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To study the effect of seed rate and row spacing on quality parameters of fenugreek (*Trigonella foenum-graecum* L.)

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Abstract
A field experiment was conducted at Chaudhary Charan Singh Haryana Agricultural University, Hisar to evaluate the effect of seed rate and row spacing on quality parameters of fenugreek (*Trigonella foenum-graecum*) cv. *Hisar Sonali*. The treatment comprised of three rows spacing (20, 30 and 40 cm) in main plot and five seed rate (16, 18, 20, 22 and 24 kg/ha). Ten competitive plants are selected randomly from each plot to record data on various parameters. Seed rate resulted significant improvement in seed quality parameters. The maximum value were recorded for test weight and germination percentage with treatment combination S_1R_3, i.e. seed rate 16 kg/ha and row spacing of 40 cm. However,the treatment combination S_5R_3, i.e. seed rate 24 kg/ha and row spacing of 40 cm, was found to be best with respect to seedling length, seedling dry weight, vigour index-I and vigour index-II.

Keywords: Fenugreek, seed rate, row spacing

Introduction
Fenugreek (*Trigonella foenum-graecum* L.) is an annual legume crop belongs to family Leguminaceae. In India during 2014-15, the crop covered an area of 123.40 million hectares with total production of 130.80 million tonnes. Out of which, more than 65% area i.e. 81.70 million hectares with total production of 84.20 million tonnes is produced by Rajasthan alone. In Haryana during 2014-15, the crop was grown in 4.80 million hectare with seed production of 8.70 million tonnes (Anonymous, 2015) [2]. Due to its low water requirement, it is being grown profitably in south western districts of Haryana mainly Hisar, Bhiwani, Rohtak, Sirsa, Mohindergarh and Rewari where both soil and climatic conditions are favourable for its growth and development (Anonymous, 2015) [2].

Seeds are the foundation of agriculture but without a steady supply of high-quality seed crop quality would be greatly decreased. Seed quality is the most vital and crucial for crop production, one of the ways to increase the productivity without adding appreciably to the extent of land now under cultivation by planting quality seed. The quality seed is important for achieving the desired goal of raising the crop either yield or for resistance or for desired quality factors. However, very little research work has been carried out on spacing and seed rate of fenugreek seed crop. Hence, there is a considerable scope of increasing the productivity of this commercial crop by adopting the improved management practices along with optimum seed rate and spacing.

Materials and Methods
The present study entitled "*Effect of seed rate and row spacing on growth and yield of fenugreek (Trigonella foenum graecum* L) was carried out at Research Farm of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar during the winter season of 2016-17 by following Randomized block design with fifteen treatment combination and three replications.

Experimental Details
Total plots: 45
Variety: Hisar Sonali (The variety Hisar Sonali was a Pureline selection from a local germplasm. The experimental material was procured from department of vegetable science CCSHAU, Hisar)

Plot Size: 4.0 m x 2.4 m
Date of sowing: 27 November, 2016

Details of treatment:
A. Seed rate (kg/ha)
S1 = 16(kg/ha), S2 = 18(kg/ha), S3 = 20(kg/ha), S4 = 22(kg/ha), S5 = 24(kg/ha)
B. Row spacing (line to line in cm)
R1 = 20 cm, R2 = 30 cm, R3 = 40 cm
Treatment combinations:
R1S1: Seed rate 16 kg/ha at 20 cm row spacing
R2S1: Seed rate 16 kg/ha at 30 cm row spacing
R3S1: Seed rate 16 kg/ha at 40 cm row spacing
R1S2: Seed rate 18 kg/ha at 20 cm row spacing
R2S2: Seed rate 18 kg/ha at 30 cm row spacing
R3S2: Seed rate 18 kg/ha at 40 cm row spacing
R1S3: Seed rate 20 kg/ha at 20 cm row spacing
R2S3: Seed rate 20 kg/ha at 30 cm row spacing
R3S3: Seed rate 20 kg/ha at 40 cm row spacing
R1S4: Seed rate 22 kg/ha at 20 cm row spacing
R2S4: Seed rate 22 kg/ha at 30 cm row spacing
R3S4: Seed rate 22 kg/ha at 40 cm row spacing
R1S5: Seed rate 24 kg/ha at 20 cm row spacing
R2S5: Seed rate 24 kg/ha at 30 cm row spacing
R3S5: Seed rate 24 kg/ha at 40 cm row spacing

Observations recorded:
During the course of experimentation, the observations were recorded for the following growth and seed yield parameters:

1. Test weight (g)
One thousand seeds replicated thrice in each genotype were counted, weighed and average seed weight of each genotype was calculated.

2. Standard germination (%)
One hundred seeds of each genotype in three replicates placed between moistened towel papers (BP) and kept at 200C temperature in seed germinator. The first count was taken on 5th day and final count on 14th day and only normal seedlings were considered for percent germination computation according to the rules of International Seed Testing Association (ISTA, 1999).

3. Seedling length (cm)
Seedling length of ten randomly selected normal seedlings from three replications of standard germination test was measured to get the averaged seedling length in centimetres

4. Seedling dry weight (mg)
Seedling dry weight was assessed after the final count in the standard germination test (14 days). The ten randomly selected normal seedlings from the three replication of standard germination test were taken and dried in a hot air oven for 24hrs at 80±10C. The dried seedlings of each replication were weighed and average seedling dry weight of each genotype was calculated.

5. Seedling vigour index
Seedling vigour indices were calculated according to the method suggested by Baki and Anderson (1973):
I. Vigour index-I (on seedling length basis)
Vigour index-I = Standard germination (%) X average seedling length (cm)
II. Vigour index-II (on seedling dry weight basis)
Vigour index-II = Standard germination (%) X average seedling dry weight (mg)

Results and Discussion
The data present in Table 1 indicate that all treatments differed significantly from each other with respect to test weight, standard germination, seedling length, seedling dry weight, vigour index-I and vigour index-II.

Table 1: Effect of seed rate and row spacing on quality parameters of fenugreek cv. Hisar Sonali

Treatments	No. of Treatments	Test Weight (g)	Standard germination (%)	Seedling length (cm)	Seedling dry weight (mg)	Vigour index-I	Vigour index-II
Row Spacing (R)	R_1(20 cm)	10.24	88.81	19.82	70.68	1762	627
	R_2(30 cm)	10.45	89.71	20.41	74.33	1832	666
	R_3(40 cm)	10.63	90.59	20.82	75.49	1888	678
	C.D. (P=0.05)	0.10	0.22	0.21	0.45	20.32	3.65
Seed Rate (S)	S_1(16kg/ha)	11.24	91.24	19.24	68.31	1756	623
	S_2(18kg/ha)	10.64	90.66	19.94	71.09	1806	645
	S_3(20kg/ha)	10.47	89.76	20.53	73.66	1843	661
	S_4(22kg/ha)	1023	88.54	20.73	76.28	1850	673
	S_5 (24kg/ha)	9.61	88.32	21.30	78.18	1882	685
	C.D. (P=0.05)	0.14	0.29	0.27	0.58	26.24	4.71
Interaction (S X R)	S_1 X R_1	10.80	90.10	18.40	66.43	1658	598
	S_1 X R_2	11.23	91.50	19.37	68.20	1772	624
	S_1 X R_3	11.70	92.13	19.97	70.30	1840	647
	S_2 X R_1	10.50	89.93	19.07	68.00	1715	612
	S_2 X R_2	10.67	90.93	20.17	72.23	1834	657
	S_2 X R_3	10.77	91.10	20.60	73.03	1871	665
	S_3 X R_1	10.30	88.80	20.30	71.13	1803	632
	S_3 X R_2	10.50	89.53	20.50	74.63	1835	668
	S_3X R_3	10.60	90.93	20.80	75.20	1892	684
	S_4 X R_1	10.10	87.77	20.40	73.07	1806	641
	S_4X R_2	10.20	88.40	20.70	77.63	1842	686
	S_4 X R_3	10.40	89.33	21.07	78.13	1903	692
	S_5 X R_1	9.50	87.43	20.93	74.77	1830	654
	S_5 X R_2	9.63	88.20	21.30	78.97	1879	697
	S_5 X R_3	9.70	89.33	21.67	80.80	1936	703
	C.D.(P=0.05)	0.23	0.50	0.47	1.80	45.45	8.16

The values for test weight ranged from 9.50 to 11.70 g. The value of test weight decreased significantly with increased in seed rate and increased with increases in row spacing. The highest mean value of test weight (11.24g) is observed with a seed rate of 16kg/ha. Brar *et al.* (1993a) [4] noticed that seed rate does not influence the test weight of seed significantly, however they obtained maximum (11.07 g) test weight with the application of 15 kg/ha and minimum (10.91g) with a seed rate of 25 kg/ha. Bommi *et al.* (2010) [3] reported the highest test weight (11.14 g) obtained with a seed rate of 30 kg/ha. In fenugreek, as the highest test weight was obtained from crop geometry (30 cm x 10 cm), the lowest values were obtained from 5 cm x 10 cm was reported by Singh *et al*. (2005) [8]. Chaudhary (2006) [5] reported that the adoption of the spacing 30x10 cm brought significant increases in the test weight (12.24 g) over the crop geometry of 22.5 x 13.3 cm (12.09 g). The germination percentage of fenugreek seeds decreased markedly with the increase in seed rate. The maximum mean value for germination percentage recorded with seed rate of 16kg/ha (91.24%) followed by a seed rate of 18kg/ha (90.66%) and the minimum mean value for germination percentage was noticed with a seed rate of 24kg/ha (88.32). The germination percentage of fenugreek seeds improved noticeably with the increased in row spacing. The row spacing levels 30 and 40cm differed significantly from each other. The highest germination rate (93.6%) of fenugreek seeds obtained from a crop sown at a spacing of 60 cm x7.5 cm as recorded by the Sharma (2000) [7]. Glamoclija *et al*. (2002) [6] noticed the germination percentage is increased with the decrease in the crop density up to 50 x 10 cm followed by a decrease with further increase in crop density. The seedling length of fenugreek plant increased significantly with increase in seed rate. The longest length of seedling was obtained with seed rate of 24 kg/ha. The results revealed that a row spacing of 40 cm showed the best result with respect to seedling length. The present results was inveterate by Verma *et al*. (1999) [10] who reported that the Vigour Index- I is directly correlate with the seedling length i.e. higher the seedling length more the Vigour Index and vice - versa. The maximum dry weight of seedling was observed with seed rate of 24 kg/ha. The observation recorded that a row spacing of 40 cm showed the best result with respect to dry weight of seedling. Singh *et al*. (1985) [9] affirmed seed quality attributes like test weight, germination percentage, seedling dry weight and Vigour Index- II were found to be better in response to planting at a wider spacing than narrow spacing. Seed vigour index-I varied from 1658 to 1936. Seed vigour index-I shows positive significant with seed rate and row spacing. The maximum mean value for vigour index-I was recorded with a seed rate of 24kg/ha (1882) and row spacing of 40 cm. seed vigour index-II varied between 598 and 703. The seed vigour index-II of fenugreek increased with increased in seed rate. The highest mean value for above parameter was observed with seed rate of 24kg/ha (685). Seed vigour increased significantly as we increase in row spacing. The highest mean value for seed vigour index-II were obtained (678) with row spacing of 40cm.

Conclusion

Based on the computed results, it can be accomplished that the various seed rates has positive impact on the quality of fenugreek seeds. Seed rate of 24 kg/ha with row spacing of 40 cm was best to get better quality characteristics under semi - arid conditions of Hisar (Haryana).

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