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Research Article

PERFORMANCE OF CHEMICAL WEED MANAGEMENT IN IRRIGATED SUNFLOWER

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Abstract: The field experiments were conducted at Department of Oilseeds, Tamil Nadu Agricultural University, Coimbatore during kharif seasons for three consecutive years from 2013 to 2015. The experiment was laid out in randomized block design with eight treatments. The crop was irrigated as per the requirement and recommended dose of fertilizers were applied for better growth and development. Pre emergence application of pendimethalin @ 1.0 kg ai/ha followed by one hand weeding at 30 DAS is the best IWM practice for getting effective and economical weed control in irrigated sunflower. Combinations of pre emergence herbicide pendimethalin and post emergence herbicides *viz*., quizalofop ethyl, propaquizofop and fenoxyprop ethyl was not effective against broad leaved weeds infested field in sunflower, though they were not were phytotoxic to sunflower.

Keywords: Sunflower, Chemical weed management, Pre emergence herbicide, Post emergence herbicide

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Introduction

Sunflower is one of the important oilseed crops in India and contributed to rapid growth in oil production in India. Sunflower is a photo and thermo-insensitive, short duration, deep-rooted, drought-resistant, widely adaptable crop [1] and offers promise for its cultivation for boosting oilseed production. Weed competition is one of the major biotic constraints in reducing sunflower productivity under irrigated conditions due to wider spacing and application of higher dose of fertilizers. The level of weed infestation of sunflower differs over location and directly affects the intensity of the competitive relationships between crops and weeds, which results in greater yield losses. In this context, the chemical method of weed management is gaining importance. Use of herbicides will provide completely weed free condition to the crop from its early growth period whereas, manual or mechanical weeding can be done only after the emergence of weeds. Application of single herbicides are not control all the weed species due to their selectivity of species. Pre-emergence herbicides will be effective against the germinating weeds but in order to minimize the second flush of weeds, it is important to apply post emergence herbicide [2]. To increase the productivity of sunflower and reduce the cost of cultivation, use of sequential application of pre and post-emergence herbicides may be the useful option rather than pre or post-emergence herbicide application alone. Application of pre and post emergence herbicide in a sequence has to investigate. Keeping this in view, the present study was undertaken to evaluate the efficacy of pre emergence and post emergence herbicides in sunflower and to find out suitable weed management practice to manage weeds in irrigated sunflower.

Materials and methods

The field experiments were conducted at Department of Oilseeds, Tamil Nadu Agricultural University, Coimbatore during kharif seasons for three consecutive years from 2013 to 2015. The experiment consists eight treatments *viz*. T1 - PE pendimethalin @ 0.75 kg a.i./ha (38.7% CS), T2 - PE pendimethalin @ 1.0 kg a.i./ha + hand weeding (HW) on 30 DAS, T3 - PE pendimethalin @ 1.0 kg a.i./ha + quizalofop Ethyl 10 EC @37.5 g a.i./ha on 15-20 DAS as EPoE, T4 - PE pendimethalin @ 1.0 kg a.i./ha + propaquizofop ethyl @ 62 g a.i./ha on 15-20 DAS as EPoE, T5 - PE pendimethalin @ 1.0 kg a.i./ha + fenoxyprop ethyl @37.5 g a.i./has on 15-20 DAS as EPoE, T6 - farmers practice (two hand weeding at 20 and 40 DAS), T7- weed free check and T8- unweeded control with three replications and laid out in randomized block design. The crop was irrigated as per the requirement and recommended dose of fertilizers were applied for better growth and development @ 60: 90: 60 kg NPK/ ha were applied as urea, single super phosphate and muriate of potash, respectively and the crop was sprayed with plant protection chemicals as and when required to maintain without pest and diseases infection. Herbicide application with manually operated knapsack sprayer delivering a spray volume of 500 lit/ha through flat-fan nozzle and hand weeding was done as per the treatment to the respective plot. The experimental soil was red loamy with 7.3pH, 0.49 dS/m electrical conductivity, 0.25% organic carbon content, low in available nitrogen (283 kg/ha), low in available phosphorus (9.8 kg/ha) and high in available potassium (408 kg/ha). The gross plot was 5.4 × 4.8 m with net plot of 4.2 × 4.2 m. Sunflower hybrid CO_2 with a duration of 90 days was selected for this study and it was sown in the ridges at 60x30cm spacing @ two seeds per hill and later it was thinned leaving one healthy seedling per hill to maintain 100 percent population. Weed density and weed dry weight at 30, 60 and 90 days after sowing were recorded from pre marked quadrants of $1m^2$area. The weed data were subjected to square root transformation ($\sqrt{x+1}$) to normalize the distribution. Weed control efficiency [3] and weed index [4] were worked out to assess the efficiency of different weed control treatments. Growth parameters, yield parameters and yield were recorded to find out the efficiency. The economics was calculated based on prevailing market prices of inputs and outputs (sunflower @ Rs. 35/kg). The yield was recorded separately for each net plot and converted into kg/ha. The data were analyzed as per the analysis of variance (ANOVA) for randomized block design at 0.05 probability.

Results and Discussion

Weed flora

Weed flora of the experimental field predominantly consisted of nine species of broad-leaved weeds, eight species of grassy weeds and a sedge weed. Predominant grassy weeds were *Cyanadon dactylon* (L.), *Dactyloctenium aegyptium* (L.), and *Echinochloa colona* (L.). *Cyperus rotundus* (L.) was the only sedge weed was found and among the broad-leaved weeds

Table-1 Effect of weed management on weed in sunflower crop

Treatment	Weed density (No./m²)		Weed dry weight (Kg /ha)		WCE (%)	WI (%)
	30 DAS	30 DAS	30 DAS	30 DAS		
T_1 - PE Pendimethalin (38.7 % CS) @ 0.75 kg a.i/ha	6.36	10.49	8.21	16.29	49.8	39.8
	(40)	(110)	(67.01)	(265)		
T_2 - PE Pendimethalin (30 % EC) @ 1 kg a.i/ha + HW 40 DAS	6.34	4.74	7.60	4.76	89.9	5.5
	(40)	(22)	(57.35)	(22)		
T_3 - PE Pendimethalin (30 % EC) @ 1.0 kg a.i/ha + EPoE Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha	6.42	11.46	7.84	21.21	40.0	25.0
	(41)	(131)	(61.04)	(449)		
T_4 - PE Pendimethalin (30 % EC) @ 1.0 kg a.i/ha + EPoE Propaquizofop @ 62 g a.i/ha	6.98	11.99	9.72	22.09	34.4	31.2
	(48)	(143)	(94.33)	(488)		
T_5 - PE Pendimethalin (30 % EC) @ 1.0 kg a.i/ha + EPoE Fenoxoprop Ethyl @ 37.5 g a.i/ha	7.21	12.27	10.16	22.63	31.3	34.3
	(52)	(150)	(102.95)	(512)		
T_6 - Farmers practice (HW at 20 & 40 DAS)	3.01	9.38	3.82	9.24	59.9	8.4
	(9)	(88)	(14.20)	(85)		
T_7 - Weed free	1.30	3.23	1.52	3.98	95.4	-
	(1)	(10)	(2.25)	(15)		
T_8 - Unweeded control	13.27	14.79	18.51	27.85	-	58.6
	(176)	(218)	(342.66)	(775)		
SEm (±)	0.35	0.15	0.479	0.269		
LSD (0.05)	0.75	0.33	1.03	0.577		

Table-2 Effect of weed management on growth and yield of sunflower crop

Treatments	Plant height (cm)	Head diameter (cm)	No. of seeds / capitulum	Test Weight (g)	Yield (kg)
T_1 - PE Pendimethalin (38.7 % CS) @ 0.75 kg a.i/ha	175	21.86	718	4.04	1267
T_2 - PE Pendimethalin (30 % EC) @ 1 kg a.i/ha + HW 40 DAS	203	28.87	1079	4.31	2188
T_3 - PE Pendimethalin (30 % EC) @ 1.0 kg a.i/ha + EPoE Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha	167	20.67	825	4.21	1579
T_4 - PE Pendimethalin (30 % EC) @ 1.0 kg a.i/ha + EPoE Propaquizofop @ 62 g a.i/ha	161	19.40	770	4.20	1447
T_5 - PE Pendimethalin (30 % EC) @ 1.0 kg a.i/ha + EPoE Fenoxoprop Ethyl @ 37.5 g a.i/ha	157	19.07	749	4.16	1383
T_6 - Farmers practice (HW at 20 & 40 DAS)	191	27.13	960	4.28	1928
T_7 - Weed free	208	30.87	1093	4.35	2204
T_8 - Unweeded control	126	12.90	540	4.03	871
SEm (±)	3.7	0.84	54	0.04	95.4
LSD (0.05)	7.9	1.80	114	0.08	202

Trianthema portulacastrum (L.), *Digera arvensis* (Forsk.) and *Parthenium hysterophorus* (L.) were the dominant ones. Dicot weeds were predominant than the monocot and sedges (Fig 1.) and among the dicots *Trianthema portulacastrum* (L.) was the major weed observed in the study.

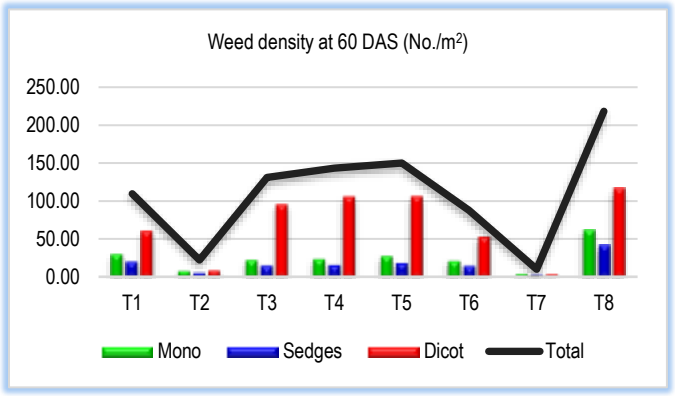

Fig-1 Weed density in experimental site at 60 DAS (Average of 3 Years)

Effect of different management practices on weed control

All the weed management treatments significantly reduce the weed density and weed dry weight over unweeded control [Table-1]. However, efficiency among the treatments varied considerably. Weed free check has recorded significantly lowest weed density and weed dry weight which was closely followed by pendimethalin @ 1.0 kg/ha as pre emergence + HW on 30 DAS. However, unweeded control recorded more total weed density. Quizalofop ethyl, propaquizafop, fenoxoprop ethyl are the group of aryloxyphenoxy propionate herbicides which has the inhibitors of acetyl CoA carboxylase mode of action which is selective for the control of annual and perennial grassy weeds in broad leaved crops [5 & 6]. Whereas in this experimental site broad leaved weeds are dominant, so these chemicals are not having significant effect on controlling weeds. However, application of post-emergence herbicides did not control the weeds effectively and it accordance with the findings of [7]. Weed control efficiency (WCE) indicated the magnitude of effective reduction of weed dry weight by weed control treatments over unweeded control. This was highly influenced by different weed control treatments. Weed free check recorded higher WCE and followed by pendimethalin @ 1.0 kg/ha as pre emergence + HW on 30 DAS. Higher WCE might be attributed to the effective weed control resulting in lower weed density. [8] Reported that weed free plot recorded 100% (WCE) followed by pendimethalin@1.5 lit/ha and one hand weeding over weedy check. These are in line with the findings of [9] who had reported that the highest weed control efficiency was recorded under weed free check. The extent of yield reduction due to weed competition as assesses through weed index (WI) has evidently indicated the suppressing effect of weed free check (T7) which had minimum weed competition and maximum seed yield. The highest yield reduction of 58.6 percent occurred under unweeded control (T8). The weed index was very low in pendimethalin @ 1.0 kg/ha as pre emergence +HW on 30 DAS (T2) (5.5 percent) followed by HW on 20 and 40 DAS (T7) (8.4 percent). Profuse weed growth restricted the vegetative growth and nutrient availability to the crop there by caused yield reduction. Similarly, [10] noticed that maximum weed index was observed under unweeded check and minimum weed index was noticed with the pre-emergence application of pendimethalin@1 kg/ha + hand weeding @ 30 DAS in groundnut.

Effect on crop growth and yield

Weed free check has recorded significantly taller plants which was on par with PE pendimethalin @ 1.0 kg/ha + HW on 30 DAS [Table-2]. Unweeded control recorded remarkably shorter plants. The head diameter contributes to the yield of sunflower. Weed free check registered higher head size compared to all other treatments. This might be due to minimum weed infestation for longer period of time in these treatments. Similar results in plant height and head diameter with weed management practices were reported [11]. Profound influence due to weed control treatments was noticed in number of seeds / head of sunflower crop.

Among all the treatments weed free check recorded higher number of seeds/head and it was comparable with pendimethalin @ 1.0 kg/ha as pre emergence + HW on 30 DAS. The lower number of seeds/ head was recorded in unweeded control. The hundred seed weight was significantly higher in weed free check and it was on par with pendimethalin @ 1.0 kg/ha as pre-emergence + HW on 30 DAS and twice hand weeding treatments. All early post emergence herbicides showed increase in growth and yield parameters compared to pre-emergence application of herbicide alone (T1). But there was no significant increase in growth and yield parameter due to dominance of broad leaved weeds in the experimental site. Similar result was found [12]. Among the weed management practices significantly higher seed yield of 2204 kg/ha was recorded with weed free check. The next best treatment was pendimethalin @ 1.0 kg/ha as pre-emergence + HW on 30 DAS with the seed yield of 2188 kg/ha. Both the above treatments were on par in their effect, and it was closely followed by HW on 20 and 40 DAS (1928 kg/ha). Whereas, unweeded control recorded conspicuously lower seed yield (871 kg/ha). All the treatments with post emergence herbicides (T3, T4 and T5) were on par each other but recorded lower yield compared to the treatment pendimethalin @ 1.0 kg/ha as pre emergence + HW on 30 DAS. Integrated use of pendimethalin and hand weeding is known to provide higher grain yield than herbicide alone [13, 14]. The reason for higher economic yields under the treatments *viz*., weed free check and pendimethalin @ 1.0 kg/ha as pre emergence + HW on 30 DAS were due to reduction in the competition from weeds at the most critical stages of crop weed competition. Reducing weeds competition at the early growth stages as well as at later growth stages of sunflower provided amiable atmosphere for the better utilization of available natural resources and cost incurred external inputs by the crop for producing more photosynthates. This might have amplified the absorption of nutrient and moisture from the soil without competition resulting in higher yield. It might be due to managing of weeds from the early growth of sunflower, as seemed from drastic reduction in density and dry matter production of weeds in weed free check, which helped in better growth of the crop resulting in significant seed yield of sunflower [15].

Economics

Higher gross return of `77,140/ha was obtained by weed free check and it was followed by pendimethalin @ 1.0 kg/ha as pre emergence + HW on 30 DAS (`76,580/ha) [Table-3]. Lower gross return (`30,485/ha) was registered by unweeded control which was followed by pendimethalin @ 1.0 kg/ha as pre emergence with the gross return of` `44,345/ha. Among the treatments pendimethalin @ 1.0 kg/ha as pre emergence + HW on 30 DAS (T2) gave the highest net return of `40,324/ha. The lowest net income of `3,917/ha was observed in unweeded control. Application of pendimethalin @ 1.0 kg/ha as pre emergence + HW on 30 DAS (T2) registered higher B: C ratio of 2.11. It was followed by pendimethalin @ 1.0 kg/ha as pre emergence + Quizalofop Ethyl 10 EC @ 37.5 g a.i/ha as early post emergence (T5) and weed free control (1.90). The lowest B: C ratio of 1.15 was recorded in unweeded control.

Table-3 Effect of weed management options on economics of sunflower crop

Treatments	Cost of cultivation (`)	Gross returns (`)	Net returns (`)	BCR
T_1	27871	44345	16474	1.59
T_2	36256	76580	40324	2.11
T_3	29137	55265	26128	1.90
T_4	29500	50645	21145	1.72
T_5	29187	48405	19218	1.66
T_6	38393	67480	29087	1.76
T_7	40543	77140	36597	1.90
T_8	26568	30485	3917	1.15

Conclusion

Pre emergence application of pendimethalin @ 1.0 kg ai/ha followed by one hand weeding at 30 DAS is the best IWM practice for getting effective and economical weed control in irrigated sunflower.

Application of research: Combinations of pre emergence herbicide pendimethalin and post emergence herbicides *viz*., quizalofop ethyl, propaquizofop and fenoxyprop ethyl was not effective against broad leaved weeds infested field in sunflower, though they were not were phytotoxic to sunflower.

Research Category: Oilseed Crop, Chemical weed management

Abbreviations:
PE: Pre-emergence, EPoE: Early Post emergence, DAS: DAS after sowing, @: at the rate, `: Indian Rupees, B:C: Benefit cost ratio, /ha: per hectare, kg/ha: Kilogram per hectare and %: Percent.

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