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RESEARCH NOTE

Weed management in sesame using herbicides with and without soil mulch in lateritic soil of West Bengal

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ABSTRACT

A field experiment was conducted during the pre-*Kharif* season of 2020 at the Agricultural Farm of the Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal with sesame variety '*Rama*' to study the weed growth and productivity of summer sesame as influenced by herbicides under two soil mulch practices. A split plot design with three replications was used for experimentation. Two soil mulch practices comprising of sowing after pre-sowing irrigation (soil mulch) and sowing followed by (*fb*) irrigation (no mulch) were allocated in the main plots and six weed managements treatments in sub-plots, *viz.* pre-emergence application (PE) of pendimethalin 1.0 kg/ha; early post-emergence application (EPoE) of fenoxaprop-p-ethyl at 60 g/ha 18 days after seeding (DAS); pretilachlor 450 g/ha PE; propaquizafop 60 g/ha EPoE at 18 DAS; untreated control and weed free check. Sesame was infested with ten weed species with predominance of grassy weeds (60.23%).Total weed density and total weed biomass at 45 DAS were reduced by 24.70% and 25.18%, respectively, under soil mulch compared to no mulch. Soil mulch recorded 12.99% higher sesame seed yield, over no mulch. Similarly, fenoxaprop-ethyl 60 g/ha EPoE, pendimethalin1.0 kg/ha PE and propaquizafop 60 g/ha EPoE produced higher sesame seed yield than other tested herbicidal treatments. Soil mulch sowing of sesame along with fenoxaprop-p-ethyl 60 g/ha EPoE or propaquizafop 60 g/ha EPoE gave effective weed management and higher sesame seed yield, specially in the fields having predominance of grassy weeds in lateritic soil of West Bengal.

Keywords: Fenoxaprop-p-ethyl, Grassy weeds, Pendimethalin, Propaquizafop, Quizalofop-p-ethyl, Sesame, Soil mulching, Weed management

Sesame, often referred to as *til*, is mainly cultivated in pre-*Kharif* season in India during warm and humid months of the year, primarily for its oil and used as a flavoring agent (Andargie *et al.* 2021). As part of the global trend towards healthier plant-based food sources, there has been a recent increase in demand for sesame grains and their byproducts. Worldwide, 7.17 million ton of sesame is produced in an area of 13.10 million ha with an average yield of 864.6 kg/ha (FAO 2022). Whereas, in India, the production is about 0.78 million ton with an area of 1.62 million ha (FAO 2022).

Weed infestation is regarded as one of the most important biotic factors responsible for low productivity of sesame. Slow early crop growth, high temperature, frequent rainfall and adequate soil moisture provide conducive environment to weeds to emerge and exploit the sesame habitat. In most of the areas sesame crop is heavily infested by weeds and thereby resulting in heavy yield loss ranging from 16-68% (Duary and Hazra 2013, Hazra and Duary 2015). Continuous application of the same herbicides year after year in the same crop in the same field may lead to shifting of weed flora and development of herbicides resistance in weed (Duary 2008). Proper and timely management of weeds, by manual weeding, in the crop field to reduce the crop-weed competition is difficult due to a sharp increase in the wages and unavailability of labor. Integrated weed management may help to keep the weed population below threshold level (Rao and Nagamani 2010). Use of stale seedbed technique, tillage practices, making the crop more competitive with the use of competitive varieties, use of crop residue as mulch are nowadays the major components of integrated weed management. Mulching is also one of the important components of integrated weed management in sesame (Fatima and Duary 2020, Fatima *et al.* 2021). Soil mulching is a simple management that uses pre-sowing irrigation followed

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by (*fb*) shallow tillage (which breaks soil capillaries and creates soil mulch) before sesame sowing to attain better weed control, limit evaporation losses and reduce the early irrigation requirement. In contrast, seeding in dry soil *fb* irrigation would require frequent irrigation because of high evaporation losses through soil capillaries in late April-May when the soil temperature is very high (~40° C). Although irrigation immediately after sowing facilitates good crop emergence, it also favors establishment of weeds along with the sesame. In contrast, when soil mulching is used, it is hypothesized that the top 2 cm of the soil layer in which most of the weeds establish dries quickly, and weed establishment is reduced; moisture below 2 cm is conserved, enabling good sesame establishment and reducing the need for early irrigation. There is also a scope of integrating herbicides with cultural practices to improve the sustainable use of herbicides. With this perspective the present experiment was conducted to study the effect of soil mulch sowing and weed management on weed growth and productivity of summer sesame.

A field experiment was conducted during pre-*Kharif* season, 2020 in the Agricultural Farm of the Institute of Agriculture, Visva-Bharati, Sriniketan, Birbhum, West Bengal. The field is situated at about $23^0$39.8232 N latitude and $87^0$37.9722 E longitude with an average altitude of 60 m above the mean sea level. The soil of the experimental site was sandy loam (Ultisol) in texture, medium to low fertility (available N-150.60 kg/ha, available P-29.13 kg/ha, available K-122.47 kg/ha with acidic reaction (pH 5.88). The field experiment was laid out in split-plot design (SPD) assigning two soil mulch practices in main plots and six weed management practices in sub-plots, replicated thrice. All the treatment plots were demarcated by ridges (bunds) on all sides (15 cm high). Two soil mulch practices comprising of sowing after pre-sowing irrigation (soil mulch) and sowing followed by irrigation (no soil mulch) were allocated in the main plot and six weed management treatments, *viz*. pre-emergence application (PE) of pendimethalin 1.0 kg/ha, early post-emergence application (EPoE) of fenoxaprop-p-ethyl 60 g/ha at 18 DAS , pretilachlor 450 g/ha PE, propaquizafop 60 g/ha EPoE at 18 days after seeding (DAS), untreated control and weed free check in sub-plots. The sesame variety '*Rama*' ('Improved Selection-5') was used in the experiment. This variety was developed from the Pulses and Oilseeds Research Station, Berhampur, West Bengal. Sesame was sown in lines manually on 2^{nd} fortnight of March, 2020 with a row spacing of 30 cm. The plant-to-plant distance was later maintained about 10 cm by thinning additional plant. The recommended doses of fertilizers (80:40:40 N:P:K kg/ha) were applied through urea, single super phosphate (SSP) and muriate of potash (MOP). Half quantity of nitrogen and full amount of phosphorus and potassium were applied in each plot as basal during final land preparation. Rest half quantity of N was applied at 21 DAS. Growth parameters and yield attributes were recorded at different growth stages of the crop. All the herbicides were applied using 500 liters of water/ha by spraying uniformly in the experimental plots as per treatments with the help of power operated knapsack sprayer. The population of grasses, sedges and broad-leaved weeds was counted by placing quadrat (0.25/m^2 area) randomly at four places and the density (no./m^2) was estimated. Weed species within the area of quadrat were counted, collected and air dried in hot air oven maintained at 70 to 75ºC temperature for recording weed biomass. The data were subjected to a square root transformation to normalize their distribution. The experimental data were analyzed statistically by the technique of "Analysis of variance" and significance was tested by variance ratio *i.e*. value at 5% level of significance as described by Gomez and Gomez (1984).

Effect on weeds

Sesame was infested with ten weed species out of which *Cynodon dactylon, Digitaria sanguinalis, Echinochloa colona* and *Dactyloctenium aegyptium* were grasses; *Cyperus iria* was the sedges; *Indigofera hirsuta, Hedyotis corymbosa, Ludwigia parviflora, Mollugo stricta* and *Malvastrum coromandelianum* were the broad-leaved weeds predominant throughout the cropping period. There was predominance of grassy weeds in the experimental field. Irrespective of herbicidal treatments, total weed density was significantly the lowest under sowing after pre-sowing irrigation (soil mulch) method. At 45 DAS, total weed density was 24.70% lower (**Table 1**) under the sowing with soil mulch method than in no soil mulch sowing. Weedy check plots registered the highest total weed density at 45 DAS and there was preponderance of grasses (60.23%), followed by broad-leaved weeds (26.82%) and sedges (12.81%) (**Table1**). Among different weed management practices, propaquizafop 60 g/ha EPoE was found to be significantly superior over the others in reducing the density of grasses at 45 DAS.

With regard to lowering down the broad-leaved weed density at 45 DAS, pretilachlor at 450 g/ha PE was most effective. Total weed density at 45 DAS was lowest with propaquizafop 60 g/ha early PoE which was statistically at par with pendimethalin 1.0 kg/ha PE and fenoxaprop ethyl at 60 g/ha EPoE.

At 45 DAS, the grass, broad-leaved, sedge and total weed biomass was lower by 27.63, 21.79, 23.61 and 25.18%, respectively under the soil mulch method than no soil mulch method (**Table 1**). Propaquizafop 60 g/ha EPoE significantly reduced the grassy and total weed biomass at 45 DAS and was on par with fenoxaprop-ethyl 60 g/ha EPoE (**Table 1**). Among herbicide treatments, broad-leaved weeds biomass at 45 DAS was significantly reduced with pretilachlor 450 g/ha PE. Sedges were numerically and significantly lower at 45 DAS with pendimethalin 1.0 kg/ha PE (**Table 1**). Grasses, broad-leaved and sedges together accumulated the highest total biomass at 45 DAS under weedy check, and their contributions to total weed biomass was 55.98, 29.12 and 14.69%, respectively (**Table 1**).

Interaction effect between sowing method and weed management practices on weed density and biomass was found significant at 45 DAS. Density of total weeds was 23.44% lower with propaquizafop under soil mulch sowing than in no soil mulch sowing. Similarly, 19.45% lower density of total weeds was observed with fenoxaprop-p-ethyl under soil mulch sowing than in no soil mulching sowing (**Figure 1**). Biomass of total weed was 21.80% lower

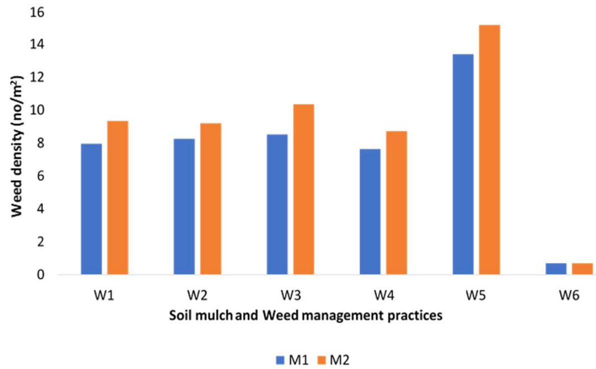

Figure 1. Interaction effect of soil mulch sowing and weed management practices on total weed density at 45 DAS

W1= Pendimethalin1.0 kg/ha PE; W2=Fenoxaprop-ethyl 60g/ha EPoE; W3 =Pretilachlor 450 g/ha PE; W4 =Propaquizafop 60 g/ha EPoE; W5 = Untreated control; W6 = Weed free check; M1 =Soil mulch sowing; M2 =No soil mulch sowing

with fenoxaprop-p-ethyl under soil mulch sowing than in no soil mulching sowing. Propaquizafop under soil mulch sowing method registered 22.01 % lower total weed biomass than in no soil mulching sowing (**Figure 2**). The results are in conformity with Fatima and Duary (2020) and Fatima *et al.* (2021).

Effect on sesame

The plant height at harvest stage of sesame was 6.25% higher (**Table 2**) under soil mulch sowing method in comparison to sowing followed by irrigation method. This might be probably due to suppression of weed seed germination by soil

Table 1. Effect of soil mulch and weed management treatments on weed density and biomass at 45 DAS

Treatment	Weed density (no./m^2) at 45 DAS**				Weed biomass (g/m^2)** at 45 DAS			
	Grass	Broad-leaved	Sedges	Total	Grass	Broad-leaved	Sedges	Total
Soil mulch								
Sowing after pre-sowing irrigation (soil mulch sowing)	5.82 (33.32)	4.59 (20.58)	2.10 (3.92)	7.75 (59.56)	6.00 (35.47)	5.04 (24.88)	2.45 (5.50)	8.28 (68.12)
Sowing followed by (*fb*) irrigation (no soil mulch)	6.68 (44.07)	5.32 (27.76)	2.32 (4.89)	8.92 (79.10)	7.04 (49.01)	5.68 (31.81)	2.77 (7.20)	9.57 (91.05)
LSD (p=0.05)	0.80	0.62	0.41	0.41	0.69	0.49	0.31	0.66
Weed management treatment								
Pendimethalin 1.0 kg/ha PE	7.11 (50.05)	4.98 (24.35)	0.71 (0.00)	8.66 (74.48)	7.60 (57.29)	5.61 (30.98)	0.71 (0.00)	9.43 (8839)
Fenoxaprop-p-ethyl 60 g/ha EPoE	5.74 (32.39)	5.98 (35.28)	2.90 (7.90)	8.73 (75.71)	5.52 (29.95)	6.42 (40.78)	4.00 (15.54)	9.32 (86.42)
Pretilachlor 450 g/ha PE	8.34 (68.99)	4.48 (19.53)	0.71 (0.00)	9.45 (88.71)	8.79 (76.81)	4.94 (23.88)	0.71 (0.00)	10.07 (100.82)
Propaquizafop 60 g/ha EPoE	4.48 (19.61)	6.15 (37.30)	3.09 (9.04)	8.18 (66.48)	5.29 (27.45)	6.40 (40.44)	3.78 (13.76)	9.08 (81.98)
Untreated control	11.10 (122.79)	7.42 (54.63)	5.16 (26.10)	14.29 (203.72)	11.19 (124.82)	8.09 (64.94)	5.77 (32.75)	14.95 (222.98)
Weed free check	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
LSD (p=0.05)	0.56	0.48	0.39	0.57	0.54	0.49	0.54	0.64

*PE = pre-emergence application; EPoE = early post-emergence application; **Figures in parentheses are the original values and the data were transformed to SQRT ($\sqrt{x+0.5}$) before analysis; DAS = days after seeding; PE = pre-emergence; EPoE = early post-emergence.

mulching resulting in less weed competition and higher nutrient uptake and greater light interception by sesame. Propaquizafop 60 g/ha EPoE recorded the highest (**Table 2**) plant height and it was comparable with pendimethalin 1.0 kg/ha PE and fenoxaprop ethyl 60 g/ha EPoE. The untreated control recorded the lowest plant height, which might be due to severe competition exerted by grassy, broad-leaved and sedge weeds throughout the growth period of sesame by shading of weeds or overcrowding in crop-weed ecosystem and competing with the crop for space, light and nutrients. Propaquizafop or fenoxaprop-p-ethyl EPoE and pendimethalin PE were able to check the weed growth, mainly grassy weeds, which were predominant, from initial stage of crop growth and for a quite long period of time reducing weed competition and creating a favorable condition of crop growth. Similar results were also reported by Fatima and Duary (2020) and Fatima *et al.* (2021) in summer sesame in lateritic belt of West Bengal.

Soil mulch sowing method registered higher seeds/capsule, number of capsules/plants than sowing followed by no soil mulch sowing method. The plant height at harvest stage of sesame was 6.25% higher and number of capsules/plants was 17.97% higher (**Table 2**) under soil mulch sowing method than under no soil mulch sowing. There was no significant difference between sowing methods in test weight of sesame. However, test weight differed significantly due to weed management practices (**Table 2**). The highest test weight of sesame was observed under weed free treatment which was significantly superior over untreated control. All other weed management practices were on par with weed free treatment with respect to test weight. Fenoxaprop-ethyl 60 g/ha EPoE registered the highest

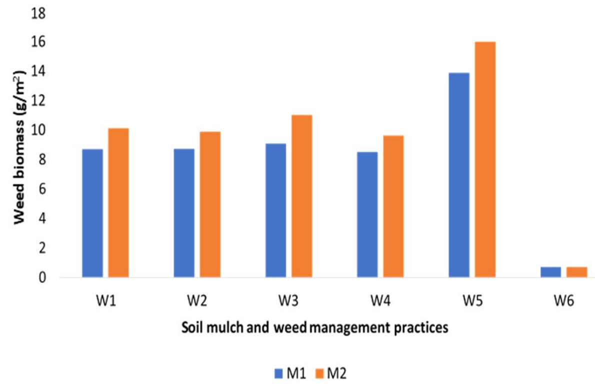

Figure 2. Interaction effect of soil mulch sowing and weed management treatments on total weed biomass at 45 DAS

W1= Pendimethalin1.0 kg/ha PE; W2= Fenoxaprop-ethyl 60 g/ha EPoE; W3 = Pretilachlor at 450 g/ha PE; W4 = Propaquizafop at 60 g/ha EPoE; W5 = Untreated control; W6 = Weed free check; M1 =Soil mulch sowing; M2 =No soil mulch sowing

number of seeds per capsule, number of capsules/plants and it was at par with that of pendimethalin 1.0 kg/ha PE and propaquizafop 60 g/ha EPoE (**Table 2**). This indicates that efficient and timely weed management practices by application of either pre-emergence or early post emergence herbicide effectively controlled dominant weeds appearing in early stage of crop growth which promoted branches and capsule formation of sesame, growth attributes and partitioning dry matter towards seed formation.

Seed and stick yield of sesame under soil mulch sowing method was about 12.99 and 12.85% higher (**Table 2**) than under the no soil mulch sowing, probably due to better weed control with soil mulching. Among weed management treatments, irrespective of the sowing method, seed and stick yield were the highest with fenoxaprop-p-ethyl 60 g/

Table 2. Effect of soil mulch and weed management treatments on plant height, yield attributes and yield of sesame

Treatment	Plant height at harvest (cm)	Capsules / plant	Seeds/ capsule	Test weight (g)	Seed yield (kg/ha)	Stick yield (kg/ha)
Soil mulch						
Sowing after pre-sowing irrigation (soil mulch sowing)	118.3	77.9	53.3	2.95	1239	2233
Sowing followed by (*fb*) irrigation (no soil mulch)	110.9	63.9	46.7	2.85	1078	1946
LSD(p=0.05)	6.95	11.9	4.5	0.49	136.5	208.2
Weed management treatments						
Pendimethalin 1.0 kg/ha PE	119.2	82.4	51.3	2.89	1225	2172
Fenoxaprop-ethyl 60 g/ha EPoE	117.3	79.5	52.7	2.87	1275	2241
Pretilachlor 450 g/ha PE	109.0	61.7	43.5	2.86	1017	1863
Propaquizafop 60 g/ha EPoE	122.0	66.7	50.3	2.87	1158	2099
Untreated control	91.7	44.8	35.8	2.40	768	1567
Weed free check	128.1	90.3	66.3	2.97	1508	2595
LSD (p=0.05)	6.22	7.89	3.11	0.44	125.8	215.6

*PE = pre-emergence application; EPoE = early post-emergence application ha EPoE which was statistically on par with pendimethalin 1.0 kg/ha PE and propaquizafop 60 g/ha EPoE. The sesame seed and stick yield increased considerably with weed management confirming the findings of Fatima and Duary (2020) in sesame.

Conclusion

Based on one season experiment, it can be concluded that sowing of sesame after pre-sowing irrigation (soil mulch sowing), as a cultural practice, has promising effect of reducing weed growth. Sowing of sesame after pre-sowing irrigation (soil mulch) along with either fenoxaprop-p-ethyl 60 g/ha EPoE or propaquizafop-p-ethyl 60 g/ha EPoE at 18 days after sowing were found effective in managing weeds and increasing yield of sesame in lateritic soil of West Bengal specially in the fields having predominance of grassy weeds.

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