

Effects of weed management practices on growth, yield and economics of fennel (*Foeniculum vulgare* Mill.)

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ABSTRACT

An experiment was conducted during *rabi* season of 2011-12 at S.D. Agricultural University, Sardarkrushinagar to find out economically viable method of weed control in fennel (*Foeniculum vulgare* Mill.). The experiment was laid out in randomized block design with four replications. Results revealed that besides weed free treatment significantly the highest plant height at all the growth stages, number of branches per plant, yield attributes such as number of umbels per plant, number of umbellates per umbel, number of seeds per umbellate, seed and straw yields of fennel were recorded with application of Pendimethalin @ 0.75 kg/ha as PE + HW at 45 DAS being at par with the treatment of HW and interculturing at 25 DAS + 45 DAS. Similarly, the lowest dry weight of weeds at harvest and weed index as well as weed control efficiency were obtained with application of Pendimethalin @ 0.75 kg/ha as PE + HW at 45 DAS being at par with the treatment of HW and interculturing at 25 DAS + 45 DAS. Maximum net return and BCR were recorded with the application of Pendimethalin @ 0.75 kg/ha as PE + HW at 45 DAS over rest of the treatments.

Key words : Fennel, plant growth, weed index, weed control efficiency

India occupies the prime position in seed spices production and play important role in earning foreign exchange through the export of seed spices. Among the different *rabi* seed spices fennel (*Foeniculum vulgare* Mill.) commonly known as *Snafu* or *Variali* is one of the most major seed spices mainly grown in Gujarat, Rajasthan, Karnataka, Panjab and Haryana. Fennel is used for flavouring the soups, liquor, sauces, pastries, confectionary and bread roll. Initially fennel being slow growing seed spices is more prone to crop weed competitions. Extent of losses caused by weeds is the highest among all the loss causing agent like insects, pests and diseases. Therefore, crop should be kept weed free during initial stage for good crop establishment by employing suitable weed control method. Due to paucity of labours, manual weeding is very costly practice of weed control. Therefore, it is need of time to explore suitable alternate cost effective methods for weed control to keep the fennel crop free from weed at an initial stage of crop. Hence, the study on different methods of weed control in fennel was carried out for realizing high production and profitability from fennel crop.

MATERIALS AND METHODS

A field experiment was carried out in *rabi* season of 2011-12 on loamy sand soil of Agronomy Instructional Farm, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar (Gujarat). The soil of the experiment field was light in texture having pH 7.4 and EC 0.11 dSm⁻¹, low in organic carbon (0.16 %), low in available nitrogen (151 kg/ha), medium in available P₂O₅ (35 kg/ha) and high in available K₂O (288 kg/ha). The average rainfall ranged from 400-500 mm during July to September. The experiment comprised of twelve weed control methods viz; unweeded check, Oxyfluorfen @ 0.15 kg/ha as pre emergence (PE), Oxyfluorfen @ 0.30 kg/ha as PE, Oxyfluorfen @ 0.15 kg/ha as PE + HW at 45 days after sowing [DAS], Oxadiargyl @ 0.050 kg/ha as post emergence [POE] at 30 DAS, Oxadiargyl @ 0.075 kg/ha as POE at 30 DAS, Oxadiargyl @ 0.050 kg/ha as POE at 30 DAS + HW at 45 DAS, Pendimethalin @ 0.75 kg/ha as PE, Pendimethalin @ 1.0 kg/ha as PE, Pendimethalin @ 0.75 kg/ha as PE + HW at 45 DAS, HW and interculturing at 25 DAS and at 45 DAS and weed free were evaluated in randomized block design with four replications. The fennel crop (cv. Gujarat

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fennel-11) was sown at 45 cm row spacing during the *rabi* season of 2011-12 by drilling with seed rate of 5 kg/ha as a irrigated crop. The temperature ranged from 4.6 °C during January and 21.7 °C in the month of April during the growth period of the fennel crop. Full dose of phosphorus and half dose of nitrogen was applied as basal prior to sowing in the form of DAP and Urea. The remaining half dose of nitrogen was applied in the form of urea in two equal split coinciding with the irrigations. The required quantity of herbicides was applied by Knapsack sprayer with flat fan nozzle using 500 liters of water per hectare. Pre emergence herbicides was applied a day after sowing and before emergence of the weeds and crop seeds; and post emergence herbicides were applied as per treatments at 30 DAS. All the standard packages of practices were followed throughout the crop season. In weed free treatment, weeds were removed as and when required to keep it weed free throughout the growing season. After uprooting the weeds, the weeds were sun dried completely till reaches to the constant weight and final dry weight of weeds was recorded for each treatment and expressed as kg/ha. Net return and cost of cultivation were calculated based on the prevailing market prices for drawing conclusion.

RESULTS AND DISCUSSION

Weed parameters

The experimental plot was highly infested with different weeds. The major weed floras observed in the crop were *Chenopodium album* L., *Amaranthus. spinosus* L., *Cyperus rotundus* L., *Portulaca oleracea* L., *Boerhaavia diffusa* L., *Argemone mexicana* L., *Tribulus terrestris* L. and *Asphodelus tenuifolius* (L.) Cav.

Application of different herbicides significantly influenced the dry weed weight, WCE and weed index. Besides, weed free treatment, the lowest dry weed weight (360 kg/ha) was recorded with the application of pendimethalin @ 0.75 kg/ha as PE + HW at 45 DAS and lowest weed index (16.42%) was recorded by the treatment of HW and interculturing at 25 DAS + 45 DAS which was followed by the application of pendimethalin @ 0.75 kg/ha as PE + HW at 45 DAS (17.99 %). The highest WCE (83.19 %) were recorded by the application of pendimethalin @ 0.75 kg/ha as PE + HW at 45 DAS but it was found at par with the treatment of HW and interculturing at 25 DAS + 45 DAS (Table 3). The lowest dry weight of weeds and weed index may be due to less weed density resulting in lower dry weight of weeds. The results of Nagar

et al., (2009) also showed that the application of pendimethalin @ 1.0 kg/ha significantly reduced the total dry weight of weeds in coriander crop. They also revealed that the spraying of pendimethalin @ 1.0 kg/ha as pre emergence recorded higher weed control efficiency and lowest weed index as compared to oxyfluorfen @ 0.25 kg/ha and oxadiargyl @ 75 g/ha. Meena and Mehta (2009) in coriander observed that the lowest weed biomass and highest WCE at maturity were recorded with Oxadiargyl @ 75 g/ha followed by hand weeding.

Growth parameters

Different weed control treatments significantly influenced the plant height and number of branches per plant at different stages as well as at harvest. Besides weed free treatment, the highest plant height at 60, 90 and 120 DAS was recorded with the application of pendimethalin @ 0.75 kg/ha as PE + HW at 45 DAS. At maturity, the highest plant height was recorded by the treatment of HW and interculturing at 25 + 45 DAS but it was found at par with the application of pendimethalin @ 0.75 kg/ha as PE + HW at 45 DAS (Table 1). Weeds were effectively controlled under these treatments and hence there was no severe competition by weeds for moisture and nutrients leading to higher plant height. Plant height at 30 DAS was not influenced with different weed control treatments.

Besides weed free treatment, the highest number of branches per plant at 90 and 120 DAS was recorded with the application of pendimethalin @ 0.75 kg/ha as PE + HW at 45 DAS. At maturity, the highest number of branches per plant was recorded by the treatment of HW and interculturing at 25 DAS + 45 DAS but it was found at par with the application of pendimethalin @ 0.75 kg/ha as PE + HW at 45 DAS. The lowest number of branches per plant was recorded under unweeded check. The more number of branches per plant in weed free and with the application of pendimethalin @ 0.75 kg/ha as PE + HW at 45 DAS might be due to less number of broad, narrow and other weed species and lower green biomass of weeds which might be reduced the competition for moisture, nutrient and light resulting in higher growth of fennel crop. These results are in accordance with the findings of Chaudhary (1989). He reported that the application of pendimethalin @ 1.0 kg/ha significantly increased the plant height and number of branches per plant of cumin crop.

Table 1 Effect of weed management practices on growth attributes of fennel

Treatment	Plant height (cm)						Number of branches/plant		
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest		90 DAS	120 DAS	At harvest
T ₁ : Unweeded check	8.3	20.2	56.7	68.0	78.0		0.5	9.2	10.3
T ₂ : Oxyfluorfen @ 0.15 kg a.i. /ha as PE	8.4	23.9	73.9	90.3	107.5		2.4	10.7	11.3
T ₃ : Oxyfluorfen @ 0.30 kg a.i. /ha as PE	9.6	24.2	81.7	102.2	109.5		5.4	11.4	12.3
T ₄ : Oxyfluorfen @ 0.15 kg a.i./ha as PE + HW at 45 DAS	8.5	23.6	89.0	116.9	129.3		4.8	11.9	12.5
T ₅ : Oxadiargyl @ 0.050 kg a.i. /ha as POE at 30 DAS	9.4	20.3	63.0	87.6	99.4		2.0	9.8	10.7
T ₆ : Oxadiargyl @ 0.075 kg a.i. /ha as POE at 30 DAS	9.3	21.3	58.8	89.5	99.2		1.6	9.7	10.6
T ₇ : Oxadiargyl @ 0.050 kg a.i. /ha as POE at 30 DAS + HW at 45DAS	9.1	21.3	77.5	95.2	108.7		4.6	10.7	11.5
T ₈ : Pendimethalin @ 0.75 kg a.i. /ha as PE	9.3	25.7	87.4	111.4	122.8		4.9	11.6	12.7
T ₉ : Pendimethalin @ 1.0 kg a.i. /ha as PE	9.4	25.2	92.2	113.5	126.9		5.2	12.0	12.6
T ₁₀ : Pendimethalin @ 0.75 kg a.i. /ha as PE + HW at 45 DAS	9.5	26.8	105.6	126.6	137.9		5.6	12.2	12.9
T ₁₁ : HW and interculturing at 25 DAS and 45 DAS	8.1	26.0	87.8	120.4	138.2		5.5	12.1	13.3
T ₁₂ : Weed free	11.0	29.1	102.3	125.8	142.1		5.7	13.1	13.9
S. Em. ±	0.73	1.56	4.50	6.22	7.76		0.19	0.43	0.49
C.D. at 5 %	NS	4.50	12.95	17.90	22.32		0.60	1.20	1.40
C.V. %	16.00	13.05	11.07	11.97	13.31		9.62	7.69	8.12

Table 2 Effect of weed management practices on yield attributes and yield of fennel

Treatment	Number of umbels/plant		Umbellates/ umbel	Seeds/ Umbellate	Seed yield (kg/ha)	Stover yield (kg/ha)	1000 seed weight (g)	Harvest index (%)
	Primary	Secondary	Total					
T ₁ : Unweeded check	5.0	8.0	13.0	16.7	17.5	2179	6.75	28.26
T ₂ : Oxyfluorfen @ 0.15 kg a.i. /ha as PE	5.4	9.0	14.4	18.2	18.7	2368	6.98	27.78
T ₃ : Oxyfluorfen @ 0.30 kg a.i. /ha as PE	5.5	9.5	15.0	21.3	20.3	2571	7.02	27.87
T ₄ : Oxyfluorfen @ 0.15 kg a.i./ha as PE + HW at 45 DAS	5.6	10.4	16.0	21.5	21.3	2523	7.10	28.62
T ₅ : Oxadiargyl @ 0.050 kg a.i. /ha as POE at 30 DAS	5.4	8.8	14.1	17.7	18.5	2400	6.85	27.42
T ₆ : Oxadiargyl @ 0.075 kg a.i. /ha as POE at 30 DAS	5.2	8.3	13.4	17.0	18.0	2182	6.80	29.44
T ₇ : Oxadiargyl @ 0.050 kg a.i. /ha as POE at 30 DAS + HW at 45DAS	5.4	10.0	15.4	18.5	19.1	2496	6.95	28.23
T ₈ : Pendimethalin @ 0.75 kg a.i. /ha as PE	6.1	12.7	18.7	20.5	21.6	3145	7.08	30.88
T ₉ : Pendimethalin @ 1.0 kg a.i. /ha as PE	6.2	12.7	18.8	22.5	22.5	3339	7.15	31.20
T ₁₀ : Pendimethalin @ 0.75 kg a.i. /ha as PE + HW at 45 DAS	6.3	13.5	19.8	22.8	25.0	3363	7.22	32.67
T ₁₁ : HW and interculturing at 25 DAS and 45 DAS	6.5	13.7	20.2	22.7	24.8	3512	7.21	31.90
T ₁₂ : Weed free	6.8	16.2	23.0	24.0	26.2	4164	7.35	32.18
S. Em. ±	0.24	0.47	0.84	1.07	0.99	186	0.11	2.68
C.D. at 5 %	0.7	1.4	2.4	3.1	2.9	112	0.31	NS
C.V. %	8.31	8.51	10.0	10.55	9.38	13.06	3.09	18.03

Table 3 Effect of weed management practices on weed indices and economics of fennel

Treatment	Weed weight (kg/ha)		Weed control efficiency (%)	Weed index (%)	Gross realization (₹/ha)	Total expenditure (₹/ha)	Net realization (₹/ha)	BCR
	Green	Dry						
T ₁ : Unweeded check (4519)*	67.21 (2141)	46.28	-	54.05	43102	21073	22029	1.05
T ₂ : Oxyfluorfen @ 0.15 kg a.i. /ha as PE (3689)	60.63 (1710)	41.36	20.12	50.91	46051	21692	24359	1.12
T ₃ : Oxyfluorfen @ 0.30 kg a.i. /ha as PE (3071)	55.33 (1651)	40.63	22.86	46.53	50150	22011	28139	1.28
T ₄ : Oxyfluorfen @ 0.15 kg a.i./ha as PE + HW at 45 DAS	53.17 (2840)	35.46 (1257)	41.30	46.10	50556	22892	27664	1.21
T ₅ : Oxadiargyl @ 0.050 kg a.i. /ha as POE at 30 DAS	59.53 (3550)	43.02 (1850)	13.51	50.89	46067	21446	24621	1.15
T ₆ : Oxadiargyl @ 0.075 kg a.i. /ha as POE at 30 DAS	62.22 (3872)	42.44 (1801)	15.93	52.06	44965	21483	23482	1.09
T ₇ : Oxadiargyl @ 0.050 kg a.i. /ha as POE at 30 DAS + HW at 45DAS	48.75 (2384)	35.79 (1280)	40.08	47.43	49314	22646	26668	1.18
T ₈ : Pendimethalin @ 0.75 kg a.i. /ha as PE (2537)	49.88 (750)	27.40	64.97	27.53	67975	22181	45794	2.06
T ₉ : Pendimethalin @ 1.0 kg a.i. /ha as PE (2332)	48.12 (671)	25.92	68.63	22.26	72925	22446	50479	2.25
T ₁₀ : Pendimethalin @ 0.75 kg a.i. /ha as PE + HW at 45 DAS	41.12 (1751)	18.98 (360)	83.19	17.99	76929	23383	53546	2.29
T ₁₁ : HW and interculturing at 25 DAS and 45 DAS	44.78 (2007)	22.12 (489)	76.73	16.42	78403	24073	54330	2.26
T ₁₂ : Weed free (0.00)	0.71 (0.00)	0.71	100.00	-	93803	28873	64930	2.25
S. Em. ±	1.88	0.80	2.95	2.47	-	-	-	-
C.D. at 5 %	5.4	2.3	8.95	7.11	-	-	-	-
C.V. %	7.63	5.03	12.95	13.73	-	-	-	-

Yield attributes and yield

Yield attributes as well as seed and straw yield were significantly influenced by various weed control practices. Results revealed that beside weed free treatment, application of pendimethalin @ 0.75 kg/ha as PE + HW at 45 DAS being at par with HW and interculturing at 25 DAS + 45 DAS recorded significantly higher yield attributes like; number of umbels per plant (20.2), number of umbellates per umbel (22.8), seeds per umbellate (25.0), 1000 seed weight (7.22 g), seed (1120 kg/ha) and straw (3512 kg/ha) yields (Table 2). Increase in yield attributes with pendimethalin @ 0.75 kg/ha as PE + HW at 45 DAS might be due to effective control of weeds resulting in lesser competition of weeds which might have ultimately resulted in better utilization of nutrients and moisture available in the soil by the fennel crop, which reflects in term of increased yield attributes and yield of fennel. These finding are in according with the findings of Sagarka *et al.*, (2005). They reported that the application of pendimethalin @ 0.90 kg/ha + one hand weeding significantly increased the seed and stover yields of coriander as compared to other treatments. Chaudhary (2000) also reported that the application of pendimethalin @ 1.0 kg/ha + one hand weeding increased harvest index and seed yield of fennel crop. The results are also in accordance with the results of Parihar and Singh (1994) in cumin crop and Nagar *et al.*, (2009) in coriander crop.

Economics

Application of weed control treatments significantly influenced the gross return, net return and benefit : cost ratio in fennel. Highest net return (₹ 54330/ha) was recorded by the treatment of HW and interculturing at 25 DAS + 45 DAS and was followed by the application of pendimethalin @ 0.75 kg/ha as PE + HW at 45 DAS (₹ 53546 /ha). In case of B : C ratio, the highest B : C ratio of 2.29 was recorded by the application of pendimethalin @ 0.75 kg/ha as PE + HW at 45 DAS (Table 3).

Thus, it is concluded that the maximum seed yield, net realization and effective control of weeds can be achieved by keeping the fennel crop weed free through out the growing period or by hand weeding and interculturing at 25 DAS + 45 DAS where there is no shortage of labours. However, under the paucity of labours, higher seed yield and net returns of *rabi* fennel can be secured by the application pendimethalin either @ 0.75 kg/ha as PE along with HW at 45 DAS or pendimethalin @ 1.0 kg/ha as PE.

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