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Response of fennel (*Foeniculum vulgare*) to irrigation and mulching

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Abstract

A field experiment was conducted to find out the effect of irrigation levels and mulching on performance of fennel. Results indicated that application of six irrigations significantly increased the plant height, number of branches plant^{-1}, total chlorophyll content, dry matter accumulation per metre row length, number of umbels plant^{-1}, umbellets umbel^{-1}, seeds umbellet^{-1} as well as seed, stover and biological yield of fennel compared to four and five irrigations. However, it remained at par with seven irrigations. Results further revealed that application of straw mulch significantly increased number of branches plant^{-1}, dry matter accumulation per metre row length, number of umbellets umbel^{-1} and yields (seed, stover and biological) over control, dust and plastic mulches. Plant height and number of umbels plant^{-1} increased significantly with straw mulch as compared to control and dust mulch, but remained at par with plastic mulch. However, in respect of number of seeds umbellet^{-1}, straw, plastic and dust mulch gave similar results.

Keywords: dust mulch, fennel, irrigation, plastic mulch, seed yield, straw mulch

Fennel (*Foeniculum vulgare* Mill.) plant is a stout, aromatic annual herb which belongs to family *Apiaceae*. The plant is pleasantly aromatic and each of the part (leaves, stalks, bulbs and seeds) is edible. The seeds contain about 9.5% protein, 10.0% fat, 42.3% carbohydrates, 18.5% fibre and 13.4% minerals (Bhunia *et al.* 2005). Further, the seeds contain about 0.7% to 6.0% volatile oil depending on the genotypes or botanical types. Water resources have become scarce, especially in the arid and semi-arid areas of Rajasthan. In such areas, instead of intensive irrigation over a limited area, the right approach would be to apply irrigation to maximum area with reduced irrigation intensity in order to increase the overall production and water use efficiency. This can be ensured by irrigating the crop at phenological stages of growth. In order to mitigate the adverse effects of water stress, efficient conservation of rain/irrigation water is of utmost importance. One of the common practices to reduce evaporation loss from the soil and prolonging the availability of moisture to the crop is the use of mulches. Mulching increases soil moisture, regulates soil temperature, suppresses weed growth, checks excessive evaporation, reduces soil erosion and improves production and quality. Keeping this in view, the present investigation was undertaken to find out the effect of irrigation and mulching practices on productivity of fennel.

The field experiment was conducted at Agronomy farm, S.K.N. College of Agriculture, Jobner during *rabi* season of 2009–10. The soil of experimental plots was loamy sand in texture, alkaline in reaction (pH 8.2), low in organic carbon (0.16%), available nitrogen (127.1 kg ha^{-1}), available phosphorus (16.9 kg P_2O_5 ha^{-1}) and medium in available potassium (175.1 kg K_2O ha^{-1}) content. The experiment comprised of 16 treatment combinations with four levels each of irrigation (4, 5, 6 and 7 irrigations) in main plot and four moisture conservation practices (control, dust mulch, plastic mulch and straw mulch) in sub plots. The experiment was laid out in split plot design with three replications. The water used for irrigation was slightly saline but could safely be used in light textured soil for irrigating fennel crop. Irrigation water belonged to C_3S_1 Class of United States Salinity Laboratory, California and had EC of 1.56 dSm^{-1} at 25°C, pH 8.15, 26.4 mmol L^{-1} Na^+, 1.0 mmol L^{-1} CO_3^{2-}, 6.5 mmol L^{-1} HCO_3^-, 2.5 meq L^{-1} RSC and 8.61 SAR.

Irrigations were given to the crop at 35, 30, 25 and 20 days interval, respectively in treatments involving in 4, 5, 6 and 7 irrigations. In order to prevent seepage effect from irrigation channels and adjoining plots, a uniform unsown buffer channel of 50 cm width was kept between main plots. Dust mulching was done twice at 20 and 55 days after sowing (DAS) manually by hoeing with the help of spade. Black plastic strip of 30 cm width and 4 m length was placed in between the rows 20 DAS in the ear marked plots and their corners were put under the bund of the bed. Straw mulch was applied with mustard stover @ 5 t ha^{-1} at 20 DAS. A uniform basal dose of 60 kg N + 40 kg P_2O_5 ha^{-1} through urea and DAP was drilled prior to sowing. The remaining 30 kg N ha^{-1} was top dressed through urea at 40 DAS. The fennel variety RF-101 was sown on 10 November, 2009. Sowing was done by *kera* method in rows spaced 45 cm apart using a recommended seed rate of 10 kg ha^{-1} at a depth of 2-3 cm. The crop was harvested on 6 April, 2010. The experimental data on growth parameters, yield attributes and yield were statistically analyzed by Fisher's 'Analysis of Variance' technique (Fisher 1950).

Result indicated that levels of irrigation failed to bring perceptible variation in plant height and dry matter accumulation at 30 DAS (Table 1) but, it influenced them significantly at later stages i.e. 60, 90 DAS and at harvest. Being at par with six irrigations, application of seven irrigations recorded the maximum plant height and dry matter and proved significantly superior over four and five irrigations. Progressive increase in number of irrigations (up to six) significantly increased the number of branches per plant over its preceding levels by 21.5% and 8.2% at 90 DAS and 19.6% and 7.2% at harvest over four and five irrigations, respectively. Total chlorophyll content in fennel leaves also increased with increase in number of irrigations from four to seven (Table 1). The highest total chlorophyll content recorded under seven irrigations was at par with six irrigations and both these levels proved significantly superior to four and five irrigations. Similar findings were reported by Patel *et al.* (2000) & Rao *et al*. (2010).

Plant height and dry matter accumulation of fennel were not affected significantly due to moisture conservation practices at early stage (30 DAS) but, at later stages, these parameters were significantly increased due to moisture conservation practices (Table 1). Use of straw mulch gave significantly higher plant height registering an increase of 19.4%, 8.2% and 6.4% at 60 DAS, 18.3%, 9.1% and 6.1% at 90 DAS and 18.5%, 9.3% and 6.3% at harvest as compared to control, dust mulch and plastic mulch, respectively. The corresponding increase in dry matter accumulation due to application of straw mulch was 20.4%, 9.0% and 6.3% at 60 DAS, 23.2%, 9.2% and 6.4% at 90 DAS and 21.2%, 9.0% and 6.6% at harvest over control, dust and plastic mulch, respectively. Mulches also significantly increased the number of branches $plant^{-1}$ at 90 DAS and at harvest. Various moisture conservation practices failed to bring any significant variation in total chlorophyll content. The greater effectiveness of straw mulch in increasing the growth components was due to the fact that it added

Table 1. Effect of irrigation levels and mulching on growth parameters of fennel

Treatment	Plant height (cm)				Branches plant^{-1}		Chlorophyll content (mg g^{-1})	Dry matter metre row^{-1} (g)			
	30 DAS	60 DAS	90 DAS	At harvest	90 DAS	At harvest		30 DAS	60 DAS	90 DAS	At harvest
Irrigation levels											
4 irrigations	5.5	14.9	55.8	99.8	5.12	6.14	1.53	3.24	19.79	68.8	145.8
5 irrigations	5.7	16.7	63.2	108.8	5.75	6.84	1.69	3.28	22.12	78.4	164.4
6 irrigations	5.8	17.9	67.5	115.8	6.22	7.34	1.81	3.31	23.67	85.3	176.5
7 irrigations	5.9	18.4	69.8	118.8	6.43	7.57	1.85	3.33	24.20	88.1	182.6
CD ($P<0.05$)	NS	1.2	4.2	7.4	0.38	0.46	0.12	NS	1.48	5.1	10.9
CV (%)	7.2	9.7	6.5	6.7	6.4	7.1	8.6	7.3	6.6	6.4	6.5
Mulching practices											
Control	5.6	15.4	58.5	101.2	5.22	6.31	1.65	3.20	20.22	70.9	150.1
Dust mulch	5.7	16.9	63.4	109.7	5.82	6.91	1.72	3.30	22.33	80.1	166.9
Plastic mulch	5.8	17.2	65.2	112.9	6.04	7.11	1.73	3.32	22.90	82.2	170.6
Straw mulch	5.9	18.3	69.2	120.0	6.45	7.56	1.78	3.34	24.34	87.4	181.9
CD ($P<0.05$)	NS	1.11	4.0	6.8	0.36	0.43	NS	NS	1.38	4.9	10.5
CV (%)	8.6	0.6	7.3	7.4	7.2	7.3	9.3	8.1	7.3	7.1	7.2

nutrients through decomposition of stover and also suppressed weed growth. These results corroborated with those reported by Poonia (2003).

Yield attributes of fennel *viz*., number of umbels plant^{-1}, umbellets umbel^{-1}, seeds umbellet^{-1} and test weight were significantly increased due to irrigation levels (Table 2). Application of six irrigations at 25 days interval was at par with seven irrigations (20 days interval) and significantly increased the number of umbels plant^{-1} by 30.9% and 8.7%, umbellets umbel^{-1} by 16.1% and 6.6% and seeds umbellet^{-1} by 16.0% and 6.5% over four and five irrigations, respectively. The maximum test weight of 4.4 g recorded under seven irrigations was 24.1% and 11.2% higher over four and five irrigations, respectively. However, it remained at par with six irrigations. These results are in close conformity with those of Patel *et al.* (2000) & Bhunia *et al.* (2005). Application of different mulches significantly influenced the yield attributes *viz*., number of umbels plant^{-1}, umbellets umbel^{-1}, seeds umbellet^{-1} and test weight of fennel (Table 2). Application of straw mulch was at par with plastic mulch and recorded significantly higher number of umbels, number of umbellets umbel^{-1}, number of seeds umbellets^{-1} over control and dust mulch, respectively. Test weight of fennel remained unaffected due to different moisture conservation practices. The superiority of mulches in improving these attributes is directly associated with their effectiveness in reducing evaporation losses by cutting of solar radiation falling on the soil surface. These findings are consonance with the results of Sekhon *et al.* (2005).

Seed, stover and biological yield increased with increase in number of irrigations from four to seven but significant increase was observed upto 6 irrigations only (Table 2). Application of six irrigations recorded significantly higher seed yield (942 kg ha^{-1}) as compared to four and five irrigations registering an increase of 39.1% and 10.1%, respectively. However, the effect of irrigation on harvest index was found to be non significant. Adequate supply of irrigation (six and seven irrigations) increased growth and yield attributes and ultimately the yield of

Table 2. Effect of irrigation levels and mulching on yield attributes and yields of fennel

Treatment	Umbels plant^{-1}	Umbellets umbel^{-1}	Seeds umbellet^{-1}	Test weight (g)	Yield (kg ha^{-1})			Harvest index (%)
					Seed	Stover	Biological	
Irrigation levels								
4 irrigations	8.79	12.13	9.54	3.54	677	2261	2938	22.8
5 irrigations	10.58	13.21	10.38	3.96	856	2733	3589	23.8
6 irrigations	11.50	14.08	11.06	4.23	942	2950	3893	24.2
7 irrigations	11.93	14.42	11.31	4.40	974	3033	4007	24.3
CD (P<0.05)	0.66	0.86	0.66	0.25	55	186	242	NS
Mulching practices								
Control	9.23	12.37	9.77	3.91	701	2312	3013	23.0
Dust mulch	10.79	13.34	10.59	4.00	873	2778	3651	23.9
Plastic mulch	11.13	13.63	10.74	4.08	913	2866	3779	24.1
Straw mulch	11.64	14.49	11.20	4.14	964	3021	3985	24.2
CD (P<0.05)	0.62	0.78	0.62	NS	49	146	192	NS

fennel. Increase in yield due to increasing frequency of irrigation might be due to higher photosynthesis and translocation of assimilates towards reproductive structures owing to increased supply of sufficient moisture. Sufficient moisture at grain development might have also increased mobilization of mineral nutrients which ultimately increased the seed yield. Singh *et al*. (2002) & Tripathi *et al*. (2009) also reported similar findings.

Seed, stover and biological yield of fennel were significantly influenced by different types of mulches (Table 2). Application of straw mulch recorded the highest seed (964 kg ha^{-1}), stover (3021 kg ha^{-1}) and biological (3985 kg ha^{-1}) yield. The increase in seed yield due to straw mulch was 37.5%, 10.4% and 5.6% over control, dust and plastic mulch, respectively. However, variation in harvest index was not significant due to different moisture conservation practices. The beneficial effect of organic mulch on seed yield was due to favourable soil moisture regime. These results are in close conformity with the findings of Sekhon *et al*. (2005). The interactive effect of irrigation levels and different type of mulches was found to be non significant with reference to all the parameters. Six irrigations at 30 days interval and application of mustard stover @ 5 t ha^{-1} as mulch at 20 DAS were found better for increasing fennel yield.

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