

## Effect of Different Weed Management Practices On Growth And Yield Of Fennel (*Foeniculum vulgare* Mill.)

CHANPREET KAUR\*, MOHINDER LAL<sup>2</sup>, SANDEEP SINGH<sup>3</sup> & KAMALESH KUMAR<sup>4</sup>

\*PG Department of Agriculture G.S.S.D.G.S. Khalsa College, Patiala, INDIA

<sup>2</sup>PG Department of Agriculture G.S.S.D.G.S. Khalsa College, Patiala, INDIA

<sup>3,4</sup>PG Department of Agriculture G.S.S.D.G.S. Khalsa College, Patiala, INDIA

**Abstract:** The experiment was conducted during the *rabi* season of 2019-20 at the Campus for research and advanced studies Dhablan of G.S.S.D.G.S. Khalsa College, Patiala. The field experiment was laid out in randomized block design with 10 different treatments that replicates three times. The results revealed that besides weed free treatment, the maximum growth attributes, yield attributes and yield were found with the application of treatment T<sub>6</sub> (Pendimethalin @1.25 kg ha<sup>-1</sup> (P.E.) + One hand weeding at 45 DAS) which was statistically at par with the application of treatment T<sub>4</sub> (Two hand weeding at 20 and 40 DAS) where as these characters were found significantly minimum under weedy check. Besides, weed free treatment, the lowest weed population, dry matter of weeds (g m<sup>-2</sup>), weed index (%) as well as highest weed control efficiency (%) was also found with the application of treatment T<sub>6</sub> (Pendimethalin @1.25 kg ha<sup>-1</sup> (P.E.) + One hand weeding at 45 DAS). Pre emergence application of pendimethalin @1.25 kg ha<sup>-1</sup> + One hand weeding at 45 DAS recorded higher B:C ratio, hence it is the most effective treatment among the other treatments.

**Keywords:** Fennel, weed population, plant growth, yield, B:C ratio

Received: July 21, 2022. Revised: September 16, 2022. Accepted: October 18, 2022. Published: November 21, 2022.

### 1. Introduction

Fennel (*Foeniculum vulgare* Mill.) is an important seed spice. It belongs to the family Apiaceae. It is a native of southern Europe and Mediterranean area. It is commonly called as 'Saunf'. In Gujarat, it is commonly called as 'Variari'. It is widely cultivated throughout the temperate and sub-tropical regions of the world for its aromatic fruits. It is long duration cold weather seed spice crop and is mainly grown during *rabi* season. India occupies first position in seed spices. India is the largest producer, consumer and exporter of the spices in the world.

Weed is recognized as the most serious problem in crop production. In general weeds compete with the main crop for light, water, space and nutrients which ultimately reduces the yield of main crop. As the initial growth of fennel is very slow, so it leads to the heavy infestation of weeds. This results in reduction in growth as well as yield. Therefore, it is essential to find out an appropriate and

economical method of weed control to keep the field free from weeds during the critical stages of crop-weed competition. The losses in yield could be as high as 91.4% (Mali and Suwalka, 1987). Application of herbicides effectively controls the weeds and can increase the yield of fennel from 43.2 to 86.9% (Voevodin and Borisenko, 1981). Prajapati *et al.* (2021) signified the importance of hand weeding at 25 and 40 DAS or application of post emergence herbicides which could benefit the crops in reducing the different weed density and ultimately reduce weed dry matter which resulted in the increase of crop yield. Keeping the crop weed free up harvest recorded higher weed control efficiency (100%) and lower weed index (%).

### 2. Materials and Methods

The field experiment was conducted during the *Rabi* season of 2019-20 at Campus for Research and Advanced Studies Dhablan of G.S.S.D.G.S. Khalsa College, Patiala. The

soil of experimental field was clayey in texture, basic in reaction (pH 7.4), low in available N ( $246.66 \text{ kg ha}^{-1}$ ), medium in available  $\text{P}_2\text{O}_5$  ( $17.45 \text{ kg ha}^{-1}$ ) and  $\text{K}_2\text{O}$  ( $210.41 \text{ kg ha}^{-1}$ ). The experiment comprised of 10 treatments, namely, T<sub>1</sub>: Weedy check, T<sub>2</sub>: Weed free, T<sub>3</sub>: One hand weeding at 35 DAS, T<sub>4</sub>: Two hand weeding at 20 and 40 DAS, T<sub>5</sub>: Pendimethalin @  $1.25 \text{ kg ha}^{-1}$  (P.E.), T<sub>6</sub>: Pendimethalin @  $1.25 \text{ kg ha}^{-1}$  (P.E.) + One Hand weeding at 45 DAS, T<sub>7</sub>: Quizalafop-ethyl @  $40 \text{ g ha}^{-1}$  (P.E.) at 40 DAS, T<sub>8</sub>: Pendimethalin @  $1.25 \text{ kg ha}^{-1}$  (P.E.) + Quizalafop-ethyl post emergence @  $40 \text{ g ha}^{-1}$  at 40 DAS, T<sub>9</sub>: Paddy straw mulch @  $5 \text{ t ha}^{-1}$ , T<sub>10</sub>: Paddy straw mulch @  $5 \text{ t ha}^{-1}$  *fb* One hand weeding at 35 DAS. The field experiment was laid out in randomized block design with three replications. The fennel was sown on 12 November with the seed rate of  $10\text{-}12 \text{ kg ha}^{-1}$  with a spacing of  $45 \times 30 \text{ cm}$ . Thinning should be done at 30-35 DAS to maintain proper spacing. Pre and post emergence herbicides were applied with the help of knapsack sprayer as per treatments. In manual weeding, weeds were uprooted and removed as per the treatments. The weed population and dry weight of weeds were recorded. Whereas, weed index and weed control efficiency were calculated by using the formulae suggested by Gill and Kumar (1969) and Mani *et al.* (1973). The data were analysed as per the standard procedure for the "Analysis of Variance" (ANOVA) as described by Gomez and Gomez (1984) The significance of treatment was tested by "F" test (variance ratio). Standard

error of mean was computed in all cases. The differences in the treatment mean were tested by using critical difference (CD) at 5% level of probability

### 3. Result and discussion

#### Weed population

The major weeds found in the experimental field were *Cynodon dactylon*, *Melilotus indica*, *Chenopodium album*, *Rumex dentatus* and *Cyperus rotandus*. The results of the present study (table 1) showed that besides weed free treatment, the lowest weed population at 90 DAS was recorded with the application of treatment T<sub>6</sub>: pendimethalin pre emergence @  $1.25 \text{ kg ha}^{-1}$  + One Hand weeding at 45 DAS (*Cynodon dactylon* 7.20, *Chenopodium album* 7.43, *Melilotus indica* 11.20, *Rumex dentatus* 5.03, *Cyperus rotandus* 2.63) which was statistically at par with the application of treatment T<sub>4</sub>: two hand weeding at 20 and 40 DAS. Whereas the highest weed population was observed with weedy check. This might be due to the eradication of weeds, as pre emergence application of pendimethalin controlled the weeds rightly from the start and prevents the germination of weed seeds. Later on, the weeds those emerges were controlled by hand weeding at 45 DAS hence do not allow to set the weed seeds. Hence the weed population is reduced.

**Table 1: Effect of different weed management practices on weed density (no. m<sup>-2</sup>) of different weed species at 90 DAS.**

Treatment	<i>Cynodon dactylon</i>	<i>Melilotus indica</i>	<i>Cyperus rotundus</i>	<i>Chenopodium album</i>	<i>Rumex dentatus</i>
T <sub>1</sub> : Weedy check	15.30	40.10	15.17	16.30	13.10
T <sub>2</sub> : Weed free	0.00	0.00	0.00	0.00	0.00
T <sub>3</sub> : One hand weeding at 35 DAS.	7.83	16.53	5.30	7.17	6.07
T <sub>4</sub> : Two hand weeding at 20 and 40 DAS	7.27	12.20	5.03	7.90	5.23
T <sub>5</sub> : Pendimethalin @ 1.25 kg ha <sup>-1</sup> (P.E.).	8.77	17.30	6.50	8.90	7.03
T <sub>6</sub> : Pendimethalin @ 1.25 kg ha <sup>-1</sup> (P.E.) + One Hand weeding at 45 DAS.	7.20	11.20	2.63	7.43	5.03
T <sub>7</sub> : Quizalafop-ethyl @ 40 g ha <sup>-1</sup> (POE) at 40 DAS.	8.30	15.73	7.30	9.07	8.60
T <sub>8</sub> : Pendimethalin @ 1.25 kg ha <sup>-1</sup> (P.E.) + Quizalafop-ethyl @ 40 g ha <sup>-1</sup> (POE) at 40 DAS.	8.03	14.13	6.93	7.93	6.93
T <sub>9</sub> : Paddy straw mulch @ 5 t ha <sup>-1</sup> .	8.90	18.10	7.93	8.87	7.83
T <sub>10</sub> : Paddy straw mulch @ 5 t ha <sup>-1</sup> /b One hand weeding at 35 DAS.	8.53	16.83	5.87	8.57	7.53
<b>SE (m)±</b>	<b>0.08</b>	<b>0.25</b>	<b>0.07</b>	<b>0.12</b>	<b>0.08</b>
<b>CD (5%)</b>	<b>0.18</b>	<b>0.56</b>	<b>0.16</b>	<b>0.27</b>	<b>0.18</b>

**Weed parameters**

The data on dry weight (g plant<sup>-1</sup>), weed index (%) and weed control efficiency (%) were recorded and presented in table 4 and graphically given in fig. 1. The results showed that besides weed free treatment, the minimum dry weight (22.00g), weed index (4.25) and highest weed control efficiency (71.72%) was recorded with application of treatment T<sub>6</sub>: pendimethalin pre emergence @ 1.25 kg ha<sup>-1</sup> + one hand weeding at 45 DAS followed by

application of treatment T<sub>4</sub>: two hand weeding at 20 and 40 DAS (23.93 g). Whereas the highest dry weight (76.63 g), weed index (32.72) and lowest weed control efficiency (0.00%) was observed with weedy check. The dry weight of weeds is related to the number of weeds. However, the dry weight of weeds increases with the increase in growth of weeds. Lowest dry weight and maximum weed control efficiency might be due to the

combined application of pre emergence application of pendimethalin and one HW at 45 DAS. Weed index (%) might be due to the lesser crop-weed competition for light, nutrients and space resulted in the better utilization of nutrients and available moisture

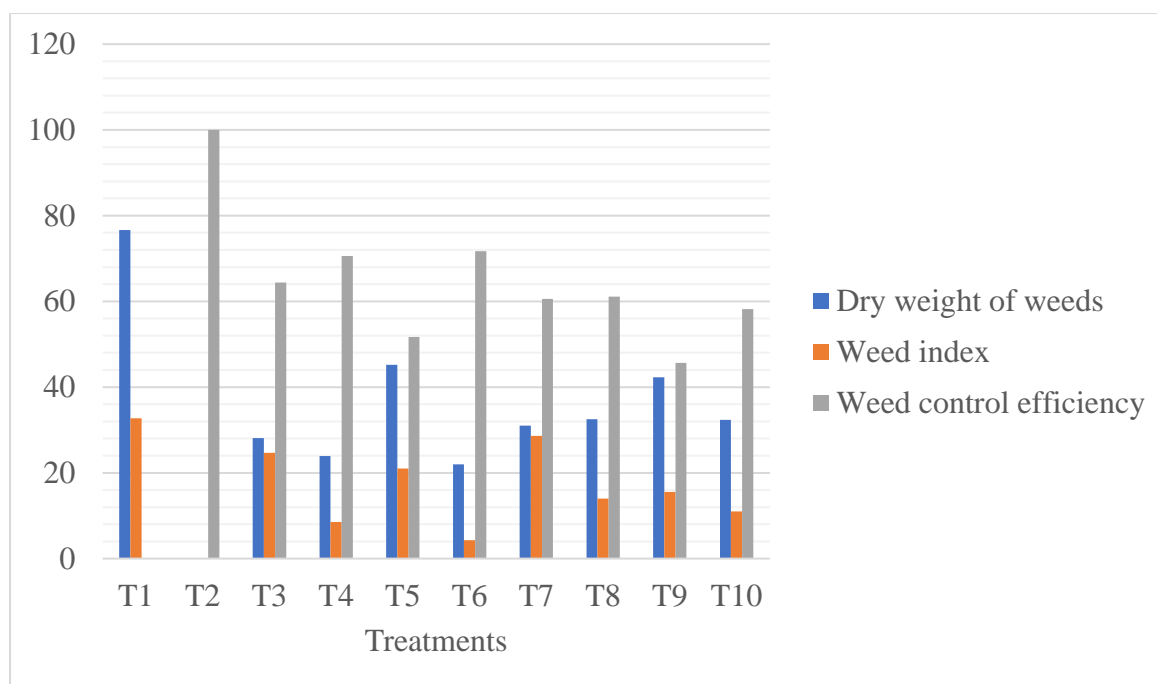
by the crop which ultimately leads to increase in the crop yield.

Similar finding was also found by Patel *et al.* (2004), Sagarka *et al.* (2005) and Thakral *et al.* (2007).

**Table 2: Effect of different weed management practices on dry weight, weed index and weed control efficiency (%).**

Treatment	Dry weight of weeds (g m <sup>-2</sup> )	Weed index (%)	Weed control efficiency (%)
T <sub>1</sub> : Weedy check	76.63	32.72	0.00
T <sub>2</sub> : Weed free	0.00	0.00	100.00
T <sub>3</sub> : One hand weeding at 35 DAS.	28.13	24.67	64.35
T <sub>4</sub> : Two hand weeding at 20 and 40 DAS	23.93	8.52	70.55
T <sub>5</sub> : Pendimethalin @ 1.25 kg ha <sup>-1</sup> (P.E.).	45.20	21.04	51.70
T <sub>6</sub> : Pendimethalin @ 1.25 kg ha <sup>-1</sup> (P.E.) + One Hand weeding at 45 DAS.	22.00	4.25	71.72
T <sub>7</sub> : Quizalafop-ethyl @ 40 g ha <sup>-1</sup> (POE) at 40 DAS.	31.00	28.65	60.59
T <sub>8</sub> : Pendimethalin @ 1.25 kg ha <sup>-1</sup> (P.E.) + Quizalafop-ethyl @ 40 g ha <sup>-1</sup> (POE) at 40 DAS.	32.53	14.00	61.08
T <sub>9</sub> : Paddy straw mulch @ 5 t ha <sup>-1</sup> .	42.30	15.54	45.64
T <sub>10</sub> : Paddy straw mulch @ 5 t ha <sup>-1</sup> <i>fb</i> One hand weeding at 35 DAS.	32.33	10.97	58.21
<b>SE (m)±</b>	<b>0.51</b>	<b>3.06</b>	<b>0.56</b>
<b>CD (5%)</b>	<b>1.16</b>	<b>6.92</b>	<b>1.27</b>

**Fig 1: Effect of different weed management practices on dry weight (g m<sup>-2</sup>), weed index (%) and weed control efficiency (%).**



### Growth attributes

All the growth attributes of fennel crop were significantly influenced due to the different weed management practices. Table 3 showed that besides weed free treatment, the maximum plant height (148.93 cm), number of branches plant<sup>-1</sup> (7.00), dry weight plant<sup>-1</sup> (40.70 g), were recorded with the application of treatment T<sub>6</sub>: pendimethalin @ 1.25 kg ha<sup>-1</sup> (P.E.) + one hand weeding at 45 DAS) which

was statistically at par with the application of treatment T<sub>4</sub>: two hand weeding at 20 and 40 DAS. Highest growth attributes under these treatments might be due to the lesser crop-weed competition which resulted in better utilization of available nutrients and moisture by the crop that leads to the vigorous growth and development of crop. These findings are in agreement with Gohil *et al.* (2014), Meena and Mehta (2009).

**Table 3: Effect of different weed management practices on plant height (cm), Number of branches plant<sup>-1</sup> and dry weight plant<sup>-1</sup> of fennel.**

Treatment	Plant height (cm)	Number of branches plant <sup>-1</sup>	Dry weight plant <sup>-1</sup> (g)
T <sub>1</sub> : Weedy check	126.57	34.23	24.97
T <sub>2</sub> : Weed free	151.03	56.73	41.43
T <sub>3</sub> : One hand weeding at 35 DAS.	133.23	42.00	28.93
T <sub>4</sub> : Two hand weeding at 20 and 40 DAS	147.50	53.63	39.73
T <sub>5</sub> : Pendimethalin @ 1.25 kg ha <sup>-1</sup> (P.E.).	135.37	45.87	29.63
T <sub>6</sub> : Pendimethalin @ 1.25 kg ha <sup>-1</sup> (P.E.) + One Hand weeding at 45 DAS.	148.93	54.37	40.70
T <sub>7</sub> : Quizalafop-ethyl @ 40 g ha <sup>-1</sup> (POE) at 40 DAS.	130.90	37.17	25.03

<b>T<sub>8</sub></b> : Pendimethalin @ 1.25 kg ha <sup>-1</sup> (P.E.) + Quizalafop-ethyl @ 40 g ha <sup>-1</sup> (POE) at 40 DAS.	140.43	49.17	35.43
<b>T<sub>9</sub></b> : Paddy straw mulch @ 5 t ha <sup>-1</sup> .	138.57	47.37	32.07
<b>T<sub>10</sub></b> : Paddy straw mulch @ 5 t ha <sup>-1</sup> <i>fb</i> One hand weeding at 35 DAS.	146.47	53.23	39.73
<b>SE (m)±</b>	<b>0.64</b>	<b>0.34</b>	<b>0.53</b>
<b>CD (5%)</b>	<b>1.44</b>	<b>0.76</b>	<b>1.20</b>

### Yield attributes and yield

Yield attributes as well as seed yield and stover yield were significantly influenced due to the different weed management practices (table 4). Besides weed free treatment, the maximum number of umbels plant<sup>-1</sup> (9.97), number of seeds umbel<sup>-1</sup> (25.87) as well as test weight (6.10 g), seed yield (10.47 q ha<sup>-1</sup>) and stover yield (32.10 q ha<sup>-1</sup>) were recorded with the application treatment T<sub>6</sub>: pendimethalin @ 1.25 kg ha<sup>-1</sup> (P.E.) +

one hand weeding at 45 DAS) which was statistically at par with the application of treatment T<sub>4</sub>: two hand weeding at 20 and 40 DAS. This might be due to the lesser crop-weed competition which resulted in better utilization of available nutrients and moisture by the crop which reflects in terms of increased yield attributes and yield of crop. Similar findings have been reported by Thakral *et al.* (2007), Patil *et al.* (2020) and Dhakad *et al.* (2017).

**Table 4: Effect of different weed management practices on yield and yield attributes of fennel.**

Treatment	Number of umbels plant <sup>-1</sup>	Number of seeds umbel <sup>-1</sup>	Test weight (g)	Seed yield (q ha <sup>-1</sup> )	Stover yield (q ha <sup>-1</sup> )
<b>T<sub>1</sub></b> : Weedy check	7.43	19.07	5.50	7.37	23.97
<b>T<sub>2</sub></b> : Weed free	10.10	26.37	6.24	10.93	32.70
<b>T<sub>3</sub></b> : One hand weeding at 35 DAS.	8.00	20.83	5.77	8.23	25.67
<b>T<sub>4</sub></b> : Two hand weeding at 20 and 40 DAS	9.50	25.00	6.04	10.00	31.80
<b>T<sub>5</sub></b> : Pendimethalin @ 1.25 kg ha <sup>-1</sup> (P.E.).	8.13	22.27	5.80	8.63	26.93
<b>T<sub>6</sub></b> : Pendimethalin @ 1.25 kg ha <sup>-1</sup> (P.E.) + One Hand weeding at 45 DAS.	9.97	25.87	6.10	10.47	32.10
<b>T<sub>7</sub></b> : Quizalafop-ethyl @ 40 g ha <sup>-1</sup> (POE) at 40 DAS.	7.80	19.77	5.70	7.80	24.93
<b>T<sub>8</sub></b> : Pendimethalin @ 1.25 kg ha <sup>-1</sup> (P.E.) + Quizalafop-ethyl @ 40 g ha <sup>-1</sup> (POE) at 40 DAS.	8.93	24.17	5.90	9.40	29.93
<b>T<sub>9</sub></b> : Paddy straw mulch @ 5 t ha <sup>-1</sup>	8.57	23.77	5.87	9.23	27.93

1.					
<b>T<sub>10</sub></b> : Paddy straw mulch @ 5 t ha <sup>-1</sup> <sup>1</sup> fb One hand weeding at 35 DAS.	9.33	24.80	5.97	9.70	31.30
<b>SE (m)±</b>	<b>0.21</b>	<b>0.44</b>	<b>0.20</b>	<b>0.33</b>	<b>0.35</b>
<b>CD (5%)</b>	<b>0.47</b>	<b>0.99</b>	<b>0.45</b>	<b>0.74</b>	<b>0.79</b>

### Economics

Application of different weed management practices significantly influenced gross return, net return and B:C ratio in fennel. Highest gross return (₹ 118343.33 ha<sup>-1</sup>), net return (₹ 82323.33 ha<sup>-1</sup>) and B:C ratio (2.29) were recorded with the application of treatment T<sub>6</sub>: pendimethalin @ 1.25 kg ha<sup>-1</sup> (P.E.) + One hand weeding at 45 DAS (table 5).

Thus it is inferred that pendimethalin @ 1.25 kg ha<sup>-1</sup> (P.E.) + One hand weeding at 45 DAS is the best weed control treatment resulting in efficient weed control which ultimately leads to higher yield and maximum economic returns. These findings are in agreement with Nagar *et al.* (2009).

**Table 5: Effect of different weed management practices on gross return, net return and benefit cost ratio of fennel.**

Treatment	Gross return (₹ ha <sup>-1</sup> )	Net return (₹ ha <sup>-1</sup> )	B:C ratio
T <sub>1</sub> : Weedy check	81033.33	49963.33	1.61
T <sub>2</sub> : Weed free	120266.67	75196.67	1.67
T <sub>3</sub> : One hand weeding at 35 DAS.	90566.67	56696.67	1.68
T <sub>4</sub> : Two hand weeding at 20 and 40 DAS	110000.00	73330.00	2.00
T <sub>5</sub> : Pendimethalin @ 1.25 kg ha <sup>-1</sup> (P.E.).	94966.67	62446.67	1.92
T <sub>6</sub> : Pendimethalin @ 1.25 kg ha <sup>-1</sup> (P.E.) + One Hand weeding at 45 DAS.	115133.33	79113.33	2.20
T <sub>7</sub> : Quizalafop-ethyl @ 40 g ha <sup>-1</sup> (POE) at 40 DAS.	85800.00	53480.00	1.65
T <sub>8</sub> : Pendimethalin @ 1.25 kg ha <sup>-1</sup> (P.E.) + Quizalafop-ethyl @ 40 g ha <sup>-1</sup> (POE) at 40 DAS.	103400.00	69630.00	2.06
T <sub>9</sub> : Paddy straw mulch @ 5 t ha <sup>-1</sup> .	101566.67	66596.67	1.90
T <sub>10</sub> : Paddy straw mulch @ 5 t ha <sup>-1</sup> fb One hand weeding at 35 DAS.	106700.00	70330.00	1.93
<b>SE (m)±</b>	<b>3604.62</b>	<b>3604.62</b>	<b>0.12</b>
<b>CD (5%)</b>	<b>8146.45</b>	<b>8146.45</b>	<b>0.26</b>

#### 4. Conclusion

It is concluded that the effective control of weeds and the maximum seed yield and net income can be obtained with application of pendimethalin @ 1.25 kg ha<sup>-1</sup> (P.E.) + One hand weeding at 45 DAS.

**Research category:** Crop Science

**Abbreviations:** Kg: Kilogram

Ha<sup>-1</sup>: Per hectare

Q ha<sup>-1</sup>: Quantile per hectare

g m<sup>-2</sup>: Gram per meter square

DAS: Day after sowing

PE: Pre emergence

POE: Post emergence

**Acknowledgement/ Funding:** author thankful to G.S.S.D.G.S. Khalsa College, Patiala, 147001, Punjab, India

**Research guide or Chairperson of research:**

Mr. Mohinder Lal

Institute: G.S.S.D.G.S. Khalsa College, Patiala, 147001, Punjab, India

Research project name or number: M. Sc. Thesis

**Author Contributions:** All author equally contributed

**Author statement:** All author read, reviewed, agree and approved the final manuscript

**Ethical approval:** this article does not contain any studies with human participants or animal performed by any of the authors.

#### References

[1] Dhakad P.S., Singh O.M., Dubey R., Gallani R. and Patil D., 2017. Effect of weed management practices on yield and its attributing traits in Coriander (*Coriandrum sativum* L.). *Research Journal of Agricultural Sciences*. 8(4):871-874.

[2] Gill G.S. and Kumar V., 1969. Weed index a new method for reporting weed control trials. *Indian Journal of Agronomy*. 16(2): 96-98.

[3] Gohil B.S., Mathukia R.K., Dobariya V.K., and Chhodavadia S.K., 2014.

Weed management and dynamics of weed seedbank in fennel. *Indian Journal of Weed Science*. 46(4) 399-401.

[4] Gomez W.A. and Gomez A.A., 1984. *Statistical procedure for Agriculture Research*. A Wiley Interscience Publication, John Wiley and Sons, New York.

[5] Mali A.L. and Suwalka S.N., 1987. Studies on weed control in fenugreek (*Trigonella foenumgraecum* L.). *Indian Journal of Agronomy*. 32(2): 188-189.

[6] Mani V.S., Pandita M.L., Gautam K.C. and Bhagwandas, 1973. Weed killing chemical in potato cultivation. *PANS*. 23(8): 17-18.

[7] Meena S.S. and Mehta R.S., 2009. Effect of weed management practices on weed indices, yield and economics of fennel (*Foeniculum vulgare* Mill). *Indian Journal of Weed Science*. 41(3&4) 195-198.

[8] Nagar R.K., Meena B.S., Dadheech R.C., 2009. Effect of integrated weed and nutrient management on weed density, productivity and economics of Coriander (*Coriandrum sativum*). *Indian Journal Weed Science*. 41 (1 & 2): 71-75

[9] Patel R.H., Shroff J., Usadadia V.P. and Shah S.N., 2004. Influence of nitrogen and weed management practices on weeds and coriander. *Indian Journal of Weed Science*. 36(1&2): 86-88.

[10] Patil J.K., Amin A.U., Tamboli Y.A. and Patel U.V., 2020. Growth, yield attributes and yield of Coriander (*Coriandrum sativum* L.) as influenced by weed management practices and nitrogen levels. *International Journal of Current Microbiology and Applied Sciences*. 9(4): 328-338.

[11] Prajapati S., Rathod S., Jat R.K., Solanki N. and Brahmhatt J., 2021. Integrated weed management in coriander (*Coriander sativum* L.) *International Journal of Agriculture Sciences*. 6: 163-173.

[12] Sagarka B.K., Ramani B.B., Mathukia R.K. and Khanpara V.D., 2005. Integrated weed management in coriander. *Indian Journal of Weed Science*. 37(3 and 4): 231- 233.



[13] Thakral K.K., Tehlan S.K., Bhatia A.K. and Malik T.P., 2007. Comparative economics of weed management practices in fennel (*Foeniculum vulgare* Mill). Haryana Journal of Horticultural Sciences. 36 Pp 169-170.

[14] Voevodin, A.V. and Borisenko, L.A., 1981. The use of herbicides for sequential of perennial and annual weeds in vegetable crops and the significance of this method for environment protection. Horticulture International Abstracts. 54(6): 3875.