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Research Article

EFFECT OF WEED MANAGEMENT PRACTICES ON WEED ATTRIBUTES, GROWTH AND YIELD ATTRIBUTES OF MESTA (*Hibiscus sabdariffa* L.)

RAJU M.*[1] AND MITRA S.[2]
[1]Tamil Nadu Rice Research Institute, Aduthurai, Thanjavur, 612 101, Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu, India
[2]All India Network Project on Jute & Allied Fibre Crops (AINPJAF), ICAR-Central Research Institute for Jute and Allied Fibers, Barrackpore, 700120, West Bengal, India
*Corresponding Author: Email - agroraju@yahoo.co.in

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Abstract: The experiment was conducted during June 2019-November 2019 at Tamil Nadu Rice Research Institute, Aduthurai, Thanjavur to evolve suitable weed management practices on weed characters and yield attributes of mesta. The results of this study showed that especially pre emergence herbicide as Pretilachlor 50 EC @ 900g/ha at 45-48 hrs of sowing with irrigation + one hand weeding (15 DAE) registered lower weed dry weight and higher weed control efficiency in all stages of crop growth. All the growth and yield parameters were significantly improved with application of pretilachlor 50 EC @ 900g/ha at 45-48 hrs of sowing with irrigation + one hand weeding (15 DAE) and it was provided a weed free situation by timely control of weeds during the critical period of crop weed competition. However, higher net return (₹ 78000/ha) and benefit cost ratio (3.44) was obtained in pretilachlor 50 EC @ 900g/ha at 45-48 hrs of sowing with irrigation + one hand weeding (15 DAE). Based on the results, it can be concluded that pre emergence herbicide as pretilachlor 50 EC @ 900g/ha at 45-48 hrs of sowing with irrigation + one hand weeding (15 DAE) enhance the weed free situation, which was led to improving the growth and yield of mesta.

Keywords: *Roselle, Fibre yield, Herbicide, Weed dry matter, Weed management*

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Introduction

Mesta (Roselle: *Hibiscus sabdariffa* L.) is one of the most important plants of the Malvaceae family and it known for both its economic and horticultural importance [1]. Africa is origin of kenaf and its various diversified forms of species are widely grown [2]. Mesta has two species such as roselle (*Hibiscus sabdariffa* L.) and kenaf (*Hibiscus cannabinus* L.). Among these two species, kenaf is grown in tropical and temperate regions. Other the fibre production, its seed is also economically important because it has the potential of edible oil [3]. The plant is indigenous to tropic Africa. Roselle is used as fibre, forage and paper pulp and has broadened our agricultural diversity to reduce pressure on forest resources. It is one of the important bast fibre crops which stand next to jute in production. It is the nearest ally of jute and plays an effective role in supplementing the short supply of jute industry. In recent years, this crop is gaining the attention of research workers since it is also used as a raw material in the paper industry substituting bamboo and eucalyptus whose supply is becoming scarce day by day. Mostly jute fibre is utilized for manufacturing of packing materials like jute bags and sacking of rice and pulses etc. Now, demand of mesta fibre is emerged to replace with jute packing materials after value addition which also provide long life. It is also used for making ropes, twines, fishing nets etc. The stalks are used in making paper pulp, structural boards, and blends with wood pulp and for thatching huts. Poor fertilizer management practices also a cause for low yield of roselle. The production of quality roselle fibre in the country is very much essential to meet the increasing demand and expand this valuable crop. The yield of any crop is mainly depending upon of the plant density per unit area. Therefore, maintaining of optimum and uniform plant growth is essential and protected from biotic and abiotic stress. Among them, biotic stress is more contribution on yield loss in particularly weed menace. An effective weed management practice is necessary for higher crop production and better economic returns [4].

Conventional manual weeding in raw jute involves around 40% of the total cost of cultivation [5] and fibre yield reduction is up to 70% under unweeded situation.

Most effective and economic cultural practices for weed control in mesta crop are not clearly known to our farmers till date. In Tamil Nadu, mesta is grown mostly under intercrop situation and utilized for both fibre as well as vegetables. Severe weed menace is noticed under this situation which is controlled by hoeing (hand weeding) and weeding and thinning operations involve about 50% or more of the labour cost. Hence, it is necessary to identify suitable weed management practices which can reduce the labour cost component and increase the net profit to the mesta farmers who belongs to small and marginal category. Therefore, the recent study has been taken to evolve suitable weed control methods for managing weeds at different growth stages, so that it can be recommended to mesta growing farmers of Cauvery delta zone of Tamil Nadu.

Materials and Methods

A field experiment was conducted at Tamil Nadu Rice Research Institute, Aduthurai, Thanjavur during June 2019-November 2019 under irrigated conditions. The soil of the experimental site is clay loam with pH of 7.5 and EC of 11.6 mS m^{-1} and nutrient status such as medium in available nitrogen (240.2kg/ha) and phosphorus (63.0kg/ha) and high in potassium (210.3kg/ha) content.

The treatments were imposed under Randomized Block Design in three replications. The treatments comprises of Pretilachlor @ 900g/ha at 45-48 hrs of sowing with irrigation + one hand weeding (15 DAE) (T1), Quizalofop ethyl 10% @ 38 g/ha at 15 DAE + one hand weeding (30 DAE) (T2), Quizalofop ethyl 5 EC 60 g + Ethoxysulfuron @ 100g/ha at 15 DAE (T3), Quizalofop ethyl 5 EC 60 g + Ethoxysulfuron @ 100g/ha at 15 DAE + one hand weeding (30 DAE) (T4), Propaquizafop 10 EC @ 90 g/ha at 15 DAE + one hand weeding (30 DAE) (T5),

Table-1 *Weed biomass, weed control efficiency and weed index under different weed control methods at Aduthurai, Tamil Nadu*

Treatments	Weed dry Biomass (q/ha)			Weed index (%)	WCE (%)		
	15 DAS	35 DAS	45 DAS		15 DAS	35 DAS	45 DAS
T_1: Pretilachlor 50 EC @ 900g/ha at 45-48 hrs of sowing with irrigation + one hand weeding (15 DAE)	0.32	0.56	0.36	0.00	73.65	46.80	73.69
T_2: Quizalofop ethyl 10% @ 38 g/ha at 15 DAE + one hand weeding (30 DAE)	0.90	0.72	0.62	10.60	24.24	33.38	52.06
T_3: Quizalofop ethyl 5 EC 60 g + Ethoxysulfuron @ 100g/ha at 15 DAE	0.60	0.78	0.72	17.19	50.49	27.80	45.49
T_4: Quizalofop ethyl 5 EC 60 g + Ethoxysulfuron @ 100g/ha at 15 DAE + one hand weeding (30 DAE)	0.93	0.60	0.53	21.53	23.17	42.95	60.37
T_5: Propaquizafop 10 EC @ 90 g/ha at 15 DAE + one hand weeding (30 DAE)	0.88	0.77	0.58	17.44	26.71	23.99	54.50
T_6: Pedimethalin 35% EC @ 525 g/ha (48 hours of sowing with irrigation or sufficient rain) + one hand weeding (15 DAE)	0.48	0.74	0.76	22.34	60.21	31.18	41.92
T_7: Nail weeder at 5 DAE + Quizalofop ethyl 5 EC 60 g at 25 DAE	0.65	0.72	0.54	17.19	45.80	35.92	59.83
T_8: Unweeded check	1.21	1.12	1.34	34.78	0.00	0.00	0.00
T_9: Two hand weedings (HW)/ Mechanical Weeding (nail weeder) at 15-20 DAE and 35-40 DAE	0.72	0.56	0.40	12.09	39.90	43.74	67.70
SEm±	0.06	0.10	0.09	-	-	-	-
$CD_{(P=0.05)}$	0.17	NS	0.26	-	-	-	-

HW: hand weeding; MW: mechanical weeding

Table-2 *Yield attributes and fibre yield of mesta under different weed control methods at Aduthurai, Tamil Nadu*

Treatments	Plant height (cm)	Basal diameter (cm)	Fibre yield (q/ha)
T_1: Pretilachlor 50 EC @ 900g/ha at 45-48 hrs of sowing with irrigation + one hand weeding (15 DAE)	263.8	2.52	27.5
T_2: Quizalofop ethyl 10% @ 38 g/ha at 15 DAE + one hand weeding (30 DAE)	247.6	2.36	24.6
T_3: Quizalofop ethyl 5 EC 60 g + Ethoxysulfuron @ 100g/ha at 15 DAE	244.0	2.34	22.76
T_4: Quizalofop ethyl 5 EC 60 g + Ethoxysulfuron @ 100g/ha at 15 DAE + one hand weeding (30 DAE)	243.3	2.27	21.58
T_5: Propaquizafop 10 EC @ 90 g/ha at 15 DAE + one hand weeding (30 DAE)	248.4	2.30	22.7
T_6: Pedimethalin 35% EC @ 525 g/ha (48 hours of sowing with irrigation or sufficient rain) + one hand weeding (15 DAE)	246.9	2.29	21.35
T_7: Nail weeder at 5 DAE + Quizalofop ethyl 5 EC 60 g at 25 DAE	244.1	2.11	22.55
T_8: Unweeded check	208.1	2.10	18.95
T_9: Two hand weedings (HW)/ Mechanical Weeding (nail weeder) at 15-20 DAE and 35-40 DAE	248.4	2.38	24.8
SEm±	3.5	0.04	0.57
$CD_{(P=0.05)}$	10.4	0.11	1.7

HW: hand weeding; MW: mechanical weeding

Table-3 *Economic of different weed control methods on mesta*

Treatments	Cost of cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
T_1: Pretilachlor 50 EC @ 900g/ha at 45-48 hrs of sowing with irrigation + one hand weeding (15 DAE)	32000	110000	78000	3.44
T_2: Quizalofop ethyl 10% @ 38 g/ha at 15 DAE + one hand weeding (30 DAE)	34200	984000	64200	2.88
T_3: Quizalofop ethyl 5 EC 60 g + Ethoxysulfuron @ 100g/ha at 15 DAE	28400	91066	62666	3.21
T_4: Quizalofop ethyl 5 EC 60 g + Ethoxysulfuron @ 100g/ha at 15 DAE + one hand weeding (30 DAE)	32000	86333	54333	2.7
T_5: Propaquizafop 10 EC @ 90 g/ha at 15 DAE + one hand weeding (30 DAE)	31900	90800	58900	2.85
T_6: Pedimethalin 35% EC @ 525 g/ha (48 hours of sowing with irrigation or sufficient rain) + one hand weeding (15 DAE)	30200	85426	55226	2.83
T_7: Nail weeder at 5 DAE + Quizalofop ethyl 5 EC 60 g at 25 DAE	33000	90213	57213	2.73
T_8: Unweeded check	27800	75800	48000	2.73
T_9: Two hand weedings (HW)/ Mechanical Weeding (nail weeder) at 15-20 DAE and 35-40 DAE	32800	99200	66400	3.02

HW: hand weeding; MW: mechanical weeding

Pendimethalin 35% EC @ 525 g/ha (48 hours of sowing with irrigation or sufficient rain) + one hand weeding (15 DAE) (T6), Nail weeder at 5 DAE + Quizalofop ethyl 5 EC 60 g at 25 DAE (T7), Unweeded check (T8) and Two hand weedings (HW)/ Mechanical weeding (nail weeder) at 15-20 DAE and 35-40 DAE (T9). The seeds of mesta was treated with Mancozeb @ 3 g/kg seed against foot and stem rot disease and sown with a spacing of 40 x 10 cm other than intercrop. Farm yard manure @ 5 t ha^{-1} was applied during last ploughing. A common fertilizer dose of 60: 13: 25 kg NPK/ha were applied as basal. The crop was maintained by adopting the recommended package of practices. Need based plant protection measures were taken up during crop growth period. The data on weed parameters and plant height, basal diameter and fibre yield were recorded periodically and the data was analysed as per the standard statistical procedures [6].

To account for the general weed flora of the experimental field, species wise weeds observed in the unweeded control plots were recorded at the period of maximum appearance of 30 days after sowing. Ten plants were selected at random in each plot and were tagged for recording the observations of the growth, yield attributes and yield. Crop was harvested at maturity, threshed and plot-wise seed and yields in kg/ha was recorded.

Weed control efficiency was calculated by using the following formula

WCE (%) = WDc - WDt / WDc × 100

Where,
WCE (%)-Weed control efficiency in percentage
WDc-Weed dry weight in unweeded check,
WDt-Weed dry weight in treated plot

Weed index was computed by adopting the formula
WI (%) = X-Y / X × 100
Where,
WI - Weed index
X - Yield from minimum weed competition plot,
Y- Yield from treated plot for which WI is to be worked out.

Results and Discussion

Weed flora

The major weed flora such as *Echinochloa colona* (L.), *Echinochloa crusgalli* (L.), *Cynodon dactylon* Pers and *Panicum repens* (L.) among grasses .In case of sedges, *Cyperus iria* (L.), *Cyperus difformis* (L.), *Cyperus rotundus* (L.) and *Fimbristylis miliacea* (L.) and *Eclipta alba* (L.), *Marsilea quadrifolia*, *Ludwigia parviflora* and *Commelina benghalensis* among broad leaved observed in mesta crop.

Effect of treatments on weed parameters

Weed density

The weed density was significantly influenced by various weed management practices on in all the crop growth stages [Table-1]. The lesser weed dry weight of 0.32,0.56 and 0.36 q /ha was recorded in pretilachlor @ 900g/ha at 45-48 hrs of sowing with irrigation + one hand weeding (15 DAE) applied plot at 15, 35 and 45 DAS respectively and next to this , the lesser weed dry eight was observed in pendimethalin 35% EC @ 525 g/ha (48 hours of sowing with irrigation or sufficient rain) + one hand weeding (15 DAE) (0.48q/ha) at 15 DAS and Quizalofop ethyl 5 EC 60 g + Ethoxysulfuron @ 100g/ha at 15 DAE + one hand weeding (30 DAE) applied plots. However, the highest weed dry weight of 1.21, 1.12 and 1.34 q/ha were recorded in 15,30 and 45 DAS respectively under unweeded check. The main evident in lower weed density was observed that pretilachlor is a broad-spectrum rice herbicide which is mainly used for pre-emergence to early post-emergence of weeds. It controls a variety of weeds effectively. The major targets of this herbicide are annual grasses, sedges, and broad level weeds. This herbicide has a specific working phenomenon where it suppresses the growth of weeds by reducing the cell division. Application of Pretilachlor 50% EC 900 ml/ ha at 45-48 hours of sowing + one hand weeding recorded lowest weed dry weight when compared to unweeded check [7]. Pre-emergence application of pretilachlor reduces the total weed density in rice [8].

Weed index and weed control efficiency

Among the different weed management practice, the lower weed index (10.60 %) was observed in application of quizalofop ethyl 10% @ 38 g/ha at 15 DAE + one hand weeding (30 DAE) next to the application of Pretilachlor 50% EC 900 ml/ ha at 45-48 hours of sowing + one hand weeding (0 value) followed by two hand weedings (HW)/ Mechanical Weeding (nail weeder) at 15-20 DAE and 35-40 DAE (12.09 %). In case of weed control efficiency, application of Pretilachlor @ 900g/ha at 45-48 hrs of sowing with irrigation + one hand weeding (15 DAE) was recorded higher weed control efficiency of 73.65, 46.80 and 73.69 % at 15, 35 and 45 DAS respectively which was followed by Pendimethalin 35% EC @ 525 g/ha (48 hours of sowing with irrigation or sufficient rain) + one hand weeding (15 DAE) (60.21%) at 15 DAS and Two hand weedings (HW)/ Mechanical Weeding (nail weeder) at 15-20 DAE and 35-40 DAE (43.74 and 67.70 % at 30 and 45 DAS).

Effect of treatments on growth and yield attributes of mesta

The data revealed that all weed management practices significantly influenced on growth and yield attributes of mesta compared to un-weeded check [Table-2]. The taller plant height of 263.8 cm was recorded under pre-emergence application of Pretilachlor 50% EC 900 ml ha^{-1} at 45-48 hours of sowing + one hand weeding) followed by Propaquizafop 10 EC @ 90 g/ha at 15 DAE + one hand weeding (30 DAE) (248.4 cm) and Two hand weedings (HW)/ Mechanical Weeding (nail weeder) at 15-20 DAE and 35-40 DAE (248.4 cm) which was at par with Quizalofop ethyl 10% @ 38 g/ha at 15 DAE + one hand weeding (30 DAE) (247.6 cm). The shorter plant height of 208.1 cm recorded in unweeded check.

With respect to stem girth, weed management practices were significantly influenced on basal diameter when compared to unweeded check. Application of Pretilachlor 50% EC 900 ml ha^{-1} at 45-48 hours of sowing + one hand weeding (15 DAE) recorded the highest basal diameter (2.52 cm) followed by two hand weedings (HW)/ Mechanical Weeding (nail weeder) at 15-20 DAE and 35-40 DAE (2.38 cm), and Quizalofop ethyl 10% @ 38 g/ha at 15 DAE + one hand weeding (30 DAE) (2.36 cm). Unweeded check recorded lower basal diameter (2.01cm).

In case of fibre yield, Pretilachlor 50% EC 900 ml/ ha at 45-48 hours of sowing + one hand weeding recorded higher fibre yield of 27.5 q/ha which was followed by Two hand weedings (HW)/ Mechanical Weeding (nail weeder) at 15-20 DAE and 35-40 DAE (24.8q/ha) and Quizalofop ethyl 10% @ 38 g/ha at 15 DAE + one hand weeding (30 DAE) (24.6q/ha). Unweeded control treatment recorded lowest fibre yield of 18.95 q /ha. The main reason for increased fibre yield in mesta is lesser weed menace in all growth stages by application of pretilachlor 50% EC 900 ml/ ha at 45-48 hours of sowing + one hand weeding treatment which inturn increased growth parameters such as plant height and basal diameter. Application of Pretilachlor 50% EC 900 ml/ ha at 45-48 hours of sowing + one hand weeding recorded higher fibre yield in mesta.

Effect of treatments on economics of mesta crop

Among the weed control treatments, Pretilachlor 50% EC 900 ml/ha + one hand weeding recorded highest net return (₹ 78000/ha) and B: C ratio (3.44) when compared to other treatments. Mainly, this might be due to the application of Pretilachlor which effectively suppressed the weeds in roselle especially in the early stages subsequently hand weeding helps to reduce the weed menace upto crop harvest. The higher fibre yield was obtained with application of pretilchlor as pre emergence in jute crop [9-12].

Conclusion

From the study, it can be concluded that all weed management treatments significantly increased the plant height, basal diameter and fibre yield of Mesta compared to unweeded check. The highest growth parameters and fibre yield recorded with Pretilachlor 50 EC 900 ml ha^{-1} + one hand weeding treatment. Application of Pretilachlor 50% EC 900 ml/ ha at 45-48 hours of sowing + one hand weeding significantly reduced the weed biomass than remaining other treatments at all crop growth stages and also recorded highest weed control efficiency, lowest weed index, highest net returns and B:C ratio. Therefore, application of Pretilachlor 50% EC 900 ml /ha at 45-48 hours of sowing + one hand weeding may be recommended for controlling the weed incidence in mesta growing areas of Cauvery delta regions of Tamil Nadu and fetches higher net profits for the farming community.

Application of research: Weed menace in mesta crop could be managed with pre emergence application of Pretilachlor 50% EC 900 ml ha^{-1} along with one hand weeding on 15 days after sowing.

Research Category: Weeds, herbicide application

Abbreviations: PE: Pre emeregence, PoE: Post emergence, DAE : Days after emergence, DAS: Days after sowing, @: at the rate, : Indian Rupees, B:C: Benefit cost ratio, /ha: Rupees per hectare, cm: centimeter, g/m^2: gram per square meter, No/m^2: Number per square meter, kg/ha: Kilogram per hectare, WCE: Weed control efficiency and %: Percent

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****Principal Investigator or Chairperson of research: Dr M. Raju**
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Study area / Sample Collection: Tamil Nadu Rice Research Institute, Aduthurai, Thanjavur, 612 101

Cultivar / Variety / Breed name: AMV 5

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Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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