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RESEARCH ARTICLE

Weed management in yellow mustard using herbicide and weed mulch in lateritic soil of West Bengal

Koushik Sar[1], B. Duary* and Avishek Pradhan

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ABSTRACT

A field experiment was conducted during 2018-19 and 2019-20 at Agriculture Farm, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal with the objective to study the integrated use of herbicide and weed mulch on weed growth and yield of yellow mustard. The soil of the experimental field was sandy loam in texture. The experiment comprising of seven treatments *viz.* pre-emergence (PE) application of pendimethalin at 0.75 kg/ha, mulching with *Eichhornia crassipes* (water hyacinth) at 15 t/ha, mulching with *Antigonon leptopus* (coral vine) at 4 t/ha, pendimethalin as PE at 0.75 kg/ha followed by mulching with *Eichhornia crassipes* (water hyacinth) at 15 t/ha , pendimethalin as PE at 0.75 kg/ha followed by mulching with *Antigonon leptopus* (coral vine) at 4 t/ha , weedy check and weed free was laid out in a randomized block design with three replications. Result revealed that pendimethalin as PE at 0.75 kg/ha followed by mulching with *Eichhornia crassipes* (water hyacinth) at 15 t/ha recorded the lower values of total weed density (5.76 and 7.01 no/m^2) and biomass (5.04 and 4.82 g/m^2) at 45 DAS and higher seed yield of 1250 and 1183 kg/ha in first and second year, respectively.

Keywords: Coral vine, higher yield, pendimethalin, water hyacinth, weed biomass, weed density

INTRODUCTION

Edible oil crops are highly significant in India's agriculture and industrial economy. India has the unpleasant distinction of being the world's largest producer, consumer, and importer of edible oil despite being the leading producer of vegetable oil globally. If the production potential of our annual edible oilseed crops is utilised through improved weed and nutrient management technology, India could eventually become self-sufficient in edible oil. Weed infestation is one of the main causes of low productivity of mustard (Singh *et al*. 2013). Weed management focuses on reducing weed growth and competition below the economical injury level in order to increase the yield and enhance the profit. Farmers need efficient weed management practices that offer a quick response to produce more. But not many management practices are available except the use of manual weeding or chemical herbicides. Manual weeding is labor intensive and tiresome. The dominance of chemical control in weed management also raises concerns that weeds are adapting to this control and that few proven alternatives are available where their effects diminish. For example, weeds are more likely to evolve resistance to herbicides where herbicide use is more intense (Duary 2008 and Duary *et al*. 2015a). Much work has not been done in this field to devise any method of weed management that would be cheap as well as feasible to be used by the local farmers and that would not have any harmful effect on the environment. Considering the ubiquity, diversity, plasticity and adaptability of weeds, it seems impossible that any single weed control technique, including herbicides, will prove to be a lasting panacea for weed management. Integrated weed management (IWM) explicitly calls for combining an array of chemical, cultural and mechanical control tools and techniques. This approach can prevent weeds from adapting and lead to successful long-term control. Mulching may be one of the important components of IWM in mustard. Use of locally available weeds as bio-organic mulch to suppress the growth of other weeds is a vital option. There is also scope of integrating herbicides with cultural practices to improve the sustainable use of herbicides. There are pre-emergence herbicides successfully used in mustard such as fluchloralin, pendimethalin, *etc*. Alternative weed management practices like use of straw and weed mulch as a component in IWM have been found effective in direct seeded rice, wheat and oilseed crops like sesame in eastern India (Fatima and Duary 2020,

Department of Agronomy, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal 731236, India

[1] Department of Agronomy, IAS, Siksha 'O' Anusandhan, Bhubaneswar, Odisha 751030, India

* Corresponding author email: bduary@yahoo.co.in

Fatima *et al*. 2020, Fatima *et al*. 2021, Malik *et al*. 2021, Kumar *et al*. 2023, Jaiswal *et al*. 2023, Jaiswal *et al*. 2024). Keeping this in view, a field experiment was carried out to study the effect of herbicide and weed mulch on weed growth and yield of yellow mustard.

MATERIALS AND METHODS

A field experiment was conducted during 2018-19 and 2019-20 at Agriculture Farm, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal (India). The soil of the experimental field was sandy loam in texture with acidic in reaction (pH 5.8), low in organic C (0.41%) and available N (145.4 kg/ha), high in available P (33.53 kg/ha) and medium in available K (133.94 kg/ha). The experiment comprising of seven treatments, *viz*. pre-emergence (PE) application of pendimethalin at 0.75 kg/ha, mulching with *Eichhornia crassipes* (water hyacinth) at 15 t/ha, mulching with *Antigonon leptopus* (coral vine) at 4 t/ha, pendimethalin as PE at 0.75 kg/ha followed by mulching with *Eichhornia crassipes* (water hyacinth) at 15 t/ha, pendimethalin as PE at 0.75 kg/ha followed by mulching with *Antigonon leptopus* (coral vine) at 4 t/ha, weedy check and weed free, was laid out in a randomized block design with three replications. The mulching was done by spreading water hyacinth and coral vine in between rows at 12 DAS. The seeds of yellow mustard variety "*B-9*" were sown on November 16, in both the years (2018-19 and 2019-20) using a seed rate of 6 kg/ha at a distance of 30 cm in rows. Plant to plant distance of 10 cm was maintained by thinning after 15 days of sowing. Recommended N, P and K at 80:40:40 kg/ha in yellow mustard were applied as per recommended practice. Source of N, P and K was urea, single super phosphate and muriate of potash, respectively. Herbicide was applied with the help of hand operated knapsack sprayer fitted with a flat fan type nozzle at 1 DAS. All other recommended agronomic practices were followed and plant protection measures were adopted as per need. Weed density was recorded by placing 50 x 50 cm quadrats from the marked sampling area in each plot and after drying them in hot air oven at 70° C, weed biomass was recorded. The data were subjected to a square root transformation to normalize their distribution. Yield attributes and seed yield of yellow mustard was recorded at harvest and statistically analyzed at a 5% level of significance. Weed control efficiency (%) was computed using the dry weight (biomass) of different category of species.

RESULTS AND DISCUSSION

Effect on weeds

Yellow mustard was infested with six weed species out of which 3 were monocots and 3 dicots. *Digitaria sanguinalis*, *Echhinochloa colona* and *Cynodon dactylon* among monocots and *Polygonum plebeium*, *Gnaphalium purpureum* and *Eclipta alba* among dicots were predominant weeds in the experimental field during both the years. *Digitaria sanguinalis* and *E. colona*, among the grasses and *Anagallis arvensis* and *Chenopodium album*, among the broadleaved weeds were the predominant weeds in yellow mustard (Teja and Duary 2018).

Pendimethalin at 0.75 kg/ha followed by mulching with water hyacinth registered significantly lower density and biomass of monocots, dicots and total weeds at 45 DAS during both the year and was at par with pendimethalin at 0.75 kg/ha followed by mulching with *Antigonon leptopus* (**Table 1**). Sole application of pendimethalin at 0.75 kg/ha performed better to control of monocot weeds during both the years and it was at par with mulching with *Eichhornia crassipes* and *Antigonon leptopus* (**Table 1**). Pendimethalin alone reduced the density of monocots weeds by 67.05 and 69.00% in first and second year, respectively. But it was less effective against dicot weeds.

Mulching with *Eichhornia crassipes* was reasonably effective in controlling dicots during both the years and it was on par with mulching with *Antigonon leptopus* (**Table 1**). Use of weed mulch alone reduced the total weed density by 51.89-54.46% and biomass by 62.57-67.45%, in the first and second year, respectively. Choudhary and Kumar (2014) reported that mulched plot registered the least weed parameters.

Integrated use of pre-emergence herbicide pendimethalin at 0.75 kg/ha followed by mulching water hyacinth or *Antigonon* reduced the density of monocot by 75.92-80.15%, dicots by 51.08-69.47% and total weeds by 66.39-75.82% in first and second year, respectively. Sole application of herbicide pendimethalin or weed mulch did not exhibit broad spectrum management of weeds. Thus, it can be emphasised that integration of both herbicide and weed mulch can give broad spectrum management of weeds. Similar results of integrated use of herbicide and other methods were also reported by Duary *et al.* (2014), Fatima and Duary, (2020), Fatima *et al*. (2020), Fatima *et al*. (2021), Malik *et al*. (2021), Kumar *et al*. (2023), Jaiswal *et al*. (2023) in sesame and direct seeded rice.

The highest density and biomass of monocots and dicots were recorded in weedy plots, whereas lowest density and biomass obtained in weed free plot at 45 DAS in both the years (**Table 1**). Duary *et al.* (2015b and 2016) and Sar and Duary (2022) also reported similar results.

Among the weed management practices, integrated use of herbicide pendimethalin at 0.75 kg/ ha and mulching with water hyacinth registered the highest weed control efficiency (WCE) at 45 days and closely followed by pendimethalin at 0.75 kg/ha followed by mulching with *Antigonon leptopus* during both the years (**Figure 1**).

Effect on crop

Number of siliquae / plant, seeds/siliqua, siliqua length and test weight were registered significantly higher with the integrated use of pendimethalin at 0.75 kg/ha and mulching with water hyacinth and it was at par with pendimethalin at 0.75 kg/ha followed by mulching with *Antigonon leptopus* during both the years **(Table 2)**. Pre emergence herbicide with mulching increased number of siliquae/plant and seeds/siliqua as reported by Raj *et al.* (2020).

All the weed management treatments significantly increased seed yield over unweeded control **(Table 2)**. Among the weed management treatments pendimethalin at 0.75 kg/ha followed by mulching with water hyacinth also registered significantly higher seed yield over other treatments during both the years and was at par with pendimethalin at 0.75 kg/ha followed by mulching with *Antigonon leptopus*. Mulching conserved soil moisture and increased in yield of mustard (Regar *et*

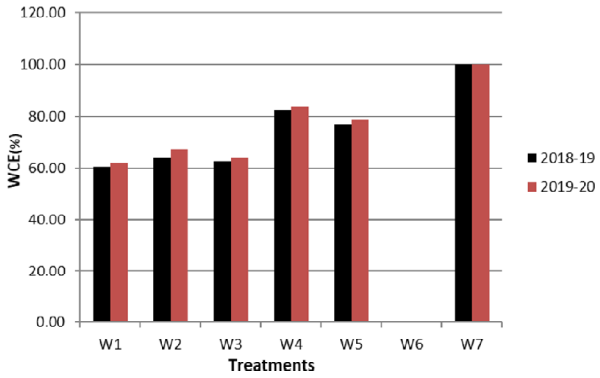
Table 1. Weed density and biomass in yellow mustard under different weed management practices at 45 DAS

Treatment	Weed density (no./m^2) at 45 DAS						Weed biomass (g/m^2) at 45 DAS					
	Monocots		Dicots		Total		Monocots		Dicots		Total	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Pendimethalin at 0.75 kg/ha	5.29 (27.67)	5.60 (31.00)	6.23 (38.33)	6.95 (48.00)	8.15 (66.00)	8.91 (79.00)	4.86 (23.39)	4.40 (19.06)	5.79 (33.14)	5.89 (34.14)	7.54 (56.53)	7.32 (53.20)
Mulching with *Eichhornia crassipes* (water hyacinth)	5.83 (33.67)	6.05 (36.33)	5.34 (28.00)	6.14 (37.33)	7.88 (61.67)	8.59 (73.67)	5.28 (27.49)	4.78 (22.42)	4.88 (23.50)	4.84 (23.57)	7.16 (50.99)	6.77 (45.99)
Mulching with *Antigonon leptopus* (Coral vine)	6.04 (36.00)	6.09 (36.67)	5.43 (29.00)	6.40 (40.67)	8.09 (65.0)	8.82 (77.33)	5.38 (28.59)	5.00 (24.59)	5.00 (24.65)	5.11 (25.65)	7.31 (53.24)	7.12 (50.24)
Pendimethalin at 0.75kg/ha followed by mulching with *Eichhornia crassipes* (water hyacinth) 15t/ha	4.18 (17.00)	4.81 (22.67)	4.00 (15.67)	5.13 (26.00)	5.76 (32.67)	7.01 (48.67)	3.84 (14.44)	3.50 (11.81)	3.19 (9.75)	3.36 (11.08)	5.04 (24.89)	4.82 (22.89)
Pendimethalin at 0.75kg/ha followed by mulching with *Antigonon leptopus* (Coral vine) 4t/ha	4.14 (16.67)	4.93 (24.00)	4.93 (24.00)	5.54 (30.33)	6.41 (40.67)	7.40 (54.33)	3.94 (15.14)	3.86 (14.45)	4.31 (18.25)	3.99 (15.58)	5.73 (32.69)	5.51 (30.03)
Weedy check	9.17 (84.00)	9.99 (99.67)	7.20 (51.33)	7.90 (62.00)	11.64 (135.13)	12.72 (161.67)	9.11 (82.9)	8.38 (69.91)	7.73 (59.35)	8.43 (70.68)	11.93 (142.2)	11.86 (140.59)
Weed free	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)	0.71 (0.00)	0.71(0.00)	0.71 (0.00)	0.71 (0.00)
LSD (p=0.05)	0.94	0.87	0.71	0.86	0.71	0.76	0.99	0.74	0.85	0.98	1.04	1.02

Figures in parentheses are the original values. The data was transformed to SQRT ($\sqrt{x+0.5}$) before analysis

Table 2. Yield attributes, seed yield and economics of yellow mustard as influenced by weed management practices

Treatment	Siliqua length (cm)		No. of siliquae/plant		No. of seeds/siliqua		Test weight (g)		Seed yield (kg/ha)		Net return (x10^3 /ha)		Returns per rupee invested	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
Pendimethalin at 0.75 kg/ha	4.21	4.14	89.44	74.44	20.22	19.22	2.51	2.48	998	827	45.55	40.89	1.48	1.23
Mulching with *Eichhornia crassipes* (Water hyacinth)	4.37	4.30	98.89	86.89	22.56	21.22	2.53	2.40	1021	958	48.08	46.36	1.37	1.29
Mulching with *Antigonon leptopus* (Coral vine)	4.29	4.19	93.56	81.89	21.56	20.42	2.51	2.37	1005	888	47.64	44.45	1.35	1.19
Pendimethalin at 0.75 kg/ha followed by mulching with *Eichhornia crassipes* (Water hyacinth) 15 t/ha	4.48	4.68	112.44	107.78	25.33	23.67	2.53	2.67	1250	1183	55.12	53.29	1.62	1.53
Pendimethalin at 0.75 kg/ha followed by mulching with *Antigonon leptopus* (Coral vine) 4 t/ha	4.47	4.57	104.78	98.11	23.67	22.73	2.56	2.59	1228	1093	54.52	50.84	1.59	1.41
Weedy check	3.81	3.44	76.56	68.22	17.11	16.11	2.48	2.35	740	617	37.72	34.37	1.15	0.96
Weed free	4.98	4.78	125.65	119.65	28.65	26.98	2.65	2.88	1315	1342	58.79	59.52	1.56	1.59
LSD(P=0.05)	0.76	0.68	10.68	10.80	2.43	2.29	0.30	0.25	205.4	185.24	-	-	-	-



W_1-pendimethalin at 0.75 kg/ha, W_2-mulching with *Eichhornia crassipes* (water hyacinth), W_3-mulching with *Antigonon leptopus* (coral vine), W_4-pendimethalin at 0.75 kg/ha followed by mulching with *Eichhornia crassipes* (water hyacinth), W_5-pendimethalin at 0.75 kg/ha followed by mulching with *Antigonon leptopus* (Coral vine), W_6-weedy check and W_7-weed free

Figure 1. Weed control efficiency (%) of different treatments

al. 2007 and Saikia *et al.* 2014). Weed free check registered significantly the highest seed yield of yellow mustard. Punia *et al.* (2017) also observed that weed free treatment recorded the highest seed yield over other treatments. The crop weed competition as a result of ineffective control of weeds caused lower values of growth attributes in unweeded plot (Mahajan *et al.* 2012; Duary *et al.* 2016). Yield reduction due to weeds in yellow mustard was 43.72% in first year and 54.02% in second year. Pendimethalin alone registered 34.86 and 34.03% yield increase over unweeded control during first and second year, respectively. Similarly, weed mulch alone was able to improve yield by 35.81-37.97% in first year and 43.92-55.26% in second year over unweeded control. However, integrated use of herbicide and weed mulch resulted in 65.54-68.91% and 77.14 to 91.73% higher yield over unweeded control in first and second year, respectively. Among the different weed management practices higher values of yield attributes and yield were obtained in the treatment pendimethalin + weed mulch. The reason for this might be the conservation of soil moisture, supplement of nutrients and other growth promoting substances from weed mulch in these treatments. Also, it may be due to higher weed control efficiency of these treatments which maintained lower weed density as well as biomass thus least crop weed competition from the very early stage of the crop till maturity facilitating higher nutrient and water uptake, accelerated photosynthetic activity, availability of optimum space for better crop growth resulting into higher dry matter accumulation and yield. among the weed management practices Weed free check registered the highest net return and returns/rupee invested during both the years followed by pendimethalin at 0.75 kg/ha followed by mulching with water hyacinth and pendimethalin at 0.75 kg/ha followed by mulching with *Antigonon leptopus*.

Conclusion

Thus, integrated use of pre-emergence herbicide pendimethalin at 0.75 kg/ha followed by mulching with easily available weeds like water hyacinth or A*ntigonon* appeared to be promising for effective weed management in yellow mustard in eastern India.

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