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Response of cumin (*Cuminum cyminum* L.) to different drip irrigation and fertigation levels

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Abstract
A research investigation was conducted at Agricultural Research Station (ARS), Mandor (Rajasthan) during *rabi* season of 2016-17 to study the response of cumin (*Cuminum cyminum* L.) to different drip irrigation and fertigation levels. The soil of experimental site was sandy-loam in nature with low in available nitrogen, medium in phosphorus and high in potassium content. Ten treatment combinations comprised three levels of drip irrigation *viz.*, $I_{0.4}$, $I_{0.6}$ and $I_{0.8}$ cumulative pan evaporation (CPE) randomized with three fertigation levels (F_{60}, F_{80} and F_{100}) and one control ($S_{0.8}$ F_{100}) were replicated three times in FRBD. The result showed that drip irrigation at 0.6 CPE ($I_{0.6}$) recorded higher yield characters (nos. of umbels plant^{-1}, umbellets umbel^{-1}, seeds umbellate^{-1} and test weight) and yield (grain, straw, biological and harvest index), proved significantly superior over surface irrigation at 0.8 CPE ($S_{0.8}$ F_{100}) and drip irrigation at 0.4 CPE ($I_{0.4}$). Results further indicated that the application of 80% RDF (F_{80}) through fertigation being at par with 100% RDF (F_{100}) recorded significantly higher yield characters (number of umbels plant^{-1}, umbellets umbel^{-1}, seeds umbellate^{-1} and test weight) and yield (grain, straw, biological and harvest index) over 60% RDF(F_{60}).

Keywords: Cumin, cumulative pan evaporation (CPE), drip irrigation, yield characters and yield

Introduction

Cumin (*Cuminum cyminum* L.), one of the most important seed spices which belongs to the family *Apiace* and widely cultivated in sub-tropical areas of the world, mainly in the countries like India, Egypt, Israel, Mexico, Iran, Pakistan and Turkey. Cumin seed commonly known as "*Jeera*" in India, is the second most important seed spice in the world after pepper. Cumin has beneficial role in curing tastelessness, poor digestions, heart disease, swellings, vomiting and chronic fever. Cumin seeds weighing 100 grams contain about 17.81 g proteins, 22.27 g fat, 44.24 g carbohydrates, 10.5 g fibre, vitamins and minerals. Its main constituent aroma compounds are cumin aldehyde and cumin alcohol. The seeds also contain about 2.5 to 3.6 per cent essential oil in indigenous collection and up to 5.5 per cent in exotic ones which has a characteristic odour and a little bitter taste and is used in perfumery and for flavoring liquors and cordials. In arid and semi-arid area of Western India, cumin is commonly grown during winter season. It is mainly cultivated in Rajasthan, Gujarat, few pockets of Madhya Pradesh and Uttar Pradesh. Therefore, Rajasthan alone contributes more than 65 per cent in acreage and 40 per cent production of cumin in the country. It is widely grown in Barmer, Jodhpur, Jalore, Naguar, Jaisalmer and Sirohi districts of western Rajasthan with a total acreage of 4.79 lakh ha with production of 2.0 lakh tons (Anonymous, 2016) [1]. Drip ensured water availability at root zone of plant by discrete application of water. Drip irrigation not only save water, but also increase yield over conventional irrigation method (Singh *et al.*, 2005) [2]. Fertigation is considered as eco-friendly as it avoids the leaching and volatilization losses of nutrients. Application of fertilizer in small quantities to the soil at any given time improves fertilizer use efficiency, helps to maintain nutritional balance and nutrient concentration at optimum level, saves energy and labour, provides opportunity to apply the nutrient at critical stages of crop growth and minimizes hazard of groundwater.

The trail was carried out at Agricultural Research Station, Mandor, Jodhpur (Rajasthan). Geographically it is located between 26º 15' N to 26º 45' North latitude and 73º 00' E to 73º 29' E longitude with an altitude of 231 meter above MSL. This region falls under Ia (Arid Western Plains Zone) agro-climatic zone of Rajasthan. The soil of the research field was sandy-loam in texture, slightly alkaline in reaction (pH 8.2), low in organic carbon (0.13%) and available nitrogen (174 kg ha^{-1}), whereas medium in phosphorus (22.2 kg P_2O_5 ha^{-1}) and available potassium (325 kg K_2O ha^{-1}). The available P_2O_5 and K_2O were analyzed by Olsen's method (Olsen *et al.*, 1954) [3] and Flame Photometric method (Jackson, 1974) [4], respectively. The trail was laid out in FRBD and replicated thrice. As per experimental plan, the treatments comprising three drip irrigation levels *i.e.* drip irrigation at 0.4 CPE ($I_{0.4}$), drip irrigation at 0.6 CPE ($I_{0.6}$) and drip irrigation at 0.8 CPE ($I_{0.8}$) and randomized with three fertigation levels *i.e.* fertigation with 60% RDF (F_{60}), fertigation with 80% RDF (F_{80}) and fertigation with 100% RDF (F_{100}) and one control (surface irrigation at 0.8 CPE with 100% RDF). Cumin variety "GC-4" was sown on 11th November, 2016 and harvested on 18th March, 2017. Sowing was done by taken 12 kg ha^{-1} seeds and sown by manually with a rows spaced of 30 cm apart and 1.5-2.5 cm depth. The crop was fertilized as per treatment (RDF 20-30-0 kg N- P_2O_5-K_2O ha^{-1}, respectively). Laterals were used with a size of 12 mm diameter in size with discharge of 3.5 liters water hour^{-1} in drip system. Drip irrigation was operated on alternate 4 days at 1.5 kg cm^2 pressure on the basis of cumulative pan evaporation (CPE) of 0.4, 0.6 and 0.8. Surface irrigation was done on basis of 0.8 CPE. In drip, three levels of fertigation 60, 80 and 100% RDF were applied through soluble fertilizers (Urea and Urea phosphate) in six splits at different stages i.e., 10% at 15 DAS, 10% at 30 DAS, 30% at 45 DAS, 30% 60 DAS, 10% at 75 DAS and 10% at 90DAS. Full dose of recommended fertilizer (RDF 30 kg N + 20 kg P_2O_5 ha^{-1}) in surface irrigation was given through urea and single super phosphate as basal dose. Sulphur fertilization by SSP in control treatment will be adjusted through single super phosphate in drip fertigation treatments.

Scanning of the data figured in table 1 indicated that different levels of drip irrigation influenced yield characters and yield of cumin. Significantly the highest nos. of umbels plant^{-1} (52.78), umbellets umbel^{-1} (5.36), seeds umbellate^{-1} (5.61), test-weight (4.98 g), seed yield (1395 ka ha^{-1}), straw yield (2411 ka ha^{-1}) and biological yield (3806 kg ha^{-1}) were recorded under drip irrigation at 0.6 CPE which was on par with drip irrigation at 0.8 CPE as compared to irrigation applied through surface at CPE of 0.8 and drip irrigation at 0.4 CPE. This is might be due to water is applied in discrete amount to root zone that improve moisture availability during crop growth period results in more physiological growth and higher dry matter accumulation by translocating of photosynthates among plant parts ultimately higher yield was obtained. The yield increase in drip irrigation with high CPE level is due to frequent water application through drip irrigation results in favorable micro climate and keeps constantly soil moisture near to field capacity which helps in increasing the yield. Similarly, increased yield characters and yield of coriander was reported by Datta *et al.*, (2006) [5]. This result also conformity with results of Kumawat *et al.*, (2013) [6].

Table 1: Yield characters and yield of Cumin as influenced by drip irrigation and fertigation levels

Treatments	Nos. of Umbels plant^{-1}	Nos. of Umbellets umbel^{-1}	Nos. Seeds umbellate^{-1}	Test-weight (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Drip irrigation levels								
$I_{0.4}$ CPE	48.13	5.01	5.28	4.74	1252	2164	3416	36.62
$I_{0.6}$ CPE	52.78	5.36	5.61	4.98	1395	2411	3806	36.72
$I_{0.8}$ CPE	50.86	5.23	5.46	4.93	1374	2408	3782	36.35
S.Em. ±	0.74	0.07	0.07	0.06	21.5	35.8	46.4	0.53
CD (P = 0.05)	2.21	0.20	0.20	0.17	64.0	106.4	137.8	NS
Fertigation levels								
F60	47.61	4.92	5.28	4.75	1292	2215	3507	36.82
F80	52.38	5.41	5.60	5.02	1372	2390	3762	36.52
F100	51.78	5.27	5.47	4.89	1357	2377	3734	36.35
S.Em. ±	0.74	0.07	0.07	0.06	21.5	35.8	46.4	0.53
CD (P = 0.05)	2.21	0.20	0.20	0.17	64.0	106.4	137.8	NS
Control vs.Other								
Control	41.07	4.53	4.73	4.47	824	1514	2338	35.25
Other	50.59	5.20	5.45	4.89	1340	2328	3668	36.56
S.Em. ±	0.96	0.09	0.09	0.07	27.8	46.2	59.9	0.68
CD (P = 0.05)	2.85	0.26	0.26	0.22	82.6	137.4	177.9	NS

The data revealed that nos. of umbels plant^{-1}, umbellets umbel^{-1}, seeds umbellate^{-1}, test- weight, seed, straw and biological yield of cumin were significantly influenced by different fertigation levels. The fertigation with 80%RDF (F_{80}) significantly recorded maximum nos. of umbels plant^{-1} (52.38), umbellets umbel^{-1} (5.41), seeds umbellate^{-1} (5.60), test-weight (5.02 g), seed yield (1372 kg ha^{-1}), straw yield (2390 kg ha^{-1}) as well as biological yield (3762 kg ha^{-1}), which was on par with 100% RDF (F_{100}). Harvest index (%) by different fertigation levels was found to be non-significant. The respective per cent increases in seed and straw yields with 80% RDF over 60% RDF were to the tune of 6.1 and 7.9 per cent. This is might be due to rhizospheric zone had maintained optimum levels of moisture by controlled application of water through drip that favoured mineralization of inorganic nutrients resulted in better growth and development of the crop. The other reason behind higher yield might be due to application of water soluble forms of nutrients under each treatment, while treatments received higher fertigation level had showed more yield (Jangir *et al.*, 2007) [7]. The increasing levels of fertigation limited the fertilizers to the moist zone of soil where the active root zone are concentrated thus, leads to enhanced consumption of nutrients, superior vegetative growth and finally yield. The result confirms the findings of Godara *et al.*, (2013) [8], Koyani *et al.*, (2015) [9] and Meena *et al.*, (2016) [10].

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