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Effect of FYM, foliar feeding of nitrogen and deficit irrigation on drip irrigated coriander (*Coriandrum sativum* L.)

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Abstract

A field experiment was conducted to study the water use, nitrogen (N) uptake and economics of coriander (*Coriandrum sativum* L.) under organic enrichment, foliar feeding of N and fertigation. Drip irrigation at 80% ETc + foliar spray of 25% N (15 kg ha^{-1}) + fertigation (45 kg ha^{-1}) gave the highest plant height, branch plant^{-1}, umbel plant^{-1}, umbelets umbel^{-1}, seed umbel^{-1}, and test weight compared to irrigation at 80% ETc and at 60% ETc (upto flowering stage) + 80% ETc (reproductive stage) with or without foliar spray. Increased yield parameters were attributed to the highest seed yield and B:C ratio of 1.90 using 265.74 mm water. Water use efficiency (WUE) was also the highest. This treatment also recorded the highest N uptake of 52.6 kg ha^{-1}. Further, addition of 10 t ha^{-1} FYM in addition to recommended nitrogen dose (60 kg ha^{-1}) gave higher yield attributes *viz*., branch plant^{-1}, umbel plant^{-1}, seed umbel^{-1} and test weight as compared to recommended level of fertilizers. Enhanced yield attributes thus increased seed yield, N removal, WUE and B:C ratio.

Keywords: coriander, foliar nutrition, nitrogen uptake, organic enrichment, water use efficiency

Introduction

Seed spices comprise the single largest group of spices of about 20 crops, the major one being coriander. The productivity of coriander in Rajasthan is influenced by many factors, of which mineral nutrition specially nitrogen (N) and proper management of irrigation are important (Bhunia *et al*. 2009).

In arid western Rajasthan, drip irrigation and N fertigation hold great promise for minimizing water and nutrient losses and improving utilization efficiency. Further, it is possible to reduce the irrigation upto pre-flowering stage and subsequently provide optimum irrigation in reproductive growth, which can ensure near optimum yield. Agriculture in Rajasthan is facing a serious problem of declining total factor productivity and low crop response to inputs, chiefly N fertilizer. Organic matter enrichment can rejuvenate the soil health and lead to increased use efficiency of water and N. Light soils of western Rajasthan are prone to increased losses of water and N. A less attended practice of foliar feeding, particularly N will prove to be effective in improving its utilization.

In the light of above facts, the present investigation was carried out to study the effect of deficit irrigation through drip system, foliar feeding of N and organic enrichment on yield attributes, yield, water and N use efficiency of coriander.

Materials and methods

The field experiment was conducted at Swami Keshwanand Rajasthan Agricultural University, Bikaner during winter seasons of 2010–11 and 2011–12 on the same piece of land. The soil was sandy loam with field capacity 7.5%, permanent wilting point 2.1%, bulk density 1.51 g kg^{-1}, pH (1:2) 8.2, electrical conductivity 0.2 dS m^{-1}, organic carbon content 0.11%, available P 16.8 kg ha^{-1} and K 320 kg ha^{-1}. There were eight treatment combinations comprising of three levels of nutrient management *viz*., control (60 kg N and 16 kg P ha^{-1} i.e., RD) and RD + 10 t FYM ha^{-1}; three levels of drip irrigation with N management *viz*., 60 kg N ha^{-1} (fertigation) + irrigation at 80% ETc, 60 kg N ha^{-1} (fertigation) + irrigation at 60% ETc upto flowering stage + 80% ETc flowering to physiological maturity, 60 kg N ha^{-1} (fertigation) + 15 kg N as foliar spray + irrigation at 60% ETc upto flowering stage + 80% ETc from flowering to physiological maturity. Fertigation in six splits at 10 days interval after sowing and foliar application of N in three splits in seven days interval were done after flowering. The treatments were evaluated in randomized block design with three replications. Coriander variety RCr 435 was shown on 10th November in both the years using 20 kg seed ha^{-1} and was harvested on 8th and 10th of April 2010–11 and 2011–12, respectively. The crop under both surface and drip irrigation was raised with canal water of good quality from Indira Gandhi Nahar Parijojana (Rajasthan Canal). The crop under surface irrigation was sown at 30 cm row spacing (recommended), while under drip irrigation, sowing was done at 20 cm × 60 cm group row spacing (20 cm between crop rows in group and 60 cm between groups) in both sides of drip lines laid at 120 cm spacing to facilitate easy water availability to each crop row under drip system, as well as, to bring down cost of drip system. Fertigation (N) was done using liquid fertilizer (19:0:0 of 'Uttam brand' name) as per treatment. Urea was used for foliar application of N. A general dose of 16 kg P was applied as basal through single super phosphate. No rainfall was received during crop growing period in both the years. Irrigation events and treatment wise irrigation are presented in Table 1. Irrigation at 80% ETc has been considered optimum for coriander based on several experiments conducted at various farms in Bikaner.

Results and discussion

Drip irrigation and foliar feeding of nitrogen

Drip irrigation at 80% ETc along with foliar spray of 25% recommended dose (15 kg ha^{-1}) of N resulted in highest height (129.4 cm), branch

Table 1. Monthwise irrigation events and irrigation water applied (mean of 2 years)

		Drip irrigation (mm)			
Month	A	80% ETc	B	C	D
November (10-30)	10	28.60	21.45	28.60	21.45
December	15	84.77	56.08	84.77	56.08
January	16	32.71	32.71	32.71	32.71
February	15	63.92	63.92	63.92	63.92
March (1-31)	16	55.74	55.74	55.74	55.74
Total	72	265.74 (mm)	229.90 (mm)	265.74 (mm)	229.90 (mm)

A=Irrigation events under dripsystem; B=60% ETc upto preflowering + 80% ETc flowering to physiological maturity; C=80% ETc + Foliar spray of N (25%); D=60% ETc upto preflowering + 80% to physiological + foliar spray of N

plant^{-1} (20.4), umbel plant^{-1} (37.3), umbelets umbel^{-1} (5.9), seed umbel^{-1} (34.3) and test weight (5.8) (Table 2) compared to drip irrigation at 80% Etc + fertigation of 60 kg N ha^{-1} and all the other treatments. Higher yield parameters were attributed to higher biological yield (45.8 q ha^{-1}) and seed yield (14.8 q ha^{-1}). It could be explained by the fact that maintenance of optimum moisture level in soil as well as maintenance of higher concentration of N through foliar spray resulted in better photosynthesis and translocation of photosynthates from source to sink. These findings are in agreement with those of Dutta & Chatterjee (2006) and Mehta *et al*. (2010). Higher seed and biological yield thus removed highest N of 52.6 kg ha^{-1} than all the other treatments (Table 3). The benefit of this treatment is further evident by the highest B:C ratio of 1.90. Deficit drip irrigation at vegetative stage (60% ETc) followed by optimum irrigation in reproductive and seed development stages (80% ETc) and foliar spraying of 25% recommended N (15 kg ha^{-1}) also recorded at par yield attributes, seed (14.3 q ha^{-1}) and biological (42.7 q ha^{-1}) yield. Deficit irrigation at vegetative stage might have encouraged better root growth and therefore better soil moisture utilization which in turn sustained yield even in water stress conditions in vegetative stages. Hence, deficit irrigation increased yield as compared to increase in quantity of water used. Thus, less water use with deficit irrigation gave the highest water use efficiency of 6.22 kg ha^{-1} mm^{-1}. These findings are in conformity of Patel *et al*. (2007) in fennel. Deficit irrigation at vegetative stage and foliar nutrition of N recorded highest harvest index of 35.5% than all other treatments. It may be due to restricted vegetative growth at initial stage and congenial water regime in reproductive stages coupled with maintenance of higher N concentration in leaf through foliar spray.

Enrichment of soil with organic matter

Addition of 10 t ha^{-1} FYM besides recommended dose of N through fertigation significantly improved yield attributes *viz*., branch plant^{-1} (20.6), umbel plant^{-1} (35.7), umbelets umbel^{-1}

Table 2. Effect of deficit irrigation and FYM enrichment on height and yield attributes of coriander (pooled of 2 years)

Treatment	Height (cm)	Branch plant^{-1}	Umbel plant^{-1}	Umbellet umbel^{-1}	Seed umbel^{-1}	Test Weight (g)
Drip irrigation and N foliar spray						
80% ETc	125.5	19.8	35.4	5.7	33.4	5.6
60% ETc upto flowering + 80% ETc flowering to physiological maturity	118.3	18.9	33.6	5.5	32.5	5.5
80% ETc + Foliar spray of N (25%)	129.4	20.4	37.3	5.9	34.3	5.8
60% ETc upto flowering + 80% ETc flowering to physiological maturity + Foliar spray of N (25%)	122.4	19.9	35.3	5.6	33.0	5.7
CD (P<0.05)	3.5	1.2	0.8	NS	0.9	0.1
Organic enrichment						
Recommended fertilizer (RD)	122.8	18.9	35.1	5.5	33.1	5.6
RD + 10 t FYM ha^{-1}	126.0	20.6	35.7	5.8	33.5	5.7
CD (P<0.05)	2.4	0.8	0.5	0.2	NS	NS

Table 3. Effect of deficit irrigation and organic enrichment on seed yield, harvest index, water use, nitrogen uptake and economics of coriander (pooled of 2 years)

Treatment	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)	Water use (mm)	WUE (kg ha^{-1} mm^{-1})	B:C ratio	N uptake (kg ha^{-1})
Drip irrigation and N foliar spray								
80% ETc	13.70	27.1	40.8	33.6	265.74	5.15	1.81	43.7
60% ETc upto flowering + 80% ETc flowering to physiological maturity	12.60	22.8	35.4	35.5	229.90	5.48	1.74	38.5
80% ETc + Foliar spray of N (25%)	14.80	31.0	45.8	32.3	265.74	5.57	1.90	52.6
60% ETc upto flowering + 80% ETc flowering to physiological maturity + Foliar spray of N (25%)	14.30	28.4	42.7	33.5	229.90	6.22	1.83	47.8
CD (P<0.05)	1.50	3.4	4.4	-	-	-	-	3.2
Organic enrichment								
Recommended fertilizer (RD)	13.05	27.0	40.0	32.7	247.82	5.26	1.79	43.6
RD + 10 t FYM ha^{-1}	14.62	27.8	42.4	34.4	247.82	5.90	1.83	47.7
CD (P<0.05)	1.10	NS	NS	-	-	-	-	2.5

(5.8), seed $umbel^{-1}$ (33.5) and test weight (5.7 g). Increased yield parameters resulted in higher seed yield (14.6 q ha^{-1}), biological yield (42.4 q ha^{-1}) and harvest index (34.4%) than the crop grown with recommended fertilizer dose only. Higher yields in turn increased N uptake (47.7 kg ha^{-1}) and WUE (5.90 kg ha^{-1} mm^{-1}). The benefit of FYM application was further depicted by higher B:C ratio of 1.83. Better N uptake by application of FYM may be explained by better availability of N and improvement in soil environment which enhanced proliferation of root system resulting in higher biomass production (Table 3). Similar results were reported by Khiriya & Singh (2003) in fenugreek.

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