + 25 % RDN through Vermicompost + *Rhizobium* (seed treatment) | 34187 | 66953.77 | 32766.77 | 0.96 |
| T12 | 50% RDN through FYM+ 50 % RDN through Vermicompost + *Rhizobium* (seed treatment) | 33250 | 68165.10 | 39915.10 | 1.05 |
| T13 | 75 % RDN through Vermicompost + 25 % RDN through FYM + *Rhizobium* (seed treatment) | 32312 | 68311.53 | 35999.53 | 1.11 |
| T14 | 100% RDN (Inorganic) | 25425 | 66010.38 | 40585.38 | 1.60 |
| T15 | 100% RDN through FYM | 35100 | 64000.30 | 28930.00 | 0.82 |
| T16 | 100 % RDN through Vermicompost | 31350 | 64413.80 | 33063.80 | 1.05 |
| T17 | *Rhizobium* (seed treatment) | 25125 | 61778.77 | 36653.77 | 1.46 |
| T18 | Control | 25100 | 44000.50 | 18950.00 | 0.75 |

**CONCLUSION**

Based on the present study it can be concluded that the application of 100 per cent recommended dose of nitrogen through vermicompost along with biofertilizer (T5 ) recorded significantly higher values for all the seed quality attributes *viz.,* test weight (1.70 g), standard germination (89.67 %), seedling length (9.10 cm), dry weight (3.98 mg), seedling vigor index-I (807.33), seedling vigor index-II (357.17). Net returns (Rs 47607.20/ha) and benefit cost ratio (1.87) was found maximum when 100 per cent recommended dose of nitrogen through inorganic sources along with biofertilizer (T1) was applied.

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