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Integrated weed management practices for dill seed (*Anethum graveolens* L.) cultivation

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Abstract

A field experiment was conducted during *rabi* season of two consecutive years 2015-16 and 2016-17 at Seed Spice Research Station, S. D. Agricultural University, Jagudan. The significantly higher growth and yield attributes were recorded with weed free treatment as compared to weedy check, but did not differ significantly with rest of the treatments. Significant lowest seed yield of dill seed was recorded under weedy check crop condition. The maximum seed yield of dill seed was recorded with weed free crop condition and was at par with all the treatments except, weedy check and application of oxadiargyl 75 g ha^{-1} as PE + Oyfluorfen @ 75 g ha^{-1} as PE at 30 DAS . The highest net profit was obtained under two inter-culturing followed by (fb) by hand weeding at 25 & 40 DAS and pre emergence application of pendimethalin @ 1.0 kg ha^{-1} which also accrued the maximum BCR value (1.89). The studies 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. Adoption of integrated approach was found to be better and was statistically similar to weed free crop condition for managing the weed intensity. Kept the crop weed free till harvest recorded higher weed control efficiency (98 %) and lower weed index (0%).

Key words : Hand weeding, interculturing, pendimethalin, oxadiargyl, oxyfluorfen, weed management.

Introduction

Spices are integral part of Indian culture and India is the worldÕs largest producer, consumer and exporter of spices, also known as ÔSeed spice bowlÕ. Among different seed spices grown, cumin, coriander, fennel, fenugreek, ajwain and dill seed *etc*. are vital *Rabi* seed spices, particularly for arid and semi arid regions of the country. Dill seed (*Anethum graveolens* L.) is one of the important medicinal and aromatic crops, belongs to family umbelliferae (Apiaceae). Dill fruits are also popularly used as carminative, aromatic stimulant and diuretic in Ayurvedic and Unani medicines. The Indian dill seed are known to contain more dillapiole (36.0%) and less carvone (19.5%) (Malhotra and Vashishtha, 2007). In India, Gujarat and Madhya Pradesh are the leading states for dill cultivation and production. Irrigated *Rabi* dill crop can be sown in the month of October. Dill seed has the nature of delayed germination, initial slow growth rate and grown under marginal land with broadcasting sowing method may increase sever weed problem during early growth stage. Pre dominant and effective method of weed control is hand weeding. Recently, fast development in industries and infrastructure sectors not only reduced labour availability in agriculture sector but increased labour wages also. Therefore, it becomes quite difficult to control weeds in time by hand weeding. Like agricultural crops, various constraints pose serious problem for cultivation of seed spices *viz*. nutrient management, water management, suitable genotype, agro-climatic condition and weed management. Satisfactory research work on the aforesaid constraints has been done by some scientist at different places of the country but little work has been carried out on the weed management, which is the major constrain for cultivation of seed spices crop. In many other crops, among the losses caused by different pests, the weed accounts for nearly 45% or more and it may be similar in case of seed spices crops. Weeds also interfere with crops to utilize nutrient, soil moisture and space that ultimately suppresses the plants growth, reduces yield and quality of produce of seed spices. If these weeds could be managed by employing the tools of weed management in integrated approach, then it can minimize the weeds below the economic threshold level (ETL) and improve yield, yield contributing character and quality of seed spices. As well as this approach will be eco-friendly in nature. The choice of any weed control measures depends largely on its efficiencies economics, so that use of post-emergence herbicides would make more acceptable to farmers, which ensure control of weeds. Weeds germination can be minimized with the help of pre-emergence application of herbicides but it cannot be

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controlled completely because some weeds germinated during early growth period of crop which can be controlled easily by either post emergence application of herbicides or by inter-culturing or hand weeding. Keeping this in view, this study was planed.

Materials and methods

A field experiment was conducted during rabi season of two consecutive years 2015-16 and 2016-17 at Seed Spice Research Station, S. D. Agricultural University, Jagudan, India on "Integrated weed management practices in dill (Anethum graveolens L.)". The soil was loamy sand in texture, neutral in soil reaction, with low in organic carbon, medium in available phosphorus and potash. There were twelve treatments consisting T1: Weedy check, T2: Weed free up to harvest, T3: Two inter-culturing followed by hand weeding at 25 & 40 DAS, T4: Pendimethalin @ 1.0 kg ha-1 as pre- emergence (PE), T5 : T4 + Oxadiargyl @ 100 g ha-1 as PE at 30 DAS, T6: T4 + Oxyfluorfen @ 75 g ha-1 as PE at 30 DAS, T7: T4 + I.C followed by HW at 35 DAS, T8: Oxadiargyl @ 100 g ha-1 as pre-emergence, T9: T8 + IC followed by HW at 35 DAS, T10: Oxadiargyl @ 75 g ha-1 as PE + Oyfluorfen @ 75 g ha-1 as PE at 30 DAS, T11 : Mixture of Pendimethalin 30 EC 1.0 kg ha-1 and Oxyfluorfen @ 50 g ha-1 as PE, T12 : T11 + IC followed by HW at 35 DAS. The treatments were replicated three times in a randomized block design. The seeds of dill variety was sown at 45 cm apart in line sowing with an application of irrigation. Hand weeding and inter-culturing operation at 25 and 40 DAS were carried out manually. In weed free treatment weeds were removed at every fifteen days interval to keep it weed free up to harvest. Pre-emergence application of all the herbicides with required quantity were sprayed by knapsack sprayer with flat fan nozzle using 500 liters of water per hectare after 3 to 4 DAS under sufficient moisture condition for better effect. Another light irrigation at 12 DAS was given to ensure uniform germination. A basal dose of half of nitrogen and full dose of phosphorus was drilled uniformly just before sowing. The remaining half dose of N was top dressed at the time of irrigation i.e. 30 DAS. Different weed flora viz., sedges, monocot and dicot weeds were counted at 20, 40 and 60 DAS. The weed count (density) was taken from the tagged spot of 0.25 m2 in the randomly selected each net plot. They were calculated and converted into square meter basis for convenience. In order to draw a valid conclusion, the weed count data are subjected to square root transformation ($\sqrt{X}$ + 0.5) as suggested by Gomez and Gomez (1984) before statistical analysis. For dry weight of weeds, the weeds were air dried completely till they reached constant weight and finally recorded for each treatment after harvest and converted in to kg ha^{-1}. Weed index (WI) and weed control efficiency (WCE) were worked out by using formulae given below by Gill & Kumar (1969) and Kondap & Upadhyay (1985), respectively. Statistical analysis procedure was followed as suggested by Panse & Sukhatme (1985).

Results and discussion

Growth and yield attributes were significantly influenced by various weed management treatments (Table 1). However, test weight was not affected significantly due to different treatments. The significantly higher growth and yield attributes were recorded with weed free treatment as compared to weedy check, but no significant difference was noted with rest of the treatments. The higher values of all the growth and yield parameters under all the treatments consisted either physical or chemical method or combinations of them which might be ascribed for better control of weeds that have favoured higher uptake of nutrients and water. Secondarily, dill crop is very hardy in nature and competes better against pest, diseases and weeds, resulting in better growth. Analogous findings have been reported by Patel ***et al.,*** (2016) in cumin, Nalini ***et al.,*** (2017) in ajwain and Meena ***et al.,*** (2013) in dill seed. The maximum and minimum values of test weight and volatile oil content were recorded with weed free and weedy check crop condition, respectively.

Seed yield

Seed yield of dill seed was significantly affected by different treatments (Table 2). Significantly the lowest seed yield of dill seed was recorded under weedy check crop condition. The maximum seed yield of dill seed was recorded with weed free crop condition and was at par with treatments T_3: Two inter-culturing followed by hand weeding at 25 & 40 DAS, T_4: Pendimethalin @ 1.0 kg ha^{-1} as pre- emergence, T_5 : T_4 + Oxadiargyl @ 100 g ha^{-1} as PE at 30 DAS, T_6: T_4 + Oxyfluorfen @ 75 g ha^{-1} as PE at 30 DAS, T_7: T_4 + IC followed by HW at 35 DAS, T8: Oxadiargyl @ 100 g ha^{-1} as pre-emergence, T_9: T_8 + IC followed by HW at 35 DAS, T_{11} : Mixture of Pendimethalin 30 EC 1.0 kg ha^{-1} and Oxyfluorfen @ 50 g ha^{-1} as PE, T_{12} : T_{11} + IC followed by HW at 35 DAS, but significantly superior over rest of the treatments *i.e.* T_1 and T_{10}. Pre emergence application of herbicides (T_4 and T_8) were equally effective with application of herbicides (T_5, T_6, T_{10} and T_{11}) both as pre and post emergence or herbicides with inter-culture (T_7, T_9 and T_{12}). The equal effect of all these treatments to produce nearby yield of dill seed might be attributed to removal of weeds during early crop weed competition period and smothering effect of dill seed on weeds during crop growth period. Meena and Mehta (2009)

Table 1. Growth and yield attributes of dill seed as influenced by different weed management treatments (Pooled data)

Treatments	Plant height (cm)	No. Of branches plant^{-1}	No. Of umbels plant^{-1}	No. Of umballates umbel^{-1}	No. of seeds umballate^{-1}	Test weight (g)
T_1: Weedy check	73.4	4.5	13.6	10.7	20.1	3.1
T_2:Weed free upto harvest	95.5	6.2	20.9	21.3	28.4	3.5
T_3: Two inter-culturing followed by hand weeding at 25 & 40 DAS	93.4	6.1	20.4	21.1	27.9	3.5
T_4: Pendimethalin @ 1.0 kg /ha as pre-mergence	93.3	5.9	20.2	20.7	26.9	3.4
T_5 :T_4 + Oxadiargy @ 100 g /ha as PE at 30 DAS	91.0	5.9	19.6	20.2	26.5	3.4
T_6: T_4 + Oxyfluorfen @ 75 g /ha as PE at 30 DAS	89.4	5.9	19.2	19.8	26.2	3.3
T_7: T_4 + I.C followed by HW at 35 DAS	94.4	6.2	20.6	20.9	27.7	3.5
T_8: Oxadiargyl @ 100 g/ha as pre-emergence	91.7	5.8	19.3	20.0	27.0	3.4
T_9: T_8 + IC followed by HW at 35 DAS	90.3	5.9	19.9	20.5	26.5	3.5
T_{10}: Oxadiargyl 75 g/ha as PE + Oxyfluorfen @ 75 g/ha as PE at 30 DAS	89.8	5.7	17.8	19.8	26.3	3.3
T_{11} : Mixture of Pendimethalin 30EC 1 kg/ha and Oxyfluorfen @ 50 g/ha as PE	92.6	5.9	20.0	20.5	26.9	3.4
T_{12} : T_{11} + IC followed by HW at 35 DAS	93.6	6.0	20.3	20.8	27.9	3.5
S. Em. ±	2.2	0.2	0.7	0.7	0.9	0.06
C.D. at 5 %	6.3	0.6	2.0	2.1	2.7	NS
C.V. %	5.96	8.66	8.95	8.76	8.56	4.85
Y x T	NS	NS	NS	NS	NS	NS

Table 2. Seed yield of dill seed and volatile oil (%) as influenced by weed management treatments.

Treatments	Dill seed yield (Kg ha^{-1})			Volatile oil (%)
	2015-16	2016-17	Pooled	
T_1: Weedy check	540	593	567	2.3
T_2:Weed free upto harvest	1360	1393	1377	2.4
T_3: Two inter-culturing followed by hand weeding at 25 & 40 DAS	1350	1380	1365	2.4
T_4: Pendimethalin @ 1.0 kg /ha as pre-mergence	1283	1302	1292	2.4
T_5 :T_4 + Oxadiargy @ 100 g /ha as PE at 30 DAS	1263	1283	1273	2.4
T_6: T_4 + Oxyfluorfen @ 75 g /ha as PE at 30 DAS	1257	1273	1265	2.3
T_7: T_4 + I.C followed by HW at 35 DAS	1277	1287	1282	2.4
T_8: Oxadiargyl @ 100 g/ha as pre-emergence	1267	1283	1275	2.4
T_9: T_8 + IC followed by HW at 35 DAS	1273	1290	1282	2.4
T_{10}: Oxadiargyl 75 g/ha as PE + Oxyfluorfen @ 75 g/ha as PE at 30 DAS	1143	1170	1157	2.4
T_{11} : Mixture of Pendimethalin 30EC 1 kg/ha and Oxyfluorfen @ 50 g/ha as PE	1247	1260	1253	2.4
T_{12} : T_{11} + IC followed by HW at 35 DAS	1277	1290	1283 (ab)	2.4
S. Em. ±	71	69	50	0.04
C.D. at 5 %	210	203	142	NS
C.V. %	10.22	9.72	9.97	4.75
Y x T	NS	NS	NS	NS

reported that hand weeding and application of pre emergence reduced the dry matter of weeds and thus increased seed yield of seed spices. Mathukia *et al.,* (2015) reported that weed free treatment secured higher cumin seed yield. The results are also in accordance with Patel *et al.,* (2016) in cumin, Nalini *et al.,* (2017) in ajwain and Meena *et al.,* (2013) in dill seed.

Economics

The maximum gross realization and cost of cultivation were recorded when crop was kept weed free up to harvest (Table 3). The highest net profit was obtained when two inter-culturing followed by hand weeding at 25 & 40 DAS and followed by pre emergence application of pendimethalin @ 1.0 kg /ha which also accured the maximum BCR value (1.89). The minimum net return and BCR values were obtained with unweeded control condition. The higher seed yield under these treatments as a result of better weed control is responsible for higher net realization per hectare. These findings are in concurrence with those observed by Yadav *et al*., (2012) and Patel *et al*., (2016).

Conclusion

Based on the results of the field experimentation, it seems quite logical to conclude that to achieve optimum yield and effective weed management in dill seed, adopting two inter-culturing followed by two hand weeding at 25 and 40 DAS and combined practice of herbicides with physical weed control seems to provide better results. During scarcity of labour to achieve the highest net income per rupee investment (BCR) pre emergence application of pendimithalin @ 1.00 kg ha^{-1} + IC followed (*fb*) HW at 35 DAS may be adopted.

Table 3. Economics of the different weed management treatments.

Treatments	Seed yield (Kg ha^{-1})	Gross realization (Rs ha^{-1})	Gross expenditure (Rs ha^{-1})	Net return (Rs ha^{-1})	BCR
T_1: Weedy check	567	28350	20259	8091	0.40
T_2:Weed free upto harvest	1377	68830	28921	39909	1.38
T_3: Two inter-culturing followed by hand weeding at 25 & 40 DAS	1365	68250	25456	42794	1.68
T_4: Pendimethalin @ 1.0 kg /ha as pre-mergence	1292	64600	22320	42280	1.89
T_5 :T_4 + Oxadiargy @ 100 g /ha as PE at 30 DAS	1273	63663	25650	38014	1.48
T_6: T_4 + Oxyfluorfen @ 75 g /ha as PE at 30 DAS	1265	63250	23109	40141	1.74
T_7: T_4 + I.C followed by HW at 35 DAS	1282	64083	24919	39164	1.57
T_8: Oxadiargyl @ 100 g/ha as pre-emergence	1275	63750	23589	40161	1.70
T_9: T_8 + IC followed by HW at 35 DAS	1282	64083	26187	37896	1.45
T_{10}: Oxadiargyl 75 g/ha as PE + Oxyfluorfen @ 75 g/ha as PE at 30 DAS	1157	57833	24724	33109	1.34
T_{11} : Mixture of Pendimethalin 30EC 1 kg/ha and Oxyfluorfen @ 50 g/ha as PE	1253	62650	22615	40676	1.77
T_{12} : T_{11} + IC followed by HW at 35 DAS	1283	64166	24573	39594	1.61

Price :Dill seed ₹ 50 kg^{-1}, Oxadiargyl : ₹ 1550 lit.$^{-1}$, Pendimethalin : ₹ 450 lit.$^{-1}$, Oxyfluorfen : ₹ 900 lit^{-1}

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