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Enhancing water use efficiency in cumin *(Cuminum cyminum L)*

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ABSTRACT

An investigation on enhancing water use efficiency in cumin was carried out during *Rabi* season of 2010-11 at the research farm of National Research Centre on Seed Spices, Ajmer (Rajasthan). The experiment comprising of three irrigation methods viz. flood, high pressure drip and low pressure drip in the main plots and four water conservation methods viz. mulching, low plastic tunnel, mulching + low tunnel and control in sub plots was conducted in split plot design with three replications. Based on one year study it reveals that the application of irrigation through low pressure drip exhibited highest level in growth parameters and yield attributes viz., umbels/plant (9.80), umbellate/plant (45.40), seed weight/plant (5.85 gm), test weight (4.36 gm) and yield (671.30 kg ha^{-1}) with maximum water use efficiency (2.66 kg ha^{-1}-mm) followed by high pressure drip irrigation. Among the various water conservation techniques mulching with 20 micron plastic sheet exhibited highest plant height at all the growth stages, branches/plant at maturity, umbellate/plant (46.73), test weight (4.62 gm), seed weight (5.74 gm plant^{-1}) and yield (684.16 kg ha^{-1}). Thus the result indicates that application of irrigation through low pressure drip irrigation and conservation of moisture by mulching with 20 micron plastic sheet is better for realizing higher growth, yield and water use efficiency.

Key words: Cumin, Drip irrigation, Mulching, Water conservation, Water use efficiency.

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INTRODUCTION

Availability of water, an essential requirement for growing the crops is becoming most precious natural resource on this planet as the usable water is under continuous pressure due to burgeoning population, diminishing ground water sources, over exploitation and poor management of the resources. For agriculture sector the availability of water is being challenged due to enhanced water requirements in other sectors of economy. Hence, water management is the need of the hour wherein every drop is to be put to its most efficient use. Irrigation water used for growing the crop needs to be managed on two fronts firstly, the method of application and secondly being the conservation in field after application. Most of the seed spices crops are grown in arid and semi arid regions hence; the efficient utilization of water for these crops is one of the biggest challenges for the seed spices producers. Drip irrigation system has proved to be of utmost importance from water and nutritional management point of view in various crops ranging from perennial plantations to annuals and seasonal vegetable crops. Cumin, known as a major seed spice is one of the prominent spice for domestic consumption as well as for earning foreign exchange through export to international market. The main use of cumin in India had been as a necessary spice gradient for cooking vegetables as well as an additive for preservation of foods and beverages besides various forms of medicines and medicinal extracts. Cumin needs optimum levels of soil moisture not only during its initial establishment and growth but also on other critical stages of flowering and seed ripening. Drip irrigation system is not only a successful water management solution in terms of saving the quantity but enhances the availability of moisture directly to root zone of plants (Sezen *et al.,* 7 and Kumar *et al.,* 1). This experiment was conducted to study the scaling up water productivity by enhancement of water use efficiency and thus by applying and control of water quantity through various combinations of treatments.

MATERIALS AND METHODS

An investigation on enhancing water use efficiency in cumin was carried out during *Rabi* season of 2010-11 at the research farm of National Research Centre on Seed Spices, Ajmer (Rajasthan). The soil of the experimental site was sandy loam with a pH of 8.82 having 0.25 percent organic carbon and 76.0, 33.4, and 234.1 kg ha^{-1} available N, P_2O_5 and K_2O, respectively. The experiment comprising of three irrigation methods viz. flood, high pressure drip and low pressure drip in the main plots and four water conservation methods viz. mulching, low plastic tunnel, mulching + low tunnel and control in sub plots was conducted in split plot design with three replications. Fully decomposed sheep manure was applied to the field @ 5.0 ton ha^{-1} and well mixed with the soil 45 days before sowing. For the protection from fungal diseases, soil treatment was made one month in advance with 0.50 ton / ha Neem cake. GC-4 variety of cumin was sown in the experimental field on 3rd November, using 12 kg seed ha^{-1} following normal recommended practices (Meena *et al.,* 2010). Seed was treated with *Trichoderma* @ 5 gm kg^{-1} seed) and soil was also treated by (*Trichoderma* 2.50 kg ha^{-1} mixed with 50 kg vermi compost).The recommended doses of NPK (30 kg N, 20 kg P_2O_5 and 20 kg K_2O ha^{-1}) were applied through fertilizers. Total quantity of phosphorus, potash and 1/3 dose of nitrogen was applied as basal dose while rest of the nitrogen given in two equal splits at 30 and 60 days after sowing as top dressing in standing crop. Sprout emergence was noticed in the evening of 9th day however on 12th day there was a good germination and crop lines were clearly visible. Sub plots of 3.00 m x 3.60 m placed at 20 cm interval were split into two parallel halves of 1.50 m width and 3.60 m length keeping 50 cm spacing in between sub plot beds for taking observations and preparing irrigation channel for flood irrigation. The crop was sown in lines spaced 25 cm apart and each half of sub plot had 6 lines where in plant to plant distance was kept at 10 cm. In conventional or flood method, irrigation was provided at 0.8 IW/CPE ratio at recommended standard intervals through main channels between pair of sub plot beds, whereas in both the drip systems i.e. low pressure and high pressure, irrigation was provided at four days interval based on 70% CPE. Main line for drip system water supply was underground 2"dia PVC pipe with standard filtration system and control valves. Water was applied in plots through16 mm diameter LLDPE Laterals with 2.2 LPH@1.0 kg cm^{-1} sq discharge capacity inline dripper placed at 30 cm distance and one lateral was placed between each pair of two rows. For moisture conservation, 20 micron thick partially transparent poly sheets were used for mulching. These sheets were also used in low tunnels for covering the crop during nights with the help of 3.5 mm thick 2.20 m long GI wires bend in curves to make an arch above the 1.50 m wide crop bed. Both the ends of GI wire were inserted manually in ground up to 6-8 inches making a vertical arch of about 40 cm height over which poly sheets were spread with ends partially buried in soil and placing brick bats on edges so as to hold them firm in the event of wind or rains. For taking plant growth parameters, five plants were selected randomly from each sub plot and observations on plant height, branches per plant, plant height at maturity and yield attributing characters viz. capsules per plant, seed weight per plant, test weight and over all yield per sub plot as well as per ha were recorded. The statistical analysis was done as per procedure suggested by Panse and Sukhamte (5).

RESULTS AND DISCUSSION

Irrigation method

Method of irrigation plays significant role in crop establishment, plant growth parameters, yield attributes and yield of cumin (Table-1).The difference was visible during initial observations of plant height recorded 60 days after sowing where maximum plant height was 13.73 cm in low pressure drip method followed by high pressure drip irrigation. The trend continued for the plant height after 80 days of sowing and at the stage of maturity where in average plant height recorded in low pressure drip was 20.90 cm and 29.23 cm, respectively followed by high pressure drip method (20.48 cm and 28.82 cm respectively). At 60 DAS and 80 DAS low pressure drip irrigation method exhibited maximum number of branches (7.87 and 8.18 branches per plant, respectively) followed by 7.77 and 7.73 in high pressure method. It reveals that the application of irrigation through low pressure drip system resulted in highest yield and yield attributes viz. umbels/plant (9.80), umbellate/plant (45.40) seed weight/ plant (5.85 gm) test weight (4.36 gm), yield (671.30 kg ha^{-1}) and water use efficiency (2.66 kg ha^{-1}-mm) followed by high pressure drip irrigation treatment (Table 2 and 3). Flood irrigation system resulted lowest value for the above. The reason for this may be super saturation level of soil after flood irrigation; the rate of flow of water in low pressure drip irrigation is less as compared to the high pressure resulting into more downward movement rather than the horizontal one that makes the crop more susceptible for soil born fungal diseases and insect attack. The quantum of water application through high pressure drip irrigation as well as low pressure drip system was same but it is the rate of flow of water that plays an important role for water movement in horizontal and vertically downward directions. In the low pressure drip system the discharge rate is slow that facilitate more downward movement of water through percolation hence horizontal spread is less. Similar results have also been reported by Lal *et al*. (2) in cumin and Tripathi *et al.* (6) in onion.

Water conservation method

The mulching helps in minimizing the water loss through evaporation and the low tunnel helps in further checking evaporation, transpiration and frost. Thus the water conservation treatment plays significant role in the crop growth and harvest. This is further clarified from the observations recorded for the soil moisture conservation measures (Table-1). Mulching is well proved method for moisture conservation as it is visible from the plant growth parameter observations where maximum plant height at 60 DAS (13.82cm), at 80 DAS (21.72cm) at Maturity (29.23 cm) and number of branches per plant at 60 DAS (7.71) and 80 DAS (8.42) were measured. Same trend was observed (Table-2) in the yield attributes and yield where mulching treatment resulted in highest no. of umbels per plant at maturity (10.02), umbellate per plant (46.73), seed weight per plant (5.74 gm), test weight (4.62gm) and yield (684.16kg ha^{-1}). The *Rabi* season of 2010-11 at the experiment station faced very rare phenomena receiving very unlikely nearly 37.8% of the irrigation water through the rain showers that had been intermittent during the crop growth period (Table-3). This may have impact on water conservation measures as the covering of low tunnels during the rains in nights did not allow any drop of water to add to the soil moisture and the combination of the two i.e. mulching and low tunnel had excessive moisture retention during the event of irrigation followed by sudden rains. Similar results were reported by Maheria *et al*. (3) in nigella.

Thus, it can be inferred that application of irrigation through low pressure drip irrigation and conservation of moisture by mulching with 20 micron plastic sheet is better for realizing higher growth, yield and water use efficiency.

Table 1. Effect of Irrigation method and water conservation measures on plant growth parameters of cumin

Treatments	Plant height (60 DAS)	No.of branches plant^{-1} (60 DAS)	Plant height (80 DAS)	No, of branches plant^{-1} (80 DAS)	Plant height (at maturity)
Irrigation method					
I_1-Flood	12.04	7.07	19.87	6.82	28.05
I_2-Drip	13.44	7.77	20.48	7.73	28.82
I_3- Low Pr Drip	13.73	7.87	20.90	8.18	29.23
S Em±	0.35	0.20	0.54	0.29	0.52
CD (P=0.05)	1.37	0.80	2.12	1.15	2.03
CV %	9.25	9.33	9.17	13.41	6.24
Conservation method					
P_1- Mulching (Mul)	13.82	7.71	21.72	8.42	29.93
P_2- Low Tunnel (Tun)	12.91	7.53	20.00	7.27	28.31
P_3- Mul + Low Tun	12.94	7.60	20.64	7.60	28.80
P_4-Control	12.62	7.42	19.30	7.02	27.76
S Em±	0.38	0.27	0.50	0.37	0.70
CD (P=0.05)	1.14	0.79	1.49	1.11	3.62
CV %	8.82	10.61	7.35	14.77	7.35

Table 2. Effect of Irrigation method and water conservation measures on yield and yield attributes of cumin

Treatments	Umbels plant^{-1}	Umbellates Plant^{-1}	Seed Wt Plant^{-1} (g)	Test Wt (g)	Yield (kg ha^{-1})
Irrigation method					
I_1-Flood	8.22	40.65	4.81	4.21	613.43
I_2-Drip	9.37	43.65	5.29	4.24	644.29
I_3- Low Pr Drip	9.80	45.40	5.85	4.36	671.30
S Em±	0.39	1.11	0.22	0.09	11.79
CD (P=0.05)	1.51	4.36	0.84	0.35	46.27
CV %	14.62	8.90	14.02	7.23	6.35
Conservation method					
P_1- Mulching (Mul)	10.02	46.73	5.74	4.62	684.16
P_2- Low Tunnel (Tun)	8.87	42.24	5.16	4.22	627.57
P_3- Mul + Low Tun	9.09	43.29	5.34	4.29	653.29
P_4-Control	8.53	40.67	5.02	3.94	607.00
S Em±	0.37	1.30	0.23	0.17	28.64
CD (P=0.05)	1.09	3.88	0.69	0.50	147.37
CV %	12.05	9.05	13.20	11.84	13.36

Table 3. Irrigation water applied and water use efficiency of cumin

Irrigation method	Rainfall (mm)	Irrigation water applied (mm)	Total water used (mm)	WUE (kg ha^{-1} mm)
I_1-Flood	152.00	150.00	302.00	2.03
I_2-Drip	152.00	100.00	252.00	2.56
I_3- Low Pr Drip	152.00	100.00	252.00	2.66

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