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Sharanya BR
Ph.D., Scholar, Department of Horticulture, University of Agriculture Sciences, GKVK, Bengaluru, Karnataka, India

IS Naruka
Professor, Department of Plantation and Spice Crops Rajmata Vijayaraje Scindia Krishi Vishva vidyalaya Gwalior, Madhya Pradesh, India

Mahesh Rugi
Department of Olericulture Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya Gwalior, Madhya Pradesh, India

Deeksha Raj N
Ph.D., Scholar horticulture Department of Horticulture University of Agriculture Sciences, GKVK, Bengaluru, Karnataka, India

Corresponding Author:
Sharanya BR
Ph.D., Scholar, Department of Horticulture, University of Agriculture Sciences, GKVK, Bengaluru, Karnataka, India

Effect of plant geometry and varieties on seed yield of fenugreek

Sharanya BR, IS Naruka, Mahesh Rugi and Deeksha Raj N

Abstract
An experiment entitled Performance of Fenugreek Varieties at Different plant Geometry for Growth, Yield and Quality traits 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 15cm, 30 cm x 10cm 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 spot design and analyzed. Treatment with plant geometry 20 cm ×15 cm recorded significantly maximum seed yield (20.8q/ha), straw yield (29.3q/ha), biological yield (50.0q/ha) and harvest index (41.5%). While, 30 cm ×15 cm treatment recorded significantly maximum number of pods per plant (39.2), pod length (12.6cm), weight of pod (413.6mg), number of seeds per pod (17.8), weight of seeds per pod (317.3mg), test weight (16.2g). Between varieties studied, fenugreek variety AFg-2 found to be significantly superior in respect of number of pods per plant (40.3), length of pod (12.9cm), weight of pod (422.2 mg), number of seeds per pod (17.9), weight of seeds per pod (319.8 mg), test weight (16.3 g), seed yield (21.2q/ha), straw yield (29.6q/ha), and biological yield (50.8q/ha) in comparison to other varieties tested.

Keywords: Plant geometry, varieties, seed yield, pods per plant, pod length, weight of pod, test weight, weight of seeds per pod, straw yield, biological yield, harvest index

Introduction
Fenugreek (*Trigonella foenum – graecum* L.) popularly known as ‘‘*methi*’’ or also called as ‘‘goat horn” or “cow horn” because the seed pods resembles like horn. Fenugreek is an annual crop belonging to the family Fabaceae. It is diploid species with chromosome number is 2n = 16. It is largely grown during *rabi* season. It is an annual herb native to South-East Europe and West Asia. It is the third largest seed spice in India after coriander and cumin. The genus Trigonella has two species they are *T. foenum-graecum* and *T. corniculata. Trigonella foenum-graecum* plants are semi-erect, tall, moderately branched with bold, typically yellow grains. Plants of *Trigonella corniculata* are bushy green, the flowers are bright orange yellow medium sized and pods are small and sickle shaped. Fenugreek seeds are rich in protein (6.3%), fat (9.5%), carbohydrates (42.3%) and vitamin A (6450 IU/100g). It contains trigonellin (0.13-0.35%) and diosgenin (1.0 g). Seeds also contain linoleic, oleic and linolenic acids. The leaves and stems are rich source of calcium, iron, carotene, ascorbic acid and protein. (Farooqi *et al*., 2003) [6].

The crop is grown on 65.94 million hectares in the country, yielding 89.61 million tonnes (Anonymous 2015) [2]. Among all the minor spices cultivated in India, this spice ranks third in terms of area and production. Rajasthan, Madhya Pradesh, Gujarat, Uttar Pradesh, Maharashtra, and Punjab are among the states where it is grown in large quantities. Fenugreek is cultivated extensively throughout Madhya Pradesh. Fenugreek is cultivated in a large area of Madhya Pradesh's Malwa region, especially in the Ratlam, Mandsaur, Ujjain, Neemuch, and Shajapur districts, which has been designated as a fenugreek agri-export zone. With an area of 15149 hectares, a production of 18178.8 tonnes, and a productivity of 1.2 metric tonnes, it is extensively grown for seed purposes in Madhya Pradesh (Anonymous 2016) [3].

Apart from its spice value, fenugreek is a valuable source of several highly desirable biologically active compounds such as galactomannan (Andrews *et al*., 1952; Garti *et al*. 1997; Brummer *et al.* 2003) [1, 9, 5], sapogenins like diosgenin (Fazli and Hardman, 1968) [7], 4-hydroxyisoleucine (Fowden *et al*., 1973) [8] and alkaloids like trigonelline (Antony and Gopinathan, 1975) [4] that have specific health benefits. Seeds are rich in essential amino acids and trigonellin for which fenugreek is so well known for medicinal uses. Seeds are also reported to contain the steroid ’’ diosgenin’’ which is used in preparation of contraceptives.

Leaves contain 18.6-20.9% protein on dry weight basis. Seeds contain 7% fixed oil and 0.02% volatile oil.

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) [10]. 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) [12]. 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.

Materials and Methods

The present investigation was conducted during September 2016 to March 2017 at the Research Farm, College of Horticulture, RVSKVV, Mandsaur (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 15cm, 30 cm x 10cm and 30 cm x 15cm 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, murate of potash and urea at the rate of 40:50:40 NPK kg/ha respectively Data was recorded for various growth parameters and statistically analyzed using the method of analysis of variance as described by Pansey and Sukhatme (1985) [13].

Results and Discussion

It is evident from the data (Table 1) that there was a significant difference in pods per plant recorded at harvest due to plant geometry of fenugreek at 30×15 cm as compared to other plant geometry tested. Plant geometry of fenugreek at 30×15 cm gave 39.2 pods per plant at harvest. Increment of pods per plant in 30×15 cm over 20×15 cm plant geometry was 19.8 per cent. The data showed that the varieties having significant effect on number of pods per plant. Further, the variety AFg-2 gives maximum pods per plant of 40.3 at harvest as compared to AFg-3. Thus, an increase in number of pods per plant is 26.3 per cent in AFg-2 as compared to variety AFg-3.

Table 1 shows that plant geometry of fenugreek significantly increased the length of pods. The significantly higher pod length (12.6 cm) was recorded in the fenugreek sown at 30×15 cm plant geometry. Thus, an increase in length of pods is 18.8 percent higher in 30×15 cm over 20×15 cm plant geometry. The data indicated that the variety having significant effect on length of pods. Further, the variety AFg-2 gave maximum length of pods (12.9 cm) as compared to other variety. Thus an increase in length of pods is 27.7 percent higher in AFg-2 as compared to variety AFg-3.

The data on weight of pods of fenugreek (Table 1) indicate that the plant geometry of fenugreek at 30×15 cm produced significantly highest weight of pod (413.6 mg) over all other plant geometry. However, the plant geometry of 30×15 cm was found significantly higher than the 20×15 cm. Thus, an increase in weight of pods is 13.75 percent in 30×15 cm over 20×15 cm. An appraisal of data (Table 1) reveals that varieties of fenugreek showed significant effect on weight of pod. Where, fenugreek variety AFg-2 recorded 422.2 mg of weight of pod over variety AFg-3 (350.6 mg). The percent increment in variety AFg-2 was 20.4 percent as compared to variety AFg-3.

A critical examination of data (Table 2) showed that there was significant difference in number of seeds per pod at plant geometry 30×15 cm (17.8) compared to 20×15 cm (16.1). Thus, an increase in number of seed per pod is 10.5 percent in plant geometry 30×15 cm as compared to 20×15 cm. Table 2 indicates that variety AFg-2 of fenugreek recorded highest number of seeds (17.9) over variety AFg-3 (15.8). Thus, an increase in number of seeds is 13.2 percent higher in AFg-2 as compared to AFg-3.

The data recorded (Table 2) explicit that weight of seeds per pod was significantly affected by various plant geometry. It is obvious from the data that 30×15 cm plant geometry significantly increased the weight of seeds per pod and registering highest value of 317.3 mg, while minimum (264.4 mg) weight of seeds per pod was recorded with plant geometry of 20×15 cm. Thus, 30×15 cm plant geometry showed 20 percent higher weight of seeds per pod over 20×15 cm of fenugreek. An examination of data presented in the same table further reveals that weight of seeds per pod was significantly affected with different fenugreek varieties. However, maximum weight of seeds per pod was observed in the variety AFg-2 (319.8 mg) over AFg-3 (255.8 mg). Thus, increment was 25.0 per cent higher in AFg-2 over AFg-3.

The data presented (Table 2) further reveals that plant geometry shown significant difference in test weight. Highest test weight of 16.2 g was recorded with 30×15 cm over 20×15 cm (15g). The percent increment was 8 in plant geometry 30×15 cm as compared to 20×15 cm.

Data presented in Table 2 further reveals that different varieties significantly influenced the test weight of seed. The maximum test weight 16.3 g was observed in fenugreek variety AFg-2. While minimum test weight 14.9 g was recorded with variety AFg-3. There was 9.39 per cent increment in test weight of AFg-2 over AFg-3.

The data with respect to the effect of different plant geometry and varieties on seed yield per hectare is presented in Table 3. Among different plant geometry, 20×15 cm gave significantly higher seed yield of 20.8q/ha as compared to all other plant geometry tested. Thus, plant geometry of 20×15 cm gave 24.5 per cent higher over 30×15 cm with respect to seed yield of

fenugreek. Varieties of fenugreek also had significant effect on seed yield per hectare. Seed yield per hectare was found to be highest in variety AFg-2 (21.2q/ha) as compared to AFg-3, AFg-1 and AFg-4. AFg-2 gave 30.6, 11 and 9.27 percent higher as compared to AFg-3, AFg-1 and AFg-4 respectively.

Table 3 shows that there was a significant effect of plant geometry on straw yield. Highest straw yield was recorded in 20×15 cm (29.3 q/ha) compared to 30×15 cm plant geometry (24.6 q/ha). Thus, plant geometry of 20×15 cm was 19.1 per cent higher over 30×15 cm with respect to straw yield of fenugreek. Varieties also had significant effect on straw yield of fenugreek. Maximum straw yield was recorded in fenugreek variety AFg-2 (29.6 q/ha) as compared to AFg-3, AFg-1 and AFg-4. AFg-2 gave 20.8, 16 and 8.4 percent higher straw yield as compared to AFg-3, AFg-1 and AFg-4 respectively.

The data recorded (Table 3) explicit that biological yield was significantly affected by various plant geometry. It is obvious from the data that plant geometry 20×15 cm significantly increased the biological yield and registering highest value of 50 q/ha, while minimum (41.3 q/ha) biological yield was recorded with crop geometry 30×15 cm. Thus, fenugreek plant geometry of 20×15 cm was 21.06 per cent higher over 30×15 cm with respect to biological yield of fenugreek. An examination of data presented in the same table further reveals that biological yield was significantly affected with the varieties. However, maximum biological yield recorded with the variety AFg-2 (50.8 q/ha). This was 24.5 per cent higher as compared to AFg-3.

Perusal of data in Table 4 reveals that there were non significant differences in harvest index with plant geometry and varieties of fenugreek.

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 30×15 cm. The superior values of number of pods/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 20×15 cm recorded maximum seed yield, straw yield, biological yield and harvest index. It may be due to accommodation of more plant population per unit area. Similar results were also reported by Kumar *et al*. (2015) [11] in fenugreek.

Table 1: Effect of plant geometry and varieties on various pod characters in fenugreek

Treatments	Number of pods per plant	Pod length (cm)	Weight of pod (mg)
Plant geometry			
20×15 cm	32.7	10.6	363.6
30×10 cm	36.5	11.5	386.6
30×15 cm	39.2	12.6	413.6
S.Em. ±	0.76	0.16	5.05
C.D. at 5%	2.65	0.57	17.4
Varieties			
AFg-1	34.7	11.4	382.8
AFg-2	40.3	12.9	422.2
AFg-3	31.9	10.1	350.6
AFg-4	37.6	12.1	396.3
S.Em. ±	0.97	0.25	6.99
C.D. at 5%	2.83	0.74	20.3

Table 2: Effect of plant geometry and varieties on number of seeds per pod, weight of seeds per pod and test weight of fenugreek

Treatments	Number of seeds per pod	Weight of seeds per pod (mg)	Test weight (g)
Plant geometry			
20×15 cm	16.1	264.4	15.0
30×10 cm	17.0	291.8	15.6
30×15 cm	17.8	317.3	16.2
S.Em. ±	0.14	4.98	0.12
C.D. at 5%	0.48	17.26	0.44
Varieties			
AFg-1	16.9	288.2	15.4
AFg-2	17.9	319.8	16.3
AFg-3	15.8	255.8	14.9
AFg-4	17.3	301.1	15.8
S.Em. ±	0.17	6.42	0.13
C.D. at 5%	0.51	18.65	0.39

Table 3: Effect of plant geometry and varieties on seed yield, straw yield and biological yield of fenugreek

Treatments	Seed yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)
Plant geometry			
20×15 cm	20.8	29.3	50.0
30×10 cm	18.6	26.3	44.9
30×15 cm	16.7	24.6	41.3
S.Em. ±	0.24	0.97	0.93
C.D. at 5%	0.84	3.37	3.22
Varieties			

AFg-1	17.9	25.5	43.4
AFg-2	21.2	29.6	50.8
AFg-3	16.3	24.5	40.8
AFg-4	19.4	27.3	46.7
S.Em. ±	0.47	0.95	1.02
C.D. at 5%	1.38	2.77	2.98

Table 4: Effect of plant geometry and varieties on harvest index of fenugreek

Treatments	Harvest index (%)
Plant geometry	
20×15 cm	41.5
30×10 cm	41.5
30×15 cm	40.4
S.Em±	0.92
CD at 5%	NS
Varieties	
AFg-1	41.3
AFg-2	41.8
AFg-3	39.9
AFg-4	41.5
S.Em. ±	1.01
C.D. at 5%	NS

Conclusion

Sowing of fenugreek at plant geometry of 20×15 cm and variety AFg-2 found to be best compared to other plant geometry and varieties tested with respect to growth, yield and quality of fenugreek.

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