Journal of Spices and Aromatic Crops
Vol. 26 (1) : 55-58 (2017)
www.indianspicesociety.in/josac/index.php/josac

Indian Society for Spices

Response of fenugreek (*Trigonella foenum-graecum*) to bio-regulators TGA and N-acetyl cystein under drip irrigation levels

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Received 09 October 2015; Revised 18 March 2016; Accepted 29 March 2016

Abstract

Field experiments were conducted during winter seasons of 2010–11 and 2011–12 at Bikaner (Rajasthan) to study the effect of bioregulators *viz.,* TGA and N-acetyl cystein under different drip irrigation levels on yield, yield attributes, water use and water use efficiency of fenugreek. The highest plant height (69 cm) and yield attributes *viz.,* branches plant^{-1} (7.6), pods plant^{-1} (46.3), pod length (13.5 cm), seed pod^{-1} (16) and test weight (12.7 g) were recorded with 100% ETc + TGA (200 ppm). Further, 80% ETc + TGA (200 ppm), and 100% ETc + N-acetyl cystein (both 10 and 20 ppm) and 100% ETc + TGA (both 100 and 200 ppm) produced comparable plant height. However, 80% ETc + N-acetyl cystein (both 10 and 20 ppm), 80% ETc + TGA (both 100 and 200 ppm), 100% ETc + N-acetyl cystein (both 10 and 20 ppm), 100% ETc + TGA (100 ppm) and 100% ETc + TGA (200 ppm) recorded at par branches plant^{-1}, pods plant^{-1}, pod length and test weight of fenugreek. Highest seed and biological yield of fenugreek were recorded with 100% ETc + N-acetyl cystein (20 ppm), which was at par with 100% ETc + N-acetyl cystein (10 ppm) and 100% ETc + TGA (both 100 and 200 ppm). Maximum water use recorded at 100% ETc with or without bioregulators, whereas maximum water use efficiency was recorded with 60% ETc + N-acetyl cystein (20 ppm) followed by 60% ETc + N-acetyl cystein (10 ppm).

Keywords: bio-regulators, drip irrigation levels, fenugreek, harvest index, N- acetyl cysteine, seed yield, TGA, water use efficiency

Arid region of Rajasthan is home to seed spice fenugreek (*Trigonella foenum-graecum*). Water is an indispensable factor for every metabolic activity of plant and limited quantity of water available for irrigation calls for proper scheduling of irrigation to improve water productivity of fenugreek (Mehta *et al*. 2010). Recent trend of scheduling irrigation on the basis of climatological approach has been considered as most scientific particularly under drip system, since it integrates all weather parameters giving them natural weightage in a given climate-plant-continuum (Parihar *et al.* 1976). On the basis of climatological approach in arid western Rajasthan, drip irrigation hold great promise for minimizing water loss and improving its utilization efficiency and yield. Foliar spray of bioregulators improves phloem translocation of photosynthate and crop productivity. Thus, they play an important role

in improving water use efficiency through enhanced phloem translocation and yield formation in arid regions. The information on bioregulators, TGA and N-acetyl cysteine and drip irrigation on fenugreek growth and yield are meager. Hence, there is a felt need to generate precise information on irrigation requirement of fenugreek through drip and effect of bio-regulators TGA and N-acetyl cysteine on fenugreek.

The field experiments were conducted during winter (*rabi*) seasons of 2010–11 and 2011–12 at Niche Area Excellence Farm, S.K. Rajasthan Agricultural University, Bikaner situated in arid North-Western plain zone of Rajasthan. The soil was sandy loam in nature, having field capacity 6.5%, permanent wilting point 1.8%, bulk density 1.52 g cc^{-1}, pH (1:2) 8.2, electrical conductivity (1:2) 0.2 dS m^{-1}. The soil was very low in organic carbon (0.11%), medium in available P (12.4 kg ha^{-1}) and high in available K (340 kg ha^{-1}). There were fifteen treatment combinations comprises of (A) three irrigation levels (60%, 80% and 100% ETc) in combination with (B) five bio-regulator levels spray *viz*., control (no bio-regulator), TGA (thioglycollic acid) -100 & 200 ppm and N-acetyl cysteine -10 ppm & 20 ppm at vegetative and seed formation stages, respectively. The experiment was laid out in randomized block design and replicated thrice. The crop variety RMt-1 was sown on 1st and 5th December using 25 kg seed ha^{-1} and harvested on 4th and 6th April during the years 2010–11 and 2011–12, respectively. Irrigation was applied from December to March at alternate days. The total irrigation water provided was 209.36, 279.15 and 348.94 mm at 60%, 80% and 100% ETc respectively (Table 1). No rainfall was received during the crop growing period and ground water was below 10 m throughout the growing period. All the cultural operations were carried out as per recommendations. Reference evapotranspiration and thereafter crop evapotranspiration were calculated from USWB Class A open pan evaporimeter reading using standard procedures. Water was applied to the crop as per treatments (Table 1). Thus applied water is mentioned as water used. Water use efficiency was calculated dividing economic yield by water used.

Plant height and yield attributes: 100% ETc + TGA (200 ppm) recorded the highest plant height (69 cm) and yield attributes *viz*., branches/plant (7.6), pods/plant (46.3), pod length (13.5 cm), seed/pod (16) and test weight (12.7 g) of fenugreek. Further, 80% ETc + TGA (200 ppm), 100% ETc + N-acetyl cystein (both 10 and 20 ppm) and 100% ETc + TGA (100 ppm and 200 ppm) gave at par plant height. However, 80% ETc + N-acetyl cystein (both 10 and 20 ppm), 80% ETc + TGA (both 100 and 200 ppm), 100% ETc + N-acetyl cystein (both 10 and 20 ppm) and 100% ETc + TGA (100 and 200 ppm) were at par for branches $plant^{-1}$, pods $plant^{-1}$, pod length and test weight of fenugreek. This might have happened due to supply of adequate irrigation water through drip at 80 and 100% ETc and higher accumulation of photosynthates by the use of Sulphydryl (-SH-) compounds, which, improved phloem translocation of photosynthates and crop productivity. Bhunia *et al.* (2015) also reported that foliar spray of thioglycollic acid (TGA) at

Table 1. Month wise irrigation events and irrigation water applied (mean of two years)

Month	Irrigation events	Drip irrigation levels (mm)		
		60% ETc	80% ETc	100% ETc
December (28 days)	14	22.97	30.63	38.29
January	16	27.34	36.45	45.56
February	14	70.68	94.24	117.80
March	15	88.37	117.83	147.29
Total	59	209.36	279.15	348.94

Table 2. Effect drip irrigation levels along with TGA and N-acetyl cystein on plant height and yield attributes of fenugreek (Pooled of two years)

Treatment	Height (cm)	Branch plant^{-1}	Pods plant^{-1}	Pod length (cm)	Seeds pod^{-1}	Test weight (g)
60% ETc	58	6.5	40.2	12.2	15.4	11.7
60% ETc + N_1	60	6.7	42.1	12.5	15.6	12.1
60% ETc + N_2	60.4	6.8	43.3	12.5	15.6	12.2
60% ETc + T_1	60.1	6.8	42.4	12.4	15.5	12.1
60% ETc + T_2	60.4	6.8	42.5	12.3	15.5	12.2
80% ETc	64	7.0	43.3	13.1	15.6	12.4
80% ETc + N_1	65	7.4	45.5	13.4	15.9	12.5
80% ETc + N_2	66	7.4	45.8	13.6	15.8	12.6
80% ETc + T_1	66	7.5	45.0	13.3	15.9	12.5
80% ETc + T_2	67	7.4	45.2	13.5	15.8	12.7
100% ETc	66	7.3	45.4	13.3	15.8	12.6
100% ETc + N_1	67	7.4	46.2	13.4	15.9	12.7
100% ETc + N_2	68	7.5	46.1	13.5	15.9	12.7
100% ETc + T_1	69	7.6	46.2	13.4	15.9	12.6
100% ETc + T_2	69	7.6	46.3	13.5	16.0	12.7
CD (P<0.05)	2.3	0.5	1.3	0.4	NS	0.5

N_1=N-acetyl cystein (10 ppm); N_2=N-acetyl cystein (20 ppm); T_1=TGA (100 ppm); T_2=TGA (200 ppm)

Table 3. Effect of drip irrigation levels along with TGA and N-acetyl cystein on yield, water use and water use efficiency of fenugreek (Pooled of two years)

Treatment	Seed yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	HI (%)	Water use (mm)	WUE (Kg ha^{-1} - mm)
60% ETc	12.65	25.58	38.23	33.09	209.36	6.04
60% ETc + N_1	12.96	25.15	38.11	34.01	209.36	6.19
60% ETc + N_2	13.23	24.07	37.30	35.47	209.36	6.32
60% ETc + T_1	12.69	24.71	37.40	33.93	209.36	6.06
60% ETc + T_2	13.11	25.49	38.60	33.96	209.36	6.26
80% ETc	14.61	29.65	44.27	33.00	279.15	5.23
80% ETc + N_1	15.16	29.94	45.10	33.61	279.15	5.43
80% ETc + N_2	15.43	29.77	45.20	34.14	279.15	5.53
80% ETc + T_1	14.94	27.84	42.78	34.92	279.15	5.35
80% ETc + T_2	15.33	27.73	43.06	35.60	279.15	5.49
100% ETc	15.45	30.55	46.00	33.58	348.94	4.43
100% ETc + N_1	15.70	30.10	45.80	34.28	348.94	4.50
100% ETc + N_2	15.78	30.32	46.10	34.23	348.94	4.52
100% ETc + T_1	15.60	30.20	45.80	34.06	348.94	4.47
100% ETc + T_2	15.68	30.12	45.80	34.23	348.94	4.49
CD (P<0.05)	0.26	0.89	1.10	NS	-	-

N_1=N-acetyl cystein (10 ppm); N_2=N-acetyl cystein (20 ppm); T_1=TGA (100 ppm); T_2=TGA (200 ppm)

vegetative and seed formation stages recorded higher yield attributes *viz.*, branches plant^{-1}, pods plant^{-1} and test weight of fenugreek.

Yield of fenugreek: Seed, biological and stover yield of fenugreek were also significantly influenced by drip irrigation and spray of bio-regulators. Highest seed (15.78 q ha^{-1}) and biological (46.10 q ha^{-1}) yield of fenugreek was recorded with 100% ETc + N-acetyl cystein (20 ppm), whereas, highest stover yield was recorded with 100% ETc alone. However, 100% ETc + TGA (both 100 and 200 ppm) and 100% ETc + N-acetyl cystein (10 ppm) also gave at par seed and biological yield of fenugreek. This might have happened due to the fact that the foliar spray of bioregulators at vegetative and seed formation stage enhanced the translocation of photosynthates, from source (leaves) to sink (seed). This is in confirmation with Bhunia *et al.* (2015), who reported that foliar spray of bio-regulators at vegetative and seed formation stages recorded maximum seed and biological yield of fenugreek.

Water use and water use efficiency: Drip irrigation levels of 60% and 80% ETc saved water by 139.58 and 69.79 mm over 100% ETc which used 348.94 mm water. Hence, increased yield coupled with less water use in drip irrigation recorded higher water use efficiency (WUE). Highest water use efficiency (6.32 kg ha^{-1} -mm) was recorded with 60% ETc + N-acetyl cystein (20 ppm) followed by 60% ETc + TGA (200 ppm). This might be due to lower water use in the treatment 60% ETc but higher seed yield of fenugreek with N-acetyl cystein (20 ppm) and TGA (200 ppm). Kharrou *et al*. (2011) also reported that drip irrigated wheat was more water efficient and saved 20% of water in comparison to surface irrigation. Lower water use efficiency in surface irrigation as compared to drip irrigation may be due to loss of irrigation water from sandy loam soil through deep percolation resulted in higher water use but lowered seed yield. Drip irrigation system saved quite a large amount of water, which can be useful in horizontal expansion of crop area in winter season when mostly irrigated crops are raised in Rajasthan.

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