Effect of plant geometry on growth, yield and quality of different varieties of fenugreek (*Trigonella foenum-graecum* L.)

B.R. Sharanya, I.S. Naruka, R.P.S Shaktawat*, S.S. Kushwah, O.P. Singh and D. Singh

Department of Plantation, Spices, Medicinal and Aromatic Crops, Rajmata Vijayaraje Scindia Krishi Vishwavidyalaya, College of Horticulture, Mandsaur-458 001, Madhya Pradesh, India.

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ABSTRACT

An experiment entitled effect of plant geometry on growth, yield and quality of different varieties of fenugreek was carried out during rabi season of 2016-17 at College of Horticulture, Mandsaur (M.P.) with 12 treatment combinations, comprising three plant geometry 20 cm x 15 cm, 30 cm x 10 cm and 30 cm x 15 cm with four varieties of fenugreek i.e. AFg-1, AFg-2, AFg-3 and AFg-4. These treatments were replicated four times in split plot design and analyzed. Treatment with plant geometry 20 cm x 15 cm recorded significantly maximum plant height, seed yield, straw yield, biological yield, harvest index and chlorophyll content. While, 30 cm x 15 cm treatment recorded significantly maximum days for 50% flowering and for maturity, number of branches, fresh weight, dry weight, number of pods per plant, pod length, weight of pod, number of seeds per pod, weight of seeds per pod, 1000-seed weight, germination percent, seedling vigour index, protein and galactomannon content. Between varieties studied, fenugreek variety AFg-2 found to be significantly superior in respect of number of branches per plant, fresh and dry weight of plant at harvest, number of pods per plant, length of pod, weight of pod, number of seeds per pod, weight of seeds per pod, 1000-seed weight, seed yield, straw yield, biological yield, chlorophyll content in leaves at 75 DAS (SPAD), germination percentage of seeds, seedling vigour index, protein and galactomannon in comparison to other varieties tested.

Key words: Fenugreek, Growth, Plant geometry, Quality, Varieties and Yield.

INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.), commonly called as ‘Greek hay’ and also called as ‘methi’ in Hindi, belonging to the family Fabaceae. The crop is cultivated in the country over an area of 65.94 thousand ha producing 89.61 thousand tonnes (Anonymous, 2015). This spice occupies the third place in area and fourth in production among all minor spices grown in India. It is grown on an extensive scale in Rajasthan, Madhya Pradesh, Gujarat, Uttar Pradesh, Maharashtra, and Punjab. In Madhya Pradesh, Fenugreek is grown in a large area of Malwa region and particularly in Ratlam, Mandsaur, Ujjain, Neemuch and Shajapur districts, due to this region has been designated as agri-export zone for fenugreek. It is widely cultivated in Madhya Pradesh for seed purpose with an area of 15149 ha, production of 18178.8 tonnes and productivity of 1.2 t/ha (Anonymous, 2016). To get maximum production of fenugreek, it is most important and essential to enhance the growth of crop and increases seed yield and this could be achieved largely by providing the most optimum plant population per unit area and balanced nutrient under field conditions, which could be provided by optimizing the spacing. The plants grown in the wider spacing exhibit more horizontal and continuous vegetative growth due to less population pressure per unit area therefore, they give less yield per unit area (Kumar, 2004). However, plants grown under normal spacing will have optimum population density per unit area which provides optimum conditions for luxuriant crop growth and better plant canopy area due to maximum light interception, photosynthetic activity, assimilation and accumulation of more photosynthates into plant system and hence they produce more seed yield with best quality traits (Mazumdar *et al.*, 2007). The growth and seed yield are largely influenced by the fertility status of the soil, apart from this genetic potential of the variety. The lack of suitable plant varieties for prevailing agro-climatic conditions is a major harness the better yield. Adaptations of improved varieties have been reported for better growth and yield. Identification of high-yielding adaptable varieties and proper plant geometry are the first and prime cultural operation to augment productivity of fenugreek. Several attempts have been made in cultivation of fenugreek in the past to increase the productivity and quality, out of which optimum plant geometry and varieties may play an important role to boost the productivity. Keeping all these in mind, an experiment entitled effect of plant geometry on growth, yield and quality of different varieties of fenugreek was conducted to increase growth, yield and quality in fenugreek.

*Corresponding author’s e-mail: rpsshkn@yahoo.co.in*
MATERIALS AND METHODS

The present investigation was conducted during September 2015 to March 2016 at the Research Farm, College of Horticulture, RVSKV, Mansa (MP). The soil of the experimental field was light black loamy in texture with low nitrogen (243.2 kg/ha), medium phosphorus (19.75 kg/ha), high potassium (448.0 kg/ha) and neutral in reaction (pH 6.5). The experiment consisted of three plant geometry 20 cm x 15 cm, 30 cm x 10 cm and 30 cm x 15 cm with four varieties of fenugreek i.e. AFg-1, AFg-2, AFg-3 and AFg-4. These treatments were evaluated under split plot design with four replications. Recommended cultural practices were followed during the entire crop period. Seeds were sown on October 17, 2016 and harvested on about 140-150 days after sowing on maturity. Phosphorous, potassium and nitrogen was applied in the form of DAP, muriate of potash and urea at the rate of 40:50:40 NPK kg/ha respectively. Data was recorded for various growth, yield and quality parameters and statistically analyzed using the method of analysis of variance as described by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Effect of plant geometry: Variation in plant height was significantly influenced by different plant geometry. Higher plant height was obtained in closer spacing 20 cm x 15 cm. Increase in plant height in narrow spacing might be due to less plant canopy which facilitated vertical growth by producing weak, lanky and taller plants due to stiff competition for space, light, nutrients and moisture. Similar results were also reported by Kumar et al. (2015) in ajwain, and Sharma et al. (2016) in coriander. In contrast with this the number of branches per plant were more in broader spacing 30 cm x 15 cm when compared to narrow spacing 20 cm x 15 cm. It may be ascribed to the better growth of plants under broader spacing and it exhibited better vegetative growth due to less plant population density and competition which resulted in more horizontal growth and plant canopy area compared to those under narrow spacing. So the branch bearing capacity increased. The results are in agreement with Mehta et al. (2011) in fennel, Naruka et al. (2012) and Muvel et al. (2015) in ajwain, and Kumar et al. (2015) in fenugreek.

Days taken for 50% flowering, days taken for maturity, fresh weight and dry weight of plant were found to be significantly influenced by different plant geometry. In the present study, plant geometry of 20 cm x 15 cm recorded minimum days for 50% flowering and for maturity. The results are in agreement with Malhothra and Vashishtha (2008), Meena et al. (2012) in nigella and Sharma et al. (2016) in coriander. In contrast with this fresh weight and dry weight were maximum with plant geometry 30 cm x 15 cm. Similar results were reported by Meena et al. (2016) in fenugreek.

In the present study it was observed that different plant geometry had significant effect on the various pod and yield attributes except harvest index. The maximum number of pods per plant, pod length, weight of pod, number of seeds per pod, weight of seeds per pod and test weight were registered under the plant geometry 30 cm x 15 cm. The superior values of number of pods per plant, weight of seeds per pod and test weight under wider spacing may be attributed to better growth and development of plants under less plant density which leads into better source to sink relationship due to availability of balanced and adequate nutrients and better light, space and moisture unlike in narrow spacing. Whereas, plant geometry 20 cm x 15 cm recorded maximum seed yield, straw yield, biological yield and harvest index. Sowing at 20 cm x 15 cm gave significantly higher seed yield of 20.8 q/ha which was 24.5 per cent higher over 30 cm x 15 cm treatment. It may be due to accommodation of more plant population per unit area. Similar results were also reported by Kumar et al. (2015) in fenugreek.

At 75 DAS, significant maximum chlorophyll was registered with plant geometry 20 x 15 cm. But the significant maximum protein content, germination % and seedling vigour index of seeds were recorded in plant geometry 30 x 15 cm respectively. These findings are similar to the findings of Kumar et al. (2015) in fenugreek.

Plant geometry had significant effect on gross return, net return and B:C ratio. Plant geometry 20 cm x 15 cm shows maximum gross return, net return and B:C ratio. These findings are similar to the findings of Kumar et al. (2015) in fenugreek.

Effect of varieties: In the present study it was observed that the plant height, number of branches per plant, days taken for 50% flowering, days taken for maturity, fresh weight and dry weight of plant shown significant difference in different varieties tested (Table 1). All these growth parameters were significantly higher with fenugreek variety AFg-2. The wide variation in growth parameters of all the genotypes might be due to their genetic makeup, which indirectly govern the morphology of the plant. These results are in conformity with the finding of Phom et al. (2014), Kumar et al. (2015), Gurjar et al. (2016) and Giridhar et al. (2016) in fenugreek.

Varieties registered significant differences for various yield attributes (Table 2). The number of pods per plant, pod length, weight of pod, number of seeds per pod, weight of seeds per pod, test weight, seed yield, straw yield and biological yield were recorded maximum with fenugreek variety AFg-2. Fenugreek variety AFg-2 gave 21.2 q/ha seed yield which was 30.6, 11.0 and 9.27 percent higher as compared to AFg-3, AFg-1 and AFg-4, respectively. These results have attributed mainly because of maximum number of branches which in turn has resulted in maximum number
Table 1: Effect of plant geometry on growth attributes of different varieties of fenugreek.

| Treatments | Plant geometry | Plant height(cm) | Branches / plant | Days to 50% flowering | Days taken for maturity | Fresh weight/ plant (g) | Dry weight/ plant (g) | Chlorophyll (SPAD Value) |
|------------|----------------|------------------|------------------|-----------------------|------------------------|------------------------|------------------------|--------------------------|
|            | 20 cm x15 cm   | 71.5             | 5.9              | 40.3                  | 128.4                  | 36.7                   | 6.9                    | 62.6                     |
|            | 30 cm x10 cm   | 70.2             | 6.1              | 42.7                  | 130.3                  | 41.0                   | 7.6                    | 56.8                     |
|            | 30 cm x15 cm   | 68.9             | 6.4              | 45.0                  | 134.2                  | 45.6                   | 8.5                    | 52.0                     |
|            | S. Em. ±       | 0.3              | 0.1              | 0.4                   | 1.0                    | 0.6                    | 0.1                    | 0.9                      |
|            | C.D. 5%        | 1.0              | 0.2              | 1.3                   | 3.3                    | 2.2                    | 0.3                    | 3.2                      |

Varieties

| Treatments | AFg-1 | 69.9 | 6.1 | 42.5 | 130.0 | 38.1 | 7.3 | 56.3 |
|------------|-------|------|-----|------|-------|------|-----|------|
| AFg-2      | 71.8  | 6.5  | 45.8 | 135.9 | 47.3 | 8.8 | 62.7 |
| AFg-3      | 69.3  | 5.8  | 39.0 | 126.8 | 36.3 | 6.6 | 51.1 |
| AFg-4      | 70.5  | 6.2  | 43.4 | 131.0 | 42.6 | 8.0 | 58.5 |
| S. Em. ±   | 0.4   | 0.1  | 0.5  | 1.6   | 1.6  | 0.2 | 1.4  |
| C.D. 5%    | 1.3   | 0.3  | 1.5  | 4.7   | 4.5  | 0.5 | 4.0  |

Table 2: Effect of plant geometry on yield attributes of different varieties of fenugreek.

| Treatments | Pods / plant | Pod length (cm) | Weight of pod (mg) | Seeds / pod (mg) | Weight of 1000-seed weight (g) | Protein (%) |
|------------|--------------|-----------------|-------------------|------------------|-------------------------------|-------------|
|            | 20 cm x15 cm | 32.7            | 10.6              | 363.6            | 16.1                          | 15.0        |
|            | 30 cm x10 cm | 36.5            | 11.5              | 386.6            | 17.0                          | 15.6        |
|            | 30 cm x15 cm | 39.2            | 12.6              | 413.6            | 17.8                          | 16.2        |
|            | S. Em. ±     | 0.8             | 0.2               | 5.0              | 0.1                           | 0.1         |
|            | C.D. 5%      | 2.7             | 0.6               | 17.4             | 0.5                           | 0.4         |

Varieties

| Treatments | AFg-1 | 34.7 | 11.4 | 382.8 | 16.9 | 288.2 | 15.4 | 18.2 |
|------------|-------|------|------|-------|------|-------|------|------|
| AFg-2      | 40.3  | 12.9 | 422.2 | 17.9 | 319.8 | 16.3 | 20.9 |
| AFg-3      | 31.9  | 10.1 | 350.6 | 15.8 | 255.8 | 14.9 | 16.4 |
| AFg-4      | 37.6  | 12.1 | 396.3 | 17.3 | 301.1 | 15.8 | 19.6 |
| S. Em. ±   | 1.0   | 0.3  | 7.0   | 0.2  | 6.4   | 0.1  | 0.4  |
| C.D. 5%    | 2.8   | 0.7  | 20.3  | 0.5  | 18.7  | 0.4  | 1.3  |

Table 3: Effect of plant geometry on yield, economics and quality of different varieties of fenugreek.

| Treatments | Seed yield (q/ha) | Straw yield (q/ha) | Biological yield (q/ha) | Harvest index (%) | Gross Return (Rs/ha) | Net Return (Rs/ha) | B:C ratio | Germination (%) | Seedling vigour index |
|------------|-------------------|-------------------|-------------------------|-------------------|---------------------|-------------------|----------|----------------|---------------------|
|            | 20 cm x15 cm      | 20.8              | 29.3                    | 50.0              | 41.5                | 74724             | 51974    | 2.28           | 84.9                |
|            | 30 cm x10 cm      | 18.6              | 26.3                    | 44.9              | 41.5                | 67124             | 44374    | 1.95           | 89.9                |
|            | 30 cm x15 cm      | 16.7              | 24.6                    | 41.3              | 40.4                | 60016             | 37666    | 1.66           | 94.0                |
|            | S. Em. ±          | 0.2               | 1.0                     | 0.9               | 0.9                 | 879               | 822      | 0.03           | 1.1                 |
|            | C.D. 5%           | 0.8               | 3.4                     | 3.2               | NS                  | 3040              | 2846     | 0.11           | 3.7                 |

Varieties

| Treatments | AFg-1 | 17.9 | 25.5 | 43.4 | 41.3 | 64573 | 49157 | 1.85 | 89.1 | 1943.7 |
|------------|-------|------|------|------|------|-------|-------|------|------|--------|
| AFg-2      | 21.2  | 29.6 | 50.8 | 41.8 | 76244 | 53628 | 2.36 | 94.8 | 2237.9 |
| AFg-3      | 16.3  | 24.5 | 40.8 | 39.9 | 58550 | 35933 | 1.58 | 84.3 | 1785.7 |
| AFg-4      | 19.4  | 27.3 | 46.7 | 41.5 | 69786 | 47169 | 2.07 | 90.1 | 1877.9 |
| S. Em. ±   | 0.5   | 1.0  | 1.0  | 1.0  | 1712  | 1704  | 0.07 | 1.6  | 39.0   |
| C.D. 5%    | 1.4   | 2.8  | 3.0  | NS   | 4969  | 4945  | 0.22 | 4.6  | 113.1  |

Table 1: Effect of plant geometry on growth attributes of different varieties of fenugreek.

Table 2: Effect of plant geometry on yield attributes of different varieties of fenugreek.

Table 3: Effect of plant geometry on yield, economics and quality of different varieties of fenugreek.

of pods per plant, pod length, fresh weight of pod and test weight in AFg-2 as compared to all other varieties tested. Higher vegetative growth especially more number of branches helped in synthesis of greater amount of food material which might have increased yield attributes. Similar results were reported in Phom et al. (2014) and Kumar et al. (2015) in fenugreek.

The chlorophyll content in leaves, germination percentage, seedling vigour index and protein content differed significantly with varieties (Table 3). Among the varieties AFg-2 recorded maximum chlorophyll, germination percentage, seedling vigour index and protein content. Similar results were reported in Phom et al. (2014) and Gurjar et al. (2016) in fenugreek.
Different varieties of fenugreek had significant effect on gross return, net return and B:C ratio. Variety AFg-2 gave maximum gross return, net return and B:C ratio. These findings are also reported by Kumar et al. (2015).

CONCLUSION
On the basis of present study, it may concluded that fenugreek sown at 20 cm x 15 cm spacing and AFg-2 variety of fenugreek gave significant values for different growth attributes, yield attributes, yield, quality and economics of fenugreek crop as compared all other treatments tested. Further, fenugreek sown at 20 cm x 15 cm plant geometry treatment gave significant maximum seed yield (20.8 q/ha), gross return (Rs 74724/ha), net return (Rs 51974/ha) and B:C ratio (2.28) and AFg-2 variety of fenugreek gave significant maximum seed yield (21.2 q/ha), gross return (Rs 76244/ha), net return (Rs 53628/ha) and B:C ratio (2.36).

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