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Effect of Rhizobium Inoculation and Different Leaf Cutting Management on Seed Quality of Fenugreek (*Trigonella foenum graecum* L.)

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A B S T R A C T

An experiment was conducted during *Rabi* season 2012-2013 for the evaluation different levels of leaf cuttings and its impact on the seed quality fenugreek genotypes. Ten genotypes were sown (November 12, 2012) with two sets of treatments (*Rhizobium* inoculation and without *Rhizobium*) and three level of leaf cuttings (no cutting, one cutting at 30 days, two cuttings at 30 and 40 days after sowing) and after attaining full maturity seeds were harvested respectively and after that different seed quality parameters were conducted to assess the effect of *Rhizobium* inoculation and three levels of leaf cutting on seed quality of fenugreek genotypes. Maximum field emergence percentage was observed for the genotype HM-348. The highest seedling length and dry weight was observed with *Rhizobium* treatment in the genotype HM-291 with no cutting. The maximum seedling vigour index was observed with *Rhizobium* treatment by the genotype HM-291 with no cutting. Minimum electrical conductivity (0.069µS/cm/seed) was observed for genotype Hisar Sonali without *Rhizobium* treatment with no cutting and HM-348 recorded maximum seed density with *Rhizobium* treatment with no cutting. The genotype HM-348 and HM-291 were observed superior in most of the seed quality parameters. Seed inoculation with *Rhizobium* culture influenced the seed quality parameters in comparison to no inoculation.

Introduction

Fenugreek (*Trigonella foenum-graecum* L.) is an annual plant in the family Fabaceae. It is also an important seed spice crop grown in Northern India during the *Rabi* season (winter season) for its leaves and seeds. It has various medicinal values and used to prevent some diseases including diabetes and knee pain. Fenugreek seeds (per 100 g) are rich sources of protein (46% of DV), dietary fiber (98% DV),B vitamins, iron (186% DV) and several other dietary minerals(USDA National Nutrient Database).Being a legume crop, it responds to inoculation with *Rhizobium* culture and supplemented with appropriate levels of nitrogen. Of all the nitrogen fixing microorganisms, *Rhizobium* has the maximum ability to fix nitrogen in association with legume crops and remainder benefits the succeeding crop, thereby improves crop and its soil productivity. Over recent years fenugreek is used as a dual purpose crop for greens leaf cutting as well for dry produce and there after living the crop for seed production has gained importance on account of the expectation of farmers to harness better returns. Seed viability and vigour are the most

important attributes of seed quality. The quality seed is pre-requisite to enhance the production and productivity. Keeping in view of the above facts, the research was conducted to judge the effects of *Rhizobium* and leaf cutting levels on seed quality parameters of fenugreek genotypes.

Materials and Methods

Seed material comprised of ten genotypes fenugreek *viz*. HM-257, HM-273, HM-291, HM-293, HM-346, HM-348, HM-355, HM-444, Hisar Suvarana and Hisar Sonali procured from the Department of Vegetable Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar. The field experimental site was located at between 29.15°N latitude 75.69°E longitude with a mean altitude of 215 m above msl. Two sets of genotypes were under taken; one set was without *Rhizobium* inoculation while the second set inoculated with *Rhizobium* culture with three level of leaf cuttings: no cutting, one cutting at 30 days after sowing, two cutting at 30 and 40 day after sowing under both the sets of treatments, after the full maturity (May 2013) the seeds were collected respectively from each leaf cutting levels and the completely randomized design (CRD) was followed to conducted laboratory testing for the seed quality parameters. All recommended agronomic practices were followed timely for successful raising the seed crop and from each plot seeds were collected for measuring seed quality attributes. The observations were recorded on seed quality parameters were field emergence percentage, seedling length, dry weight, seedling vigour index, electrical conductivity, seed density as per the standard procedures.

Results and Discussion

With *Rhizobium* treatment, maximum field emergence percentage (Table 1) with no cutting was recorded for HM-348 (91.66 %), at one cutting HM-346 (91.66 %) and with two cuttings HM-346 (90.66 %). Without *Rhizobium* treatment the maximum field emergence percentage recorded for HM-291 (90.00 %) with no cutting, at one cutting HM-348 (91.00 %) and with two cuttings HM-348 (92.00 %) respectively. Similar observation were also recorded in Bengal gram, Moth Bean, Green gram, Peas by Pawar *et al.*, (2014) and mentioned that seeds dressed with *Rhizobium* showed high seed germination and emergence percentage over control. Seedling length decreased significantly at one cutting and two cuttings as compared to no cutting in both the treatment. With *Rhizobium* treatment maximum seedling length (Table 2) was recorded by genotype HM-291(25.99 cm) with no cutting, HM-348 (25.00 cm) at one cutting and HM-257 (23.90 cm) at two cuttings respectively. Without *Rhizobium* treatment, maximum seedling length was recorded by genotype HM-348 (24.11 cm) with no cutting, Hisar Suvarna (23.00 cm) at one cutting and HM-291 (21.90 cm) with two cuttings respectively.

Badar *et al.*, (2016) confirmed the similar finding in fenugreek that application of *Rhizobium* promotes the seedling length and other growth parameters. Similar results were also reported by Anitha *et al.*, (2015) in fenugreek and suggested that increase in seedling length due to bolder seeds, having higher test weight.

Soundari *et al.*, (2015) also recorded increase in root and shoot length in fenugreek that were treated with *Rhizobium* culture and proved to be best in enhancing root length. Dry weight decreased significantly in one cutting and two cuttings as compared to no cutting in both the treatment. With *Rhizobium* treatment maximum dry weight of seedling (Table 3) was recorded by genotype HM-291 (80.11 mg) with no cutting, while HM-348

(79.11 mg) with one cutting and also in two cuttings (80.02 mg) respectively. Without *Rhizobium* treatment maximum dry weight recorded for genotype HM-348 as 80.00 mg, 79.00 mg and 78.67 mg with no cutting, one cutting and two cuttings, respectively. These results were confirmed by Parakhia *et al.*, (2000) in fenugreek that co-inoculation of *Azotobacter* with *Rhizobium* resulted in higher fresh and dry weight in comparison to control treatment. Sharangi *et al.*, (2005) also reported that with *Rhizobium* inoculation highest dry matter was found compared to without inoculation. Similar results were also reported by Badar *et al.*, (2016) and Anitha *et al.*, (2015) in fenugreek. Soundari *et al.*, (2015) found that *Rhizobium* inoculated plants showed increased dry weight in fenugreek. Kumar (2011) also reported similar effect of *Rhizobium* inoculation in pea. Seedling vigour index appeared slightly lower in two cuttings compared to no cutting and one cutting in both *Rhizobium* treatments**.** With *Rhizobium* treatment maximum seedling vigour index (Table 4) for genotype is HM-291 (7780.28) with no cutting, HM-348 with one cutting (7627.10) and two cuttings (7672.31) respectively.

Table.1 Effect of *Rhizobium* treatments and leaf cuttings levels on field emergence percentage among different genotypes of fenugreek

Sr. no	Genotype	Without *Rhizobium*				With *Rhizobium*				
		No Cutting	One Cutting	Two Cutting	Genotype Mean	No Cutting	One Cutting	Two Cutting	Genotype Mean	Overall Mean
1	HM-257	85.00	84.66	84.33	**84.66**	84.33	86.33	84.66	**85.11**	**84.88**
2	HM-273	85.66	86.33	85.66	**85.88**	84.66	86.00	86.66	**85.77**	**85.83**
3	HM-291	90.00	89.66	91.33	**90.33**	86.00	90.33	90.00	**88.77**	**89.55**
4	HM-293	86.66	87.00	86.66	**86.77**	89.00	86.33	87.00	**87.44**	**87.11**
5	HM-346	86.66	90.33	90.00	**89.00**	86.33	91.66	90.66	**89.55**	**89.27**
6	HM-348	89.00	91.00	92.00	**90.66**	91.66	91.33	90.00	**91.00**	**90.83**
7	HM-355	89.33	84.66	85.00	**86.33**	83.66	83.33	83.00	**83.33**	**84.83**
8	HM-444	83.66	89.33	88.66	**87.22**	90.66	90.33	90.00	**90.33**	**88.77**
9	Hisar Suvarna	85.00	84.66	85.66	**85.11**	86.00	85.66	85.00	**85.55**	**85.33**
10	Hisar Sonali	86.00	86.00	87.00	**86.33**	89.66	85.33	85.33	**86.77**	**86.55**
Cutting mean		**86.70**	**87.36**	**87.63**	**87.23**	**87.20**	**87.66**	**87.23**	**87.36**	**87.30**

C.D. at 5 % comparing two mean values of:

Rhizobium Treatment (A) =NS Genotypes (B) = 0.348 Cutting(C) = 0.191

A X B = 0.492 A X C = 0.269 B X C= 0.603 A X B X C = 0.852

Table.2 Effect of *Rhizobium* treatments and leaf cuttings levels on seedling length (cm) among different genotypes of fenugreek

Sr. no	Genotype	Without *Rhizobium*				With *Rhizobium*				
		No Cutting	One Cutting	Two Cutting	Genotype Mean	No Cutting	One Cutting	Two Cutting	Genotype Mean	Overall Mean
1	HM-257	20.09	19.89	19.53	**19.84**	20.54	20.27	23.90	**21.57**	**20.70**
2	HM-273	19.30	19.30	18.30	**18.97**	20.31	20.91	20.95	**20.72**	**19.84**
3	HM-291	22.54	22.27	21.90	**22.24**	25.99	19.53	18.99	**21.50**	**21.87**
4	HM-293	18.60	18.00	18.60	**18.40**	16.99	17.00	15.02	**16.33**	**17.37**
5	HM-346	15.98	15.80	15.78	**15.85**	16.40	16.06	16.05	**16.17**	**16.01**
6	HM-348	24.11	19.99	19.90	**21.33**	24.65	25.00	18.65	**22.77**	**22.05**
7	HM-355	19.66	20.86	20.61	**20.38**	19.91	20.91	20.91	**20.57**	**20.47**
8	HM-444	19.31	19.31	19.40	**19.34**	20.02	19.99	20.00	**20.00**	**19.67**
9	Hisar Suvarna	20.58	23.00	21.31	**21.63**	20.10	21.01	21.00	**20.70**	**21.16**
10	Hisar Sonali	21.28	22.21	19.99	**21.16**	22.00	22.51	22.12	**22.21**	**21.68**
Cutting mean		**20.14**	**20.06**	**19.53**	**19.91**	**20.69**	**20.32**	**19.76**	**20.25**	**19.16**

C.D. at 5 % comparing two mean values of:

Rhizobium Treatment (A) =0.034 Genotypes (B) = 0.075 Cutting(C) = 0.041

A X B = 0.106 A X C = 0.058 B X C= 0.13 A X B X C = 0.184

Table.3 Effect of *Rhizobium* treatments and leaf cuttings levels on dry weight (mg) among different genotypes of fenugreek

Sr. no	Genotype	Without *Rhizobium*				With *Rhizobium*				
		No Cutting	One Cutting	Two Cutting	Genotype Mean	No Cutting	One Cutting	Two Cutting	Genotype Mean	Overall mean
1	HM-257	75.00	75.00	74.00	**74.66**	76.06	75.09	75.09	**75.41**	**75.04**
2	HM-273	71.00	70.82	69.78	**70.53**	71.73	70.10	70.81	**70.88**	**70.70**
3	HM-291	79.00	77.17	77.09	**77.75**	80.11	78.11	78.10	**78.77**	**78.26**
4	HM-293	77.92	77.74	76.98	**77.54**	79.39	77.97	76.15	**77.83**	**77.69**
5	HM-346	65.13	65.99	64.99	**65.37**	65.98	66.02	65.02	**65.67**	**65.52**
6	HM-348	80.00	79.00	78.67	**79.22**	79.93	79.11	80.02	**79.69**	**79.45**
7	HM-355	67.33	67.23	67.10	**67.22**	68.15	68.11	68.81	**68.35**	**67.79**
8	HM-444	69.99	70.01	70.02	**70.00**	70.02	70.02	70.03	**70.02**	**70.01**
9	Hisar Suvarna	61.31	61.00	61.00	**61.10**	62.11	62.10	62.09	**62.10**	**61.60**
10	Hisar Sonali	67.74	66.60	66.49	**66.94**	70.00	69.99	69.99	**69.99**	**68.47**
Cutting mean		**71.44**	**71.05**	**70.61**	**71.03**	**72.35**	**71.66**	**71.61**	**71.87**	**71.45**

C.D. at 5 % comparing two mean values of:

Rhizobium Treatment (A) =0.055 Genotypes (B) = 0.122 Cutting(C) = 0.067

A X B = 0.173 A X C = 0.095 B X C= 0.212 A X B X C = 0.29

Table.4 Effect of *Rhizobium* treatments and leaf cuttings levels on Vigour index among different genotypes of fenugreek

Sr. no	Genotype	Without *Rhizobium*				With *Rhizobium*				
		No Cutting	One Cutting	Two Cutting	Genotype Mean	No Cutting	One Cutting	Two Cutting	Genotype Mean	Overall mean
1	HM-257	7,200.14	7,374.50	7,104.00	**7,226.21**	7,303.60	7,285.13	7,215.78	**7,268.17**	**7,247.19**
2	HM-273	6,816.64	6,769.54	6,698.88	**6,761.69**	6,957.81	6,856.43	6,797.76	**6,870.67**	**6,816.18**
3	HM-291	7,592.48	7,485.23	7,462.31	**7,513.34**	7,780.28	7,576.41	7,497.60	**7,618.10**	**7,565.72**
4	HM-293	7,465.37	7,463.04	7,374.68	**7,434.37**	7,628.36	7,492.97	7,379.43	**7,500.26**	**7,467.31**
5	HM-346	6,252.80	6,400.36	6,245.85	**6,299.67**	6,340.89	6,337.92	6,306.94	**6,328.58**	**6,314.13**
6	HM-348	7,678.40	7,593.01	7,481.89	**7,584.43**	7,699.49	7,627.10	7,672.31	**7,666.30**	**7,625.37**
7	HM-355	6,524.27	6,521.63	6,441.02	**6,495.64**	6,633.62	6,674.09	6,605.76	**6,637.82**	**6,566.73**
8	HM-444	6,707.69	6,725.01	6,713.74	**6,715.48**	6,721.92	6,792.91	6,791.97	**6,768.93**	**6,742.21**
9	Hisar Suvarna	6,504.39	6,459.63	6,382.47	**6,448.83**	6,776.23	6,845.81	6,773.40	**6,798.48**	**6,623.66**
10	Hisar Sonali	5,886.40	5,916.59	5,855.39	**5,886.13**	6,000.56	6,024.02	5,960.96	**5,995.18**	**5,940.65**
Cutting mean		**6,862.86**	**6,870.85**	**6,776.02**	**6,836.58**	**6,984.28**	**6,951.28**	**6,900.19**	**6,945.25**	**6,890.91**

C.D. at 5 % comparing two mean values of:

Rhizobium Treatment (A) =11.11 Genotypes (B) = 28.884 Cutting(C) = 13.607

A X B = 35.134 A X C = 19.244 B X C= 43.03 A X B X C = 60.854

Table.5 Effect of *Rhizobium* treatments and leaf cuttings levels on electrical conductivity (µS/cm/seed) among different genotypes of fenugreek

Sr. no	Genotype	Without *Rhizobium*				With *Rhizobium*				
		No Cutting	One Cutting	Two Cutting	Genotype Mean	No Cutting	One Cutting	Two Cutting	Genotype Mean	Overall mean
1	HM-257	0.125	0.125	0.122	**0.124**	0.131	0.132	0.131	**0.131**	**0.128**
2	HM-273	0.125	0.124	0.125	**0.124**	0.124	0.125	0.124	**0.124**	**0.124**
3	HM-291	0.180	0.180	0.180	**0.180**	0.170	0.170	0.169	**0.170**	**0.175**
4	HM-293	0.142	0.142	0.142	**0.142**	0.144	0.144	0.145	**0.144**	**0.143**
5	HM-346	0.087	0.087	0.080	**0.084**	0.090	0.090	0.090	**0.090**	**0.087**
6	HM-348	0.133	0.132	0.131	**0.132**	0.143	0.142	0.142	**0.142**	**0.137**
7	HM-355	0.119	0.118	0.117	**0.118**	0.118	0.117	0.118	**0.118**	**0.118**
8	HM-444	0.143	0.142	0.143	**0.143**	0.151	0.154	0.153	**0.153**	**0.148**
9	Hisar Suvarna	0.113	0.113	0.113	**0.113**	0.112	0.112	0.111	**0.112**	**0.113**
10	Hisar Sonali	0.069	0.070	0.098	**0.079**	0.097	0.098	0.098	**0.098**	**0.088**
Cutting mean		**0.124**	**0.123**	**0.125**	**0.124**	**0.128**	**0.128**	**0.128**	**0.1282**	**0.126**

C.D. at 5 % comparing two mean values of:

Rhizobium Treatment (A) =0.003 Genotypes (B) = 0.006 Cutting(C) = NS

A X B = 0.09 A X C = NS B X C= NS A X B X C = NS

Table.6 Effect of *Rhizobium* treatments and leaf cuttings levels on seed density (g /cc) among different genotypes of fenugreek

Sr.no	Genotype	Without *Rhizobium*				With *Rhizobium*				
		No Cutting	One Cutting	Two Cutting	Genotype Mean	No Cutting	One Cutting	Two Cutting	Genotype Mean	Overall mean
1	HM-257	1.123	1.040	1.109	**1.090**	1.162	1.217	1.093	**1.160**	**1.124**
2	HM-273	1.430	1.405	1.380	**1.410**	1.477	1.441	1.331	**1.420**	**1.411**
3	HM-291	1.123	1.122	1.111	**1.120**	1.231	1.130	1.220	**1.190**	**1.156**
4	HM-293	1.446	1.321	1.343	**1.370**	1.243	1.415	1.109	**1.260**	**1.313**
5	HM-346	1.323	1.141	1.083	**1.180**	1.376	1.162	1.108	**1.220**	**1.199**
6	HM-348	1.443	1.442	1.433	**1.440**	1.538	1.533	1.444	**1.510**	**1.472**
7	HM-355	1.328	1.313	1.290	**1.310**	1.333	1.332	1.320	**1.330**	**1.319**
8	HM-444	1.348	1.342	1.322	**1.340**	1.454	1.455	1.331	**1.410**	**1.375**
9	Hisar Suvarna	1.237	1.226	1.192	**1.220**	1.251	1.236	1.175	**1.220**	**1.220**
10	Hisar Sonali	1.160	1.121	1.083	**1.120**	1.244	1.471	1.123	**1.280**	**1.200**
Cutting mean		**1.300**	**1.250**	**1.230**	**1.260**	**1.330**	**1.340**	**1.230**	**1.300**	**1.278**

C.D. at 5 % comparing two mean values of:
Rhizobium Treatment (A) =0.028 Genotypes (B) = 0.063 Cutting(C) = 0.034
A X B = 0.09 A X C = 0.049 B X C= NS A X B X C = NS

Without *Rhizobium* treatment genotype HM-348 registered maximum vigour index as 7678.40, 7593.01and 7481.89 with no cutting, one cutting and two cuttings respectively. Kumar *et al.,* (2011) also observed that inoculation *Rhizobium* + *Ensifer meliltoi* has maximum vigour and alone application *Rhizobium* has positive and significant effect on fenugreek. Observation of table 5 revealed that, seed inoculated with *Rhizobium* culture showed slightly higher electrical conductivity except the genotype HM-291 and Hisar Suvarna as compared to no seed inoculation with *Rhizobium* culture at all the cutting levels respectively. Maximum electrical conductivity 0.180 (µS/cm/seed) recorded for genotype HM-291 without *Rhizobium*, at all cutting levels respectively, and the minimum electrical conductivity (0.069) was observed for genotype Hisar Sonali without *Rhizobium* treatment with no cutting. Saxena *et al.,* (1987) reported a negative relationship between electrical conductivity and the levels of reducing sugars in lechate with percent germination and other vigour and viability of vegetable seeds. Seed density in fenugreek seeds of different genotypes appeared slightly lower in two cuttings compared to no cutting and one cutting in both treatments respectively. With *Rhizobium* treatment maximum seed density (Table 6) recorded was for HM-348 with no cutting (1.538), one cutting (1.533) and with two cuttings (1.444) Without *Rhizobium* treatment maximum seed density (1.446) was recorded for HM-293 with no cutting, with one cutting (1.442) and two cuttings (1.443) maximum seed density recorded by genotype HM-348.

It is concluded that seed inoculation with *Rhizobium* culture improved all seed quality parameters compared to no seed inoculation with *Rhizobium* culture at all the cutting levels. All the characters decreased significantly at one cutting and two cuttings as compared to no cutting in both the *Rhizobium* treatment. The present investigation results and its derived inference summarized as that the inoculation with *Rhizobium* is beneficial, economical and ecological safe and better. Genotype HM-348 and HM-291 were observed superior in terms of seed quality parameters. Therefore, seed treatment with *Rhizobium* should be followed for obtaining higher leaf and seed yield along with good quality seed.

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