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RESEARCH ARTICLE :

Weed dynamics, growth, yield and economics of ajwain (*Trachyspermum ammi*) influenced by integrated weed management

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SUMMARY : A Field experiments conducted at Hyderabad (Telangana), to find out the economic feasibility of weed management practices in terms of weed control efficiency and performance of Ajwain (*Trachyspermum ammi*) indicated that weed-free treatments resulted in higher plant growth, maximum yield attributes and seed yield followed by oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS. Maximum net returns (Rs. 67692ha^{-1}) and highest cost : benefit ratio (1:2.7) was obtained in oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS.

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KEY WORDS :
Ajwain, Herbicides, Weed management, Yield, Economics

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BACKGROUND AND OBJECTIVES

Ajwain is traditionally a *Rabi* season crop and its productivity is low due to several factors and one of them is uncontrolled weed growth during the critical periods, and also at subsequent stages of the crop growth. Ajwain is generally infested with grasses, sedges and broad leaved weeds which smother ajwain at early stages of crop growth ultimately cause yield loss. Among the several weed control measures hand weeding is mostly practiced. Of late this practice has became uneconomical due to increased cost of manual labour, besides non-availability of labour during peak periods of agricultural operations and time taken for weeding make the practice of hand weeding is not possible always. National Research Centre on Seed Spices (NRCSS) recommends application of pendimethalin @ 1.0 kg *a.i* ha^{-1} as pre-emergence for weed management in ajwain. However, the chemical is costly and not cost effective to farmers.In the current situations, when labour availability is serious problem, weed management in a crop of 150-180 days duration without post-emergence herbicides is difficult. Hence there in a clear need to evaluate their efficacy and toxicity of pre-emergence, post-emergence herbicides and their combinations on ajwain and also the

effectiveness of integrated weed management approaches involving the mechanical methods conjunction with pre-emergence herbicide usage. This will lead to identification of effective and economical weed control strategy for productivity enhancement in ajwain.

RESOURCES AND METHODS

The experiment was carried out at College of Agriculture, Rajendranagar, Hyderabad (Telangana) during the *Rabi* season of 2012-13. The experiment comprised of 13 treatments namely, T_1 Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb hand weeding at 40 DAS, T_2 - Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb hand weeding at 40 DAS, T_3 -Pretilachlor @ 0.5 kg *a.i* ha^{-1} as PE fb hand weeding at 40 DAS, T_4 -Quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS, T_5 Propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS, T_6 - Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS, T_7 Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS, T_8 - Pretilachlor @ 0.5 kg *a.i* ha^{-1} as PE fb quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS, T_9- Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS, T_{10}-Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS, T_{11}-Pretilachlor @ 0.5 kg *a.i* ha^{-1} as PE fb propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS, T_{12}-Hand weeding at 20, 40 and 60 DAS and T_{13} -Weedy check. The experiment was laid out in a Randomized Block Design with three replications. The soil of the experimental site was sandy loam with a pH of 7.8 and having 0.35% organic carbon and 226, 18 and 236 kg ha^{-1} low in available nitrogen and available phosphorus and medium in potassium, respectively. Irrigation and other cultural practices were adopted as per recommendation. Observations on growth, yield attributing characters, yield and economics were taken. Net returns and benefit : cost (B : C) ratio were also worked out. Weed control efficiency (WCE) was calculated as per the formula suggested by Patil and Patil (1983). Observations on weed dry matter were recorded for whole plot of 4.5 m x 4.0 m, which was used to calculate the WCE.WCE (%) = [(DMC-DMT)/DMC] x 100 where, DMC is the dry matter weight of weeds in control plot and DMT is the dry matter weight of weeds in treated plot. Weed index (WI) was calculated as per the formula suggested by Gill and Kumar (1969). WI (%) = [(X-Y)/X] x 100 where, X is the yield from weed-free plot and Y is the yield from treated plot.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Weed parameters :

The weed flora associated with experimental crop consisted of grasses *viz.*, *Cynodon dactylon*, *Dactyloctenium aegyptium* and *Celotia argentia*, sedges *viz.*, *Cyperus rotundus* and broadleaved weeds *viz.*, *Digera arvensis, Trianthemaportulacastrum, Commelina benghalensis, Parthenium hysterophorus, Euphorbia hirta* and *Hemidismus indica*. Among all weed sps, *Cynodon dactylon*, *Cyperus rotundus* and *Parthenium hysterophorus* were the most dominant ones. Population of broad leaf weedsat the harvesting stage was missing on account of shorter life span than that of ajwain crop. At harvest the lowest weed dry matter was recorded in hand weeding at 20, 40 and 60 DAS (5.87 g m^{-2}) which was significantly superior over all other treatments. The next best treatment was oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb quizalfop-p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS (7.00 g m^{-2}) and it was at par with oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb hand weeding at 40 DAS (7.06 g m^{-2}). Significantly the highest weed dry matter was recorded with weedy check (12.91 g m^{-2}) shows in Table 1. The studies signified the importance of hand weeding at 40 DAS or application of post emergence herbicides which could benefit the crops in reducing the weed dry matter ultimately increase the crop yields. Similar results were obtained with hand weeding in cumin by Chaudhary and Gupta (1991).

Hand weeding at 20, 40 and 60 DAS recorded the highest weed control efficiency of 79.78% followed by application of oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb quizalfop-p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS (72.68%), oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb hand weeding at 40 DAS (70.51%). Significantly lower weed control efficiency was recorded with propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS (37.31%) and quizalfop-p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS (44.63%) because of reduced action of post emergency

application of herbicides alone. Maximum weed control efficiency recorded in hand weeding is due to continuous removal of weeds upto 60 days after sowing followed by application of different herbicides. These results are in accordance with the results indicated by Sharma and Jain (2005) and Mehriya *et al.* (2007).

Growth :

The plant height at harvest was significantly higher with hand weeding at 20, 40 and 60 DAS (123 cm) than all other treatments but it was at par with application of oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb quizalfop-p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS (117 cm) and oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb hand weeding at 40 DAS (116 cm). The next best treatment to recorded plant height was pretilachlor @ 0.5 kg *a.i* ha^{-1} as PE fb quizalfop-p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE (113 cm), pendimethalin @ 1.0 kg *a.i* ha^{-1} fb hand weeding at 40 DAS (112 cm) and pendimethalin @ 1.0 kg *a.i* ha^{-1} fb quizalfop-p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS (107 cm).

At harvest, significantly higher dry matter (7386 kg ha^{-1}) was recorded with hand weeding at 20, 40 and 60 DAS over all other treatments and it was at par with application of oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb quizalfop-p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS (7025 kg ha^{-1}), oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb hand weeding at 40 DAS (6856 kg ha^{-1}). The dry matter was significantly lower in unweeded control (4126 kg ha^{-1}) than rest of the treatments. The higher dry matter where in hand weeding and post emergence treatments were imposed might be due to checking of weed growth efficiently besides increased availability of nutrients to crop. Similar results were found by Susila and Rajkumar (2011).

Yield parameters and yield :

Hand weeding gave significantly number of umbels $plant^{-1}$, seeds $umbel^{-1}$ and test weight (Table 2) and higher seed yield (1,155 kg ha^{-1}) and haulm yield (1316 kg ha^{-1}) over all other treatments (Table 3). Among integrated weed control treatments, oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS proved efficient in recording higher weed control efficiency (72.68%), seed yield (1,019 kg ha^{-1}) and haulm yield (1221 kg ha^{-1}) with better weed index (11.77). This

Table 1: Effect of different integrated weed control treatments on weed dry matter, WCE (%) and Weed index in ajwain at harvest during *Rabi*, 2012-13

Sr. No.	Treatments	Weed dry matter (g m^{-2})	WCE (%)	WI(%)
T_1	Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb hand weeding at 40 DAS	8.45 (70.53)	57.89	35.93
T_2	Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb hand weeding at 40 DAS	7.06 (48.92)	70.51	16.97
T_3	Pretilachlor @ 0.5 kg *a.i* ha^{-1}as PE fb hand weeding at 40 DAS	8.81 (76.66)	53.79	45.63
T_4	Quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	9.63 (91.86)	44.63	54.98
T_5	Propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	10.24 (104.00)	37.31	57.14
T_6	Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	8.63 (73.73)	55.56	33.16
T_7	Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb quizalfop-p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	6.80 (45.13)	72.68	11.77
T_8	Pretilachlor @ 0.5 kg *a.i* ha^{-1} as PE fb quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	9.31 (85.80)	48.28	48.23
T_9	Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	9.10 (81.86)	50.65	42.94
T_{10}	Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	8.87 (77.73)	53.15	36.28
T_{11}	Pretilachlor @ 0.5 kg *a.i* ha^{-1} as PE fb propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	9.31 (85.73)	48.32	53.59
T_{12}	Hand weeding at 20, 40 and 60 DAS	5.87 (33.60)	79.75	-
T_{13}	Weedy check	12.91 (165.90)	-	64.33
	S.E.±	0.37	-	
	C.D. (P=0.05)	1.08	-	

Original values are given in parentheses, which were transformed to $\sqrt{x+1}$

was closely followed by oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb hand weeding at 40 DAS which recorded a seed yield of 959 kg ha^{-1} and haulm yield (1212 kg ha^{-1}) with a weed index of 16.97.These findings are conformity with Meena and Mehta (2009) reported that hand weeding and application of pre emergence reduced the dry matter of weeds and thus increased in yield attributing and seed yield of seed spices.

Economics :

Significantly higher net returns (67692 Rs.ha^{-1}) was realized in oxyfluorfen @0.12 kg *a.i* ha^{-1} as PE fb quizalfop-p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS followed by hand weeding 20, 40 60 DAS(65432 Rs.ha^{-1}), oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE supplemented with one hand weeding at 40 DAS (55232 Rs. ha^{-1}) compared to other treatments while, weedy check recorded significantly lower net returns (6132 Rs. ha^{-1}) over rest of the treatments. The B: C ratio was significantly higher (2.7) due to application of oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb quizalfop-p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS and oxyfluorfen @ 0.12 kg

Table 2: Effect of different integrated weed control treatments on plant height (cm) and dry matter (kg ha^{-1}) of ajwain at harvest during *Rabi,* 2012-13

Sr. No.	Treatments	Plant height (cm)	Dry matter (kg /ha)
T_1	Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb hand weeding at 40 DAS	112	6217
T_2	Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb hand weeding at 40 DAS	116	6856
T_3	Pretilachlor @ 0.5 kg *a.i* ha^{-1}as PE fb hand weeding at 40 DAS	105	6126
T_4	Quizalfop -p-ethyl @0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	105	5868
T_5	Propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	104	5669
T_6	Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	107	6312
T_7	Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb quizalfop-p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	117	7025
T_8	Pretilachlor @ 0.5 kg *a.i* ha^{-1} as PE fb quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	113	5640
T_9	Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	108	5463
T_{10}	Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	109	6018
T_{11}	Pretilachlor @ 0.5 kg *a.i* ha^{-1} as PE fb propaquizafop@ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	103	5166
T_{12}	Hand weeding at 20, 40 and 60 DAS	123	7386
T_{13}	Weedy check	99	4126
	S.E.±	3.1	208
	C.D. (P=0.05)	8.6	608

Table 3 : Effect of different integrated weed control treatments on yield parameters in ajwain at harvest during *Rabi,* 2012-13

Sr. No.	Treatments	Umbel/ plant	Seed/ Umbel	1000 seed weight
T_1	Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb hand weeding at 40 DAS	150	162	1.16
T_2	Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb hand weeding at 40 DAS	243	195	1.40
T_3	Pretilachlor @ 0.5 kg *a.i* ha^{-1}as PE fb hand weeding at 40 DAS	113	118	1.06
T_4	Quizalfop -p-ethyl @0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	93	89	1.06
T_5	Propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	82	82	1.00
T_6	Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb quizalfop –p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	180	180	1.30
T_7	Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb quizalfop-p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	270	203	1.53
T_8	Pretilachlor @ 0.5 kg *a.i* ha^{-1} as PE fb quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	106	103	1.23
T_9	Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	120	127	1.16
T_{10}	Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	140	142	1.16
T_{11}	Pretilachlor @ 0.5 kg *a.i* ha^{-1} as PE fb propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	102	94	1.10
T_{12}	Hand weeding at 20, 40 and 60 DAS	343	218	1.60
T_{13}	Weedy check	64.3	73.3	1.06
	S.E.±	6.44	1.81	-
	C.D. (P=0.05)	18.9	5.31	-

Table 4 : Seed yield and haulm yield of different integrated weed control treatments in ajwain during *Rabi*, 2012-13

Sr. No.	Treatments	Seed yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
T_1	Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb Hand weeding at 40 DAS	740	886
T_2	Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb Hand weeding at 40 DAS	959	1212
T_3	Pretilachlor @ 0.5 kg *a.i* ha^{-1} as PE fb Hand weeding at 40 DAS	628	834
T_4	Quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	520	641
T_5	Propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	495	626
T_6	Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE	772	931
T_7	Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE	1065	1222
T_8	Pretilachlor @ 0.5 kg *a.i* ha^{-1} as PE fb quizalfop -p-ethyl 0.05 kg *a.i* ha^{-1} as PoE	598	665
T_9	Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE	659	787
T_{10}	Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE	736	813
T_{11}	Pretilachlor @ 0.5 kg *a.i* ha^{-1} as PE fb propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE	536	673
T_{12}	Hand weeding at 20, 40 and 60 DAS	1155	1316
T_{13}	Weedy check	412	600
	S.E.±	29	31.2
	C.D. (P=0.05)	84	91

Table 5 : Economics of different integrated weed control treatments ajwain during *Rabi*, 2012-13

Sr. No.	Treatments	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio
T_1	Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb Hand weeding at 40 DAS	40950	74000	33050	1.8
T_2	Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb Hand weeding at 40 DAS	40668	95900	55232	2.4
T_3	Pretilachlor @ 0.5 kg *a.i* ha^{-1} as PE fb Hand weeding at 40 DAS	40188	62800	22612	1.6
T_4	Quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	37208	52000	14792	1.4
T_5	Propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE at 20 DAS	36418	49500	13082	1.4
T_6	Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE	38090	77200	39110	2.0
T_7	Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb quizalfop -p-ethyl @ 0.05 kg *a.i* ha^{-1} as PoE	38808	106500	67692	2.7
T_8	Pretilachlor @ 0.5 kg *a.i* ha^{-1} as PE fb quizalfop -p-ethyl 0.05 kg *a.i* ha^{-1} as PoE	38328	59800	21472	1.6
T_9	Pendimethalin @ 1.0 kg *a.i* ha^{-1} as PE fb propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE	37300	65900	28600	1.8
T_{10}	Oxyfluorfen @ 0.12 kg *a.i* ha^{-1} as PE fb propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE	38018	73600	35582	1.9
T_{11}	Pretilachlor @ 0.5 kg *a.i* ha^{-1} as PE fb propaquizafop @ 0.05 kg *a.i* ha^{-1} as PoE	37538	53600	16062	1.4
T_{12}	Hand weeding at 20, 40 and 60 DAS	50068	115500	65432	2.3
T_{13}	Weedy check	35068	41200	6132	1.2

a.i ha^{-1} as PE fb hand weeding at 40 DAS (2.4) over rest of the treatments. Hand weeding at 20, 40 and 60 DAS recorded a Benefit cost ratio of 2.3 whereas, weedy check recorded significantly lower B: C ratio (1.2) over rest of the treatments due to lower seed yield shows in Table 4.

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