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Chemical weed management in sesame (*Sesamum indicum* L.)

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Abstract: A field experiment was conducted on medium black soil during *kharif* 2013 at the College of Agriculture, University of Agricultural Sciences, Raichur to study chemical weed management in sesame (*Sesamum indicum* L.). The results revealed that pre-emergence application of alachlor 50 EC @ 0.75 kg a.i. ha^{-1} + Hand weeding (HW) at 30 days after sowing (DAS) + Intercultivation (IC) at 45 DAS significantly reduced the weed density (6.53/m^2), dry weight of weeds (1.80 g/m^2) and weed index (16.89%) by increasing the weed control efficiency (74.24 %). This was followed by post-emergence application of quizalofop ethyl 5 EC @ 40 g a.i. ha^{-1} at 20 DAS + IC at 45 DAS. Weed free check resulted in significantly higher dry matter production of sesame (29.95 g/plant) followed by pre-emergence application of alachlor 50 EC @ 0.75 kg a.i. ha^{-1} + HW at 30 DAS + IC at 45 DAS (26.89 g/plant). With regard to the yield and economics, pre-emergence application of alachlor 50 EC @ 0.75 kg a.i. ha^{-1} + HW at 30 DAS + IC at 45 DAS gave significantly higher seed yield (488 kg ha^{-1}) and higher gross returns (₹ 57,600 ha^{-1}), net returns (₹ 29,482 ha^{-1}) but higher BC ratio (2.25) was recorded with application of quizalofop ethyl 5 EC @ 40 g a.i. ha^{-1} as post-emergence application at 20 DAS + IC at 45 DAS.

Key words: Imazethapyr, Quizalofop ethyl, Sesame, Weed management

Introduction

Sesame (*Sesamum indicum* L.) is one of the important oilseed crops in Indian agriculture. Sesame seed has pronounced antioxidant activity and thereby offer higher shelf life and is called as "seeds of immortality". Sesame oil has excellent nutritional, medicinal, cosmetic and cooking qualities. The sesame cake is used as organic manure as well as a good concentrate feed for livestock. India is the world's largest producer of sesame accounting for nearly 35 per cent of the total production of sesame in the world but productivity is very low. Lack of proper weed management is one of the main constraints for poor yields of sesame. Yield losses due to crop weed competition in sesame have been estimated to be 50-75 per cent. Simultaneous emergence and rapid growth of weeds leads to weed competition for moisture, light, space and nutrients. The period from 15 to 30 DAS is the most critical period of crop weed competition in sesame. Manual weeding is the common practice to control weeds in sesame. However, hike in labour wages as well as scarcity of labourers compels the farmers to search for other alternative methods of weed management. Herbicidal weed management is more favourable due to scarcity in availability of human labour during peak season. Therefore, the present attempt has been made to study chemical weed management in sesame.

Material and methods

The field experiment was carried out during *kharif,* 2013 at the Agricultural College farm, Raichur, Karnataka. The soil of the experimental site was medium black soil having pH of 8.21 with 223.25 kg ha^{-1} available N, 33.41 kg ha^{-1} available P_2O_5 and 195.30 kg ha^{-1} available K_2O. The experiment was laid out in randomized block design with three replications and eight treatments. Sesame variety DS-1 was sown with a spacing of 30 x 15 cm in a 5.4 x 4.5 m plot. The crop was fertilized with entire quantities of 50 kg N, 25 kg P_2O_5 and 25 kg K_2O ha^{-1}. Alachlor 50 EC, butachlor 50 EC, pendimethalin 30 EC and pendimethalin 38.7 CS were applied as pre-emergence and quizalofop ethyl and Imazethapyr were applied as post-emergence at 20 DAS with hand knapsack sprayer fitted with flat fan nozzle at spray volume of 750 litres ha^{-1}. Density and biomass of weeds were recorded at 20, 40, 60 DAS and at harvest with the help of 50 x 50 cm quadrant by throwing it randomly at four places in each plot. Data related to weed density and weed dry matter were converted to square root transformation before analysis. Visual injury ratings to sesame crop was estimated at 19 and 29 days after sowing on 0-10 scale where, 0=no injury to 10=complete mortality. NPK content in weeds at harvest were determined by using alkaline permanganate method, calorometrically by Olsen's method and Flame photometer methods, respectively. The nutrient uptake by weeds were calculated by multiplying the per cent NPK content in plants with their respective dry weight. The economic analysis of each treatment was done on the basis of prevailing market price of inputs used and produce obtained from each treatment.

Results and discussion

The dominant weed flora of the experimental field included *Agropyron repens* (L.), *Cyperus rotundus* L., *Cynodon dactylon* (L.) Pers., *Abutilon indicum* (L.) Sweet, *Acalypha indica* L., *Ageratum conyzoides* L., *Commelina benghalensis* L., *Cyanotis* sps., *Parthenium hysterophorus* L., *Phyllanthus maderaspatensis* L., *Portulaca oleracea* L., *Tribulus terrestris* L. and *Xanthium strumarium* L. All the weed control treatments recorded significantly lower weed density and weed dry weight as compared to unweeded check at different stages of crop growth. Weed free check recorded the lowest weed density and weed dry weight as compared to other treatments. Among

the herbicidal treatments, the lowest total weed density (6.53/m^2) and weed dry matter (1.80/m^2) were noticed in alachlor 50 EC @ 0.75 kg a.i. ha^{-1} as Pre-emergence (PRE) application + HW at 30 DAS + IC at 45 DAS (T_3) and was followed by quizalofop ethyl 5 EC @ 40 g a.i. ha^{-1} as Post-emergence (POE) application at 20 DAS + IC at 45 DAS (T_7) which were on par with each other (Table 1). This result is in conformity with the findings of Joseph *et al.* (2006). The treatments *viz.,* butachlor 50 EC @ 1 kg a.i. ha^{-1} as PRE application + HW at 30 DAS + IC at 45 DAS (T_6) and imazethapyr 10 SL @ 75 g a.i. ha^{-1} as POE application at 20 DAS + IC at 45 DAS (T_8) were in ascending order of total weed count and on par with each other. The highest total weed count (11.09/m^2) was recorded in unweeded check (T_1) and was followed by pendimethalin 30 EC @ 1 kg a.i. ha^{-1} as PRE application + HW at 30 DAS + IC at 45 DAS (T_4) which differed significantly from each other.

Among the herbicidal treatments, the highest weed control efficiency (74.16 %) was recorded in recommended practice *i.e.,* alachlor 50 EC @ 0.75 kg a.i. ha^{-1} as PRE application + HW at 30 DAS + IC at 45 DAS (T_3) followed by quizalofop ethyl 5 EC @ 40 g a.i. ha^{-1} as POE application at 20 DAS + IC at 45 DAS (Table 1). The higher weed control efficiency is attributed to lower dry weight of weeds. This might be due to the combination of both cultural and chemical methods which was found to be more effective in suppressing the weed density as well as weed dry matter. Similar results were obtained by Joseph *et al.* (2006). Weed index is directly related to the reduction in yield due to weed population and weed dry weight. The results showed that the lowest weed index (16.89%) was recorded in recommended practice *i.e.,* alachlor 50 EC @ 0.75 kg a.i. ha^{-1} as PRE application + HW at 30 DAS + IC at 45 DAS (T_3) and was followed by quizalofop ethyl 5 EC @ 40 g a.i. ha^{-1} as POE application at 20 DAS + IC at 45 DAS (T_7) which were on par with each other. The highest weed index (85.11%) was recorded under imazethapyr 10 SL @ 75 g a.i. ha^{-1} as POE application at 20 DAS + IC at 45 DAS (T_8) because of the severe phytotoxicity of this herbicide to sesame. James *et al.* (2001) reported that acifluorfen, imazethapyr, imazapic and 2, 4-DB reduced sesame yield when compared with the untreated check.

The highest dry matter production per plant at harvest (29.95 g/plant) was recorded in weed free check (T_2) and was followed by recommended practice (T_3). The next best treatments were quizalofop ethyl 5 EC @ 40 g a.i. ha^{-1} as POE application at 20 DAS + IC at 45 DAS (T_7) and butachlor 50 EC @ 1 kg a.i. ha^{-1} as PRE application + HW at 30 DAS + IC at 45 DAS (T_6) which were on par with each other.

Table 1. Effect of weed control treatments on weed density, dry weight of weeds, weed control efficiency, weed index, crop phytotoxicity, dry matter production and uptake of NPK by weeds

Tr. No.	Treatment	Weed density/ m^2 at harvest	Dry wt of weeds at harvest (g/m^2)	WI (%)	WCE (%)	Crop phytotoxicity ratings		DMP (g/plant) at harvest	Uptake by weeds (kg/ha)		
						19 DAS	29 DAS		N	P	K
T_1	Unweeded check	122.00 (11.09)	238.87 (2.38)	68.95	0.00	-	-	16.24	35.00	5.90	32.67
T_2	Weed free check (HW at 15 DAS + IC at 30 and 45 DAS)	0.00 (1.00)	0.00 (0.30)	0.00	100.00	-	-	29.95	0.00	0.00	0.00
T_3	Recommended practice (Alachlor 50 EC @ 0.75 kg a.i. ha^{-1} as PRE application + HW at 30 DAS + IC at 45 DAS)	41.66 (6.53)	61.53 (1.80)	16.89	74.24	0.00	-	26.80	7.23	1.80	6.17
T_4	Pendimethalin 30 EC @ 1 kg a.i. ha^{-1} as PRE application + HW at 30 DAS + IC at 45 DAS	67.34 (8.31)	97.37 (2.00)	52.71	59.23	0.33	-	22.87	10.57	2.70	9.57
T_5	Pendimethalin 38.7 CS @ 1 kg a.i. ha^{-1} as PRE application + HW at 30 DAS + IC at 45 DAS	62.00 (7.94)	93.85 (1.98)	51.78	60.70	0.67	-	23.68	10.48	2.50	9.23
T_6	Butachlor 50 EC @ 1 kg a.i. ha^{-1} as PRE application + HW at 30 DAS + IC at 45 DAS	49.33 (7.09)	83.36 (1.93)	36.20	60.91	0.00	-	25.13	8.23	2.30	8.17
T_7	Quizalofop ethyl 5 EC @ 40 g a.i. ha^{-1} as POE application at 20 DAS + IC at 45 DAS	44.67 (6.78)	69.67 (1.84)	28.95	70.83	-	0.00	25.45	8.17	2.23	7.83
T_8	Imazethapyr 10 SL @ 75 g a.i. ha^{-1} as POE application at 20 DAS + IC at 45 DAS	54.67 (7.46)	85.10 (1.94)	85.11	64.26	-	8.00	9.62	8.35	2.36	8.43
	S.Em.±	0.11	0.01	4.12	1.02	-	-	0.46	0.45	0.17	0.65
	C.D. at 5%	0.34	0.04	12.50	3.08	-	-	1.41	1.37	0.52	1.97

Figures in the parentheses are $\sqrt{x+1}$ transformations

EC- Emulsifiable concentrate, CS- Capsular suspension, SL- Soluble liquid, HW- Hand weeding, IC- Intercultivation, DAS- Days after sowing, PRE- Pre-emergence- POE- Post-emergence

Unweeded check (T_1) recorded significantly higher uptake of nutrients by weeds (35.00, 5.96 and 32.67 kg N, P_2O_5 and K_2O ha^{-1}, respectively) over all other treatments (Table 1). This might be due to the profused growth of weeds during the crop growth. Similar findings were reported for NPK uptake by weeds in sesame (Bhadauria *et al.,* 2012). Among the herbicidal treatments, the lowest nutrient removal by weeds (7.23, 1.80 and 6.17 kg N, P_2O_5, K_2O ha^{-1}, respectively) was found to be in recommended practice (T_3) and was followed by quizalofop ethyl 5 EC @ 40 g a.i. ha^{-1} as POE application at 20 DAS + IC at 45 DAS (T_7). This might be due to lower weed population and dry weight of weeds during the crop growth period.

The highest number of capsules per plant (31.67), number of seeds per capsule (38.33), seed yield (588 kg ha^{-1}), stalk yield (2520 kg ha^{-1}) and harvest index (0.19) were recorded in weed free check and was followed by alachlor 50 EC @ 0.75 kg a.i. ha^{-1} as PRE application + HW at 30 DAS + IC at 45 DAS (T_3) and quizalofop ethyl 5 EC @ 40 g a.i. ha^{-1} as POE application at 20 DAS + IC at 45 DAS (Table 2). This might be due the application of herbicide and cultural practices resulting in reduced crop weed competition and creating good environment for better growth of plant which gave higher yield of sesame. Similar results were reported by Parvender Sheoran *et al.* (2012) and Bhadauria *et al.* (2012a). The lowest seed yield (86.00 kg ha^{-1}) was recorded in imazethapyr 10 SL @ 75 g a.i. ha^{-1} as POE application at 20 DAS + IC at 45 DAS (T_8) due to severe phytotoxic effect on the crop. Unweeded check (T_1) recorded the next lowest (179.67 kg ha^{-1}) seed yield due to severe weed competition with sesame which resulted in stunted growth and lower yield.

Significantly higher net returns (₹ 42,982 ha^{-1}) was recorded in weed free check (Table 2) and was followed by recommended practice *i.e.,* alachlor 50 EC @ 0.75 kg a.i. ha^{-1} as PRE application + HW at 30 DAS + IC at 45 DAS (T_3) and quizalofop ethyl 5 EC @ 40 g a.i. ha^{-1} as POE application at 20 DAS + IC at 45 DAS (T_7). Joseph *et al.* (2006) reported that application of pre- or post-emergence herbicide followed by cultural practices recorded higher net returns of sesame. On the other hand, significantly lower net returns (₹ 11,816 ha^{-1}) was recorded in imazethapyr 10 SL @ 75 g a.i. ha^{-1} as POE application at 20 DAS + IC at 45 DAS (T_8) due to phytotoxicity of the chemical which led to reduced seed yield of sesame. The next lowest (₹ 2,012 ha^{-1}) net returns was recorded in unweeded check (T_1). This might be due severe crop weed competition as reflected in seed yield (180 kg ha^{-1}). This is in agreement with the findings of Kumar and Thakur (2005).

The highest BC ratio (2.56) was obtained from weed free check (T_2) and was followed by quizalofop ethyl 5 EC @ 40 g a.i. ha^{-1} as POE application at 20 DAS + IC at 45 DAS (T_7). The treatments like quizalofop ethyl 5 EC @ 40 g a.i. ha^{-1} as POE application at 20 DAS + IC at 45 DAS (T_7) and recommended practice (T_3) were on par with each other. Similar results were also reported by Bhadauria *et al.* (2012a) and

Table 2. Number of capsules per plant, number of seeds per capsule, seed yield, stalk yield, harvest index and economics of sesame as influenced by weed control treatments

Tr. No.	Treatment	Number of capsules per plant	Number of seeds per capsule	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	H I	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	BC ratio
T_1	Unweeded check	18.00	23.00	180	1267	0.12	19,548	21,560	2,012	1.10
T_2	Weed free check (HW at 15 DAS + IC at 30 and 45 DAS)	31.67	38.33	588	2520	0.19	27,618	70,600	42,982	2.56
T_3	Recommended practice (Alachlor 50 EC @ 0.75 kg a.i. ha^{-1}as PRE application + HW at 30 DAS + IC at 45 DAS)	29.00	34.33	480	2356	0.16	28,118	57,600	29,482	2.05
T_4	Pendimethalin 30 EC @ 1 kg a.i. ha^{-1} as PRE application + HW at 30 DAS + IC at 45 DAS	21.67	26.67	273	1683	0.14	28,755	32,800	4,045	1.14
T_5	Pendimethalin 38.7 CS @ 1 kg a.i. ha^{-1} as PRE application + HW at 30 DAS + IC at 45 DAS	22.67	27.33	283	1750	0.14	28,937	34,000	5,063	1.17
T_6	Butachlor 50 EC @ 1 kg a.i. ha^{-1} as PRE application + HW at 30 DAS + IC at 45 DAS	25.67	29.00	367	2100	0.15	28,194	44,000	15,806	1.56
T_7	Quizalofop ethyl 5 EC @ 40 g a.i. ha^{-1} as POE application at 20 DAS + IC at 45 DAS	27.00	31.33	410	2239	0.15	21,868	49,200	27,332	2.25
T_8	Imazethapyr 10 SL @ 75 g a.i. ha^{-1} as POE application at 20 DAS + IC at 45 DAS	13.73	19.00	86	713	0.10	22,176	10,360	-11,816	0.47
	S.Em.±	0.88	1.20	25	48	0.01	-	2952	2952	0.10
	C.D. at 5%	2.68	3.64	75	145	0.02	-	8956	8956	0.33

EC: Emulsifiable concentrate CS: Capsular suspension SL: Soluble liquid HW: Hand weeding IC: Intercultivation
DAS- Days after sowing, PRE- Pre-emergence, POE- Post-emergence, HI- Harvest index

Parvender Sheoran *et al.* (2012). The lowest BC ratio (0.47) was obtained with imazethapyr 10 SL @ 75 g a.i. ha^{-1} as POE application at 20 DAS + IC at 45 DAS (T_8) due to phytotoxic effect on crop and was followed by unweeded check (T_1).

Based on the above experimentation, it can be concluded that pre-emergence application of alachlor 50 EC @ 0.75 kg a.i. ha^{-1} + HW at 30 DAS + IC at 45 DAS produced significantly higher seed yield of sesame, gross and net returns.

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