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Short communication

Weed management in sesame with sequential application of herbicides

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Sesame (*Sesamum indicum* L.) is one of the most important oilseed crops next to groundnut, rapeseed and mustard in India. It is the oldest oilseed crop known to human being and used by man since antiquity. In India, sesame was cultivated in an area of 1.70 million hectares with a production of 0.68 million tonnes and average productivity of 402 kg/ha. Among the several constraints in sesame production, heavy weed infestation is one of the major factors limiting the yield of sesame. The loss of seed yield due to uncontrolled weed growth in sesame has been reported as high as 70% in sandy loam soils (Dungarwal *et al.* 2003). Pre-emergence application of pendimethalin 1000 g/ha is recommended for line sown sesame to control the weeds, but the selectivity of pendimethalin is mainly depends on soil type and depth of sowing of crop. In broadcasted sesame, most of the crop seeds are placed at shallow depth, hence applied pre-emergence herbicides comes in close contact with crop seeds results in phytotoxicity or stand loss of sesame. In order to achieve the broad spectrum and season long weed control in broadcasted sesame, the present experiment was undertaken to identify the suitable pre-and post-emergence herbicide in sandy loam soils.

A field experiment was conducted during summer season of 2015 at S.V. Agricultural College, Tirupati campus of Acharya N.G. Ranga Agricultural University, Andhra Pradesh. The soil of the experimental field was sandy loam in texture with low in organic carbon, available nitrogen and available phosphorus and medium in available potassium with a soil P^H of 6.4. The experiment was laid out in a randomized block design with eleven treatments and three replications. The treatments consisted of pre-emergence application of pendimethalin 750 g/ha, oxyfluorfen 75 g/ha, oxadiargyl 75 g/ha alone and sequential application of these pre-emergence herbicides with post-emergence herbicides *viz.*, quizalofop 50 g/ha and propaquizafop 60 g/ha applied at 20 DAS including two hand weedings at 20 and 40 DAS and unweeded check (Table 1). Sesame seed variety '*YLM-66*' at 7 kg/ha was broadcasted on 12th January, 2015 by mixing the seed with sand (1:3) for uniform distribution of seed. The crop was harvested on 9th April, 2015. The recommended dose of 60, 20 and 20 kg N, P_2O_5 and K_2O/ha was applied in the form of urea, single super phosphate and muriate of potash, respectively. The half of the dose of nitrogen along with entire dose of phosphorus and potassium were applied as basal at the time of sowing and the remaining half of the dose of nitrogen was top dressed at 30 DAS. The crop was irrigated whenever needed. The pre-and post-emergence herbicides were applied at one and 20 DAS, respectively with the help of knapsack sprayer fitted with flat fan nozzle by using spray fluid at 500 l/ha. The category wise weed density and dry weight of weeds associated with crop were recorded at harvest and subjected to square root ($\sqrt{x+0.5}$) transformation before statistical analysis. The economics was calculated on the basis of prevailing market price of sesame seed. All the recommended management practices, except weed management were adopted to raise the broadcasted sesame.

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Effect on weeds

The major weed flora observed in the experimental field was *Cyperus rotundus* (40.0%), *Commelina benghalensis* (10.0%), *Cleome viscosa* (8.0%), *Boerhavia diffusa* (5.0%), *Phyllanthus niruri* (5.0%), *Dactyloctenium aegyptium* (5.0%) and *Digitaria sanguinalis* (4.0%) in broadcasted sesame. The density and dry weight of grasses, sedges and broad-leaved weeds were significantly influenced by the application of pre-and post-emergence herbicides. Among the sequential application of herbicides, the lowest density and dry weight of grasses was recorded with pre-emergence application of pendimethalin 750 g/ha + quizalofop 50 g/ha applied at 20 DAS, which was statistically similar to pre-emergence application of pendimethalin 750 g/ha + propaquizafop 60 g/ha applied at 20 DAS. However, hand weeding twice at 20 and 40 DAS recorded

significantly lesser density and dry weight of grasses than rest of the weed management practices (Table 1). Pendimethalin controlled most of the annual grasses and broad-leaved weeds at the time of germination of weed seeds and the late coming grassy weeds were effectively controlled by application of quizalofop or propiquizafop. These results were in conformity with the findings of Sivasankar and Subramanyam (2011). The lowest density and dry weight of sedges and broad-leaved weeds were recorded with pre-emergence application of oxyfluorfen 75 g/ha + propiquizafop 60 g/ha or quizalofop 50 g/ha applied at 20 DAS and both the sequential application of herbicides were comparable with each other, among the chemical weed management practices. This might be due to effective control of annual sedges and broad-leaved weeds by the pre-emergence application of oxyfluorfen 75 g/ ha, which was more effective in suppressing the weed growth compared to pendimethalin 750 g/ha or oxadiargyl 75 g/ha. Pendimethalin 750 g/ha was failed to control *Commelina benghalensis* more effectively than rest of the pre-emergence herbicides tried. The lowest total weed dry weight with higher weed control efficiency was recorded with hand weeding twice at 20 and 40 DAS due to complete removal of all the categories of weeds more effectively including the tubers of *Cyperus rotundus* as it accounts for 40% of the total weed density in the experimental field. The next best weed management practice in recording lower weed dry weight and higher weed control efficiency was the pre-emergence application of oxyfluorfen 75 g/ha + quizalofop 50 g/ha applied at 20 DAS. These results were in conformity with the findings of Vafaei *et al*. (2013) in sesame. Pre-emergence application of oxadiargyl 75 g/ha alone or in combination with post-emergence herbicides *i.e*. quizalofop or propaquizafop applied at 20 DAS were not effective as that of oxyflurfen or pendimethalin alone or in combination with post-emergence herbicides applied in broad casted sesame.

Effect on crop

The yield components and seed yield of broadcasted sesame were significantly influenced by the sequential application of pre-and post-emergence herbicides (Table 2). The highest number of capsules/ plant, number of seeds/capsule, test weight and seed yield of sesame were recorded with two hand weedings at 20 and 40 DAS and it was closely followed by pre-emergence application of oxyfluorfen 75 g/ha + quizalofop 50 g/ha applied at 20 DAS. The yield increased in these weed management practices was 71.39% and 61.13% compared to unweeded check. This might be due to decreased competition for growth resources by weeds resulting

Table 1. Weed density, weed dry weight and weed control efficiency (%) as influenced by different pre-and post- emergence herbicides in broadcasted sesame

Treatment	Dose (g/ ha)	Time of application (DAS)	Weed density (no./ m^2)				Weed dry weight (g /m^2)				Weed control efficiency (%)
			Grasses	Sedges	BLWs	Total	Grasses	Sedges	BLWs	Total	
Pendimethalin	750	1	16.27 (4.23)	126.70 (11.36)	55.90 (7.54)	198.87 (14.19)	15.46 (4.00)	44.82 (6.75)	38.02 (6.14)	98.30 (9.98)	31.97 (34.41)
Oxyfluorfen	75	1	18.44 (4.50)	118.90 (11.01)	51.40 (7.23)	188.74 (13.83)	17.51 (4.24)	43.54 (6.65)	37.89 (6.13)	98.94 (10.01)	31.52 (34.13)
Oxadiargyl	75	1	22.67 (4.97)	130.60 (11.53)	60.8 (7.86)	214.07 (14.73)	19.62 (4.49)	45.02 (6.77)	38.24 (6.16)	102.88 (10.20)	28.80 (32.43)
Pendimethalin + quizalofop	750 + 50	1 + 20	6.01 (2.63)	76.80 (8.85)	39.40 (6.34)	122.21 (11.13)	3.91 (2.10)	32.60 (5.77)	32.42 (5.68)	68.93 (8.36)	52.30 (46.30)
Oxyfluorfen + quizalofop	75 + 50	1 + 20	7.89 (2.99)	64.30 (8.11)	30.10 (5.55)	102.29 (10.19)	4.57 (2.25)	29.50 (5.49)	23.78 (4.88)	57.85 (7.67)	59.97 (50.73)
Oxadiargyl + quizalofop	75 + 50	1 + 20	10.80 (3.47)	86.80 (9.41)	44.70 (6.75)	142.30 (12.01)	6.24 (2.60)	35.87 (6.05)	35.84 (5.96)	77.95 (8.89)	46.06 (42.72)
Pendimethalin + propaquizafop	750 + 60	1 + 20	6.82 (2.79)	80.90 (9.08)	38.40 (6.26)	126.12 (11.31)	4.08 (2.14)	33.94 (5.88)	34.92 (5.89)	72.94 (8.60)	49.53 (44.71)
Oxyfluorfen + propaquizafop	75 + 60	1 + 20	8.04 (3.02)	63.00 (8.02)	29.20 (5.47)	100.24 (10.09)	4.92 (2.33)	30.08 (5.55)	25.82 (5.08)	60.82 (7.86)	57.92 (49.54)
Oxadiargyl + propaquizafop	75 + 60	1 + 20	12.04 (3.66)	84.8 (9.30)	46.30 (6.86)	143.14 (12.05)	6.94 (2.73)	37.45 (6.18)	36.08 (5.99)	80.47 (9.03)	44.32 (41.72)
Two hand weedings	-	20 + 40	5.24 (2.47)	53.80 (7.42)	16.60 (4.15)	75.64 (8.77)	5.32 (2.41)	8.00 (2.92)	5.05 (2.33)	18.37 (4.36)	87.28 (69.26)
Unweeded check			44.8 (6.96)	147.20 (12.24)	92.40 (9.67)	284.40 (16.97)	42.75 (6.57)	51.05 (7.18)	50.72 (7.16)	144.52 (12.04)	-
LSD (P=0.05)			0.22	0.58	0.520	1.23	0.31	0.42	0.40	0.75	-

Figures in parentheses are the square root transformed ($\sqrt{x+0.5}$) values

Table 2. Effect of different pre-and post-emergence herbicides on yield attributes, seed yield and economics of broadcasted sesame during summer, 2015

Treatment	Dose (g/ha)	Time of application (DAS)	Number of capsules/ plant	Number of seeds/ capsule	Test weight (g)	Seed yield (kg/ ha)	Net returns (Rs./ha)	Benefit-cost ratio
Pendimethalin	750	1	30.6	43.2	2.80	554	13380	1.67
Oxyfluorfen	75	1	31.9	45.4	2.82	582	16310	1.88
Oxadiargyl	75	1	28.9	41.0	2.78	527	13044	1.70
Pendimethalin + quizalofop	750 + 50	1 + 20	35.2	52.5	2.90	752	22990	2.04
Oxyfluorfen + quizalofop	75 + 50	1 + 20	37.2	59.0	2.93	784	26160	2.25
Oxadiargyl + quizalofop	75 + 50	1 + 20	33.6	48.4	2.85	677	19774	1.95
Pendimethalin + propaquizafop	750 + 60	1 + 20	34.8	51.2	2.89	751	23200	2.06
Oxyfluorfen + propaquizafop	75 + 60	1 + 20	36.8	57.4	2.92	779	26130	2.27
Oxadiargyl + propaquizafop	75 + 60	1 + 20	33.1	47.2	2.84	666	19384	1.94
Two hand weedings	-	20 + 40	40.1	61.4	2.98	833	24620	1.97
Unweeded check			25.4	38.9	2.76	486	11500	1.65
LSD (P=0.05)			0.53	1.65	0.05	25.0	1115	0.03

in better photosynthesis and resultant partitioning in crop manifested to increase all the yield components. These results were in conformity with those of Sootrakar *et al.* (1995). The highest net returns were obtained with pre-emergence application of oxyfluorfen 75 g/ha + quizalofop 50 g/ha applied at 20 DAS and the highest benefit-cost ratio was obtained with pre-emergence application of oxyfluorfen 75 g/ ha + propaquizafop 60 g/ha applied at 20 DAS and both the weed management practices obtained maximum net returns and benefit-cost ratio than hand weeding twice due to reduced cost of cultivation and increased seed yield. Among the herbicidal treatments, the lowest yield components, seed yield and net returns were recorded with pre-emergence application of oxadiargyl 75 g/ha alone or in combination with quizalofop/propiquizafop due to reduced stature of yield components as a result of poor weed control. Further, pre-emergence application of oxadiargyl 75 g/ha showed phytotoxicity rating of 4.0 in 0-10 scale where, '0' indicates no injury and normal growth and '10' indicates complete destruction of broadcasted sesame. Nethra and Jagannath (2011) also reported the phytotoxicity effect of oxadiargyl on germination and early seedling growth of sunflower and maize.

SUMMARY

A field experiment was conducted at S.V. Agricultural College Farm, Tirupati during summer, 2015 in a randomized block design with eleven weed management practices consisting of pre-emergence application of pendimethalin 750 g/ha, oxyfluorfen 75 g/ha, oxadiargyl 75 g/ha alone and in combination with post-emergence application of quizalofop 50 g/ha and propaquizafop 60 g/ha at 20 DAS, two hand weedings and unweeded check. The lowest density and dry weight of weeds with higher weed control efficiency, higher stature of yield components and seed yield of broadcasted sesame were registered with two hand weedings at 20 and 40 DAS. The next best weed management practice for broad spectrum weed control and increased seed yield of broadcasted sesame was with pre-emergence application of oxyfluorfen 75 g/ha + quizalofop 50 g/ha applied at 20 DAS. Pre-emergence application of oxadiargyl 75 g/ ha alone or in combination with post-emergence herbicides failed to control the weeds as the pre-emergence application of oxadiargyl recorded phytotoxicity rating of 4.0 on sesame seedlings in 0-10 scale in sandy loam soils.

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