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Effect of irrigation and different seed treatment methods on growth and yield of fenugreek (*Trigonella foenum graecum* L.)

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Abstract

A field experiment was conducted to study the effect of irrigation and different seed treatment methods on growth and yield of fenugreek (*Trigonella foenum graecum* L.) at Horticulture Unit, NRCSS, Tabiji (Ajmer). Nine treatment combinations comprising of three irrigation methods viz., pressurized drip irrigation, micro sprinkler and surface irrigation in main plot and three seed treatments viz., Bavistin, *Trichoderma viride* and control (no treatment) in sub-plots were evaluated in split plot design with three replications. Application of irrigation through drip and micro sprinkler resulted significantly higher growth, yield attributes, seed yield, net return and B: C ratio over surface irrigation method. Drip as well as micro sprinkler exhibited at par yield and yield attributes .The highest plant height (47.67 cm), number of pod plant^{-1} (49.79), number of seed pod^{-1} (15.27), and seed yield (2043.96 kg ha^{-1}) was recorded in drip followed by irrigation with micro sprinkler, which were significantly higher over surface irrigation method (1577.51kg ha^{-1}). Seed treatment with Bavistin and *T. viride* were found significantly superior over no seed treatment in respect to growth parameters, yield attributes, seed yield and economic returns. The highest plant height (46.74 cm), number of pod plant^{-1} (51.11), number of seed pod^{-1} (14.91), seed yield (2007.83 kg ha^{-1}) was recorded with seed treatment by *T. viride*. Application of irrigation through drip along with seed treatment with *T. viride* resulted the highest gross return (Rs.74981 ha^{-1}), net returns (Rs. 54277 ha^{-1}) and B: C ratio (2.62). Thus it can be concluded that application of irrigation through drip along with seed treatment by *Trichoderma viride* is the best treatments combination for exploiting higher yield and net returns from fenugreek crop.

Key words : B: C ratio, economic returns, *trigonella foenum graecum, trichoderma viride,* bavistin, micro irrigation, yield.

Introduction

Fenugreek is an important major seed spice crop mainly grown in arid and semi arid regions of India. It is grown in 94 thousand hectare area with production of 1.16 lakh tones and productivity is 1200 kg ha^{-1} (Indian Horticulture Database, 2012). In India, the major fenugreek growing states are Rajasthan, Gujarat, Madhya Pradesh, Tamil Nadu, Uttar Pradesh and Punjab. More than 80 per cent area and production of the country is contributed by Rajasthan state alone. Surface irrigation methods like flooding, check basin, furrow and ring basin are being followed since long back in which only one half of the water released is utilized for crop production. A significant part of the applied water is lost in conveyance, application, run-off and evaporation resulting in very low water use efficiency. The conventional systems of irrigation revolving round the concept of replenishing of the moisture level to field capacity (FC) after 50 to 60 % depletion. The system do not permit the restricting of the water to meet the requirement at the root zone, thus leading of the excessive percolation and other losses, which results in problem of water logging, soil salinity and even drought like conditions at tail ends of the system. These conditions have created low productivity levels of irrigated agriculture. This necessitates the use of modern systems of irrigation, which irrigates the plants rather than the field and results in productive use of water. Micro irrigation has emerged as an appropriate water saving technique especially for low spaced high value crops in water scarcity of seed spice growing area. Reduction in water consumption due to drip method of irrigation over the surface method of irrigation varies from 30 to 70 percent for different crops. Several research workers reported that through micro sprinkler higher crop yields can be obtained along with considerable saving in irrigation (Kumar *et al.*, 7) Therefore, efforts are now directed to harness available quantity of water and put them to efficient use to realize higher productivity per drop (Solamalai *et al.*, 10). On the other hand, fenugreek is also very susceptible to seed born diseases *viz., root* rot, damping off etc., which affect the seed germination and seedling vigor. Therefore, it is necessary to evaluate the different seed treatment methods for ensuring effective control of seed born diseases. Keeping in view the above mentioned facts the present investigation was carried out to find the efficient irrigation and seed treatment method for realizing higher yield and net returns from fenugreek crop.

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Materials and methods

A field experiment on performance of fenugreek under different irrigation system and seed treatment methods was carried out at research farm of National Research Centre on Seed Spices, Ajmer (Rajasthan) during 2010-11. The soil of the experimental site was sandy loam with a pH of 8.82 having 0.25 percent organic carbon and 76.0, 33.4, and 234.1 kg ha^{-1} available N, P_2O_5 and K_2O, respectively. The experiment comprising three irrigation methods viz., pressurized drip irrigation, micro sprinkler and surface irrigation method in main plots and three seed treatment methods viz., seed treatment by Bavistin (2g kg^{-1} seed) and *Trichoderma viride* (4g kg^{-1} seed) before sowing of seed. Each plot has 3 lateral lines of drip, the drippers were fitted on lateral lines at the distance of 30 cm in surface drip treatments. Normal operating pressure was maintained at 1.0 kg sq cm^{-1} for surface drip system. The 6 micro sprinklers were provided to each plot of 4.0 m × 2.0 m as per treatments at 2.0 meter distance. The micro sprinkler had a discharge of 16 liter $hour^{-1}$ at 1.0 kg $sqcm^{-1}$ pressure. Economics of different treatments was worked out in terms of net return ha^{-1} and cost of the treatment. Benefit: cost ratio (B: C) was also calculated for assessing economic viability of various treatments. The periodical observation on growth and yield attributes were recorded. Sowing of RMt-305 variety was done after treating the seed using 20 kg seed ha^{-1} at 25 cm line to line spacing. In conventional method, irrigation was provided at 1.0 IW/CPE ratio whereas, drip and micro sprinkler irrigation was provided at four days interval based on 70 and 80 CPE, respectively. Laterals of 16 mm diameter having inline dripper at 30 cm distance and 2.25 liter $hour^{-1}$ discharge were fixed between each pair of two rows. In micro sprinkler, 20 mm size laterals with sprinklers at 4 meter distance and 16 liter $hour^{-1}$ discharge were used. Total five irrigations of 50 mm depth in conventional method at 1.0 IW/CPE ratio and 18 irrigation in drip and micro sprinkler method at 70 and 80 percent CPE at four days interval was applied. A uniform dose of 30 kg N, 40 kg P_2O_5 and 20 kg K_2O ha^{-1} through urea, single super phosphate and murate of potash, respectively, were applied and well mixed with soil before sowing. Five plants were selected randomly from each plot and observations on plant height, branches $plant^{-1}$, 50 per cent flowering, no of pods $plant^{-1}$, no of seeds pod^{-1}, seed yield $plant^{-1}$ and seed yield $hectare^{-1}$ were recorded along with the test weight. The results were discussed and statistical analysis was done as per the procedure suggested by Panse and Sukhatme (9).

Results and discussion

Effect of irrigation methods

The results of present investigation clearly indicate that days to germination, plant height at harvest and number of branches per plant were significantly increased with different methods of irrigation. However, days to 50 per cent flowering were not significantly influenced. (Table 1). The earliest germination (3.44 days), highest plant height (47.67 cm) and number of branches $plant^{-1}$ (6.69) were recorded with irrigation through drip method being at par with micro sprinkler irrigation. This might be due the fact that availability of adequate soil moisture to the plants thorough out the crop growth period, facilitated absorption of adequate quantity of water leading to higher uptake of nutrients resulting in higher turger pressure of the merismetic cells, thereby causing better cell division and enlargement which enhanced plant height. In drip irrigation, water tension remains low and almost constant for entire growth period of the crop as compared to surface irrigation (Hapase, 6). It may be due to the fact that under micro sprinkler and drip irrigation, water was applied in right quantities at right time and at right place, which provided sufficient soil moisture surrounding root zone area constantly, which favour better growth, vigor of plant resulting in more number of branches per plant. Similar results were also reported by Ghetia (4) in groundnut.

Varying methods of irrigation significantly influenced number of pods $plant^{-1}$, number of seeds pod^{-1}, test weight of seed, seed yield $plant^{-1}$ seed, straw and biological yields of fenugreek. Irrigation with drip method gave the highest number of pods $plant^{-1}$, length of pod, seed pod^{-1}, test weight (16.26 g) and seed yield $plant^{-1}$ (6.69 g) and seed yield ha^{-1} (2043.96 kg) which were significantly higher over control. Application of irrigation with drip system exhibited 10.49, 8.76 and 29.57 per cent higher number of seeds pod^{-1}, test weight and seed yield (kg ha^{-1}), respectively followed by micro sprinkler over surface irrigation. The superiority of drip and micro sprinkler for these yield attributing parameters could be explained on the basis of moisture status and nutrients availability in the soil. In drip and micro sprinkler treatments, the soil remains moist and soft because of frequent irrigation on the basis of evapo-transpiration demand of the crop. In drip and micro sprinkler irrigation, right quantity of water is applied in the vicinity of root zone which helps in maintaining optimum water potential in plant system favoring photosynthesis, which consequently resulted in better growth and higher yield attributes of the crop. These results are in conformity with the findings reported by Ghetia (4), in groundnut and Desai *et al*., (3) in onion.

Effect of seed treatments

Days to germination, plant height at harvest and number of branches per plant were significantly influenced by different seed treatment methods. Seed treatment by *Trichoderma* resulted earliest seed germination (3.56 days), the highest plant height (46.74 cm), number of branches $plant^{-1}$ (6.50) and number of leaves $plant^{-1}$ (57.59) at harvest (Table 1). Seed treatment with *Trichoderma* exhibited 4.63, 14.43 and 7.16 per cent higher plant height, number of branches $plant^{-1}$ and number of leaves $plant^{-1}$ at harvest, respectively over no seed treatment. This was

Table 1. Effect of irrigation and seed treatment methods on growth and yield of fenugreek.

Treatments	Days to germination	Plant height at harvest	No. of branches plant^{-1}	Number of leaves plant^{-1}	Days to 50% flowering	No. of pods plant^{-1}	Number of seed pod^{-1}	Seed yield plant^{-1} (g)	Test weight (g)	Seed yield (kg ha^{-1})
Irrigation methods (I)										
Surface irrigation (control)	4.11	42.31	5.30	49.67	42.22	13.82	5.03	5.30	14.95	1577.51
Drip irrigation	3.44	47.67	6.69	57.80	49.79	15.27	8.73	6.69	16.26	2043.96
Micro sprinkler irrigation	3.56	46.32	6.17	57.26	49.47	14.16	7.27	6.17	15.79	1897.40
SEm±	0.11	1.18	0.15	1.39	1.19	0.39	0.65	0.15	0.42	52.85
CD ($P = 0.05$)	0.44	4.64	0.59	5.46	NS	NS	2.54	0.59	NS	206.88
Seed treatments (S)										
No treatment (control)	4.00	44.67	5.68	53.74	43.93	13.73	6.46	5.68	15.29	1675.21
Bavistin (2g kg^{-1} seed)	3.56	44.89	5.98	53.39	46.43	14.60	6.92	5.98	15.56	1835.83
Trichoderma (4 g kg^{-1} seed)	3.56	46.74	6.50	57.59	51.11	14.91	7.66	6.50	16.16	2007.83
SEm±	0.09	1.06	0.14	1.28	1.09	0.34	0.45	0.14	0.37	38.10
CD ($P = 0.05$)	0.27	3.27	0.43	3.94	3.34	1.05	1.37	0.43	NS	117.04
Interaction (I × S)	NS	NS	S	NS	NS	NS	NS	NS	S	NS

Table 2. Interaction effect of irrigation and seed treatment methods on number of branch plant^{-1}.

Irrigation Methods & Seed treatments	**Methods of irrigation**		
	Surface (I_0)	**Drip (I_1)**	**Micro sprinkler (I_2)**
No treatment (S_0)	5.0	5.2	5.7
Bavistin (S_1)	6.1	6.7	7.3
Trichoderma (S_2)	5.9	6.1	6.5
S Em $\pm$		0.24	
CD (P = 0.05)		0.75	

Table 3. Interaction effect of irrigation and seed treatment methods on test weight of seed.

Irrigation Methods & Seed treatments	**Methods of irrigation**		
	Surface (I_0)	**Drip (I_1)**	**Micro sprinkler (I_2)**
No treatment (S_0)	14.52	14.73	15.81
Bavistin (S_1)	15.73	16.41	16.64
Trichoderma (S_2)	15.62	15.72	16.03
SEm$\pm$		0.63	
CD (P = 0.05)		1.95	

Table 4. Benefit cost ratio with the application of irrigation and seed treatment methods on fenugreek crop

Treatments	**Seed yield (kg ha^{-1})**	**Straw yield (kg ha^{-1})**	**Cost of cultivation (Rs ha^{-1})**	**Gross returns (Rs ha^{-1})**	**Net returns (Rs ha^{-1})**	**B:C Ratio**
I_0 S_0	1435.42	1235.42	16978.00	47404.28	30426.28	1.79
I_0 S_1	1552.04	1352.05	17146.00	51369.43	34223.43	1.99
I_0 S_2	1745.08	1545.07	17143.00	57932.65	40789.65	2.37
I_1 S_0	1826.37	1626.35	20538.67	60696.44	40157.77	1.95
I_1 S_1	2059.00	1859.01	20706.67	68606.07	47899.4	2.31
I_1 S_2	2246.50	2046.55	20703.67	74981.35	54277.68	2.62
I_2 S_0	1763.83	1563.83	18697.33	58570.22	39872.89	2.13
I_2 S_1	1896.46	1696.46	18865.33	63079.64	44214.31	2.34
I_2 S_2	2031.91	1831.82	18862.33	67684.31	48821.98	2.58

Sale price: Seed= Rs. 27 kg^{-1}, Straw = Rs. 7 kg^{-1}

due to positive response against soil born pathogens and growth promotion by *Trichoderma* which is attributed to solublization and sequestration of many plant nutrients such as P, Mn, Fe and Zn and supply to the plants, which in turn into increased plant growth. *Trichoderma viride* is a parasite of other fungi and can rapidly colonize plant roots, there by outcompeting pathogens for nutrients and space. *Trichoderma viride* also promotes plant growth in the absence of pathogens reduces wilt incidence, these findings corroborate the results reported by Altomare *et al.* (1) and Benitez *et al*. (2).

Yield attributes and seed yield were also significantly influenced with different seed treatment. The maximum number of pods plant^{-1} (51.11), maximum number of seeds pod^{-1} (14.91), the highest test weight of seed (16.16 g), the highest seed yield plant^{-1} (7.66 g) and the highest seed yield ha^{-1} (2007.83 kg) was recorded with seed treatment by *Trichoderma viride* being at par with seed treatment by Bevistin. Number of pods plant^{-1}, number of seeds pod^{-1} , test weight of seed, seed yield plant^{-1} and seed yield ha^{-1} increased to the tune of 16.34, 8.59, 5.68, 18.57 and 19.85 per cent, respectively with seed treatment by *Trichoderma viride* over no seed treatment. However, overall improvement in vegetative growth due to biological and non biological methods to control of fungi favorably influenced flowering and finally resulted in higher seed yield attributes (Gupta *et al*., 5). These results corroborate with the findings of Altomre *et al*. (1) and Benitez *et al*. (2).

Interaction effect of irrigation methods and seed treatments

Interaction effect of irrigation methods and seed treatments on number of branches plant^{-1}, test weight, gross returns, net returns and B: C ratio was found significant. The highest number of branches plant^{-1} (7.3) and test weight (16.64 g) was recorded under I_2S_1 (Micro sprinkler Irrigation method + Bavistin treatment) which was at par with the I_1S_1 (Drip irrigation + Bavistin treatment) at harvest (Table 2 & 3). This might be due to favorable soil moisture condition along with the balanced availability of plant nutrient by drip and micro sprinkler irrigation. They maintained appropriate soil moisture and air ratio throughout the plant growth period right in the root zone and disease free of the crop. Data (Table 4) revealed, net returns and B: C ratio was significantly influenced by different treatment combinations. Application of irrigation with drip system and seed treatment by *T. viride* resulted significantly higher gross returns (Rs.74981.35 ha^{-1}), net return (Rs. 54277.68 ha^{-1}) and B: C ratio (2.62) (Table 4). Maximum gross return, net return and BCR with irrigation by drip and seed treatment by *Trichoderma* viride is due to higher yield obtained under these treatments. Similar, findings were also reported by Mehta *et al*. (8) in fenugreek and Smith *et al*. (11).

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