International J. Seed Spices 5(1), January 2015:63-67

Response of crop geometry, fertilizer levels and genotypes on productivity of fenugreek (*Trigonella foenum-graecum* L.)

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Abstract

An experiment was conducted during Rabi season of 2012-13 to study the effect of crop geometry, fertilizer levels and genotypes on growth and yield of fenugreek (Trigonella foenum-graecum L.). The field experiment consisted of two spacing viz., 30 cm x10 cm (S_1), 22 cm x 10 cm (S_2) and two fertilizer levels viz., F_1- 40:40:20 kg NPK per ha, F_2- 50:50:25 kg NPK per ha and three genotypes viz., Ajmer Fenugreek-1 (V_1), Ajmer Fenugreek-3 (V_2) and Ajmer Fenugreek-4 (V_3). The experiment was laid out in factorial randomized block design with three replications. Result revealed that significantly higher seed yield (2437.4 kg ha^{-1}), straw yield (3356.8 kg ha^{-1}), biological yield (5794.2 ha^{-1}), net return (Rs.57358 ha^{-1}) and BCR (2.5) were recorded with sowing at a spacing of 22 cm x 10 cm as compared to 30 cm x 10 cm spacing but numbers of pods per plant (37.0), seed yield per plant (43.5 g), test weight (16.6 g) and harvest index (41.80) were higher in 30 cm x 10 cm spacing. Irrespective of spacing and genotypes, the application of 125 percent RDF (NPK 50:50:25) recorded significantly more pods (40.7) per plant, seed yield (41.9 g) per plant, seed yield (2249.1 kgha^{-1}), straw yield (3094.2 kgha^{-1}), biological yield (5343.2 kgha^{-1}), 1000 seed weight (16.4 g), harvest index (42.07), net return (Rs.51091.0 ha^{-1}) and BCR (2.3) as compared to 100 percent RDF(NPK 40:20:20). Significantly higher number of pods (42.9/pod), seed yield (45.9 g/plant), seed yield (2270.7 kgha^{-1}), straw yield (3066.8 kgha^{-1}), biological yield (5337.4 kgha^{-1}), net return (Rs.51927.0 ha^{-1}) and BCR (2.3) were recorded with AFg-4. Thus, it is inferred that sowing at 22 cm x 10 cm spacing with application of 125 percent of recommended dose of fertilizer is better for realizing higher yield, net return and BCR.

Key words: Crop geometry, fenugreek, fertility, genotypes.

Introduction

Fenugreek (*Trigonella foenum-graecum* L.) is an old cultivated spice crop of India which belongs to the family Fabaceae. The major fenugreek producing countries are India, Argentina, Egypt, Southern France, Morocco, Spain, Bulgaria, Pakistan, Afghanistan, Turkey and China. India is one of the major producer and exporter of fenugreek. In India, fenugreek production is concentrated mainly in Rajasthan, Gujarat, Madhya Pradesh, Chhattisgarh, Maharashtra, Haryana, Punjab and Uttar Pradesh with an area of 93605 ha and annual production of 115929 tonnes along with a productivity of 1238 kgha^{-1} (Anonymous.,1). Rajasthan is the major fenugreek producer in India. In Rajasthan, it is widely grown in Sikar, Jaipur, Chittorgarh, Jhunjhunu, Kota, Pali, Alwar, Jhalawar and Churu districts. 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 and fertilizer levels. 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.,3). 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.*,4).Similar to spacing, judicious application of nutrients play a decisive role in deciding the ultimate success of seed production of fenugreek crop by realizing higher growth and seed yield. The growth and seed yield are largely influenced by the nutrient fertility status of the soil apart from genetic potential of the variety. Altering the soil nutrients and fertility status by providing balanced and adequate dose

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of major nutrients like nitrogen, phosphorus and potassium as per the crop requirement, is one of the easiest way to boost up the productivity of fenugreek. National Research Centre on Seed Spices has developed new fenugreek varieties and these varieties may have different nutrient and spacing requirements. Hence, it is important to standardize the optimum levels of major nutrients for realizing better seed crop productivity. Under this backdrop scenario, there is a need to develop a suitable production technology for newly developed varieties of fenugreek by optimizing the spacing and fertilizer levels to get luxurious crop growth and higher seed production. Thus, the present investigation was carried out with an object to find optimum crop geometry and suitable fertilizer doses for fenugreek varieties.

Materials and methods

The field experiment on effect of crop geometry and fertilizer levels on different genotypes of fenugreek (Trigonella foenum-graecum L.) was conducted at National Research Centre on Seed Spices, Ajmer (Raj), India during rabi season of 2012-13. The soil of the experimental site was sandy loam with a pH 8.92 having 0.21 per cent organic carbon and 76.0, 33.4 and 234.1 kg/ha available N, P_2O_5 and K_2O respectively. The field experiment consisted of two spacing viz., 30 cm x10 cm (S_1),22 cm x10 cm (S_2) and two fertilizer levels viz., F_1 40:40:20 kg NPK per ha, F_2 50:50:25 kg NPK per ha and three genotypes viz., Ajmer Fenugreek-1(V_1), Ajmer Fenugreek-3(V_2) and Ajmer Fenugreek-4(V_3). The experiment was laid out in randomized block design with factorial concept in three replications. Different genotypes of fenugreek were sown at two crop geometry as per treatments. Fertilizers in the form of di-ammonium phosphate (DAP) and muriate of potash (MOP) were applied as single basal dose to each of the plots at two to three inches deep as per the treatment. Immediately after sowing, light irrigation was applied to ensure proper germination and establishment of crop. Seed treatment with Rhizobium meliloti was done before sowing. Weeds are controlled by manual hand weeding as per need of the crop. Five plants were selected randomly from each plot and their dry weight was taken after drying in oven at70°C for 72 hours or till constant weight was obtained. Observations on plant height, branches per plant, yield attributing characters viz. pods per plant, pod length, and seeds per pod and yield were recorded. The statistical analysis was done as per procedure suggested by (Panse and Sukhatm.,9).

Results and discussion

Growth parameters

Variation in plant height, number of primary branches per plant, secondary branches per plant and number of nodules per plant at different growth stages was recorded in different spacing. Higher plant height at 60 DAS, 90 DAS and at harvest were obtained in closer spacing but more primary branches per plant, secondary branches per plant, dry matter accumulation per plant and number of nodules per plant at 60 and 90 DAS were recorded in wider spacing of 30 cm x 10 cm as compared to narrow spacing. 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 (Pandey *et al.*, 8).In contrast to plant height, the number of primary branches per plant, number of secondary branches per plant, plant dry matter nodules per plant at 90 DAS and at harvest were significantly more in the broader spacing of 30 cm x 10 cm than in closer spacing of 22 cm x 10 cm and 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 (1,48,148 plants/ha).The similar results were reported by (Mohammed *et al.*, 7) and (Mehta *et al.*, 5) in fenugreek.

Irrespective of genotypes and plant spacing, application of varying fertilizers level resulted marked differences in plant height, dry matter accumulation per plant, number of primary branches per plant, number of secondary branches per plant, number of nodules per plant at different growth stages of plant. Application of 125 percent RDF (50:50:25 kg NPK per ha) exhibited higher plant height, dry matter accumulation per plant, number of primary and secondary branches per plant and number of nodules per plant at different growth stages of crop compared to application of 100 per cent RDF. The significant rise in growth parameters noticed under higher fertilizer level may be ascribed to greater uptake of nutrients by the plants favoring better cell division, elongation, amino acid and protein synthesis and it might have produced more plant height, number of branches and plant dry matter production compared to recommended fertilizer level. The similar increase in growth parameters under higher fertilizer levels were also noticed by (Kumar *et al.*, 3) in french bean and (Mehta *et al.*, 6).

The growth parameters varied markedly due to genotypes irrespective of spacing's and fertilizer levels at different growth stages viz., 60 & 90 DAS and at harvest. At harvest, AFg-1 recorded significantly the highest plant height, number of primary branches, number of secondary branches, plant dry matter and nodules dry matter followed by recommended AFg-3. The significant rise in growth parameters noticed under genotypes AFg-4 may be due to its genetic make which reflected in higher growth parameters.

Yield attributes and yield

Irrespective of fertilizer levels and genotype, varying spacing exhibited marked difference in yield attribute and yield. Wider spacing of 30 cm X 10 cm resulted more number of pods per plant (37.0), weight per pod (0.368 g) and test weight (16.6 g) over narrow spacing of 22 cm x 10 cm (Table 2). The superior values of number of pods/plant, weight 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. These results are in conformity with those of (Pastucha. 10) and (Kumar., 3) in fenugreek, and (Mazumdar *et al.*, 4) in hyacinth bean. On the contrary, significant but reciprocal trend was noticed in the closer spacing by registering more seed yield, straw yield and biological yield over broader spacing. Narrow spacing of crop resulted 29.5 and 27.9 per cent higher seed yield and straw yield, respectively over wider spacing. This may be attributed to about 25.3 per cent more plant population density noticed in closer spacing over wider spacing (1,11,111plants/ha). These results are in corroborative with the findings of (Prakash *et al.*, 11) in moth bean and (Shaikh and Kumbhar., 12) in soybean

Irrespective of spacing and genotype, application of varying level of fertilizers influenced yield attributes and yield of crop. Maximum number of pods per plant (40.7), test weight (16.40 g), seed yield (2249.1 kg ha^{-1}), straw yield (3094.2 kg /ha) and harvest index (42.07 %) were obtained with the application of 125 percent higher recommended level of fertilizer comprising of 50:50:25 kg NPK per ha over 100 percent RDF which might be due to more availability of nutrient which leads to higher growth and yield parameters leading to higher yield. These results corroborate with the findings of (Dataram *et al.*, 2) in fenugreek and (Kumar et al., 3) in french bean and (Mehta *et al.*, 6).

Different genotype of fenugreek significantly influence

Table 1: Effect of spacing, fertilizer levels and genotypes on plant height, dry matter wt. /plant and number of Branches, number of nodules /plant at different growth stages of fenugreek

Treatments	Plant height (cm)			Plant fresh wt. (g)		Plant dry wt. (g)		No of primary branches /plant			No. of sec. branches/plant			No. of nodules/plant	
	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	60 DAS	90 DAS	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest	60 DAS	90 DAS
Crop geometry															
30cm x 10 cm (S_1)	30.7	55.9	66.6	21.91	40.63	4.74	7.29	5.6	5.9	5.9	3.8	4.5	4.5	5.2	7.0
22 cm x 10cm (S_2)	34.5	66.4	76.0	24.25	45.06	4.30	6.73	5.4	5.9	5.9	3.5	4.6	4.6	5.0	6.2
S.Em±	0.9	2.1	2.1	0.36	0.62	0.07	0.11	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
CD (P = 0.05)	2.5	6.2	6.2	1.06	1.83	0.21	0.32	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.3
Fertilizer levels															
100% RDF (NPK: 40:20:20) (F)	33.4	59.9	70.0	24.57	39.86	4.77	6.89	5.4	5.8	5.8	3.4	4.3	4.3	5.1	6.1
125% RDF (NPK: 50:25:25)(F_2)	31.8	62.4	72.5	21.58	45.82	4.27	7.13	5.6	6.0	6.0	3.8	4.8	4.8	5.1	7.2
S.Em±	0.9	2.1	2.1	0.36	0.62	0.07	0.11	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
CD (P = 0.05)	2.5	6.2	6.2	1.06	1.83	0.21	0.32	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.3
Genotypes															
AFg-1 (V)	31.2	60.4	70.0	22.4	38.5	4.35	6.73	5.5	5.9	5.9	3.4	4.3	4.3	5.3	6.6
AFg-3(V_2)	34.1	61.7	71.8	20.5	35.8	4.59	6.35	5.2	5.8	5.8	3.1	3.7	3.7	4.4	6.0
AFg-4(V_3)	32.5	61.5	72.1	26.3	54.2	4.63	7.95	5.8	6.2	6.2	4.4	5.7	5.7	5.7	7.3
S.Em±	1.1	2.6	2.6	0.4	0.8	0.09	0.13	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
CD (P = 0.05)	3.1	7.6	7.5	1.3	2.2	0.25	0.39	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.4

Table 2: Effect of spacing, fertilizer levels and genotypes on yield attributes and seed yield in fenugreek

Treatments	No. of pods/ plant	Pod length (cm)	Pod weight (g)	No. of seeds/ pod	Test wt. (g)	Seed yield (kg/ ha)	Straw yield (kg/ ha)	Biological yield (kg/ha)	Harvest Index (%)
Crop geometry									
30 cm x 10 cm (S_1)	37.0	10.8	0.388	17.2	16.6	1882.6	2623.8	4506.4	41.80
22 cm x10 cm (S_2)	35.6	10.5	0.368	17.3	15.7	2437.4	3356.8	5794.2	42.05
S.Em±	0.5	0.1	0.012	0.3	0.4	32.0	51.8	79.7	0.25
CD (P = 0.05)	1.5	0.4	0.036	0.8	1.1	93.8	151.9	233.6	0.74
Fertilizer levels									
100% RDF (NPK: 40:20:20) (F_1)	32.0	10.6	0.374	17.2	15.8	2070.9	2886.5	4957.4	41.78
125% RDF (NPK: 50:25:25) (F_2)	40.7	10.6	0.382	17.2	16.4	2249.1	3094.2	5343.2	42.07
S.Em±	0.5	0.1	0.012	0.3	0.4	32.0	51.8	79.7	0.25
CD (P = 0.05)	1.5	0.4	0.036	0.8	1.1	93.8	151.9	233.6	1.04
Genotypes									
AFg-1 (V_1)	35.4	10.1	0.365	17.4	15.5	2137.9	2972.0	5109.9	41.85
AFg 3 (V_2)	30.6	10.4	0.358	16.8	15.7	2071.4	2932.3	5003.6	41.40
AFg 4(V_3)	42.9	11.3	0.413	17.5	17.2	2270.7	3066.8	5337.4	42.52
S.Em±	0.6	0.2	0.015	0.3	0.5	39.2	63.5	97.6	0.31
CD (P = 0.05)	1.9	0.5	0.044	0.9	1.4	114.9	186.1	286.2	0.90

Table 3: Effect of spacing, fertilizer levels and genotypes on yield and return in fenugreek

Treatments	Seed yield (kg/ ha)	Straw yield (kg/ ha)	Gross return (Rs/ha)	Net return (Rs /ha)	BCR
Crop geometry					
30 cm x 10 cm (S_1)	1882.6	2623.8	61725.4	39548.44	1.8
22 cm x10 cm (S_2)	2437.4	3356.8	79835.9	57358.89	2.5
S.Em±	32.0	51.8	1044.3	1044.26	0.05
CD (P = 0.05)	93.8	151.9	3062.3	3062.25	0.1
Fertilizer levels					
100% RDF (NPK: 40:20:20) (F_1)	2070.9	2886.5	67900.8	45815.78	2.1
125% RDF (NPK: 50:25:25) (F_2)	2249.1	3094.2	73660.6	51091.56	2.3
S.Em±	32.0	51.8	1044.3	1044.26	0.05
CD (P = 0.05)	93.8	151.9	3062.3	4330.68	0.14
Genotypes					
AFg-1 (V_1)	2137.9	2972.0	70081.5	47754.50	2.1
AFg-3 (V_2)	2071.4	2932.3	68006.2	45679.17	2.0
AFg-4(V_3)	2270.7	3066.8	74254.3	51927.33	2.3
S.Em±	39.2	63.5	1279.0	1278.95	0.1
CD (P = 0.05)	114.9	186.1	3750.5	3750.48	0.2

yield attributes and yield of fenugreek. AFg-4 genotype exhibited significantly more number of pods per plant (42.9), length of pod (10.4 cm) weight per pod (0.413 g), number of seeds per pod (17.5), test weight (16.40 g), seed yield (2249.1 kg ha^{-1}), straw yield (3094.2 kg ha^{-1}) and harvest index (42.07 %)

Economic analysis

Varying spacing significantly influenced gross return, net return and BCR. Sowing of fenugreek at narrow spacing (22 cm x 10 cm) resulted higher gross return (Rs.79835 ha^{-1}), net return (Rs.57358 ha^{-1}) and BCR (2.5) over wider spacing (Table 3).The higher return in narrow spacing is due to higher plant population and seed yield. Irrespective to genotype and spacing, application of varying levels of fertilizer significantly affected the gross return, net return and BCR. Application of 125 percent RDF exhibited higher gross return. Net return and BCR compared to application of 100 % RDF. Application of 125 percent RDF resulted in 8.48 and 11.5 percent higher gross return and net return, respectively over 100 percent RDF. The higher return with application of 125 percent RDF is due to higher seed yield per plant and higher yield per hectare. Returns and BCR were significantly influenced by different genotypes of fenugreek. AFg-4 genotype exhibited the highest gross return (Rs.68006 ha^{-1}), net return (Rs.51927 ha^{-1}) and BCR (2.3), respectively.

Conclusion

Thus, it is concluded that sowing at 22 cm x10 cm spacing with application of 125 per cent of recommended dose of fertilizer is better for realizing higher yield, net return and BCR in all the fenugreek varieties tested.

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Received : August 2014; Revised : November 2014
Accepted : December 2014