

# Plant Spacing Response on Growth and Yield of Fenugreek in High Altitude of Uttarakhand

Dinesh Tiwari, Sandeep Upadhyay, Ajaya Paliwal

**Abstract**— A field experiment was conducted on clay loam soil at MAPs Block, College of Horticulture, VCSG Uttarakhand University of Horticulture and Forestry (VCSG UUHF), Bharsar, Pauri Garhwal (Uttarakhand) India during 2015 to evaluate the response of plant spacing on growth and yield of fenugreek. The experiment was conducted in the randomized block design with four replications. In the present investigation, the treatment comprised of the six treatments of plant spacing viz, 5 cm x 10 cm, 10 cm x 10 cm, 15 cm x 10 cm, 20 cm x 10 cm, 25 cm x 10 cm and 30 cm x 10 cm. The highest seed yield (494.45 kg /ha) was obtained with 20 cm x 10 cm plant spacing.

**Index Terms**—Bharsar, Fenugreek, Growth and Yield.

## I. INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.), 2n=16 is a multipurpose crop grown during winter season in northern Indian. Fenugreek is the third largest seed spice in India after coriander and cumin, specially known as 'Common Methi' belonging to the family *Fabaceae* and sub family *Papilionaceae*, is widely used as spice and condiment to add flavour in various foods (Dwivedi *et al.*, 2006). Fenugreek leaves and seeds have been used extensively for medicinal purposes. Fenugreek seed is known to exhibit anti-diabetic and anti-nociceptive properties and effects such as hypocholesterolaemic, anti-cancer and thyroxine-induced hyperglycaemia. India is the major producer and exporter of this seed spice. The dried fenugreek seeds, the leaves, fresh and dried and the tender shoots are all consumed and is valued as food, flavouring agent and medicines. In recent past, its high market price has attracted the farmers to include this crop in their cropping system. Fenugreek seed has both food and medicinal value particularly against digestive disorders. Being a leguminous crop, the root nodules enrich the soil with atmospheric nitrogen. The importance of fenugreek seed has further increased due to the presence of alkaloids 'diosgenin' and 'trigonellin' having pharmaceutical use. It is one of the crops in which both leaves as well as seed are consumed in one or the other form. In order to get higher production of good quality vegetable and seed spice, it is required to produce quality seed. One of the significant

subject increasing yield and quality is to regulate the optimum plant density on the field. Plant density varies according to the cultivar, yield capacity of the soil, irrigation condition and cultivation objectives (Tuncturk, 2011).

Thus, keeping in view the potentialities of plant spacing for higher seed yield in fenugreek, the experiment carried out with the objective, to study the effect of plant spacing on growth and yield of fenugreek in high altitude hilly area of Uttarakhand.

## II. MATERIAL AND METHODS

The present investigation was carried on effect of plant spacing on growth and yield of fenugreek in high altitude hilly area of Uttarakhand, the college of Horticulture, VCSG UUHF, Bharsar of the year 2015. The experiment was laid out in the Randomized Block Design (RBD) with four replications and six treatments of plant spacing (5 cm x 10 cm, 10 cm x 10 cm, 15 cm x 10 cm, 20 cm x 10 cm, 25 cm x 10 cm and 30 cm x 10 cm). The variety was Pusa Early Bunching. All the recommended agronomic packages of practices were followed to raise healthy fenugreek crop except plant spacing. Data were recorded on ten competitive plants selected randomly in each replication on various quantitative characters.

### Location and Climate

The college of Horticulture, VCSG UUHF Bharsar is situated at 30.06° N Latitude, 78.99° E longitude and at the altitude of 1900 meters above the mean sea level under temperate climate. Generally, days of Bharsar are fairly warm followed by cool nights in summers. The area receives adequate sunshine hours whereas the growing period is shorter due to long winter. The main features of the Bharsar climate are mild hot summers, higher precipitation during rainy season, prolonged cold winters and occasional snow fall during winter season. The climatic factors such as precipitation, temperature, relative humidity and wind, in association with elevation, slope aspects, drainage, vegetation, *etc.* are responsible for the niche micro-climate of this region.

### Soil

The soil of the experimental plot was sandy loam in texture having high in organic carbon (0.85 %), low in available nitrogen (205.6 Kg/ha) and medium in available phosphorus (18.4 Kg/ha) and potassium (184.6 Kg/ha) with neutral in soil reaction (6.8 pH). The experiment was carried out at the same site with same layout during both the years. The treatment was consisted of six plant spacing (5 cm x 10 cm, 10 cm x 10 cm, 15 cm x 10 cm, 20 cm x 10 cm, 25 cm x 10 cm and 30 cm x 10 cm). The experiment was laid down in randomized block

**Dinesh Tiwari**, Department of Plantation Crops, Spices, Medicinal and Aromatic Plants, College of Horticulture, VCSG Uttarakhand University of Horticulture and Forestry, Bharsar, District Pauri Garhwal, Uttarakhand, India,

**Sandeep Upadhyay**, Department of Natural Research Management, College of Horticulture, VCSG Uttarakhand University of Horticulture and Forestry, Bharsar, District Pauri Garhwal, Uttarakhand, India,

**Ajaya Paliwal**, Department of Crop Improvement, College of Horticulture, VCSG Uttarakhand University of Horticulture and Forestry, Bharsar- 246123 District Pauri Garhwal, Uttarakhand, India,

design with 4 replications. Fenugreek was sown at different plant spacing as per treatments. Recommended dose of fertilizer (RDF) for fenugreek was 30:25:40 Kg NPK/ha, which were applied as basal dose at the time of sowing. Fertilizers in treatments were given as per row arrangements. The source of nutrients were Urea (46 % N), MOP (60 % K<sub>2</sub>O) and NPK (12:32:16 NPK). Farmyard manure (FYM) at the rate of 15 t/ ha was also applied as per treatment on dry weight basis just before sowing. The seed of fenugreek (PEB) was sown on March 11 in 2015 and harvested on July 7, 2015.

Detailed accounts of each data type and collection methods are discussed here under.

**Plant height:** Average height measured in centimeter from the ground level to the tip of the last pod on the main stem of the same plants used to determine number of pods per plant. It was determined on the date of harvest.

**Number of branches per plant:** The average number of branches per plant counted from the ten sample plants before harvesting.

**Number of pods per branch:** The average number of pods per branch counted from the ten sample plants before harvesting.

**Number of pods per plant:** The average number of pods counted from the ten sample plants before harvesting.

**Thousand seed weight:** Weight of 1000 seeds in grams at 12 per cent moisture content determined from average weight of two samples of 250 seeds each multiplied by four.

**Seed yield per hectare:** Seed yield from each net plot area was recorded and converted into kilogram per hectare at 12 per cent moisture.

#### Statistical analysis

The experiment data obtained were analyzed by using analysis of variance (ANOVA) technique for each character as prescribed for a randomized block design layout. The interpretation of data was done on the basis of 'F' test. The critical differences (CD) at 5% level of probability in tables of experimental results with standard error of means (SEM±) as described by Snedecor and Cochran (1968).

### III. RESULTS AND DISCUSSION

#### Effect on plant height

The highest plant height was observed with plant spacing of 30 cm x 10 cm than rest other spacings. The lowest height was recorded with spacing of 5 cm x 40 cm (Table 1).

The growth of fenugreek measured in terms of plant height (Table 1) was in superior order under plant spacing of 30 cm x 10 cm as compared to other plant spacing. Plant height increased with increasing plant spacing. Here it may be pointed out that, the competition between plants for space, sunlight, nutrients, water etc. was very less as compared to other which resulted better growth and development of plant spacing of 30 cm x 10 cm. Singh *et al.* (2005) reported highest plant height in 22.5 cm row spacing while Halesh *et al.* (2000) and Gowda *et al.* (2006) obtained the highest plant heights from the 30 cm row spacing. On the other hand, Mohamed (1990) reported that plant height of fenugreek was not affected by increase in row spacing.

#### Effect on number of branches per plant

The highest number of branches was observed with plant spacing of 25 cm x 10 cm and 30 cm x 10 than rest other spacings. The lowest number of branches was recorded with spacing of 5 cm x 10 cm (Table 1). The number of branches increased with increasing row spacing. In previous studies, similar results were reported by Halesh *et al.* (2000), Gowda *et al.* (2006) and Mohamed (1990) for the number of branches in fenugreek.

#### Effect on number of pods per branch

Significantly higher number of pods per branch was observed with plant spacing of 30 cm x 10 cm than rest other spacings except plant spacing 25 cm x 10 cm which was reported at par with plant spacing 30 cm x 10 cm. The lowest number of pods per branch was recorded in 5 cm x 10 cm plant spacing of fenugreek (Table 1).

#### Effect on number of pods per plant

Significantly higher number of pods per plant was observed with plant spacing of 30 cm x 10 cm than rest other spacings except plant spacing 25 cm x 10 cm which was reported at par with plant spacing 30 cm x 10 cm. The lowest number of pods per plant was recorded in 5 cm x 10 cm plant spacing of fenugreek (Table 1).

The number of pods increased with increasing row spacing. Mohamed (1990) reported that the number of pods increased by increasing row spacing in fenugreek which is supported our results. Singh *et al.* (2005) reported that the yield traits and yield traits decreased with increasing row spacing.

#### Effect on test weight

Significantly higher test weight was observed with plant spacing of 30 cm x 10 cm than plant spacing with 5 cm x 10 cm, remaining plant spacing's were reported at par with plant spacing of 30 cm x 10 cm. The lowest test weight was recorded in 5 cm x 10 cm plant spacing of fenugreek (Table 1).

As the highest thousand seed weight was obtained from plant spacing 30 cm x 10 cm, the lowest values were obtained from 5 cm x 10 cm. It was reported by Singh *et al.* (2005) that closer spacing treatments gave the higher yield and yield components in fenugreek.

#### Effect on seed yield

The seed yield being chief economic characteristic, need special consideration, while evaluating the treatment effects. Significantly higher seed yield (494.45 kg/ ha) was observed with plant spacing of 20 cm x 10 cm than plant spacing with 5 cm x 10 cm and 10 cm x 10 cm; remaining plant spacings like 15 cm x 10 cm, 25 cm x 10 cm and 30 cm x 10 cm were noticed at par with plant spacing of 20 cm x 10 cm. The lowest test weight was recorded in 5 cm x 10 cm plant spacing of fenugreek (Table 1).

Final yield of crop is the cumulative effect of yield attributes and the factors, which directly and indirectly influence them. A crop can perform the best, only when spread of the foliage on the ground surface is in such a manner that the utilization of natural resources would be maximum. In present study, seed yield per hectare of fenugreek increased significantly by the plant spacing with 20 cm x 10 cm. As discussed earlier, this might be mainly due to

improvement in growth which resulted marked improvement in yield attributes of fenugreek (Table 1).

Yield of a crop is resultant of a per plant yield and plant population in a unit area, while per plant yield is dependent on yield attributes like number branches per plant, number of number of pods/ branch, number of pods per plant and test weight etc..

The best seed yield of 494.45 kg ha<sup>-1</sup> was recorded with plant spacing 20 cm x 10 cm and this was followed by yield (480.56 kg ha<sup>-1</sup>) obtained under plant spacing 15 cm x 10 cm, 447.22 kg ha<sup>-1</sup> with plant spacing 25 cm x 10 cm, 436.11 kg ha<sup>-1</sup> with plant spacing 30 cm x 10 cm while the lowest of 288.89 kg ha<sup>-1</sup> was obtained from the plant spacing 5 cm x 10 cm.

An increase in the plant density results in increased competition among the plants for growth requirement factors such as adequate space for growth and development of shoots and roots, light, nutrients and moisture, and as a result, individual plants show less growth and development. But, despite the reduced growth and development of individual plants, the total biological yield per unit area increases due to increased number of plants per unit area (Peiman Zandi *et al.*, 2011). Singh and Nand (1984), Gill *et al.* (2005) and Singh *et al.* (2005) found that the maximum seed yields were obtained from the closer row spacing treatments.

On the basis of results, it may be concluded that regulation of plant population can significantly improve the yield and quality of fenugreek seed. A plant spacing of 20 cm x 10 cm was found to be most suitable for obtaining highest yield of good quality fenugreek seed, and thus, may be recommended for clay loam soil conditions of high altitude hilly area of Uttarakhand.

#### ACKNOWLEDGMENT

The authors are thankful to the Prof. B.P. Nautiyal, Dean College of Horticulture and Honorable Vice Chancellor, Prof. Mathew Prasad, VCSG Uttarakhand University of Horticulture and Forestry, Bharsar for their encouragement, guidance, suggestions, and provided opportunities.

#### REFERENCES

- [1] A. K. Dwivedi, S. Singh and R. Rajan 2006. Suitable varieties of fenugreek for Jharkhand spices and medicinal and Aromatic plants in Eastern region pp. 95-101.
- [2] R. Tuncturk, 2011. The effects of varying row spacing and phosphorus doses on the yield and quality of fenugreek (*Trigonella foenum-graecum* L.). *Turkish J. Field Crop*, 16(2): 142-148.
- [3] G. W. Snedecor and W. G. Cochran, "Statistical methods" in Oxford and IBH Publishing Company Calcutta 6th ed. 1968, pp. 593.
- [4] S. Singh, G. S. Buttar, S.P. Singh and D. S. Brar, 2005. Effect of different dates of sowing and row spacing on yield of fenugreek (*Trigonella foenum-graecum* L.). *Journal of Medicinal and Aromatic Plant Sciences*, 27(4): 629-630.
- [5] D. P. Halesh, M. C. Gowda, A. A. Farooqi, M. Vasundhara, and K. N. Srinivasappa, "Influence of nitrogen and phosphorus on growth, yield and nutrient content of fenugreek (*Trigonella foenum-graecum* L.). Spices and aromatic plants: Challenges and opportunities in the new century." *Contributory papers, Cent.Conf. on Spices and Aromatic Plants*, Calicut, Kerala, India, 20-23 September 2000, pp.191-194.
- [6] M. C. Gowda, D. P. Halesh and A. A. Farooqi, 2006. Effect of dates of sowing and spacing on growth of fenugreek (*Trigonella foenum-graecum* L.). *Biomed.*, 1(2): 141-146.
- [7] M. A. Mohamed, 1990. Differences in growth, seed yield and chemical constituents of fenugreek plants (*Trigonella foenum-graecum* L.) due to some agricultural treatments. *Egyptian Journal of Agronomy*. 15 (1-2): 117-123.

- [8] PeimanZandi, Amir HosseinShirani Rad and Leila Bazrkar- Khatibani, 2011. Agronomic study of fenugreek grown under different inter-row spacing and nitrogen levels in a paddy field of Iran. *Am-Euras. J. Agric. & Environ. Sci.*, 10(4): 544-550.
- [9] J. N. Singh and K. Nand, 1984. Effect of dates of sowing, row spacing and nitrogen levels on the grain yield of fenugrecks. *Indian Drugs*. 21 (2): 536-540.
- [10] B. S. Gill, A. Salaria, D. Singh and S. S. Sani, 2005. Agronomic manipulations for maximum production of *Trigonella foenum-graecum* L. in Punjab. *Indian Journal of Arecanut. Spices and Medicinal Plants*. 7 (2): 69-71.

**Table I: Effect of plant spacing on plant height, No. of branches per plant, No. of pods per plant, test weight, seed yield**

Treatments	Plant height (cm)	No. of branches/ plant	No. of pods/ branch	No. of pods/ plant	Test weight (g)	Yield (kg/ ha)
5 cm x 10 cm	27.28	2.85	3.43	10.40	13.14	288.89
10 cm x 10 cm	28.20	2.90	3.87	11.75	13.80	294.44
15 cm x 10 cm	30.10	2.90	3.89	12.20	13.87	480.56
20 cm x 10 cm	30.75	3.10	3.94	12.25	14.16	494.45
25 cm x 10 cm	32.33	3.15	5.21	14.95	15.52	447.22
30 cm x 10 cm	32.95	3.15	5.32	15.30	15.52	436.11
SEm±	1.89	0.17	0.24	0.76	0.74	20.37
CD at 5 %	5.76	0.51	0.74	2.30	2.24	61.40
CV	12.62	11.32	11.56	11.94	10.40	10.01



**Dr Dinesh Tiwari** gained his Master's V.B.S. Purvanchal University, Jaunpur Uttar Pradesh in 2005 and Ph.D. in Agronomy from GBPUA & T Pantnagar, Uttarakhand in 2010, India. He qualified for ASRB National Eligibility Test in subject Agronomy and Agrometeorology in year 2010.



Dr. Sandeep Upadhyay is Assistant Professor Soil Science and Head of Natural Resource Management at Uttarakhand University of Horticulture and Forestry located at Bharsar, Uttarakhand in India. On educational front, he holds Master's, ASRB NET and Ph.D. degree in Soil Science. His area of interest is Soil testing and fertility evaluation. He also has published several research and technical papers in various journals and periodicals.



Dr Ajaya Paliwal, attained MSc in Genetics from IARI, New Delhi and PhD in Genetics and Plant Breeding from GBPUA&T, Pantnagar presently working as Assistant Professor in the Department of Crop Improvement, College of Horticulture, VCSG Uttarakhand University of Horticulture and Forestry, Bharsar-246123 District Pauri Garhwal, Uttarakhand, India, 7060888692 (e-mail: ajay.paliwal@gmail.com) He qualified for ASRB National Eligibility Test in his subject for Genetics and Plant Breeding in year 2008, 2010. He also has published several research and technical papers in various journals and periodicals.