

Effect of Different Leaf Cuttings and *Rhizobium* Inoculation on Quantitative Characters of Fenugreek (*Trigonella foenum graecum* L.)

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Abstract An experiment was carried out during 2012-13 to study the effect of *Rhizobium* inoculation and different cutting management on growth and yield parameters of fenugreek. Ten genotypes of fenugreek seeds were treated with *Rhizobium* and had three levels of leaf cuttings as no cutting, one cutting at 30 days, two cuttings at 30 and 40 days after sowing. *Rhizobium* inoculation positively influenced the plant height, number of branches, pods per plant, seeds per pod, leaf yield and seed yield. In successive leaf cutting management among different genotypes there was decrease in growth, yield and yield attributes. The result revealed that genotype HM-348 was observed best genotype in terms of growth, leaf and seed yields with *Rhizobium* inoculation and no cutting found superior among all the genotypes in comparison to one cutting and two cutting of fenugreek.

Keywords Fenugreek, *Rhizobium*, Cutting.

Introduction

Fenugreek is an annual plant, its seed and leaf is used for human consumption, fodder for animals and green manure to enrich soil fertility. It is a commercially important spice crop grown during winter season as a leafy vegetable and has got wide adaptability with respect to soil and climatic conditions. Biological nitrogen fixation, a microbiological process which converts atmospheric nitrogen into plant useable form offers economically attractive and economically sound means of reducing external inputs and improving internal sources. Use of *Rhizobacteria* to supplement nitrogen nutrition is a well-recognized strategy for reducing the cost of crop production as well as sustainability. *Rhizobium* spp. are well known group of bacteria that act as the primary symbiotic fixer of nitrogen. In recent years more emphasis has been given to the bio fertilizers use for sustainable farming. Pulse *Rhizobia* differ not only among themselves but it is effective in legume crops. The seed inoculation with *Rhizobium* is effective and fenugreek being a legume crop it responds to inoculation of *Rhizobium* and supplements with appropriate levels of nitrogen. In present time, organic and green leafy vegetables are in more demand, therefore, the cutting management has been gaining importance among the agricultural researchers and farmers so that green leaves may be obtained for vegetable as well fodder purposes, simultaneously, to get the economic benefits in terms of multi leaf cuttings and seed yield. Therefore, the present investigation comprising of ten genotypes was carried out with *Rhizobium* treat-

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Table 1. Effect of *Rhizobium* treatments and leaf cuttings levels on plant height (cm) among different genotypes of fenugreek. CD at 5% comparing two mean values of : *Rhizobium* Treatment (A) = 0.699, Genotype (B) = 1.563, Cutting (C) = 0.856, A×B = 1.211, A×C=1.211, B × C=2.708, A×B×C=3.83.

Sl. No.	Genotype	No. cutting	Without <i>Rhizobium</i>			Geno- type mean	No. cutting	With <i>Rhizobium</i>			Over- all mean
			One cutting	Two cutting	One cutting			Two cutting	Geno- type mean		
1	HM-257	82.86	72.80	53.33	69.67	83.13	73.06	55.06	70.42	70.04	
2	HM-273	84.86	72.86	43.00	66.91	90.46	74.16	59.73	74.79	70.85	
3	HM-291	83.13	77.93	49.33	70.13	85.66	78.40	56.06	73.38	71.75	
4	HM-293	74.53	73.46	53.26	67.09	80.80	62.00	55.13	65.98	66.53	
5	HM-346	89.66	52.46	43.46	61.87	99.06	75.46	60.93	78.49	70.17	
6	HM-348	95.60	83.00	46.95	75.19	105.73	95.60	56.86	86.07	80.62	
7	HM-355	99.00	75.86	53.93	76.27	102.00	77.33	61.33	80.22	78.24	
8	HM-444	87.86	65.00	53.20	68.69	93.00	79.26	65.06	79.18	73.93	
9	Hisar Suvarna	93.93	70.73	64.93	76.53	97.20	81.73	66.62	81.85	79.19	
10	Hisar Sonali	86.93	69.80	56.60	71.11	90.26	73.53	66.60	76.80	73.95	
Cutting mean		87.84	71.39	51.80	70.35	92.75	77.06	60.34	76.72	73.53	

ment and leaf cutting management with the objective to assess the efficacy of *Rhizobium* inoculation and its effect on cutting levels in different genotypes.

Materials and Methods

Seed material comprised of ten genotypes viz. HM-257, HM-273, HM-291, HM-293, HM-346, HM-348, HM-355, HM-444, Hisar Suvarana and Hisar Sonali of

fenugreek 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. Both sets were sown (November 12, 2012) in randomized block de-

Table 2. Effect of *Rhizobium* treatments and leaf cuttings levels on number of branches per plant among different genotypes of fenugreek. CD at 5% comparing two mean values of : *Rhizobium* Treatment (A) = 0.08, Genotype (B) = 0.197, Cutting (C) = 0.108, A×B = 0.279, A×C=NS, B × C=0.341, A×B×C=0.483.

Sl. No.	Genotype	No. cutting	Without <i>Rhizobium</i>			Geno- type mean	No. cutting	With <i>Rhizobium</i>			Over- all mean
			One cutting	Two cutting	One cutting			Two cutting	Geno- type mean		
1	HM-257	4.66	4.40	3.56	4.21	6.26	5.13	4.73	5.38	4.79	
2	HM-273	5.07	4.93	4.46	4.82	5.53	5.20	4.33	5.02	4.92	
3	HM-291	5.60	5.13	4.40	5.04	4.70	4.40	4.20	4.43	4.73	
4	HM-293	5.80	3.66	4.20	4.56	6.40	4.06	4.40	4.96	4.75	
5	HM-346	5.46	4.33	4.00	4.60	5.53	5.53	3.73	4.93	4.76	
6	HM-348	5.13	4.73	4.66	4.84	5.43	5.60	5.13	5.39	5.11	
7	HM-355	5.56	4.40	4.60	4.86	5.46	5.70	4.33	5.17	5.01	
8	HM-444	6.00	4.66	4.00	4.89	6.00	5.13	4.20	5.11	5.00	
9	Hisar Suvarna	5.00	4.33	4.46	4.60	6.46	4.40	5.33	5.40	5.00	
10	Hisar Sonali	5.33	5.33	5.06	5.24	5.36	4.20	4.40	4.66	4.95	
Cutting mean		5.36	4.59	4.34	4.77	5.72	4.94	4.48	5.04	4.90	

Table 3. Effect of *Rhizobium* treatments and leaf cuttings levels on number of pods per plant among different genotypes of fenugreek. CD at 5% comparing two mean values of : *Rhizobium* Treatment (A) = 0.791, Genotype (B) = 1.768, Cutting (C) = 0.968, AxB = 2.5, AxC=NS, B × C=3.062, AxBxC=4.331.

Sl. No.	Genotype	No. cutting	Without <i>Rhizobium</i>			Geno-type mean	No. cutting	With <i>Rhizobium</i>			Over-all mean
			One cutting	Two cutting	One cutting			Two cutting	Geno-type mean		
1	HM-257	71.66	62.00	33.73	55.80	72.00	68.66	43.06	61.24	58.52	
2	HM-273	71.00	61.33	32.33	54.89	73.46	69.66	36.92	60.02	57.45	
3	HM-291	81.93	74.33	48.33	68.20	95.86	78.63	51.46	75.32	71.76	
4	HM-293	81.06	72.00	41.66	64.91	85.53	81.72	45.83	71.03	67.97	
5	HM-346	87.00	41.33	20.66	49.67	90.66	67.06	41.93	66.56	58.11	
6	HM-348	87.93	57.13	50.53	65.20	99.26	84.33	67.40	83.67	74.43	
7	HM-355	75.33	62.66	40.86	59.62	87.66	64.73	44.93	65.78	62.70	
8	HM-444	71.06	47.00	32.66	50.24	82.26	50.73	51.33	61.44	55.84	
9	Hisar										
	Suvarna	71.26	66.00	44.80	60.69	82.86	71.86	47.93	67.56	64.12	
10	Hisar										
	Sonali	75.26	71.66	56.53	67.82	97.93	75.00	59.66	77.53	72.67	
	Cutting mean	77.35	61.55	40.21	59.70	86.75	71.24	49.05	69.01	64.35	

sign with three replication and sowing was done at spacing 50 × 10 cm and the plot size 3.0 × 1.50 m. The observation were recorded on different parameters among the plots with three level of leaf cuttings: no cutting, one cutting at 30 days after sowing, two cutting at 30 and 40 day after sowing. All recommended agronomic practices were followed timely for successful raising the crop. Randomly ten competitive plants were taken to record observation on six quantitative characters namely plant height (cm), number of

branches per plant, number of pods per plant, number of seeds per pod, leaf yield (q/ha) and seed yield (q/ha).

Results and Discussion

Plant height (cm)

Seed inoculation with *Rhizobium* culture positively influenced the plant height at all cutting levels over

Table 4. Effect of *Rhizobium* treatments and leaf cuttings levels on seeds per pods among different genotypes of fenugreek. CD at 5% comparing two mean values of : *Rhizobium* Treatment (A) = 0.163, Genotype (B) = 0.365, Cutting (C) = 0.2, AxB = 0.517, AxC=NS, B × C=0.633, AxBxC=0.895.

Sl. No.	Genotype	No. cutting	Without <i>Rhizobium</i>			Geno-type mean	No. cutting	With <i>Rhizobium</i>			Over-all mean
			One cutting	Two cutting	One cutting			Two cutting	Geno-type mean		
1	HM-257	15.93	15.61	15.30	15.62	16.83	16.44	15.63	16.30	15.96	
2	HM-273	15.61	15.53	15.00	15.38	16.76	16.30	15.83	16.30	15.84	
3	HM-291	16.26	15.66	15.00	15.64	16.43	17.84	15.96	16.74	16.19	
4	HM-293	16.07	15.53	15.33	15.65	16.07	16.2	15.77	16.01	15.83	
5	HM-346	15.07	14.81	14.66	14.85	16.67	15.67	15.32	15.89	15.37	
6	HM-348	18.20	17.81	16.66	17.56	18.60	17.32	16.16	17.36	17.46	
7	HM-355	18.07	16.66	16.73	17.16	18.24	17.31	16.16	17.24	17.20	
8	HM-444	16.94	16.93	16.90	16.92	16.56	16.97	17.03	16.85	16.88	
9	Hisar										
	Suvarna	14.74	16.83	15.64	15.74	15.64	16.13	16.43	16.06	15.90	
10	Hisar										
	Sonali	16.94	16.20	17.74	16.96	15.34	17.20	16.97	16.50	16.73	
	Cutting mean	16.38	16.16	15.89	16.14	16.71	16.74	16.13	16.53	16.33	

Table 5. Effect of *Rhizobium* treatments and leaf cuttings levels on leaf yield (q/ha) among different genotypes of fenugreek. CD at 5% comparing two mean values of : *Rhizobium* Treatment (A) = 0.886, Genotype (B) = 1.982, Cutting (C) = 0.886, A×B = 2.803, A×C=1.254, B × C=2.803, A×B×C=NS.

Sl. No.	Genotype	Without <i>Rhizobium</i>			With <i>Rhizobium</i>			Overall mean
		One cutting	Two cutting	Geno-type mean	One cutting	Two cutting	Geno-type mean	
1	HM-257	50.96	76.75	63.85	52.39	82.46	67.43	65.42
2	HM-273	52.37	74.93	63.65	53.66	82.00	67.83	65.74
3	HM-291	53.29	80.62	66.95	57.22	82.87	70.05	68.51
4	HM-293	56.91	103.90	80.41	52.50	103.45	77.97	79.18
5	HM-346	59.45	87.05	73.25	62.36	93.06	77.71	75.48
6	HM-348	70.82	123.56	97.19	70.86	130.02	100.44	98.81
7	HM-355	61.41	94.80	78.11	59.67	101.82	80.74	79.42
8	HM-444	50.22	78.99	64.61	53.89	85.25	69.57	67.09
9	Hisar Suvarna	56.26	112.33	84.29	59.16	116.11	87.63	85.96
10	Hisar Sonali	53.53	98.29	75.91	59.12	103.01	81.07	78.49
	Cutting mean	56.52	93.12	74.82	58.08	98.00	78.04	76.43

the without *Rhizobium* inoculation. The maximum plant height (Table 1) was recorded with *Rhizobium* inoculation at no cutting (105.73 cm) by cultivar HM-348 ; in one cutting (95.60 cm) by cultivar HM-348, and under two cuttings in genotype Hisar Suvarna (66.62 cm). However all the genotypes showed decreasing trend in plant height as the cutting frequency increased under both the *Rhizobium* treatments. The minimum plant height (43.00 cm) by the genotype HM-273 in two cuttings without *Rhizobium* inoculation. The overall mean plant height over dif-

ferent cuttings and *Rhizobium* treatments was recorded as 73.53 cm. Meena et al. [1] similar findings were also reported in fenugreek plants that have positive and significant effect of *Rhizobium* inoculation alone or dual inoculation with *Rhizobium*+PSB and give maximum plant height over control.

Number of branches per plant

Number of branches decreased significantly in one cutting and two cuttings as compared to no cutting

Table 6. Effect of *Rhizobium* treatments and leaf cuttings levels on seed yield (q/ha) among different genotypes of fenugreek. CD at 5% comparing two mean values of : *Rhizobium* Treatment (A) = 0.338, Genotype (B) = 0.757, Cutting (C) = 0.415, A×B = NS, A×C=0.586, B × C=1.311, A×B×C=NS.

Sl. No.	Genotype	No. cutting	Without <i>Rhizobium</i>			With <i>Rhizobium</i>			Overall mean	
			One cutting	Two cutting	Geno-type mean	One cutting	Two cutting	Geno-type mean		
1	HM-257	20.12	7.81	5.14	11.02	21.97	9.29	6.03	12.43	11.72
2	HM-273	24.16	10.84	6.22	13.74	24.61	12.64	6.66	14.63	14.18
3	HM-291	22.15	14.23	5.73	14.04	24.83	15.24	7.71	15.92	14.98
4	HM-293	20.53	10.53	4.66	11.91	23.88	12.99	4.11	13.66	12.78
5	HM-346	24.66	10.11	3.66	12.81	24.96	10.66	4.27	13.29	13.05
6	HM-348	25.63	18.66	7.78	17.34	27.66	19.71	8.78	18.71	18.02
7	HM-355	21.11	12.36	6.12	13.19	23.16	13.32	8.42	14.96	14.07
8	HM-444	19.26	10.11	3.66	11.01	19.92	11.81	5.69	12.47	11.74
9	Hisar Suvarna	24.11	13.11	7.87	15.03	25.26	16.11	6.33	15.91	15.47
10	Hisar Sonali	21.47	15.11	7.74	14.77	23.71	16.47	7.73	15.97	15.37
	Cutting mean	22.32	12.28	5.86	13.47	23.99	13.82	6.57	14.79	14.13

under both *Rhizobium* treatments irrespective of genotypes. With *Rhizobium* treatment maximum number of branches per plant (Table 2) was recorded by genotype Hisar Suvarna (6.46) with no cutting, with one cutting HM-355 (5.70) and two cuttings by Hisar Suvarna (5.33), respectively. The overall average number of branches per plant over the cuttings and *Rhizobium* treatments was recorded 4.90 the minimum number of branches per plant (3.56) was observed for genotype HM-257 at two cuttings in without *Rhizobium* treatment. Fenugreek seed inoculation with *Rhizobium* had a great effect on number of branches and hence it has positive and significant effect on quantitative characters [2]. Fenugreek plants have positive and significant effect of *Rhizobium* inoculation alone or dual inoculation with *Rhizobium* + PSB and give maximum number of branches over control. Similar results were obtained by other researchers [1, 3].

Number of pods per plant

Number of pods per plant decreased significantly among all the genotypes at one cutting and two cuttings as compared to no cutting under both the *Rhizobium* treatments. Seed treatment with *Rhizobium* positively influenced the number of pods per plant among different genotypes of fenugreek irrespective of cutting levels. With *Rhizobium* treatment maximum number of pods per plant (Table 3) was recorded by genotype HM-348 as 99.26, 84.33 and 67.40 under no cutting, one cutting and two cuttings, respectively. The overall average number of pods per plant over the cuttings and *Rhizobium* treatments was recorded as 64.35 and the minimum number of pods per plant (20.66) was observed in HM-346 without *Rhizobium* treatment. Similar finding also report in fenugreek that application of organic manure and bio-fertilizers and *Rhizobium* + yeast resulted the increased values for growth characters such as plant height, number of pods per plant and yield components [4].

Number of seeds per pod

Number of seeds per pod decreased significantly at one cutting and two cuttings as compared to no cutting in both the *Rhizobium* treatments. With *Rhizobium* treatment maximum number of seeds per pod

(Table 4) was recorded by genotype HM-348 (18.60) with no cutting, at one cutting HM-291 (17.84) and at two cuttings HM-444 (17.03), respectively. The overall average number of seeds per pod over the cuttings and *Rhizobium* treatments was recorded as 16.33 and the minimum number of seeds per pod was observed at two cuttings in genotype HM-346 (14.66) without *Rhizobium* treatment. Increase in seed yield was mainly due to increased number of pods per plant and numbers of seeds per pods due to *Rhizobium* inoculation in no cutting management, similar results were recorded in fenugreek [5]. It is found that in fenugreek single or dual application of organic manure and bio-fertilizers and *Rhizobium* + yeast resulted in the increased number of seeds per pod, number of branches and seed yield [4].

Leaf yield (q/ha)

Maximum leaf yield was (Table 5) recorded by genotypes HM-348 as 70.86 q/ha and 70.82 q/ha one cutting and 130.02 q/ha 123.56 q/ha after two cuttings under seed treatment with *Rhizobium* and without seed treatment, respectively. The overall average leaf yield over the cuttings and *Rhizobium* treatments was recorded as 76.43 q/ha and the maximum leaf yield was observed at two cutting in the genotype HM-348 (130.02 q/ha) with *Rhizobium* treatment and the minimum leaf yield was observed at one cuttings in genotype HM-444 (50.22 q/ha) without *Rhizobium* treatment. *Rhizobium* inoculation increased the green and seed yield, whereas in case of cutting management there was a decreasing trend in leaf and seed yield with the increase frequency of cutting. The results were close conformity with findings in fenugreek [5].

Seed yield (q/ha)

Under seed treatment with *Rhizobium* maximum seed yield was recorded for genotype HM-348 under different cutting levels i.e. 27.66 q/ha, 19.71 q/ha and 8.78 q/ha for no cutting, one cutting and two cutting respectively. Without *Rhizobium* treatment maximum seed yield of 25.63 q/ha (HM-348), 18.66 q/ha (HM-348) and 7.87 q/ha (Hisar Suvarna) was recorded under no cutting, one cutting and two cutting respectively (Table 6). All the fenugreek genotypes differed

significantly for seed yield irrespective of different cuttings and *Rhizobium* treatments. The overall average of seed yield over the cuttings and treatments was recorded 14.13 q/ha and the maximum seed yield observed for genotype HM-348 (27.66 q/ha) with *Rhizobium* treatment with no cutting and the minimum seed yield was observed in HM-444 and HM-346 (3.66 q/ha) without *Rhizobium* treatment under two cuttings respectively. In fenugreek maximum seed yield was due to bolder seeds, which is due to the nutrition of fenugreek plants and also nutrient combination (*Rhizobium* and PSB) reflected on seed quality [6]. It is also mentioned that application of organic manures and *Rhizobium* inoculation enhanced the seed yield in fenugreek [7] and also resulted that combined inoculation with *Rhizobium* + PSB and *Rhizobium* inoculation alone in fenugreek give highest seed yield over without inoculation [8]. Some researchers also found that there was a negative effect of different cutting management in leaf and seed yield of fenugreek and highest seed yield was obtained with no cutting [5].

Conclusion

On the basis of the present investigation it could be concluded that significant differences / variability was observed among the genotypes for almost all the yield components. Seed treatment with *Rhizobium* and leaf cutting management has significant impact upon the seed yield, leaf yield and its component irrespective of the genotype. In successive leaf cutting treatments irrespective of genotypes there was decrease in the seed yield and other parameters. Genotype HM-348 was observed the best genotype in terms of growth, seed and leaf yield. Therefore, the present study suggested that the seed must be treated

with *Rhizobium* to harness the beneficial effects. Moreover, one cutting at 30 days may be economically as compared to with no cutting management for additional returns.

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