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Combine effect of organic manure and weed management practices on weeds and yield of transplanted *rabi* fennel

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Abstract
Two years field experiment was conducted during *rabi* season of 2016-17 and 2017-18 at AICRP-Weed Management Farm, AAU, Anand to study the combine effect of organic manure and weed management practices on weeds and yield of transplanted *rabi* fennel. Among organic manure, application of vermicompost 8.0 t/ha recorded significantly higher seed yield of fennel as compared to application of FYM 20 t/ha. Among weed management practices, application of paddy straw mulch 10 t/ha *fb* HW at 30 and 60 days after transplanting (DATP) and IC+HW carried out at 30 and 60 DATP *fb* earthing-up at 75 days after transplanting recorded significantly lower density and dry biomass of monocot and dicot weeds at harvest. Significantly the highest seed yield (2.88 t/ha), gross return (Rs. 288000/ha), net return (Rs. 196116/ha) and B:C ratio (3.13) was achieved under application of paddy straw mulch 10 t/ha *fb* HW at 30 and 60 DATP.

Keywords: Mulch, weed density, weed dry weight, seed yield

Introduction
Fennel (*Foeniculum vulgare*) is a flowering plant species in the carrot family. It is a hardy, perennial herb with yellow flowers and feathery leaves. Fennel is known for its licorice-like flavor, but it also has many health benefits, and it has long been used in natural remedies and it is cultivated extensively in the U.S., France, India and Russia. Medicinal and aromatic plants are major crops of domestic and industrial interest. Medicinal and aromatic plants are increasingly organically grown to enhance profitability. However, the presence of weeds may lead to a decrease in both yield and quality. Therefore, nonchemical methods of weed control are needed. There is no reliable study of worldwide damage due to weeds. However, it is widely known that losses caused by weeds have exceeded the losses from any category of agricultural pests such as insects, nematodes, diseases, rodents, etc. The potential crop yield loss without weed control was estimated by 43 per cent on a global scale (Oerke, 2006) [9]. Soil mulching with plant wastes or synthetic mulches is one of the management practices for reducing soil evaporation; it increases water retention, increasing WUE and weed control in crop fields (Awodoyin *et al*., 2007) [2]. Mulching suppresses the weeds through their physical presence with soil surface by shading, lowering soil temperature, allelopathic activity and blocking the light required for germination of many small-seeded weed species. Similarly, Ramakrishna *et al*. (2006) reported that polythene and straw mulches had higher weed control efficacy than chemical weed control in groundnut. Moreover, decomposition of mulch, humus is added in to the soil which increases water holding capacity of soil. Rice straw and sawdust mulching significantly reduced the total dry weight of weeds in onion at 45 days after transplanting. Broad-leaved weeds were more susceptible than grassy weeds to mulching treatments (Abouziena and Radwan, 2014) [1].

Addition of organic manure like FYM and vermicompost not only add the organic matter content in soil but also supply some major and micro nutrients. Fennel, being slow growing habit suffers from heavy weed infestation during initial growth stages hence, it is necessary to find out an alternate economical viable method of weed control to keep fennel fields weed free at the critical stages of crop-weed competition. Looking to the view of above, an experiment was planned to study the combine effect of organic manure and weed management practices on weeds and yield of transplanted *rabi* fennel.

Materials and Methods

A field investigation was conducted during two consecutive *rabi* season of the year 2016-17 and 2017-18 at AICRP-Weed Management, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat). The soil of the experimental field was loamy sand in texture having low in available nitrogen and medium in available phosphorus and high in potassium with pH 8.0. The experiment was laid out in a split plot design with three replications. Experiment comprised of ten treatments in which two organic manure *viz.*, M_1: Farm yard manure 20 t/ha and M_2 : Vermicompost 8.0 t/ha were allotted to main plot while five weed management practices *viz.*,W_1 : Paddy straw mulch 5 t/ha *fb* HW at 30 and 60 DATP, W_2 : Paddy straw mulch 10 t/ha *fb* HW at 30 and 60 DATP, W_3 : IC+HW at 30 and 60 DATP *fb* earthing-up at 75 DATP, W_4 : Pendimethalin 0.75 kg/ha pre-transplant *fb* IC+HW at 40 DATP and W_5: Weedy check were relegated to sub-plot. The fennel cv. GF 12 was transplanted in the experimental field on 15 and 16 September 2017 and 2018, respectively keeping the row to row distance of 90 cm and plant to plant distance of 60 cm. Entire quantities of FYM and vermicompost were applied as per treatment directly in the furrow before transplanting of fennel for proper decomposition. Pendimethalin was applied as pre-transplanting with the help of a Knapsack sprayer fitted with flat fan nozzle with a spray volume of 600 l/ha then after paddy straw mulch was spread after transplanting as per the treatment. Interculturing (IC) and hand weeding (HW) were carried out as per the treatments. The other recommended packages of practices were followed throughout the growing season to raise the crop during both the years of experimentation. Periodical weed density and dry biomass of weeds were recorded from the randomly selected four spots by using 0.25 m^2 iron quadrate from net plot area. Observation on seed and stalk yield of fennel was recorded from the net plot area and converted in to hectare. Data on various parameters recorded during the course of investigation was statistically analysed as per the standard procedure suggested by Cochran and Cox (1957) [3].

Results and Discussion

Effect on weed density

Data pertaining to periodical recorded weed density of monocot and dicot weed was found to be non significant due to organic manure treatment except density of monocot weed at 90 DATP and during 2016-17 and in pooled at harvest (Table 1 and 2). Among the organic manure treatments, significantly the highest density of monocot and dicot weed at 90 DATP was recorded under application of vermicompost 8.0 t/ha. This indicated that application of FYM showed superiority in reducing the density of weeds in comparison to vermicompost.

Data presented in Table 1 and 2 indicated that weed management practices significantly affected the density of monocot and dicot weed at all the intervals. Application of pendimethalin 0.75 kg/ha pre transplant *fb* IC + HW at 40 DATP recorded significantly lower density of monocot as well as dicot weed at 30 and 60 DATP. This might be because of escaped weeds from applied herbicide were removed by intercultivation and hand weeding. However, paddy straw mulch 10 t/ha *fb* HW at 30 and 60 DATP also showed superiority in reducing density of monocot and dicot weed as compared to other weed management practices. The effectiveness of paddy straw mulch might be due to lack of sunlight to the weeds because mulch physically hinders the emergence of the weeds thus, preventing the growth of weeds. Mohler and Teasdale (1993) [8] reported that weed-suppressing effect of mulch can also result from a limited amount of light reaching the soil surface and as a result reducing the germination and growth of weeds. In comparison to herbicide application and mulching treatment, density of monocot and dicot weed at 30 and 60 DATP was recorded significantly lower under application of pendimethalin 0.75 kg/ha pre transplant *fb* IC + HW at 40 DATP. At 90 DATP, IC + HW at 30 and 40 DATP *fb* earthing up at 75 DATP proved efficient in reducing density of monocot and dicot weed as compared to mulching and herbicidal treatment. The effectiveness of pendimethalin with integration of hand weeding in reducing density of weeds was also observed by Meena and Mehta (2009) [7] in fennel. At harvest, application of paddy straw mulch 10 t/ha *fb* HW at 30 and 60 DATP effective in significant reduction in density of monocot and dicot weed than application of pendimethalin 0.75 kg/ha pre transplant *fb* HW at 40 DATP and weedy check. Among all the weed management practices, weedy check registered significantly the highest density of monocot and dicot weed during both the years as well as in pooled results at all the intervals.

Table 1: Effect of organic manure and weed management practices on weed density (No./m^2) in fennel

Sr. No.	Treatment	Density of weeds at 30 DATP						Density of weeds at 60 DATP					
		Monocot			Dicot			Monocot			Dicot		
		2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
(A) Organic Manure (M)													
M_1	Farm yard manure 20 t/ha	8.27 (75.5)	10.7 (147)	9.49 (111)	10.4 (119)	6.38 (48.0)	8.38 (83.5)	7.63 (89.1)	5.35 (48.7)	6.49 (68.9)	8.38 (92.7)	9.05 (134)	8.71 (113)
M_2	Vermicompost 8.0 t/ha	7.91 (67.2)	10.4 (153)	9.14 (110)	10.1 (107)	6.69 (54.0)	8.40 (80.5)	6.69 (73.3)	5.45 (56.1)	6.07 (64.7)	9.05 (126)	9.08 (137)	9.07 (132)
	S. Em.±	0.108	0.275	0.148	0.215	0.178	0.140	0.253	0.321	0.204	0.131	0.220	0.128
	CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	CV%	5.2	10.1	8.7	8.2	10.6	9.1	13.7	23.0	17.8	5.8	9.4	7.9
(B) Weed Management Practices (W)													
W_1	Paddy straw mulch 5 t/ha *fb* HW at 30, 60 DATP	7.28 (52.7)	9.15 (86.0)	8.21 (69.4)	10.4 (107)	5.36 (28.0)	7.86 (67.5)	5.17 (27.3)	3.63 (12.7)	4.40 (20.0)	13.0 (169)	6.77 (46.0)	9.89 (108)
W_2	Paddy straw mulch 10 t/ha *fb* HW at 30, 60 DATP	5.41 (28.7)	6.62 (43.3)	6.01 (36.0)	8.09 (64.7)	5.06 (26.0)	6.58 (45.4)	4.91 (24.0)	2.82 (8.00)	3.87 (16.0)	7.14 (53.7)	5.49 (33.3)	6.32 (43.5)
W_3	IC + HW at 30 and 60 DATP *fb* earthing-up at 75 DATP	10.4 (109)	13.5 (181)	11.9 (90.5)	12.7 (163)	6.04 (36.7)	9.35 (99.9)	7.97 (74.0)	4.74 (21.7)	6.36 (47.9)	5.47 (29.3)	22.6 (508)	14.0 (269)
W_4	Pendimethalin 0.75 kg/ha pre-transplant *fb* IC +	5.74	2.72	4.23	6.29	4.01	5.15	1.00	1.00	1.00	1.00	1.00	1.00

	HW at 40 DATP	(32.7)	(6.67)	(19.7)	(39.3)	(16.0)	(27.7)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
W_5	Weedy check	11.6 (133)	22.1 (433)	16.2 (283)	13.8 (190)	12.2 (148)	13.0 (169)	16.8 (281)	14.8 (220)	15.8 (251)	17.0 (295)	9.52 (90.7)	13.2 (193)
	S. Em.±	0.293	0.376	2.20	0.352	0.328	1.033	0.340	0.328	0.584	0.290	0.580	4.92
	CD (P=0.05)	0.878	1.13	NS	1.06	0.984	4.06	1.02	0.984	2.29	0.870	1.74	NS
	CV%	8.9	8.7	8.8	8.4	12.3	9.9	11.6	14.9	13.0	8.2	15.7	12.6
	Interaction M X W	Sig.	Sig.	NS	Sig.	Sig.	NS	Sig.	NS	NS	Sig.	NS	NS

Note: Data subjected to √(X+1) transformation. Figures in parentheses are means of original values.

Table 2: Effect of organic manure and weed management practices on weed density (No./m^2) in fennel

Sr. No.	Treatment	Density of weeds at 90 DATP						Density of weeds at harvest					
		Monocot			Dicot			Monocot			Dicot		
		2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
(A) Organic Manure (M)													
M_1	Farm yard manure 20 t/ha	4.33 (34.7)	5.50 (34.4)	4.91 (34.6)	5.20 (48.5)	7.25 (72.0)	6.22 (60.3)	3.53 (22.1)	7.00 (50.9)	5.26 (36.5)	2.82 (12.0)	6.20 (40.0)	4.51 (26.0)
M_2	Vermicompost 8.0 t/ha	5.76 (49.9)	6.78 (54.0)	6.27 (52.0)	5.53 (50.6)	7.73 (72.5)	6.63 (62.0)	4.07 (32.0)	7.56 (58.5)	5.82 (45.3)	2.51 (8.80)	6.67 (45.6)	4.59 (27.2)
	S. Em±	0.134	0.191	0.117	0.196	0.183	0.134	0.088	0.208	0.113	0.106	0.196	0.112
	CD (P=0.05)	0.818	1.16	0.458	NS	NS	NS	0.535	NS	0.443	NS	NS	NS
	CV%	10.3	12.0	11.4	14.2	9.5	11.4	9.0	11.1	11.2	15.5	11.8	13.4
(B) Weed Management Practices (W)													
W_1	Paddy straw mulch 5 t/ha *fb* HW at 30, 60 DATP	3.35 (10.8)	5.66 (31.3)	4.50 (21.1)	3.87 (15.0)	8.59 (73.3)	6.23 (44.2)	1.00 (0.00)	5.72 (32.0)	3.36 (16.0)	1.00 (0.00)	6.05 (36.7)	3.53 (18.4)
W_2	Paddy straw mulch 10 t/ha *fb* HW at 30, 60 DATP	2.07 (3.33)	5.26 (27.3)	3.67 (15.3)	4.44 (20.7)	4.39 (20.0)	4.41 (20.4)	1.00 (0.00)	5.29 (27.3)	3.14 (13.7)	1.00 (0.00)	4.75 (22.0)	2.87 (11.0)
W_3	IC + HW at 30 and 60 DATP *fb* earthing-up at 75 DATP	1.00 (0.00)	2.62 (6.00)	1.81 (3.00)	1.00 (0.00)	4.73 (22.0)	2.87 (11.0)	1.00 (0.00)	8.44 (70.5)	4.72 (35.3)	1.00 (0.00)	5.39 (28.7)	3.20 (14.4)
W_4	Pendimethalin 0.75 kg/ha pre-transplant *fb* IC + HW at 40 DATP	7.25 (63.5)	6.99 (53.0)	7.12 (58.3)	3.28 (10.3)	14.9 (223)	9.10 (117)	6.05 (36.0)	8.43 (71.3)	7.24 (53.7)	4.85 (22.7)	7.92 (62.0)	6.38 (42.4)
W_5	Weedy check	11.6 (134)	10.2 (103)	10.9 (119)	14.2 (202)	4.83 (23.3)	9.53 (113)	9.96 (99.3)	8.53 (72.3)	9.24 (85.8)	5.47 (29.3)	8.06 (64.7)	6.77 (47.0)
	S. Em±	0.201	0.275	0.939	0.249	0.357	3.85	0.153	0.359	1.64	0.097	0.355	0.496
	CD (P=0.05)	0.602	0.825	3.69	0.747	1.07	NS	0.458	1.08	NS	0.290	1.07	1.95
	CV%	9.7	11.0	10.6	11.4	11.7	11.7	9.8	12.1	12.2	8.9	13.5	14.0
	Interaction M X W	Sig.	Sig.	NS	Sig.	NS	NS	Sig.	NS	NS	Sig.	NS	NS

Note: Data subjected to √(X+1) transformation. Figures in parentheses are means of original values.

Effect on weed dry weight

Results presented in Table 3 and 4 revealed that weed dry weigh of dicot weeds was found to be significant due to organic manure at 30 DATP while at 90 DATP in pooled analysis and at harvest monocot and dicot weed dry weight during 2016-17. Significantly the highest dicot weed dry weight was recorded under application of vermicompost 8.0 t/ha at 30 DAS and monocot weed dry weight at 90 DATP and at harvest in pooled results. Further, application of vermicompost 8.0 t/ha also registered significantly the highest monocot and dicot weed dry weight during 2016-17 at harvest (Table 4). This might be due to the fact that, more number of monocot and dicot weed in above treatment resulted in increased the dry matter accordingly.

Among weed management practices, IC + HW at 30 and 60 DATP *fb* earthing up at 75 DATP recorded significantly higher monocot and dicot weed dry weight, while weedy check registered significantly the highest weed dry weight at 30 DATP. This indicates the effective control of early as well as late flushes of weeds resulted in lower weed biomass. At 60 DATP application of pendimethalin 0.75 kg/ha pre transplant *fb* IC + HW at 40 DATP provide complete control of monocot and dicot weed during both the years as well as in pooled results. This might be due to pre transplant application of pendimethalin provide control of germinating weeds and later emerged weeds can be managed by hand weeding which leads to reduction in density of weeds. These results confirm the findings of Gohil *et al*. (2014) [4] and Kumar *et al*. (2015) [5] in fennel. Further, significantly the lowest monocot and dicot weed dry weight was registered under IC + HW at 30 and 60 DATP *fb* earthing-up at 75 DATP at 90 DATP. Among mulching treatment, paddy straw mulch 10 t/ha *fb* HW at 30 and 60 DATP proved efficient in reducing monocot and dicot weed dry weight in comparison to paddy straw mulch 5 t/ha *fb* HW at 30 and 60 DATP at 90 DATP and at harvest. Application of pendimethalin 0.75 kg/ha pre transplant *fb* IC + HW at 40 DATP recorded maximum monocot and dicot weed dry weight as compared to other weed management practices except weedy check at harvest. Weedy check recorded the highest dry biomass of monocot and dicot weed owing to uncontrolled condition which favoured the luxurious growth of weeds leading to increased weed dry weight. The results are in accordance with the findings of Meena and Mehta (2009) [7].

Table 3: Effect of organic manure and weed management practices on weed dry biomass in fennel

Sr. No.	Treatment	Weed dry biomass (g/m²) at 30 DATP						Weed dry biomass (g/m²) at 60 DATP					
		Monocot			Dicot			Monocot			Dicot		
		2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
(A) Organic Manure (M)													
M_1	Farm yard manure 20 t/ha	5.50 (29.5)	10.6 (129)	8.07 (79.3)	3.73 (13.5)	5.97 (35.7)	4.85 (24.6)	5.62 (60.2)	7.45 (112)	6.54 (86.1)	5.66 (40.0)	4.91 (29.5)	5.29 (34.8)
M_2	Vermicompost 8.0 t/ha	6.00 (37.0)	10.3 (122)	8.16 (79.5)	4.38 (19.0)	7.00 (50.9)	5.69 (35.0)	5.68 (55.4)	6.94 (96.5)	6.31 (76.0)	6.05 (48.3)	5.32 (35.4)	5.69 (41.9)
	S. Em±	0.098	0.153	0.288	0.083	0.148	0.085	0.042	0.154	0.800	0.223	0.156	0.136
	CD (P=0.05)	NS	NS	NS	0.507	0.902	0.334	NS	NS	NS	NS	NS	NS
	CV%	6.6	5.6	6.1	8.0	8.9	8.8	2.9	8.3	6.8	14.8	11.8	13.6
(B) Weed Management Practices (W)													
W_1	Paddy straw mulch 5 t/ha *fb* HW at 30, 60 DATP	5.39 (28.1)	9.65 (95.1)	7.52 (61.6)	4.01 (15.8)	6.52 (43.0)	5.27 (29.4)	4.75 (22.3)	4.83 (22.7)	4.79 (22.5)	7.08 (50.1)	4.83 (22.6)	5.95 (36.4)
W_2	Paddy straw mulch 10 t/ha *fb* HW at 30, 60 DATP	4.99 (24.1)	7.32 (53.8)	6.16 (59.6)	3.78 (13.8)	6.39 (42.3)	5.08 (28.1)	3.40 (11.4)	3.93 (14.7)	3.67 (13.1)	5.49 (29.7)	4.40 (18.6)	4.95 (24.2)
W_3	IC + HW at 30 and 60 DATP *fb* earthing-up at 75 DATP	5.15 (25.9)	12.4 (155)	8.78 (90.5)	4.32 (17.8)	7.13 (50.7)	5.73 (34.3)	3.49 (12.2)	4.74 (21.7)	4.11 (17.0)	4.90 (23.8)	9.07 (81.8)	6.99 (52.8)
W_4	Pendimethalin 0.75 kg/ha pre-transplant *fb* IC + HW at 40 DATP	7.00 (50.5)	6.33 (43.9)	6.67 (47.2)	3.03 (8.30)	4.65 (21.5)	3.84 (14.9)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
W_5	Weedy check	6.20 (37.5)	16.7 (280)	11.5 (159)	5.14 (25.5)	7.72 (59.0)	6.43 (42.3)	15.6 (243)	21.5 (462)	18.5 (353)	10.8 (117)	6.29 (39.3)	8.55 (78.2)
	S. Em±	0.188	0.533	2.16	0.113	0.309	0.164	0.192	0.230	1.23	0.305	0.213	1.61
	CD (P=0.05)	0.564	1.60	NS	0.338	0.926	0.475	0.575	0.689	4.84	0.914	0.639	NS
	CV%	8.0	12.5	12.7	6.8	11.7	10.8	8.3	7.8	8.1	12.8	10.2	11.7
	Interaction M X W	Sig.	Sig.	NS	Sig.	Sig.	Sig.	Sig.	NS	NS	Sig.	NS	Sig.

Note: Data subjected to √(X+1) transformation. Figures in parentheses are means of original values.

Table 4: Effect of organic manure and weed management practices on weed dry biomass in fennel

Sr. No.	Treatment	Weed dry biomass (g/m²) at 90 DATP						Weed dry biomass (g/m²) at harvest					
		Monocot			Dicot			Monocot			Dicot		
		2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled	2016-17	2017-18	Pooled
(A) Organic Manure (M)													
M_1	Farm yard manure 20 t/ha	4.62 (49.3)	7.04 (69.5)	5.83 (59.4)	4.02 (24.6)	5.40 (33.4)	4.71 (29.0)	5.81 (68.9)	10.8 (125)	8.31 (97.0)	8.20 (144)	12.5 (164)	10.3 (154)
M_2	Vermicompost 8.0 t/ha	4.95 (46.0)	7.70 (82.8)	6.33 (64.4)	4.01 (23.0)	6.30 (46.1)	5.16 (34.6)	6.89 (116)	9.66 (107)	8.27 (112)	10.6 (275)	11.1 (129)	10.9 (202)
	S. Em±	0.095	0.216	0.118	0.101	0.167	0.323	0.160	0.280	0.785	0.181	0.370	1.33
	CD (P=0.05)	NS	NS	0.464	NS	NS	NS	0.975	NS	NS	1.10	NS	NS
	CV%	7.7	11.4	10.6	9.8	11.0	10.8	9.8	10.6	10.7	7.5	12.2	10.7
(B) Weed Management Practices (W)													
W_1	Paddy straw mulch 5 t/ha *fb* HW at 30, 60 DATP	2.01 (3.48)	5.99 (35.8)	4.00 (19.6)	2.60 (6.14)	4.52 (19.7)	3.56 (12.9)	1.00 (0.00)	8.58 (75.1)	4.79 (37.6)	1.00 (0.00)	10.3 (106)	5.65 (52.9)
W_2	Paddy straw mulch 10 t/ha *fb* HW at 30, 60 DATP	1.81 (2.41)	5.49 (30.2)	3.65 (16.3)	2.99 (8.34)	3.73 (13.9)	3.36 (11.1)	1.00 (0.00)	8.13 (68.4)	4.56 (34.2)	1.00 (0.00)	9.17 (84.6)	5.08 (42.3)
W_3	IC + HW at 30 and 60 DATP *fb* earthing-up at 75 DATP	1.00 (0.00)	2.99 (8.16)	1.99 (4.08)	1.00 (0.00)	3.58 (12.1)	2.29 (60.5)	1.00 (0.00)	8.71 (76.0)	4.85 (38.0)	1.00 (0.00)	11.4 (30.7)	6.21 (15.4)
W_4	Pendimethalin 0.75 kg/ha pre-transplant *fb* IC + HW at 40 DATP	4.58 (21.6)	6.07 (40.7)	5.33 (30.9)	4.03 (15.4)	9.54 (90.3)	6.79 (52.9)	10.1 (103)	9.27 (85.7)	9.70 (94.4)	18.0 (325)	11.1 (124)	14.6 (225)
W_5	Weedy check	14.5 (211)	16.3 (266)	15.4 (239)	9.48 (89.0)	7.88 (62.8)	8.68 (75.9)	18.6 (360)	16.5 (272)	17.6 (316)	26.0 (724)	16.9 (287)	21.5 (506)
	S. Em±	0.255	0.339	0.578	0.181	0.319	1.30	0.189	0.513	2.47	0.333	0.439	4.77
	CD (P=0.05)	0.766	1.02	2.27	0.543	0.956	NS	0.568	1.54	NS	0.998	1.32	NS
	CV%	13.1	11.3	12.1	11.1	13.3	12.9	7.3	12.3	11.4	8.7	9.1	9.0
	Interaction M X W	Sig.	Sig.	NS	Sig.	NS	NS	Sig.	NS	NS	Sig.	NS	NS

Note: Data subjected to √(X+1) transformation. Figures in parentheses are means of original values.

Effect on yield and economics

Data pertaining to seed yield of fennel revealed that organic sources significantly influenced seed yield of fennel on pooled basis (Table 5). Results indicated that significantly the highest seed yield of fennel was achieved under application of vermicompost 8.0 t/ha. Among weed management practices, paddy straw mulch 10 t/ha *fb* HW at 30 and 60 DATP recorded significantly higher seed yield as compared to pendimethalin 0.75 kg/ha pre-transplant *fb* IC + HW at 40 DATP and weedy check. Increase in yield under mulching treatment might be due to effective weed control resulting in meager competition of weeds and conservation of soil moisture which might have resulted in the better utilization of nutrients and moisture available in the soil by helps to increased rate of photosynthesis and supply of photosynthates to various metabolic sinks. Positive response of straw mulch

on yield of fennel was also observed by Meena *et al*. (2014) [6]. Significantly the lowest seed yield was recorded under weedy check treatment. Further, data on economics also indicated that the higher gross return, net return and B:C ratio was achieved under paddy straw mulch 10 t/ha *fb* HW at 30 and 60 DATP while in case of organic manure treatments, application of FYM 20 t/ha recorded higher B:C ratio.

Table 5: Yield and economics of fennel as influenced by organic manure and weed management practices (Two years pooled)

Sr. No.	Treatment	Fennel seed yield (t/ha)	Gross return (₹/ha)	Cost of cultivation (₹/ha)	Net return (₹/ha)	B:C ratio
(A) Organic Manure (M)						
M_1	Farm yard manure 20 t/ha	1.94	194000	76480	117520	2.54
M_2	Vermicompost 8.0 t/ha	2.09	209000	95590	113410	2.19
(B) Weed Management Practices (W)						
W_1	Paddy straw mulch 5 t/ha *fb* HW at 30, 60 DATP	2.30	23000	85994	144006	2.67
W_2	Paddy straw mulch 10 t/ha *fb* HW at 30, 60 DATP	2.88	288000	91884	196116	3.13
W_3	IC + HW at 30 and 60 DATP *fb* earthing-up at 75 DATP	2.49	249000	90244	158756	2.76
W_4	Pendimethalin 0.75 kg/ha pre-transplant *fb* IC + HW at 40 DATP	1.90	190000	85509	104491	2.22
W_5	Weedy check	0.490	49000	76544	-27544	-0.64

Price of produce:	Fennel seed = ₹ 100/kg	M_1 = ₹ 20000 + 1750 =₹. 21780, M_2 = ₹ 40000 + 890 = ₹ 40890
	Green gram: seed @ ₹ 55.75, Haulm @ Rs. 2/kg	W_1 = ₹ 5000 + 890 + 3560 = ₹ 21780,
Cost of inputs:	Paddy straw mulch ₹ 1.0/kg	W_2 = ₹10000 + 1780 + 3560 = ₹ 15340
	FYM = ₹ 1/kg, Vermicompost = ₹ 5/kg	W_3 = ₹ 3200 + 8900 + 1600 = ₹ 13700
	Pendimethalin (Stomp 30 EC) = ₹ 490/lit	W_4 =₹. 1225 + 800 +1600 + 5340 = ₹ 8965
	Herbicide application cost = ₹800/ha/application	BC ratio = Gross return / Cost of cultivation

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