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Effect of irrigation and nutrient levels on growth and yield of coriander (*Coriandrum sativum*)

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ABSTRACT

A field experiment was carried out on sandy loam soil at Morena during winter season of 2006-07 and 2007-08 to study the effect of irrigation schedules and nutrient levels (% recommended NPK fertilization) on growth, yield, quality of coriander (*Coriandrum sativum* L.). Irrigation at 20, 40 and 60 days after sowing (DAS) maintained higher umblets/plant, umbel/plant, 1,000-seed weight, production efficiency, nutrient use and N, P, K and S uptake. Maximum seed yield (1.96 tonne/ha), biomass production (4.66 tonnes/ha), net returns (Rs.86,815/ha) and B:C ratio (8.19) were also recorded under 3 irrigations, which resulted in 38.31% and 3.93% increase in seed yield over 2 (20 and 40 DAS) and 4 (20, 40, 60 and 80 DAS) irrigation respectively. The application of 100% recommended dose of fertilizer (RDF) (60:17.6:16.6:30 kg N: P: K: S/ha) registered significantly higher yield attributes, water use efficiency, production efficiency, N: P: K and S uptake and 20.65% and 12.04% increased in seed yield over 50% and 75% RDF respectively. The: interaction effect of irrigation and fertility levels on seed yield was also found significant and positive. The maximum yield (2.09 tonne/ha) was recorded with the combined application of 3 irrigations and 100% RDF followed by three irrigation and 125% RDF (2.02 tonne/ha).

Key words: Coriander, Economics, Fertilizer combinations, Water use efficiency, Yield

Coriander (*Coriandrum sativum* L.) is used as common flavoring substance. The stems, leaves and fruits have pleasant aroma. Dry fruits are extensively used in preparation of curry powder, pickling spices, medicines. The total area under the spices and condiments in India is over 1 million ha and they account for an annual export of about 0.25 million tones of spices. The spices having wider adoptability and high yield potential. Low productivity of coriander (428 kg/ha) may be ascribed to many reasons, out of which inadequate and imbalanced fertilization with limited moisture are the major factor. The increase in seed yield of coriander from 35-45% due to application of fertilizer and irrigation has been reported by various researchers (Prabhu *et al.*, 2002, Lakpale *et al.*, 2007 and Tripathi, 2008).

Application of essential plant nutrients in right proportion and in optimum quantity through correct method tailored for specific soil-crop-climate condition. Water is a key input for sustainable crop production. Adequate and timely availability of irrigation water to crops plants is realized for higher yield and good quality of coriander. With these views, an experiment was conducted to asses the effect of irrigation and nutrients on growth, yield and economics of coriander.

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MATERIALS AND METHODS

The field experiments was conducted during winter of 2006-07 and 2007-08 at Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Zonal Agricultural Research Station, Morena, Madhya Pradesh. The tract enjoys semi-arid subtropical climate with annual average rainfall of 700 mm. No rainfall occured during crop growth period. The soil of experimental field was sandy loam with field capacity 21.9%, permanent wilting point 6.9%, bulk density 1.38 g/cc, electrical conductivity 0.32 dS/m, 135–13.2–315–16.4 kg/ha of available N-P-K-S and pH 7.6. The initial soil moisture content at sowing and harveste were recorded 16.62% and 10.42% respectively. During crop growth period the cumulative pan evaporation was recorded 500.9 mm. The experiment was laid out in split-plot design with 4 replications, keeping 3 irrigation schedules viz. 20 and 40 days after sowing (DAS) (I_1), 20, 40 and 60 DAS (I_2) and 20, 40, 60 and 80 DAS (I_3) in main plots and 4 fertility levels viz., 50%, 75%, 100%

(60:17.6:16.6:30) and 125% N: P: K and S kg/ha as recommended dose of fertilizer in sub-plots. One-third of the nitrogen and full dose of phosphorus, potash and sulphur were applied as basal and the remaining nitrogen was applied in 2 split at 20 and 40 days after sowing. Nitogen, phosphorus, potash and sulphur was applied through urea, single super phosphate, muriate of potash and remaining dose of sulphur was adjusted with gypsum. Coriander 'Jawahar Dhania' was sown in 3rd week of October and harvested in 1st week of March. The crop was sown 30 cm apart with a seed rate of 15 kg/ha. Irrigations at a depth of 7 cm in each irrigation were applied as per treatment and other recommended packages of practice were adopted during the crop growth periods in both the years. The data on various growth and yield characters were recorded and statistically analysed. The nutrient use kg seed/kg nutrient was calculated by dividing the seed yield with total nutrients. Economics of each treatment in relation to irrigation and fertilizers were worked out taking into account in current prices of produce (Rs 50,250/tonne) and fertilizers as well as expenditure on irrigation. The estimated cost of applied 1 irrigation was Rs 600/ha. The prices of N, P, K and S were Rs. 11, 21, 7.60 and 29/kg, respectively.

RESULTS AND DISCUSSION

Effect of irrigation

The growth and yield components, seed yield, biological yield, water use efficiency, production efficiency and nutrient use of coriander influenced significantly in both the years as well as in pooled data (Tables 1 and 3). The plant height and branches/plant recorded significantly superior than 3 and 4 irrigation treatments over 2 irrigations. However, the difference between 3 and 4 irrigations remain statistically at par. Similar to growth characters, the yield parameters like umbets/plant, umbels/plant and test weight were registered significantly higher with the crop receiving 3 and 4 irrigations over 2 irrigations. Improvement in growth and yield components resulted due to adequate and timely supply of water increased the turgidity of cells, opening of stomata, more photosynthates and their translocation (Singh *et al.*, 2002 and Lakple *et al.*, 2007). Minimum values of all the attributes were recorded with 2 irrigations applied at 20 and 40 DAS, which might have exposed the crop to relatively more adverse conditions in water stress and affects various physiological processes adversely, resulting in poor growth (Singh *et al.*, 2002).

The seed and biological yields of coriander were affected significantly with 3 and 4 irrigations over 2 irrigations (Table 1). The irrigation applied at 20, 40 and 60 DAS (I_2) showed best performance in increasing the seed yield (1.96 tonne/ha) and biomass production (4.66 tonne/ha) and resulted 38.31% and 3.93% in seed yield and 31.81% and 6.16% in biological yields over 2 (I_1) and 4(I_3) irrigations respectively. This increase in yield was mainly owing to the improvement in growth as well as yield contributing characters (Singh *et al.*, 2002 and Lakpale *et al.*, 2007).

Mean seasonal consumptive use of water was markedly higher with increase irrigations that with reduced irrigations (Table 3). This might be due to the fact that under more irrigation (I_3), evaporation was at potential rate due to availability of more water (soil moisture) than the crop irrigated with less irrigations (I_1 or I_2). Higher water use

Table 1. Effect of irrigation schedules and nutrients management on growth and yield attributes of coriander (mean of two years)

Treatment	Plant height (cm)	Branches/ plant (No.)	Umblets/ plant (No.)	Umbel/ plant (No.)	1,000 seed weight (g)	Seed yield (tonne/ha)		Biomass production (tonne/ha)	Harvest Index (%)
						2006-07	2007-08		
Irrigation Schedules (Days after sowing)									
20 and 40	118.3	17.10	24.56	103.7	10.71	1.48	1.49	3.36	44.34
20, 40 and 60	129.5	20.27	27.47	117.1	11.89	2.04	1.88	4.66	42.06
20, 40 , 60 and 80	132.2	19.86	26.37	113.9	11.61	1.86	1.83	4.49	41.20
SEm±	2.2	0.42	0.46	2.2	0.18	0.09	0.06	0.21	
CD (P=0.05)	6.8	1.33	1.41	6.7	0.58	0.27	0.18	0.64	
Nutrients levels (% of recommended NPKS)									
50	123.7	17.71	24.66	104.7	10.79	1.60	1.56	3.38	46.74
75	125.4	18.65	25.58	108.3	11.30	1.73	1.68	4.05	42.22
100	128.1	20.00	27.33	116.9	11.76	1.95	1.88	4.58	41.70
125	129.5	20.01	26.96	116.4	11.75	1.89	1.80	4.51	40.79
SEm±	0.6	0.25	0.28	1.3	0.09	0.03	0.03	0.07	
CD (P =0.05)	1.9	0.77	0.87	4.0	0.31	0.11	0.10	0.21	

Table 2. Interaction effect of irrigation and fertility levels on seed yield (t/ha) of coriander (pooled)

Per cent of recommended NPKS levels	Irrigation schedules (days after sowing)		
	20 and 40	20, 40 and 60	20, 40, 60 and 80
50	1.23	1.78	1.69
75	1.37	1.94	1.83
100	1.68	2.09	1.97
125	1.62	2.02	1.90
SEm±		0.05	
CD (P=0.05)		0.16	

efficiency was achieved under 2 (67.72 kg/ha-cm) and 3 (67.47 kg/ha-cm) over 4 (51.37 kg/ha-cm) irrigations. A little increase in water use efficiency (WUE) was also observed with application of 2 irrigations over 3 irrigations, but difference was non-significant. Thus water use efficiency was increase with decreased in irrigations. This means that production of grain per mm of water used decreased with increase in water supply and the relative increase in grain yield of coriander has not been in proportion to the increase in consumptive use, there by resulting in decreased in WUE under more irrigations (Singh *et al.,* 2002 and Lakpale *et al.,* 2007). Three irrigation applied at 20, 40 and 60 DAS recorded significantly higher production efficiency (14.54 kg/ha/day) and nutrient use (16.41 kg seed/kg nutrient) over 2 irrigations given at 20 and 40 DAS. Three and 4 irrigations remain statistically at par in respect to production efficiency and nutrient use.

Effect of fertility levels

Nutrient levels significantly influenced the growth and yield parameter, seed yield, biological yield, water use efficiency, production efficiency and nutrient use of coriander (Table 1 and 3). Application of 100% RDF significantly increased the plant height, branches/plant, umbels/plant and 1,000 seed-weight when compared with 50% and 75% RDF. Further increase in fertilizer doses (125% RDF) did not influence these characters. Application of 100% RDF gave 1.90 t/ha seed yield and 4.58 tonne/ha biological yield, which were significantly higher than 50% and 75% RDF and on a par with those of 125% RDF. The mean data showed that application of nutrients at 75% RDF and 100% RDF resulted in 12.04% and 20.65% increased in seed yield and 13.14% and 28.01% in biological yield over 50% RDF respectively. These results corroborate with Rao *et al.* (1983), Channabasavanna (2002), Prabhu *et al.* (2002). The better yield attributes and yield with application of nutrient might be due to its key role in root development energy

Table 3. Effect of irrigation schedules and nutrient management on efficiencies, yield, economics, total uptake and nutrient status after harvest of coriander (pooled)

Treatment	Consumptive use of water (mm)	Water use efficiency (kg/ha-cm)	Production efficiency (kg/ha/day)	Nutrient use (kg seed/ kg nutrient)	Cost of cultivation (Rs/ha×10³)	Net returns (Rs/ha×10³)	Net B:C ratio	Total nutrient uptake (kg/ha)			Available nutrient status (kg/ha)		
								N	P	K	N	P	K
Irrigation schedules (days after sowing)													
20 and 40	257.1	67.72	11.03	12.11	10.1	64.6	6.40	55.2	29.2	84.6	128	13.1	311
20, 40 and 60	289.6	67.47	14.54	16.41	10.6	86.8	8.19	70.4	36.5	103.4	130	13.3	316
20, 40 , 60 and 80	307.1	51.37	13.07	15.55	11.1	81.5	7.34	61.8	32.8	90.2	131	13.5	324
SEm±		2.67	0.56	0.69				2.7	2.1	3.2	1.3	0.3	4.4
CD (P=0.05)		8.07	1.71	2.13				7.6	6.2	9.7	NS	NS	NS
Nutrients levels (Per cent of recommended NPKS)													
50	211.5	55.60	11.76	20.95	9.6	72.9	7.59	54.6	28.7	83.4	128	13.0	314
75	252.1	59.87	12.66	15.20	10.1	75.4	7.47	57.6	31.8	86.7	130	13.2	317
100	293.6	67.81	14.19	12.77	10.6	85.1	8.03	63.7	34.4	92.8	130	13.6	318
125	336.0	65.45	13.39	9.86	11.1	81.2	7.32	73.8	36.3	107.4	132	13.6	320
SEm±		1.32	0.26	1.21				2.2	0.8	2.8	0.34	0.06	0.7
CD (P=0.05)		4.01	0.80	3.66				6.5	2.5	8.4	1.0	0.2	2.1
Initial status											135.5	13.2	315

translocation and metabolic process of plant through which increased translocation of photosynthate towards sink development might have occurred.

Averaged over treatments, seasonal consumptive use of water by coriander was recorded to be markedly higher (336 mm) with 125% RDF followed by decreased dose of fertilizers (Table 3). The water use efficiency and production efficiency with increasing nutrient levels from 50% to 100% RDF. The maximum water use efficiency (67.81 kg/ha-cm) and production efficiency (14.19 kg/ha/day) were observed with 100% RDF and on a par with those of 125% RDF. The higher water use efficiency and production efficiency with 100% RDF may be attributed to their favourable effect on yield attributing characters and ultimately seed yield (Tripathi and Rajput, 2006). However, reduction in nutrient use was noted with increasing levels of fertilizer application and maximum (20.95 kg seed/kg nutrient) was recorded with 50% RDF. This might be owing to increase in seed yield in diminishing manner with increasing levels of fertilizers.

Irrigation and fertility levels interaction

The interaction effect of irrigation and fertility levels on seed yield of coriander was significant and positive in pooled data over 2 years (Table 2). The maximum yield (2.09 tonne/ha) was obtained with the combined application of 3 irrigations at 20, 40 and 60 DAS and 100% RDF.

Soil moisture extraction pattern

Soil moisture depletion was higher from upper and middle layers with the increase in number of irrigations (Fig.1). It might be due greater availability of soil moisture in these layers and the existence of maximum roots in these layers. When the crop suffered from scarcity of water (I_1) more water was depleted from lower layer (40-60cm). It might be due to stress in the upper and middle layers.

The fertility levels remarkably influenced the soil moisture extraction pattern. The moisture depletion increased with the increasing levels of fertilizer application. The maximum soil moisture extraction was recorded with 125% RDF could be attributed to increased root biomass by increase availability of soil moisture as well as nutrient.

Nutrient uptake and fertility status

Irrigation schedules showed significant effect on nutrient uptake of coriander (Table 3). The N, P and K uptake of coriander were found maximum under with irrigation at 20, 40 and 60 DAS and least with 20 and 40 DAS irrigation. The higher nutrient uptake under I_2 may be due to combined effect of high nutrient content and higher seed and stover yield. On the other hand, a drastic reduction in

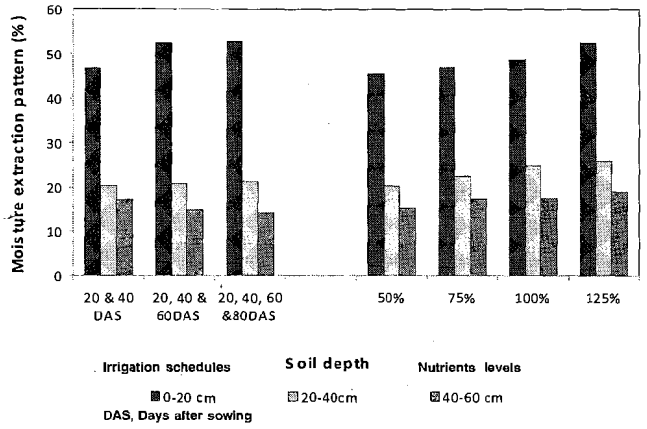

Fig. 1. Effect of irrigation and fertility levels on moisture extraction pattern (%) from different soil depths

the total uptake of N, P and K under I_1 could be the result of insufficient soil water content for dissolving nutrients and causing their mineralization. These results are in conformity with those of Lal *et al.* (1997). Irrigation schedules did not show significant effect on nutrient status of soil after harvest of the crop.

Increasing levels of fertility improved the total uptake of various nutrients by coriander (Table 3). The total uptake of N, P and K was found maximum under 125% RDF which was significantly superior to all others fertility treatments. Nutrient status of the soil also influenced with the increasing levels of fertility. The maximum N, P and K content of soil was found under 125% RDF which was significantly superior over 50% RDF.

Economics

The mean values of 2 years data revealed that highest returns and benefit :cost ratio (8.19) were found with 3 irrigation applied at 20, 40 and 60 DAS (Table 3). Further, the maximum net returns and benefit:cost ratio (8.03) were realized with 100% RDF. This might be due to higher productivity in these treatments. Similar findings were also reported by Lakpale *et al.* (2007) and Choudhary *et al.* (2008). The maximum harvest index were recorded with two irrigations given at 20 and 40 DAS (44.34%) and 50% RDF (46.74%).

Consequently higher productivity and profitability of coriander 3 irrigations (20, 40 and 60 DAS) along with 100% RDF (60:17.6:16.6:30 kg N:P:K:S/ha) is recommended.

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