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Comparative efficacy of sprinkler and surface methods of irrigation in cumin (*Cuminum cyminum*) under arid western Rajasthan conditions

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ABSTRACT

A field study was undertaken during winter seasons of 2002-03 and 2003-04 at Mandor-Jodhpur to compare the efficacy of sprinkler method of irrigation with conventional check-basin method and to work out an appropriate irrigation schedule and the operating time for sprinklers. The pooled results revealed that application of five irrigations through sprinklers operated for 3 hr produced seed yield (411 kg/ha) on a par with that of recommended irrigation schedule applied through conventional irrigation method, but it saved water up to 41 per cent with higher WUE (0.260 kg seed/m^3) and net returns (Rs 16,558/ha). Further increase in irrigation frequency (six irrigations) did not cause significant impact on cumin productivity and net returns.

Key words: Cumin, Irrigation frequency, Consumptive use, Water-use efficiency, Moisture-use rate

Overexploitation of ground water in the recent past has reduced the water-table, thus making the availability of sub-surface irrigation water not only scarce but also costly. As land levelling and application of irrigation through check basin are not feasible in undulating topography of cumin-growing area, sprinkler irrigation system can be useful for water saving and increasing the cropped area with the same quantum of water and thus sustaining crop productivity in this region. Western Rajasthan has great potential for cumin (*Cuminum cyminum* L.) cultivation owing to suitability of this region to meet specific climatic requirements like dry and moderate cool weather and the cloudless atmosphere during seed-filling period in conjunction with well-drained light-textured soils. Though the crop responds to variable irrigation frequency in surface method (Patel *et al.*, 1992), information on suitable irrigation schedule in terms of frequency and operating period of sprinkler system is meagre for the arid western Rajasthan. Hence an attempt was made to find out the appropriate irrigation schedule through sprinkler system for yield sustainability in cumin and to compute the quantum of water saving and moisture use in comparison with surface method of irrigation.

MATERIALS AND METHODS

A field investigation was carried out on sandy loam soil (alfisols) at Agricultural Research Station, Mandor-Jodhpur (Rajasthan) during winter season of 2002-03 and 2003-04. The six treatment combinations of irrigation frequency, viz. four (F_4 = at sowing, 10, 45 and 80 DAS), five (F_5 = at sowing, 10,30,55 and 80 DAS) and six irrigations (F_6 = at sowing, 10, 30, 50, 70 and 90 DAS) and the operating period of 3 (H_3) and 4 hours (H_4) of sprinkler system were compared with the recommended five irrigations applied through surface method (SM_5). The trial was laid out in randomized block design with three replications. The soil was low in organic carbon (0.20%), and high in available P (37 kg/ha) and available K (244 kg/ha) with pH 8.6. The field capacity and permanent wilting point in 45 cm root-zone soil profile were 9.04 and 2.82 per cent respectively, with a bulk density of 1.50 Mg/m^3. Moderately cool climate was prevalent during the crop-growth period. Irrigation-application efficiency of surface method was 85 per cent. The time taken to apply the required amount of water for each basin measuring 3 × 3 m area (450 × 85% = 530 litres/basin) to maintain the desired depth of irrigation water (50 mm) was 3.5 min. (discharge = 150 litres/min.). The irrigation depth was computed from the available soil moisture, apparent specific gravity and effective rooting depth. Sprinkler system was operated with continuous arrangement of nozzle at a distance of 20 feet, maintaining operating pressure of 1.5 kg/cm^2 at the head-end. Uniformity coefficient for sprinkler system was 0.75, which was not adversely influenced by low wind velocity (< 5 km/hr). The total quantity of water applied in

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the surface method was 5,88,235 litres/ha and the corresponding values for sprinkler system operated for 3 hr were 3,55,556 and for 4 hr were 4,74,074 in 2002-03; and 3,40,000 and 4,53,333 litres/ha in 2003-04 respectively in each irrigation. Cumin 'RZ 19' was sown in rows 30 cm apart on 25 November 2002 and 10 November 2003. A uniform dose of 15 kg nitrogen (50%) and full dose of phosphorus (20 kg/ha) were applied basal, and the remaining half dose of nitrogen was top-dressed at the time of third irrigation, coinciding with branching stage. Soil samples were collected from three successive layers (0-15, 15-30 and 30-45 cm) to determine soil-moisture content by gravimetric method at sowing, before each irrigation and 24 hr after applying irrigation, and at harvest of the crop. In 2002-03 the rainfall during crop season was 38 mm. Therefore, the sixth irrigation was not applied due to cloudy weather and intermittent rain during seed-formation stage in the second fortnight of February to avoid invasion of insects and diseases. Moisture use by the crop such as consumptive use (CU) and water-use efficiency (WUE) were computed following the method suggested by Dastane (1972). Weed management, thinning and other operations were carried out as per recommendation of the crop for the region. The crop was harvested on 15 March 2003 and 12 March 2004.

RESULTS AND DISCUSSION

Effect of irrigation on yield and yield attributes

With increase in irrigation frequency through sprinkler from four to five, a marked improvement was observed in plant growth, yield attributes and yield of cumin (Table 1). The pooled data of two seasons show that the application of five irrigations through sprinkler operated for 3 hr recorded better growth, yield attributes and seed yield of cumin (411 kg), which was significantly higher than under four irrigations. This increase in growth and yield attributes of cumin with increased irrigation frequency could be attributed to potential role of water in modifying the soil and water environment conducive to better crop growth. Adequate supply of moisture ensured adequate supply of nutrients, which helped the plants to produce with better growth and yield attributes and later on diverted or supplied enough photosynthates to the seed (higher test weight), resulting in higher seed yield. Bhati (1993) also observed similar effect of irrigation in fenugreek. However, further increase in the irrigation frequency from five to six and prolonging the operating hours of sprinklers to 4 hr did not cause any significant improvement in seed yield and net income of cumin. This was because cumin is a short-stature crop and its water requirement is also low. Excess irrigations may increase the chances of pest and disease infestation in cumin. Our results are in close conformity with the findings of Jangir and Singh (1996).

Effect of irrigation method

Pooled experimental results of two seasons (Table 1) revealed no significant difference in seed yield of cumin due to the application of recommended irrigation schedule either through surface method or through sprinkler method of irrigation. However, sprinkler irrigation method recorded higher WUE (0.260 kg seed/m^3 water used), higher CU (160 mm), higher net returns (Rs 16,558/ha) along with 41 per cent less quantity of water (174 mm) than the surface irrigation method (294 mm) (Table 2). The reason is that these soils possess poor water-holding capacity, which caused greater percolation of water to the deeper zone, beyond the reach of cumin roots. Thus the excess amount of water applied through surface method did not have any contribution in plant growth and yield. Patel *et al.* (1992) also obtained similar results.

Effect of irrigation on moisture use

The successive increase in irrigation frequency through

Table 1. Effect of sprinkler and surface methods of irrigation on yield attributes, seed yield and net monetary returns (NMR) of cumin (pooled mean of 2002-03 and 2003-04)

Treatment	Plant height (cm)	Umbels/plant	Seeds/umbel	Test weight (g)	Seed yield (q/ha)	NMR (Rs/ha)
F_4H_3	31	17	25	3.77	2.71	7,457
F_5H_3	36	32	30	4.50	4.11	16,558
F_6H_3	36	28	32	4.47	3.76	13,778
F_4H_4	32	19	27	4.10	3.09	9,683
F_5H_4	38	35	31	4.54	4.32	17,463
F_6H_4	37	32	32	4.73	4.12	15,786
SM_5	36	35	30	4.96	3.76	11,858
CD (P=0.05)	3	3	3	0.64	0.55	2,363

Cost of cultivation includes cultivation charges and operational cost as per treatment
Sale price of cumin seed was at Rs 70/kg

Table 2. Effect of sprinkler and surface method of irrigation on total water applied, CU, WUE and moisture-use rate of cumin (pooled mean of 2002-03 and 2003-04)

Treatment	Total water applied (mm)	Water saving (%)	CU (mm)	WUE (kg seed/m^3 water used)	Moisture-use rate (mm/day)
F_4H_3	139	53	129	0.212	1.11
F_5H_3	174	41	160	0.260	1.37
F_6H_3	191	35	189	0.204	1.63
F_4H_4	186	37	126	0.245	1.08
F_5H_4	232	21	152	0.286	1.30
F_6H_4	255	13	184	0.228	1.58
SM_5	294	-	158	0.238	1.36

sprinkler from four to six with different operating periods (3-4 hr) progressively increased the seasonal water application, CU of water and daily moisture-use rate (Table 2). The most appropriate and remunerative sprinkler irrigation schedule (F_5H_3) worked out by this study saved 41 per cent water compared with surface method (294 mm), leading to absence of stress throughout crop season in addition to maintenance of favourable micro-climatic condition, which helped generate higher yield than that of surface method. The CU of water by cumin computed under this irrigation schedule (F_5H_3) was 160 mm, which was nearly the same as in surface method (158 mm). The increased daily moisture-use rate at higher-soil moisture availability was probably due to regulation of physiological activity towards seed production. Water-use efficiency (WUE) of cumin did not follow the same trend as CU, since the increase in seed yield was not commensurate with increase in evapro-transpiration under enhanced water supply.

It was concluded that in cumin, to save water, obtain high WUE and net income, the recommended schedule of irrigation (5 irrigations) can be given through sprinklers operated for 3 hr in arid western region of Rajasthan.

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