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Effect of Seed Rate and Nutrition Level on Growth and Seed Yield of *Trigonella corniculata* L.

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ABSTRACT

Optimum quantity of seed rate and fertilizers are required to enhance the growth and increase the production is need of the day. Consequently, an experiment was conducted at CCS Haryana Agricultural University, Hisar during *rabi* season to study the effect of seed rate levels and fertilizer levels on coriander. The uppermost value for plant height, pod length, number of branches per plant, number of pods per plant and number of seeds per pod were recorded with seed rate of 7.5 kg/ha. The maximum value for plant height, pod length, number of seeds per pod, and biological yield was recorded with nitrogen dose of 60 kg/ha. The number of branches per plant, number of pods per plant, seed yield and harvest index attained utmost with 40 kg/ha while days to 50% flowering and days to maturity recorded highest with 20 kg/ha. Seed rate of 10.6 kg/ha and nitrogen dose of 40 kg/ha was found to be best to get higher seed yield and seed rate of 7.5 kg/ha and nitrogen dose of 40 kg/ha to get better growth and yield under semi-arid conditions.

Keywords Fenugreek, Nitrogen, Kasuri methi, Seeds, Pods.

INTRODUCTION

In India, raising the productivity and improving the quality of seed are the major thrust areas in seed spices. India ranks first in area and production of fenugreek in the world with the total area of 210 (000 ha) producing 297 (000MT) with the productivity of 760kg/ha (Anonymous 2019). In order to increase the export share and agricultural GDP, it is essential that fenugreek production should be increased so that besides export, the domestic consumption is not affected. Kasuri methi (*Trigonella corniculata* L.), is a semi-arid crop belonging to family Fabaceae. It is a strongly scented annual herb and remains in rosette condition during the vegetative growth period (Kumar *et al.* 2021). The yield of kasuri methi is about three times less than to desi methi or fenugreek but it is more profitable crop than to fenugreek (*T. foenumgraecum* L.) because its leaves and seeds both are economic. It is also recommended as a cure for baldness in man. Kasuri methi is recognized as a vital source of essential minerals, vitamins and dietary fibers. Fenugreek extract is used as a flavoring agent and also stimulate the digestion and general

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metabolism. It is used as vegetable, spice as well as fodder and to some extent for medicinal purpose being used to cut down cholesterol levels, reducing skin marks and blemishes, carminative, antipyretic tonic aphrodisiac and highly beneficial for treating poor liver functions and dyspepsia. The seeds are used in treatment of chronic cough, diarrhoea, dysentery, dropsy, enlargement of liver and spleen rickets, gout, diabetes, and arthritis (Anupama *et al*. 2017).

Plant nutrients play specific and important role in growth and development of a plant. Adequate mineral fertilization is considered to be one of the most important pre requisites in this respect. Fenugreek being a legume crop, its roots are endued with root nodules containing "*Rhizobium*" which fix atmospheric nitrogen for plant, thus its cultivation enriches the soil with nitrogen and does not require much nitrogen except in small quantities as a starter dose in the beginning for its growth. In addition to, an adequate supply of nitrogen to fenugreek will provide an efficient source to sink relationship leading to higher productivity. However, intensive agriculture and adoption of exhaustive high yielding varieties of crops have led to heavy withdrawal of nutrients from the soil during past few years and fertilizer use remained much below as compared to removal of fertilizers. Nitrogen plays a key role in the synthesis of chlorophyll as well as in amino acids which contribute to the building unit of protein and thus growth of plant. Furthermore, adoption of improper dose of seed rate is another impediment in realizing higher yield potential of the crop (Deora *et al.* 2011).

Kasuri methi ripens in 165 days and produce 6-8 quintals seed per hectare. The productivity of kasuri methi is low in sandy clay loam soils of semi-arid region due to nutrient deficiencies particularly those of N and P as well as their imbalance and inadequate use. The productivity of kasuri methi can be increased by proper fertilizer management. There is a need to standardize various agronomic techniques to improve growth and seed yield in fenugreek. Balanced nutrient and proper seed rate, obviously these factors will not only enhance the productivity of seed but also decide the ultimate commercial success of fenugreek crop (Meena *et al.* 2017). Hence, the adoption of good management practices with respect to the use of proper seed rate and nitrogen levels is very important for increasing the yield of seed. Considering the above facts, the experiment was conducted to find out the optimum level of seed rate and fertilizers in kasuri methi for growth and high seed yield.

MATERIALS AND METHODS

The field experiment was conducted at Research Farm of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar, during *rabi* season of 2017-18 and 2018–19. Hisar is situated between 29°10' North latitude and 75°46' East longitudes and 215.2 m above mean sea level. This tract is characterized by semi-arid climate with hot and dry winds during summer and dry severe cold in winter. The total rainfall as well as its distribution in the region is subjected to large variation. About 80–90% of the total rainfall (400 mm) is received through southwest monsoon during July–September. The physico-chemical properties of soil of the experimental field are described in the Table 1 given below :

The experiment was laid in split plot design with four replications, keeping four seed rate levels, viz. S_1 : 7.5 kg ha^{-1}, S_2: 9.0 kg ha^{-1}, S_3: 10.5 kg ha^{-1} and S_4: 12.0 kg ha^{-1} in main plots and three fertilizer levels, i.e., N_1: Nitrogen 20 kg ha^{-1} (N_{20} kg ha^{-1}), N_2: Nitrogen 40 kg ha^{-1} (N_{40} kg ha^{-1}) and N_3 : Nitrogen 60 kg ha^{-1} (N_{60} kg ha^{-1}) in sub-plots. The recommended dose of fertilizers for the State is 30 kg/ha nitrogen and 25 kg/ha phosphorus. The nitrogen is applied by broadcasting in the field at the time of sowing.

The experimental field was prepared by three

Table 1. Physico-chemical properties of soil of the experimental field.

Sl. No.	Parameters	2017-18	2018-19
1	Soil texture	Sandy loam	Sandy loam
2	pH	8.11	8.15
3	EC (dS/m)	0.39	0.38
4	Organic carbon (%)	0.39	0.42
5	Available nitrogen (kg/ha)	140.00	132.00
6	Available phosphorus (kg/ha)	20.00	15.00
7	Available potassium (kg/ha)	214	204

harrowing each followed by planking to prepare a suitable seedbed. Seeds of fenugreek cv Pusa Kasuri were sown in the last week of November on flat seedbeds in rows 30 cm apart. Thinning was done when the plants attained a height of 10 cm and bearing 3–4 leaves to keep the plant to plant distance 20 cm apart. The crop was harvested in the month of April. Other cultural operations and plant protection measures were applied as per package of practices. Observations were recorded on plant height, days to 50% flowering, number of branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant, pod length, number of seeds per pod, days to maturity, seed yield (q ha^{-1}), biological yield (q ha^{-1}) and harvest index (%). The pooled data presented in the tables are the mean values of different parameters. The statistical method described by Panse and Sukhatme (1961) was followed for the analysis and interpretation of experimental results. All the tests of significance were made at 5% level of the significance. Experimental data of different parameters were analyzed in two-factor Randomized Block Design with three replications by using OPSTAT statistical software (http://14.139.232.166/opstat/index.asp) developed by Chaudhry Charan Singh Haryana Agricultural University, Hisar, Haryana, India.

RESULTS AND DISCUSSION

The increasing levels of seed rate resulted in the plant height at harvest turn down distinctly. The value of plant height ranged from 49.9 to 60.5 cm. The maximum plant height (60.5 cm) was registered with seed rate of 7.5 kg/ha followed by seed rate of 9 kg/ha (57.9 cm), while the minimum plant height (52.8 cm) was recorded with a seed rate of 12 kg/ha. On the other hand, the plant height increased significantly with increase in nitrogen levels. The maximum plant height (58.9 cm) was attained with the application of 60 kg/ha nitrogen level which was at par with 40 kg N/ha while the minimum plant height (54.5 cm) was obtained with nitrogen level of 20 kg/ha (Table 2).

Interaction effects of various seed rates and different nitrogen levels on plant height showed significant variation among the treatments combinations. Significantly maximum plant height (63.7 cm) was registered with a treatment combination N_3S_1 i.e. seed rate 7.5 kg/ha and nitrogen level of 20 kg/ha which was at par with N_3S_2 and N_2S_3 while the minimum plant height (49.9 cm) was recorded with treatment combination N_1S_4 i.e. nitrogen level of 20 kg/ha and seed rate 12 kg/ha. The results are in accordance with the findings of Toncer and Kizil (2004) in black cumin and Moniruzzaman *et al.* (2013) in fenugreek. The plan height increases with increase in nitrogen level and the best results were obtained with nitrogen dose of 60 kg/ha the response of nitrogen on plant height may be due to more availability of nutrients through inorganic fertilizers application. The results are in accordance with the findings of Roussis *et al.* (2017) in black cumin. The interaction combination N_4S_1 give the maximum height of plant this may be due to better vegetative growth by nitrogenous fertilizers and more availability of space.

Days to 50% flowering

In kasuri methi, the seed rate and nitrogen levels played a significant role in 50% flowering (Table 3). The data of days to 50% flowering varied between 75.6 and 81.7 among different treatments. The days taken to flowering in 50% plants decreased significantly with the increase in the seed rate. The crop sown with a seed rate of 12 kg/ha resulted earliest 50% flowering in (76.92 days) whereas, the crop sown with a seed rate of 7.5 kg/ha took maximum number of days to flowering in 50% plants (80.48 days). The nitrogen levels treatments showed significant variation for days to 50% flowering. The days taken to flowering in 50% plants increased markedly with the increase in nitrogen levels. The crop raised with nitrogen application of 20 kg/ha showed earliest flowering in 50% plants (77.23 days) which was at par with nitrogen level of 40 kg/ha (78.13 days).

The interaction effect of seed rate and nitrogen levels showed non-significant variation for days to 50% flowering, however, the treatment combination N_1S_4 (nitrogen levels of 20 kg/ha and seed rate 12 kg/ha) took minimum number of days to 50% flowering (75.66 days). The treatment combination N_3S_1 i.e. nitrogen levels of 60 kg/ha and seed rate of 7.5 kg/ha took maximum number of days (81.76 days) to flowering in 50% plants. As regards various levels of nitrogen, 60 kg N/ha (79.05 days) recorded maximum

mean number of days for flower initiation and 50% flowering as compared to 20 kg N/ha and 40 kg N/ ha. This might be due to adverse effect of higher dose of nitrogen, which prolonged the vegetative growth of plant leading to delay flowering. The results of present study confirms findings of Halesh *et al.* (1998) in fenugreek, Mehta *et al.* (2012), Moniruzzaman *et al.* (2013) in fenugreek and Diwan *et al.* (2018) in coriander. Interaction of seed rate and nitrogen level results non-significant variation among the different combination with respect to days taken to flowering in 50% plants however the treatment combination N_1S_4 i.e. nitrogen dose of 20 kg/ha and seed rate of 12 kg/ha took minimum number of days to attain the 50% flowering in plants.

Table 2. Effect of seed rate and nitrogen levels on plant height (cm) at maturity of kasuri methi. CD (p= 0.05) Seed rate (S) = 2.3, Nitrogen levels (N) = 1.9, S × N =3.9.

Seed rate nitrogen levels	S_1 (7.5 kg/ha)	S_2 (9.0 kg/ha)	S_3 (10.5 kg/ha)	S_4 (12.0 kg/ha)	Mean
N_1 (20 kg/ha)	58.7	57.4	52.1	49.9	54.5
N_2 (40 kg/ha)	59.1	56.3	60.6	54.0	57.5
N_3 (60 kg/ha)	63.7	60.0	57.5	54.6	58.9
Mean	60.5	57.9	56.7	52.8	

Days to maturity

The seed rate and nitrogen levels played a significant role for days to maturity (Table 4). The data for days to maturity varied between 135.7 to 148.7 days under various treatments. The data indicated that various seed rates differed significantly with respect to days to maturity. The perusal of crop sown with a seed rate of 12 kg/ha resulted earliest maturity (137.9 days) which was at par with 10.5 kg and 9 kg/ha of seed rate. Whereas, the crop sown with a seed rate of 7.5 kg/ha took maximum number of days to maturity (144.0 days).

The nitrogen treatments also showed significant variation for days to maturity. The days taken to maturity increased remarkably with the increase in nitrogen levels. The crop raised at a nitrogen level of 20 kg/ha showed earliest maturity in plants (137.7 days) which is at par with 40 kg N/ha (139.9 days). However, maximum days to maturity (143.5 days) was noticed with a nitrogen level of 60 kg/ha. The interaction effect of seed rate and nitrogen levels recorded non-significant variation for days to maturity however the treatment combination N_1S_4 (nitrogen levels of 20 kg/ha with seed rate of 12 kg/ha) took minimum number of days to maturity (135.7 days). The treatment combination N_3S_1 i.e. nitrogen levels of 60 kg/ha and seed rate of 7.5 kg/ha took maximum number of days (148.7 days) to maturity. This may be due to the stress condition generated by over crowding in plants and in stress condition the vegetative phase is short leads to early maturity.

The results are in consensus with the findings of Sridevi (2011) who reported pronounced effect of integrated nutrient management on days to 50% flowering and days to maturity, but contradict to the findings of Brar *et al.* (1993) who observed delay in maturity with increase in seed rate in fenugreek. As regards various levels of nitrogen, it was observed that number of days to maturity increases with increase in dose of nitrogen and 20 kg N/ha recorded minimum mean number of days for maturity. This may be due to adverse effect of higher dose of nitrogen, which prolonged the vegetative growth of plant leading to delay maturity. The results are in accordance with the findings of Jagdale and Dalve (2010) who reported that maturity of fenugreek were found to be delayed with an increased level of nitrogen per hectare.

Interaction of seed rate and nitrogen level results non-significant variation among the different combination with respect to days taken to maturity in plants however the treatment combination N_1S_4 i.e. nitrogen levels of 20 kg/ha and seed rate of 12 kg/ha took minimum number of days to attain the maturity in plants.

Pod length (cm)

The data pertaining to pod length measured in cm are presented in Table 5. The perusal of data depict that the various seed rate treatments differed significantly with respect to pod length. The size of pod length decreased markedly with increase in seed rate. The

Table 3. Effect of seed rate and nitrogen levels on days to 50% flowering of kasuri methi. CD (p= 0.05), Seed rate (S) = 1.2, Nitrogen levels (N) = 1.0, S × N =NS.

Seed rate nitrogen levels	S_1 (7.5 kg/ha)	S_2 (9.0 kg/ha)	S_3 (10.5 kg/ha)	S_4 (12.0 kg/ha)	Mean
N_1 (20 kg/ha)	79.3	77.6	76.2	75.6	77.2
N_2 (40 kg/ha)	80.3	78.1	76.7	77.3	78.1
N_3 (60 kg/ha)	81.7	78.6	78.0	77.7	79.0
Mean	80.4	78.1	77.0	76.9	

maximum mean value for pod length (2.17 cm) was noticed with a seed rate of 7.5 kg/ha which was at par with seed rate of 9 kg/ha, while the minimum mean value for pod length (1.80 cm) was noticed with a seed rate of 12 kg/ha.

Similarly nitrogen levels treatments also differed significantly for pod length. The pod size increased significantly with increase in nitrogen levels. The maximum length of pod (2.11 cm) was noticed with the application of 60 kg N/ha which was at par 40 kg N/ha whereas, a nitrogen level of 20 kg/ha attained least value (1.89 cm) for pod length.

Interaction effect of seed rate and nitrogen levels showed considerable variation in pod length. The crop when sown with a seed rate of 7.5 kg/ha and application of 60 kg N/ha produced significantly larger pods (2.32 cm) which was at par with treatments viz. N_3S_2, N_2S_2, N_2S_1, $N_1S_1$and N_3S_3, while the minimum value for pod length (1.71 cm) was registered with a treatment combination N_1S_4 i.e. nitrogen level of 20 kg/ha and seed rate of 12 kg/ha. As regards various levels of nitrogen, the length of pod decreases significantly with increase in nitrogen levels and 60 kg N/ha recorded maximum pod length as compared to 20 kg N/ha and 40 kg N/ha. The results are in accordance with the findings of Chaudhary (1999a) and Pareek and Gupta (1981) in fenugreek who observed increased number of pods per plant by application of nitrogen.

Interaction effect of seed rate and nitrogen level results considerable variation in pod length. Kasuri methi seed rate of 7.5 kg/ha with nitrogen level of 60 kg/ha showed significantly better result. This might be due to less competition among the plants to gain nutrients which might have resulted in higher manufacture of food and its subsequent partitioning to sink.

Number of branches per plant

The data presented in Table 6 showed significant effect of various seed rates and nitrogen levels on number of branches per plant. The number of branches per plant reduced significantly with increase in seed rate. The perusal of data reveals that number of branches per plant varied from 5.86 to 7.53 under various treatment combinations. The crop was sown with seed rate of 7.5 kg/ha recorded maximum number of branches per plant (7.17) which was at par with seed rate of 9 kg/ha (6.94). However, minimum number of branches per plant (5.97) was observed when the crop was sown with a seed rate of 12 kg/ha. This may be due to more space and less competition among the plants which lead to better growth and more number of branches in kasuri methi. The results were confirmed with the findings of Brar *et al.* (1993) in fenugreek and Toncer and Kizil (2004) in black cumin. The number of branches per plant improved remarkably with increasing in nitrogen levels. The maximum number of branches per plant resulted application of 60 kg N/ha (7.07) which was at par with 40 kg N/ha (7.02). The crop sown at nitrogen level of 20 kg/ha showed minimum number of branches per plant (10.69). It might be attributed to increased activity of lateral meristem and uptake of more nitrogen by the plants required to intensify vegetative growth. Among the different levels of nitrogen, N_3` (60 kg/ha) had highest number of branches per plant which is at par with N_2 (40 kg/ha) and the minimum in N_1 (20 kg/ha) at maturity. Similar results were observed by Patidar *et al.* (2004) in cumin, Tuncturk *et al.* (2011) and Sharma (2000) in fenugreek.

Interaction effect of various seed rates and nitrogen level treatments indicated significant variation for number of branches per plant. The maximum value number branches per plant (7.53) was observed with treatment combination of N_3S_1 i.e. application of 60kg N/ha with seed rate of 7.5 kg/ha which was at par with N_2S_1, N_2S_2, N_3S_2, N_2S_3, N_3S_3. The treatment combination N_1S_4 i.e. 20 kg N/ha and seed rate of 12

kg/ha recorded minimum number of branches per plant (5.86). These results are similar with the findings reported by Chaudhary (1999) in fenugreek who reported beneficial effect of treatment combination.

Number of pods per plant

The data pertaining to the number of pods per plant have been presented in Table 7. The perusal of the data shows that the various seed rates differed significantly with respect to number of pods per plant. The values for number of pods per plant ranged from 1576 to 2037 under different seed rate treatments. The number of pods per plant had the inverse relationship with seed rate. The maximum mean value for number of pods per plant was registered with the seed rate of 7.5 kg/ha (1968) which was at par seed rate of 9 kg/ha (1931), whereas, minimum mean number of pods per plant (1670) was registered with seed rate of 12 kg/ha. These results are similar with the findings reported by Brar *et al*. (1993) and Chaudhary (1999) in fenugreek.

All the treatment for nitrogen levels differed significantly from each other concerning for number of pods per plant. The number of pods per plant vary differently with nitrogen levels. The number of pods per plant does not increase with increase in nitrogen levels. The maximum number of pods per plant (1944) was recorded with application of 40 kg N/ha which was at par with 60 kg N/ha (1935), whereas, the treatment of 20 kg N/ha resulted least number of pods per plant (1716). The results are in accordance with the findings of Tuncturk *et al.* (2011) and Sharma (2000) in fenugreek.

Interaction effect of seed rate and nitrogen levels resulted in significant variation with respect to number of pods per plant. When the crop was sown with seed rate of 7.5 kg/ha along with 40 kg N/ha resulted in maximum number of pods (2037) which was statistically at par with treatment viz. N_3S_1, N_2S_2, N_3S_2, N_2S_3 and N_3S_3. The treatment combinations N1S4 i.e. nitrogen dose of 20 kg/ha and seed rate of 12 kg/ha recorded minimum pods per plant (1576). This may be due to less availability of light, space and moisture condition required for better reproductive growth of kasuri methi plant.

Number of seeds per pod

Seed rate showed significant variation for number of seeds per pod as shown in Table 8. The number of seeds per pod decreased distinctly with the increase in seed rate. The mean value for number of seeds per pod (6.58) was recorded with seed rate of 7.5 kg/ha which was at par with seed rate of 9.0 kg/ha (6.41). The least number of seeds per pod (5.70) was noticed when the crop was sown with seed rate of 12 kg/ha. These results are similar with the findings reported by Sunil (2010) in black cumin. The results of present research are contradictory to those of Bommi *et al.* (2010) who observed that number of seeds per pod increases with increase in seed rate in fenugreek.

Significant variation was noticed among the nitrogen levels treatments with respect to number of seeds per pod. The number of seeds per pod increased significantly with the increasing in nitrogen levels. The application of 60 kg N/ha resulted in maximum mean value for the number of seeds per pod, however, the crop applied with nitrogen levels of 20 kg/ha observed least number of seeds per pod (6.0). These results were in support with the findings of Mavai (1998) who reported that seeds per pod were significantly increased by nitrogen applications.

Noticeable variation was observed for the interactive effect of seed rate and nitrogen levels. The treatment combination N_3S_1, i.e. application of 60 kg N/ha and seed rate of 7.5 kg/ha recorded maximum with respect to number of seeds per pod (6.73) which was at par with treatment combination N_3S_2 i.e. 60 kg N/ha with seed rate of 9.0 kg/ha (15.7) while seed rate of 12 kg/ha and along with application of 20 kg N/ha noticed the minimum number of seeds per pod (5.56). The increase in number of seeds per pod might be attributed to improved growth, increased photosynthesis and greater mobilization of nutrients towards reproductive sites due to less competition because of lesser plant population per unit area and better availability of nitrogen.

Seed yield

The data pertaining to seed yield per hectare have been presented in Table 9. The data indicated signifi-

Table 4. Effect of seed rate and nitrogen levels on days to maturity of kasuri methi. CD (P= 0.05), Seed rate (S) = 4.9, Nitrogen levels (N) = 4.2, S × N =NS.

Seed rate nitrogen levels	S_1 (7.5 kg/ha)	S_2 (9.0 kg/ha)	S_3 (10.5 kg/ha)	S_4 (12.0 kg/ha)	Mean
N_1 (20 kg/ha)	139.7	138.1	137.5	135.7	137.7
N_2 (40 kg/ha)	143.5	138.8	138.4	139.1	13.9
N_3 (60 kg/ha)	148.7	143.7	142.7	139.1	143.5
Mean	144.0	140.2	139.5	137.9	

Table 6. Effect of seed rate and nitrogen levels on number of branches per plant of. kasuri methi. CD (p= 0.05), Seed rate (S) = 0.29, Nitrogen levels (N) = 0.25, S × N =0.52.

Seed rate nitrogen levels	S_1 (7.5 kg/ha)	S_2 (9.0 kg/ha)	S_3 (10.5 kg/ha)	S_4 (12.0 kg/ha)	Mean
N_1 (20 kg/ha)	6.50	6.23	6.0	5.86	6.15
N_2 (40 kg/ha)	7.50	7.39	7.29	5.96	7.02
N_3 (60 kg/ha)	7.53	7.42	7.26	6.10	7.07
Mean	7.17	6.94	6.91	5.97	

cant variation among different seed rates with respect to seed yield per hectare. The value for seed yield per hectare varied from 746.7 to 931.0 kg/ha. Among various seed rate treatments, the seed yield per hectare improved considerably with the increase in seed rate up to S_3 (10.5 kg/ha) and decreased thereafter. The treatment vis-à-vis seed rate of 10.5 kg/ha resulted in maximum mean seed yield per hectare (869.9 kg/ha) which was at par with seed rate of 9.0 kg/ha, while the crop sown with seed rate of 7.5 kg/ha registered the minimum mean seed yield per hectare (786.5 kg/ha). The results of present investigation substantiate the findings of Kanwar and Saimbhi (1989) and Toncer and Kizil (2004) in fenugreek.

Application of different nitrogen levels viz. 20, 40 and 60 kg/ha, differed significantly from each other with respect to seed yield per hectare. The maximum mean seed yield per hectare (865.4 kg/ha) was recorded with application of 40 kg N/ha which was at par with 60 kg N/ha however, minimum mean seed yield (755.8 kg/ha) was registered with application of 20 kg/ha nitrogen. The results of present investigation substantiate the findings of Zandi *et al.* (2011). The results obtained were contradictory to Bommi *et al.* (2010) who noticed that seed yield increase with increasing nitrogen level in fenugreek.

Interaction effect of various seed rates and nitrogen levels showed noticeable variation with respect to seed yield per hectare. The crop sown with seed rate of 10.5 kg/ha and applied with 40 kg N/ha recorded maximum seed yield (931.0 kg/ha) which was at par with N_2S_2, N_3S_2, N_3S_3. However, the seed rate of 7.5 kg/ha along with application 20 kg N/ha resulted minimum yield (746.7 kg/ha).

Table 5. Effect of seed rate and nitrogen levels on pod length of kasuri methi. CD (p= 0.05), Seed rate (S) = 0.16, Nitrogen levels (N) = 0.14, S × N =0.28.

Seed rate nitrogen levels	S_1 (7.5 kg/ha)	S_2 (9.0 kg/ha)	S_3 (10.5 kg/ha)	S_4 (12.0 kg/ha)	Mean
N_1 (20 kg/ha)	2.10	2.01	1.76	1.71	1.89
N_2 (40 kg/ha)	2.10	2.07	1.91	1.90	1.99
N_3 (60 kg/ha)	2.32	2.19	2.14	1.96	2.11
Mean	2.17	2.09	1.93	1.80	

Table 7. Effect of seed rate and nitrogen levels on number of pods per plant of kasuri methi. CD (p= 0.05), Seed rate (S) = 81, Nitrogen levels (N) = 70, S × N = 141.2.

Seed rate nitrogen levels	S_1 (7.5 kg/ha)	S_2 (9.0 kg/ha)	S_3 (10.5 kg/ha)	S_4 (12.0 kg/ha)	Mean
N_1 (20 kg/ha)	1836	1760	1693	1576	1716
N_2 (40 kg/ha)	2037	2023	1987	1730	1944
N_3 (60 kg/ha)	2031	2011	1992	1705	1935
Mean	1968	1931	1690	1670	

Biological yield

The perusal of data presented in Table 10 showed

Table 8. Effect of seed rate and nitrogen levels on number of seeds per pod of kasuri methi. CD (p= 0.05), Seed rate (S) = 0.18, Nitrogen levels (N) = 0.16, S × N =0.32.

Seed rate nitrogen levels	S_1 (7.5 kg/ha)	S_2 (9.0 kg/ha)	S_3 (10.5 kg/ha)	S_4 (12.0 kg/ha)	Mean
N_1 (20 kg/ha)	6.66	6.06	5.73	5.56	6.00
N_2 (40 kg/ha)	6.36	6.46	6.20	5.30	6.19
N_3 (60 kg/ha)	6.73	6.70	6.06	5.80	6.32
Mean	6.58	6.41	6.00	5.70	

Table 10. Effect of seed rate and nitrogen levels on biological yield of kasuri methi. CD (p= 0.05) Seed rate, (S) = 124, Nitrogen levels (N) = 107, S × N =215.7.

Seed rate nitrogen levels	S_1 (7.5 kg/ha)	S_2 (9.0 kg/ha)	S_3 (10.5 kg/ha)	S_4 (12.0 kg/ha)	Mean
N_1 (20 kg/ha)	2526	2757	2778	2568	2657
N_2 (40 kg/ha)	2750	2805	2851	2826	2808
N_3 (60 kg/ha)	3049	3067	3206	2993	3079
Mean	2775	2876	2945	2796	

that different seed rate treatments differed significantly with respect to biological yield per hectare. The biological yield ranged from 2526 to 3206 kg/ha among various seed rate treatments and improved significantly with increase in seed rate up to S_3 (10.5 kg/ha) and decreased thereafter. The maximum mean biological yield (2945 kg/ha) recorded under seed rate of 10.5 kg/ha which was at par with 9 kg/ha (2876 kg/ha), while minimum biological yield (2775 kg/ha) was recorded with a seed rate of 7.5 kg/ha. The results of present experiment are accordance with findings of Taneja *et al.* (1985) and Brar *et al.* (1993) in fenugreek.

The perusal of data showed that effect of nitrogen levels viz. 20, 30 and 40 kg/ha differed significantly from each other with respect to biological yield per hectare. The biological yield per hectare had positive correlation with application of different nitrogen levels. The maximum mean value for biological yield (3079 kg/ha) was obtained with the application of 60 kg/ha nitrogen, however, minimum mean biological yield (2657 kg/ha) was recorded with application of 20 kg/ha nitrogen. The results of present experiment are accordance with findings of Zandi *et al.* (2011) in fenugreek.

Interaction effect of various seed rates and nitrogen levels indicated remarkable variation for biological yield. The maximum value for biological yield (3206 kg/hectare) was registered with seed rate of 10.5 kg/ha along with the application of 60 kg/ha nitrogen which was at par with N_3S_1, N_3S_2, N_3S_4. The crop sown with seed rate of 7.5 kg/ha and supplied with 20 kg N/ha resulted in minimum biological yield (2526 kg/ha).

Table 9. Effect of seed rate and nitrogen levels on seed yield of kasuri methi. CD (p= 0.05), Seed rate (S) = 48.2, Nitrogen levels (N) = 41.8, S x N =81.3.

Seed rate nitrogen levels	S_1 (7.5 kg/ha)	S_2 (9.0 kg/ha)	S_3 (10.5 kg/ha)	S_4 (12.0 kg/ha)	Mean
N_1 (20 kg/ha)	746.7	761.9	763.4	751.1	755.8
N_2 (40 kg/ha)	824.3	888.2	931.0	816.4	865.0
N_3 (60 kg/ha)	819.8	906.5	915.2	792.0	858.4
Mean	796.9	862.2	869.9	786.5	

Table 11. Effect of seed rate and nitrogen levels on harvest index of kasuri methi CD (p= 0.05), Seed rate (S) = 2.1, Nitrogen levels (N) = 1.8, S × N =3.62.

Seed rate nitrogen levels	S_1 (7.5 kg/ha)	S_2 (9.0 kg/ha)	S_3 (10.5 kg/ha)	S_4 (12.0 kg/ha)	Mean
N_1 (20 kg/ha)	29.5	27.6	27.4	29.2	28.5
N_2 (40 kg/ha)	30.1	29.3	33.1	28.7	30.3
N_3 (60 kg/ha)	26.9	29.7	28.5	27.4	28.1
Mean	28.8	28.9	29.7	28.5	

Harvest index (%)

The data pertaining to harvest index have been de-

picted in Table 11. The analysis of data reveals that seed rates differed significantly with respect to harvest index. The harvest index of kasuri methi shows a typical trend with respect to seed rate. The maximum mean value of harvest index (29.7%) was recorded by sowing the crop under 10.5 kg/ha seed rate which was at par with 7.5, 9.0 and 12 kg/ha having harvest index of 28.8, 28.9 and 28.5% respectively. The results of present experiment are accordance with findings of Mavai *et al.* (2000) in fenugreek. The beneficial effect of seed rate on kasuri methi with respect to harvest index were contradictory to those of Muhammad *et al*. (2005) who observed that different spatial arrangement showed non-significant effect on harvest index of fenugreek.

The effect of application of different nitrogen levels also differed significantly with respect to harvest index which increased significantly with the increase in nitrogen levels up to N_2. The maximum mean value for harvest index (30.3%) was observed with application of 40 kg N/ha which was at par with 20 kg/ha nitrogen (28.5%), while the minimum harvest index (28.1%) noticed under nitrogen level of 60 kg/ha. The results of present experiment are accordance with findings of Zandi *et al.* (2011) in fenugreek.

The interaction of seed rate and nitrogen levels differed significantly with respect to harvest index. The crop raised with a treatment combination N_2S_3 i.e. of 40 kg/ha nitrogen and seed rate of 10.5 kg/ha resulted in highest harvest index (33.1%) followed by N_1S_1 i.e. 20 kg/ha nitrogen and seed rate of 7.5 kg/ha (29.5%). The minimum harvest index (26.9%) noticed with treatment combination N_3S_1 i.e. application of 60 kg/ha nitrogen and seed rate of 7.5 kg/ha. It might be due to increase in vegetative growth resulting higher biological yield per hectare.

CONCLUSION

Based on the experimental results, it can be concluded that the various seed rate improved the growth and yield of fenugreek seeds. Seed rate of 10.6 kg/ha and nitrogen dose of 40 kg/ha was found to be best to get higher seed yield and seed rate of 7.5 kg/ha and nitrogen dose of 40 kg/ha to get better growth and yield under semi-arid conditions.

REFERENCES

Anonymous (2019) Spice Board Annual Report 2018-19. Ministry of commerce and Industry, Government of India.

Anupama G, Hegde LN, Hegde NK, Devappa V, Mastiholi AB, Nishani S (2017) Effect of nitrogen and spacing levels on physiological and yield parameters of kasuri methi (*Trigonella corniculata* L.) var. Pusa Kasuri. *Int J Curr Microbiol Appl Sci* 6 (9) : 723—733.

Bommi PV, Jinturkar SP, Barkule SR, Bhosale AM, Noor S (2010) Effect of graded levels of nitrogen and seed rate on yield and yield parameters of fenugreek (*Trigonella foe num graecum* L.) cv RMt- 1. *Asian J Horticulture* 5 (2) : 469—471.

Brar RS, Yadav BD, Joon RK (1993) Effect of row spacing and seed rate on growth and seed yield of fenugreek (Trigo*nella foenum-graecum*). *Forage Research* 19 (1) : 104—106.

Chaudhary GR (1999) Response of fenugreek (*Trigonella foenum-graecum* L.) to seed rate and fertilizer application. *Indian Journal of Agronomy* 44 (2) : 427—429.

Chaudhary GR (1999a) Response of fenugreek (*Trigonella foenum - graecum* L.) to N, P and *Rhizobium* inoculation. *Indian Journal of Agronomy* 44 (2) : 424—426.

Deora NS, Singh J, Reager ML (2011) Studies on nutrient management and seed rate on growth and herbage yield of fenugreek (*Trigonella corniculata* L.) cv Kasuri in Rajasthan. *Journal of Spices and Aromatic Crops* 18 (1) : 19—21.

Diwan G, Bisen BP, Maida P (2018) Effect of nitrogen doses and row spacing on growth and seed yield of coriander (*Coriandrum sativum* L.). *International Journal of Chemical Science* 6 (4) : 2768—2772.

Halesh DP, Farooqi AA, Vasundhara M, Srinivasappa KN, Gowda MC (1998) Effects of date of sowing and spacing on growth and yield in fenugreek (*Trigonella foenum graecum* L.) in proceedings of the Centennial Conference on Spices and Aromatic Plants: Challenges and Opportunities, Calicut, Kerala, India, 20—23 : September 129—132.

Jagdale YL, Dalve PD (2010) Effect of nitrogen and phosphorus levels on growth, flowering and pod formation of fenugreek. *Asian J Horticult* 5 (2) : 301—304.

Kanwar JS, Saimbhi MS (1989) Effect of plant spacing and seed rate on seed yield of fenugreek. *Vegetable Sci* 16 (1): 75—77.

Kumar N, Deshmukh UB, Singh J, Kumari V, Sahu SK, Patel S (2021) Effect of integrated nutrients management on growth, yield, productivity and profitability of fenugreek (*Trigonella foenum graecum* L.) cv RMt pp 305.

Mavai D (1998) Effect of seed rate and fertilizer application on seed production of fenugreek (*Trigonella foenum-graecum* L.) (Doctoral dissertation, Vegetable Crops, CCSHAU, Hisar).

Mavai D, Lal S, Singh A, Baswana KS, Singh N (2000) Response of fenugreek (*Trigonella foenum-graecum* L.) to seed rate, nitrogen and phosphorus fertilizer. *Haryana J Horticult Sci* 29 (3-4) : 244—246.

Meena S, Shivran AC, Giana GK, Jat ML, Yadav G, Boori PK (2017) Growth and production potential of fenugreek as influenced by intercropping systems and Sulfur levels. *J Pharmacog Phytochem* 6 (4) : 1945—1949.

Mehta RS, Anwer MM, Aishwath OP, Meena RS (2012) Growth, yield and quality of fenugreek (*Trigonella foenum-graecum*

L.) as influenced by nitrogen, phosphorus and biofertilizers. *Ind J Horticult* 69 (1) : 94—97.

Moniruzzaman M, Rehman MM, Hossain MM, Sirajul Karim AJM, Khaliq QA (2013) Effect of seed rate and sowing method on foliage production of different genotypes of coriander (*Coriandrum sativum* L.). *Bangladesh J Agricult Res* 38 (3) : 435—445.

Muhammad B, Muhammad A, Mehmood S (2005) Effect of phosphorus levels on growth and yield of fenugreek (*Trigonella foenum graecum* L.) grown under different spatial arrangements. *Internat J Agricult Biol* 7(3) : 504—507.

Panse VG, Sukhatme PV (1961) Statistical methods for agricultural workers. Statistical methods for agricultural workers. ICAR New Delhi.

Pareek SK, Gupta R (1981) Effect of fertilizer application on seed yield and diosgenin content in fenugreek. *Ind J Agricult Sci* 50 (10) : 746—749.

Patidar M, Balaram B, Singh MP, Singh G (2004) Influence of nitrogen on growth and yield of cumin (*Cuminum cyminum* L.). *J Medical Aromatic Pl Sci* 13 (2) : 126—128.

Roussis I, Travlos I, Bilalis D, Kakabouki I (2017) Influence of seed rate and fertilization on yield and yield component of (*Nigella sativa* L.) cultivate under Mediterranean semi-arid conditions. *Agro-life Sci J* 6 (1) : 218—223.

Sharma SK (2000) Response of nitrogen and spacing on fenugreek seed production. *Horticult J* 13 (2) : 39—42.

Sridevi C (2011) Effect of different levels of nitrogen and phosphorus on growth and seed yield of coriander (*Coriandrum sativum* L.) cv *sudha* (Doctoral dissertation, Andhra Pradesh Horticultural University).

Sunil DS (2010) Effect of row spacing, seed rate and clipping on yield and quality of cluster bean (*Cymopsis tetragonoloba* (L.) Taub.) (Doctoral dissertation, Anand Agricultural University, Anand).

Taneja KD, Gill PS, Rana DS (1985) Effect of sowing time, row spacing and seed rate on seed production of metha (*Trigonella foenum-graecum* L.). *Forage Research* 11(1) : 33—36.

Toncer O, Kizil S (2004) Effect of seed rate on agronomic and technologic characters of (*Nigella sativa* L.). *Int J Agricult Biol* 6 (3) : 529—532.

Tuncturk R, Celen A, Tuncturk M (2011) Effect of Nitrogen and spacing levels on growth and yield attributes of fenugreek (*Trigonella foenum-graecum* L.). *Turkish J Field Crops* 16(1): 69—75.

Zandi P, Shirani–Rad AH, Daneshian J, Bazrkar–Khatibani L (2011) Agronomic and morphologic analysis of fenugreek (*Trigonella foenum-graecum* L.) under nitrogen fertilizer and plant density via factor analysis. *African J Agric Res* 6 (5) : 1134—1140.