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RESEARCH ARTICLE

Effect of integrated weed management on growth, yield and economics of jute fibre production

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ABSTRACT

A field experiment was carried out at Jute Research Station, Katihar, Bihar to study the effect of integrated weed management practices on growth, yield and economics of *tossa* jute. The experiment was taken up with eight treatments comprising: use of butachlor with different formulations (50% EC and 5% granules) and dosages of (1.0 kg and 1.5 kg/ha), pretilachlor 1.0 kg/ha as pre-emergence application (PE) followed by (*fb*) one hand weeding (HW) at 20 days after emergence of crop (DAE), quizalofop-ethyl 60 g/ha + sticker 1 ml/ l as post-emergence application (PoE) at 15 DAE *fb* one HW at 35 DAE and other treatments include hand weeding twice at 15 and 35 DAE and weedy check. A randomized block design with three replications was used. Amongst tested weed control treatments, quizalofop-ethyl 60g/ha PoE at 15 DAE *fb* one hand weeding at 35 DAE was found effective in significantly increasing the plant height, basal diameter and fibre yield of jute over weedy check and was economical compared to hand weeding twice.

Keywords: Herbicidal efficiency index, Quizalofop-ethyl, Tossa jute, Integrated weed management

INTRODUCTION

Jute is the second most important natural fibre crop after cotton in India. It is largely cultivated in the alluvial plains of West Bengal, Bihar, Orissa and Assam. It plays an important role in the country's economy (Kumar *et al*. 2013). Jute fibre is a raw material for packaging industries and emerged as a versatile raw material for diverse applications in textile industries, paper industries, building and automotive industries, use as soil saver, decorative and furnishing materials, etc. In India jute is grown in 6.8 lakh hectares, producing 9.9 million bales (1bale =180 kg) with average productivity of 2.64 t/ha during 2019-20 (Agricultural statistics at a glance 2021). National average yield (2.64 t/ha) is low as compared to potential yield of 3 t/ha, mostly due to non-availability of quality seed of high-yielding varieties and traditional non-scientific cultivation practices (Price policy for jute 2020-21). In eastern India, jute is mostly cultivated by small and marginal farmers, where conventional manual weeding is a commonly adopted practice which accounts for 30 % of the total cost of cultivation. The yield reduction is up to 70%, if crop remains un-weeded (Ghorai 2013) as jute is a poor competitor with weeds because of its initial slow and erect growing nature. A survey on weed flora in jute growing area indicated that grassy weeds contributed about 60-70% of the total weed population (Kumar *et al.* 2013). Therefore, timely weed control is essential for optimizing the yield of jute. The age old practice of controlling weeds in jute by manual weeding is effective but time consuming, tedious, timely weed control may not be possible manually due to non -availability of labourers and high labour expenses due to high wage rates during peak period of weeding operations. Hence, integration of different weed management practices holds a great promise for effective, timely and economic weed management. Thus, the present study was carried out to evaluate the integration of different weed management practices and assess the weed control efficiency of integrated weed management practice and its influence on productivity of Jute.

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MATERIALS AND METHODS

A field experiment was conducted for two years during *Kharif* season of 2013 and 2014 under All India Network project (AINP) on Jute & Allied fibres

at Jute Research Station, Katihar of Bihar Agricultural University, Bihar, India. The farm is situated at approximately 25^0 31.8`N, latitude and $87^0$ 34`E, longitude with an average altitude 30 m above the mean sea level. The climate of the study area is characterized by hot and wet summer with the average annual rainfall of 1200 mm. The total amount of rainfall received was 1223 mm and 1434 mm during 2013 and 2014, respectively.

Soil of the experimental site was silty loam in texture with neutral soil reaction (pH 7.6), low in organic carbon (OC) (0.49%), available nitrogen (160 kg/ha) and available potassium (84 kg/ha) and medium in available phosphorus (20 kg/ha). Experiment was carried out with eight treatments comprising: use of pre-emergence application (PE) of butachlor, at 2 days after sowing (DAS), using different formulations (50% EC and 5% granular) and different doses of 1 kg and 1.5 kg/ha, pretilachlor 1.0 kg/ha were applied followed by (*fb*) one hand weeding at 20 DAE, post-emergence application (PoE) of quizalofop ethyl 60 g/ha + sticker (Dhanuvit) 1 ml/ litre at 15 DAE *fb* one hand weeding at 35 DAE and other treatments include hand weeding twice at 15 and 35 DAE and weedy check with three replications in a randomized block design. Jute variety JRO-524 was sown in April 28th and May 3rd during 2013 and 2014 respectively with seed rate of 5 kg/ha and spacing of 30 x 5 cm between rows and within a row was used. Fertilizer dosage of 60:30:30 N:P:K kg/ha was applied and two sprays of dimethoate was taken up to control Bihar hairy caterpillar.

All the herbicides were sprayed with battery operated knap-sack sprayer fitted with flat-fan nozzle using spray volume of 500 l/ha. Data on weed biomass were recorded at 15 DAE and 45 DAE using 0.25 m^2 quadrat placed randomly in each plot and the data was subjected to square root transformation of (X+1.0) before analysis.

Weed control index

Weed control index was calculated to compare the different weed control treatments on the basis of biomass. It indicates the per cent reduction in the dry weight (biomass) in the treated plots compared to weedy plots. The formula is as follows (Das 2008):

$$WCI = \frac{WDC\text{-}WDT}{DMC} \times 100$$

Where, WDC is the weed biomass in unweeded control (g/m^2) and WDT is the weed biomass in treated plot (g/m^2).

Weed index (WI)

Weed index is the per cent reduction in crop yield under a particular treatment due to the presence of weeds in comparison to weed free plot (Das 2008). WI is used to assess the efficacy of an herbicide. Lesser the WI, better is the efficiency of an herbicide. It is expressed in percentage and was determined with the help of following formula:

$$WI\ (\%) = \frac{X - Y}{X} \times 100$$

Where, WI = Weed index; X = Crop yield from weed free plot (hand weeding) and Y = Crop yield from the treated plot for which weed index is to be worked out.

Herbicide efficiency index (HEI)

This index represents the potential of a particular herbicide for controlling the weeds along with their phyto-toxicity effect on the crop (Krishnamurthy *et al.* 1975)

$$HEI = \frac{\frac{(Yt\text{-}Yc)}{Yt} \times 100}{\frac{WDMt}{WDMc} \times 100}$$

Where, Yt-crop yield from treated plot, Yc-crop yield from weedy check plot, WDMt-weed biomass in treated plot and WDMc-weed biomass in weedy check plot.

Observations on crop, *viz*. plant height was recorded with scale and basal diameter was estimated using caliper, whereas for fibre yield estimation, harvested jute plants are left in field for two days for drying, after drying they are bundled and immersed in pond for 15-20 days for retting process. After completion of retting, fibre is extracted from stem and dried, fibre weight is recorded. The economics of weed management was worked out. Since the results trend was same in 2013-14 and 2014-15, the pooled data of the two years are presented and used for discussion.

RESULTS AND DISCUSSION

Weed flora

The dominant weed flora observed in the experimental plots were *Cyperus rotundus,* the sedge and *Echinochloa crus-galli*, *Echinochloa colona, Cynodon dactylon*, *Digitaria sanguinalis*, *Eleusine indica*, among grasses. The predominant broad-leaved weeds include: *Digera arvensis*, *Portulaca*

oleracea, Physalis minima, Phyllanthus niruri etc. Similar results were reported by Kumar *et al*. (2014), Masumi *et al*. (2011) and Mukherjee *et al*. (2011).

Weed biomass

Hand weeding twice at 15 and at 35 DAE provided weed free condition with 81% weed control (**Table 1**). Among the different herbicide treatments, quizalofop-ethyl 60g/ ha PoE at 15 DAE *fb* 1 HW at 35 DAE resulted in lowest weed biomass (1.23 t/ ha) at 45 DAE as it was more effective in suppressing the weed density and weed dry matter. The higher weed biomass at 45 DAE recorded with pre-emergence herbicide, might be due to decreased efficacy of herbicides on the subsequent flushes of weeds especially *Cyperus rotundus* and other dominant grassy weeds which quite commonly predominate after receiving rains. Similar results with use of PoE herbicides like quizalofop-ethyl and propaquizafop significantly controlled the grassy weeds which were problematic in raising successful jute crop were also reported by Ghoria *et al. (*2013), Sarkar *et al.* (2005) and Sarkar (2006).

Weed indices

The higher weed control efficiency (81.30%) and lowest weed index (WI) at 45 DAE was recorded with hand weeding twice at 15 DAE and 35 DAE (**Table 1**). The highest WI (55.54%) and lowest WCE was recorded with weedy check due to unchecked weed growth throughout the crop growth period and the consequent competition for growth resources resulted in the reduction of yield. Among weed control treatments, quizalofop ethyl 60 g/ha PoE at 15 DAE *fb* 1 HW at 35 DAE recorded highest WCE (77.41%), lowest WI and higher HEI (4.99%) which might be due effective control of grassy weeds dominant in the experimental field. Whereas, pre-emergence herbicides butachlor (50% EC) 1.5 kg/ha recorded the highest WCE (71.67%) at 45 DAE over other pre-emergence herbicides. Thus, quizalofop-ethyl PoE was found more effective than pre-emergence herbicides in managing weeds in jute as reported by Sarkar (2006) and Ghorai *et al.* (2013)

Crop growth and fibre yield

During both the years, quizalofop-ethyl 60 g/ha at 15 DAE *fb* one HW at 35 DAE recorded taller plants (291.8 cm) with highest basal diameter (1.80 cm) over other herbicidal treatments used in experimentation (**Table 2**), which might be due to suppression of weed growth resulted in better crop growth.

Significant improvement in jute fibre yield was observed with all the weed control treatments when compared to weedy check during both the years (**Table 2**) might be due to decreased crop weed competition for resources (sunlight, nutrients and space) The quizalofop-ethyl 60 g/ha *fb* one HW recorded highest fibre yield (2.77 t/ha) owing to highest plant height (291.8 cm) and basal diameter (1.80 cm). It provided better control of weeds during crop growth period resulting in better yield advantage compared to other herbicidal treatments used in experiment. Similar beneficial effects were reported by Ghorai *et al.* (2013), Sarkar (2006).

Economics

All the weed management treatments recorded better monetary returns compared to weedy check which recorded the lowest net returns (₹ 13470) and B:C (0.81) (**Table 3**). The hand weeding twice recorded high cost of cultivation (₹ 22698/-) with benefit:cost (2.0) and was superior to other

Table 1. Effect of weed control treatments on weed biomass, weed control efficiency (WCE), weed index (WI) and herbicide control efficiency (HCE)

Treatment	Weed biomass at 15 DAS (t/ha)		Pooled	Weed biomass at 45 DAS (t/ha)		Pooled mean	Weed management Indices Pooled mean of two years (2013-2014)		
	2013	2014		2013	2014		WCE (%)	WI (%)	HEI (%)
Butachlor 50% EC 1.0 kg/ha PE *fb* 1 HW at 20 DAE	1.15(1.33)	1.20(1.42)	1.18(1.38)	1.38(1.72)	1.56(1.91)	1.47(1.81)	65.96	22.26	2.42
Butachlor 50% EC 1.5 kg/ha PE *fb1* HW at 20 DAE	1.12(1.27)	1.13(1.29)	1.12(1.28)	1.24(1.51)	1.45(1.54)	1.34(1.53)	71.57	13.78	3.35
Butachlor 5% G 1.0 kg/ha PE *fb* 1 HW at 20 DAE	1.18(1.39)	1.23(1.52)	1.21(1.46)	1.50(2.07)	1.64(2.28)	1.57(2.17)	59.54	28.49	1.54
Butachlor 5% G 1.5 kg/ha PE *fb*1 HW at 20 DAE	1.14(1.31)	1.17(1.37)	1.16(1.34)	1.41(1.82)	1.56(1.98)	1.48(1.90)	64.59	21.04	2.28
Pretilachlor 50% EC 1.0 kg/ha PE *fb* 1 HW at 20 DAE	1.07(1.17)	1.15(1.33)	1.11(1.25)	1.28(1.74)	1.53(1.64)	1.40(1.69)	68.34	15.88	2.97
Quizalofop-ethyl 60 g/ha + sticker 1 ml/l PoE at 15 DAE *fb* 1 HW at 35 DAE	1.06(1.12)	1.10(1.22)	1.08(1.17)	1.12(1.15)	1.34(1.28)	1.23(1.21)	77.41	7.20	4.99
Unweeded check	1.67(2.83)	1.81(3.27)	1.74(3.05)	2.28(5.55)	2.06(5.19)	2.17(5.37)	0.00	55.54	-
Hand weeding twice at 15 DAE and 35 DAE	1.04(1.08)	1.06(1.10)	1.04(1.09)	1.01(0.98)	1.26(1.03)	1.14(1.01	81.30	-	-
LSD (p=0.05)	0.011	0.005	0.11	0.14	0.02	0.149	2.32	3.43	0.35

Data subjected to $\sqrt{x+0.5}$ transformation and figures in parentheses are original weed biomass in t ha; PE: pre-emergence; PoE: post-emergence; *fb*: followed by; HW: hand weeding; DAE: days after emergence

Table. 2. Effect of weed management practices on growth parameters at harvest (120 DAS) and fibre yield of jute

Treatment	Plant height (cm)		Pooled mean	Basal diameter (cm)		Pooled mean	Fibre yield (t/ha)		Pooled mean
	2013	2014		2013	2014		2013	2014	(t/ha)
Butachlor 50% EC 1.0 kg/ha PE *fb* 1 HW at 20 DAE	277.7	265.0	271.3	1.73	1.59	1.66	2.31	2.26	2.28
Butachlor 50% EC 1.5 kg/ha PE *fb1* HW at 20 DAE	291.0	288.7	289.8	1.82	1.71	1.77	2.54	2.52	2.53
Butachlor 5% G 1.0 kg/ha PE *fb* 1 HW at 20 DAE	271.0	256.3	263.7	1.68	1.49	1.59	2.17	2.03	2.10
Butachlor 5% G 1.5 kg/ha PE *fb*1 HW at 20 DAE	283.7	272.2	277.9	1.78	1.56	1.67	2.41	2.25	2.33
Pretilachlor 50% EC 1.0 kg/ha PE *fb* 1 HW at 20 DAE	285.3	280.0	282.7	1.80	1.66	1.73	2.53	2.42	2.48
Quizalofop-ethyl 60 g/ha + sticker 1 ml/l PoE at 15 DAE *fb* 1 HW at 35 DAE	290.0	293.7	291.8	1.85	1.75	1.80	2.77	2.69	2.73
Unweeded check	242.4	233.3	237.9	1.52	1.44	1.48	1.30	1.32	1.31
Hand weeding twice at 15 DAE and 35 DAE	324.1	301.7	312.9	1.90	1.80	1.85	2.98	2.93	2.96
LSD (p=0.05)	20.4	17.1	8.5	0.15	0.11	0.05	0.23	0.24	0.11

Table 3. Economics of weed management treatments in jute

Treatment	Cost of cultivation of 2 years (x10^3 `/)	Net returns (x10^3 `/ha)		Pooled mean	B:C		Pooled mean
		2013	2014		2013	2014	
Butachlor 50% EC 1.0 kg/ha PE *fb* 1 HW at 20 DAE	20.57	32.48	31.47	31.98	1.58	1.53	1.55
Butachlor 50% EC 1.5 kg/ha PE *fb1* HW at 20 DAE	20.68	37.74	37.30	37.52	1.83	1.80	1.81
Butachlor 5% G 1.0 kg/ha PE *fb* 1 HW at 20 DAE	20.75	29.24	25.86	27.55	1.41	1.25	1.33
Butachlor 5% G 1.5 kg/ha PE *fb*1 HW at 20 DAE	21.05	34.38	30.75	32.56	1.63	1.46	1.55
Pretilachlor 50% EC 1.0 kg/ha PE *fb* 1 HW at 20 DAE	20.95	37.32	34.68	36.00	1.78	1.66	1.72
Quizalofop-ethyl 60 g/ha + sticker 1 ml/l PoE at 15 DAE *fb* 1 HW at 35 DAE	21.65	42.14	40.34	41.24	1.95	1.86	1.91
Unweeded check	16.70	13.20	13.74	13.47	0.79	0.82	0.81
Hand weeding twice at 15 DAE and 35 DAE	22.70	45.92	44.77	45.34	2.02	1.97	2.00
LSD (p=0.05)	-	5.33	5.48	2.59	0.25	0.27	0.12

treatments but the cost of cultivation (₹ 22,648/ha) was higher compared to other treatments.

Quizalofop-ethyl 60 g/ha PoE at 15 DAE (when the grassy weeds were 3-4 leaf stage) not only controlled the grassy weeds but also resulted in higher fibre yield and net returns than other herbicides as reported by Sarkar (2006). It may be concluded that when the labour availability is scarce and costly, quizalofop-ethyl 60 g/ha PoE at 15 DAE *fb* one hand weeding at 35 DAE may be used as it was found effective in significantly increasing the plant height, basal diameter and fibre yield of jute over weedy check and was economical compared to hand weeding twice.

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