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Effect of stale seedbed and subsequent application of herbicides on weeds and productivity of jute (*Corchoru solitorius* L.) fibre

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ABSTRACT

A field experiment was conducted to find out suitable weed management practice for control of broad spectrum weeds in jute during 2015 and 2016. Seven weed management practices viz., T_1: Farmers practices , T_2: Stale seed bed (SSB) + glyphosate 41% SL 1.25 kg/ha, T_3: SSB+glyphosate 1.75 kg/ha, T_4: SSB + glyphosate 1.25 kg/ha + pretilachlor 50% EC 1.0 kg/ha, T_5: SSB +glyphosate 1.75kg/ha + pretilachlor 1.0 kg/ha, T_6: SSB +glyphosate 1.25 kg/ha+butachlor 50 % EC 1.0 kg/ha and T_7: SSB + glyphosate 1.75 kg/ha + butachlor1.0 kg/ha were tested in randomised block design (RBD) with three replication. *Cyperus rotundus* was dominant weed species with 60-75 % of relative density in experimental field. SSB + glyphosate 1.75 kg/ha + pretilachlor 1.0 kg/ha effectively controlled density and dry weight of *Cyperus rotundus*, grass weeds (*Echinochloa colonum* and *Eleusine indica*), broad leaved weeds (*Physalis minima,* and *Trianthema portulacastrum*) compared to farmers' practices. SSB + glyphosate 1.75 kg/ha + pretilachlor 1.0 kg/ha also recorded the highest plant height (293 cm and 335 cm), basal diameter (2.14 and 2.19 cm) and fibre yield (34.9 and 38.9 q/ha) of jute during 2015 and 2016. This treatment also recorded the highest net income (Rs 54182 and 75687/ha) and benefit-cost ratio (1.23 and 1.46) in jute cultivation during 2015 and 2016, Therefore, SSB with glyphosate 1.75 kg/ha +pretilachlor 1.0 kg/ha may be practiced for effective weeds control specially *Cyperus rotundus*, higher productivity and income in jute cultivation.

Keywords: Jute, *Cyperus rotundus*, Stale seedbed, weeds

INTRODUCTION

Jute (*Corchorus olitorius* L.) is an important cash crop of small and marginal farmers Indo-Bangladesh continent sustaining livelihood of 4.0 million of families (Mahapatra *et al.,* 2012 and Ghorai *et al.,* 2013).Its biodegradability, ability to be used as an annual renewable resource and short growing period (100-120 days) enables the farmers to fit the crop in the prevalent rice based cropping system during the pre-*kharif* (summer) season even under rainfed condition. Among various agro-techniques to enhance and sustained the productivity and profitability of jute, weed management is important one. Because, weeds reduced the fibre yield up to 80% if not controlled (Ghorai *et al.,* 2013). Manual weeding which is prevalent among the jute farmers to get higher yield fetches about 40-50 % cost of production (Kumar *et al*., 2015a) and some weeds like *Cyperus rotundus* cannot effectively controlled manually. Moreover, scarcity of labour and/ or high soil moisture due to rainfall during critical period of weed control *i.e.* 7- 42 days after sowing of jute crop hampered the jute fibre yield (Ghorai *et al,*. 2013; Kumar *et al.* 2015a). Few pre-emergence herbicides like pretilachlor and butachlor at 1.0 kg/ha and post-emergence herbicide quizalofop ethyl at 40 g/ha have been recommended to control of grass weeds and few broad leaved weeds (Ghoari, 2008, Ghorai *et al.,* 2013). But continuous and long term use of these herbicides led to enhance the infestation of *Cyperus rotundus* and some hard to control broad leaved weeds like *Portulaca quardifida*, *Euphorbia microphyla*. Therefore, there is need to think alternative methods to control broad spectrum weeds, simultaneously to avoid early weed competition to crop. Stale seedbed (SSB) where soil tillage applied from several days or weeks prior to sowing of crop to stimulate weed emergence and killing them by secondary tillage during seedbed preparation and/or by using broad spectrum herbicides (Kumar *et al.,* 2015a) may be alternative to weed control methods in jute. Effectiveness of SSB with glyphosate to broad spectrum weeds including *Cyperus rotundus* has been reported by Kumar *et al.* (2015b) and Ammena *et al.* (2013).

Moreover, disadvantage of SSB like 7-10 days waiting time between spray of glyphosate and sowing of crop has also been eliminating in jute as no waiting time required for sowing of jute as it has been reported by Kumar *et al.* (2015b). Jute crop can be sown on stale seedbed after application glyphosate if sufficient soil moisture available otherwise provides irrigation after

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sowing. Jute germination was not harmed on the same day glyphosate spray and jute sowing on SSB. Since, glyphosate is almost instantaneously inactivated by adsorption to clay minerals and cationic binding sites of the soil matrix (Piccolo *et al.*, 1992 and Dong-Mei *et al.*, 2004) and prone to rapid microbial degradation (Giesy *et al.*, 2000). Because, glyphosate bind with soil clay particle and deactivate in soil and hence, secondary flushes of weeds emerges after 25- 30 days of sowing of crop. At this stage jute crop cannot compete with flushes of weeds, hence, weeding is necessary. There is need to avoid costly manual weeding or control of secondary flushes of weeds in jute. Therefore, a study was conducted with integration of stale seedbed with post emergence application glyphosate with pre-emergence herbicides (pretilachlor and butachlor) to control broad spectrum weeds and to continue their long term effect on weeds. We hypothesized that glyphosate application on stale seedbed killed the emerged weeds and pre-emergence herbicide will killed the flushes of germinating weeds in jute crop.

MATERIALS AND METHODS

A field experiment was conducted during 2015 and 2016 at Central Research Institute for Jute and Allied Fibres (CRIJAF), Barrackpore, Kolkata, West Bengal. In this region, hot humid climate prevailed during jute growing season (Fig. 1) with average maximum and minimum temperature varied from 30-41^{0}C and 25-29^{0}C respectively, maximum and minimum relative humidity (RH) 80-98% and 55-89%, respectively, and rainfall of 1000-1200 mm.The experimental soil belongs to Typic Ustochrept with loam texture (Sand 54%, Silt-34% Clay-12%) having the general characteristics: pH (1: 2.5 w/v) in water 7.20, organic carbon 6.50 g/kg and available N, P and K were 280, 32 and 185 kg/ha, respectively. A total of seven treatments viz., T_1: Farmers practices where two ploughing (one cultivator and one roravator) were applied before the sowing of crop and two hand weeding at 20 and 40 days after sowing (DAS), T_2:Stale seed bed (SSB) where one harrowing and one rotavator then one irrigation was appliedon 25th March and kept field undisturbed up to 25 days to allowed weeds to grow then glyphosate 41% SL 1.25 kg/ha sprayed on SSB and jute crop was sown before spray on same day, T_3: SSB (same as T_2) with spray higher doses of glyphosate 41% SL 1.75 kg/ha, T4: SSB (same as T_2) with spray of glyphosate 41% SL 1.25 kg/ha with tank mixof pretilachlor 50 % EC 1.0 kg/ha, T_5: SSB (same as T_2) with spray of glyphosate 41% SL 1.75 kg/ha with tank mix of pretilachlor 50% EC 1.0 kg/ha, T_6: SSB (same as T_2) with spray of glyphosate 41% SL 1.25 kg/ha with tank mix of butachlor 50 % EC 1.0 kg/ha and T_7: SSB (same as T_2) with spray of glyphosate 41% SL 1.75 kg/ha with tank mix of butachlor 50% EC 1.0 kg/ha were tested in Randomised Block Design (RBD) with three replication. Jute crop was sown at 25 × 7 cm spacing with 5 kg/ha seed rate.

A total of 80: 40: 40 kg/ha of N, P_2O_5 and K_2O, respectively, applied where total amount of P_2O_5 and K_2O was applied at basal and N applied at two split doses, half dose at time of sowing and half dose after thinning of crop at 35 DAS. Weed density was recorded from randomly selected quadrants (0.50 m × 0.50 m) at 25 DAS of jute. Crop was harvested at 120 days from net plot area of 3×4 m (12 m^2) prior to this 10 randomly selected plants were sampled from each plot for measuring yield attributes i.e. pant height and basal diameter. After harvesting of crop 10-12 kg bundle of jute plant were made and left in field for 3 days for shedding of leaves there after bundle taken for retting in water pond. A *jak* of 10 bundles of two layers was made and pour in pond about 2 feet deep from water surface by plastic bag filled with concrete and stone for proper retting. After 25 day individual plant in *jak* was completely retted as it was checked by pulling retted bark/fibre from stem when its easily peel off indicates that retting process completed.

Fibre extracted manually from jute stem and dried in sunlight up to moisture 14% and weighed and fibre yield recorded in q/ha. The cost of inputs (seed, fertilizer, herbicides pesticide, irrigation and human labour) and field tillage operations was taken for calculating the total cost of production by prevailing market price of input. The prevailing minimum support price for the jute fibre (Rs 2700/q in 2015 and 3200 in 2016) was considered and gross income were worked out by multiplying the quantity and price of produce. Further, net income were calculated by deducting the total cost of production from gross income every year

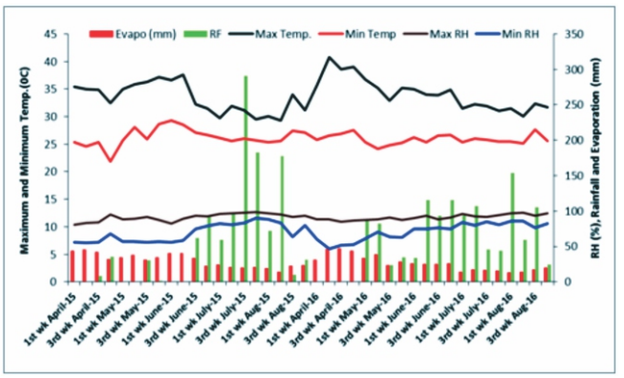

Fig. 1: Weekly weather parameter during crop growing season during 2015 and 2016

and benefit-cost ratio calculated by dividing net income by cost of cultivation. All data were then subjected to analysis of variance (ANOVA) and means were separated by the standard errors of the means. Weed density and dry weight data was transformed by square root transformation before statistical analyses. Significance of treatments was tested by the variance ratio (i.e. F value) at $P < 0.05$ (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION:

Weed flora:

The weed flora on the stale seedbed was consisted of two grasses: *Eleusine indica* and *Brachiaria repens,* one sedges: *Cyperus rotundus*, and none of the broad-leaved weeds. However, after sowing of crops addition to those weeds *Echinochloa colonum* a grass weed and three broad leaved weeds *viz. Physalis minima, Portulaca oleracea Trianthema portulacatrum,* were recorded. The relative dominance of *Cyperus rotundus* was 60-75% on the stale seedbed, however, the weeds species was recorded in farmers practices in jute crop were *Cyperus rotundus* with relative density of 46.0 % followed by broad leaved weeds (30 %) and the relative density was for grass weeds (24%).

Effects on weeds

A significant effect ($P<0.05$) of stale seedbed (SSB) with herbicides on weed density and dry biomass was observed in jute during 2015 and 2016 (Table 1). *Cyperus rotundus* density significantly reduced by SSB + glyphosate with and without pretilachlor and butachlor compared to farmers practices. SSB with glyphosate recoded to be reduced the broad spectrum weeds before the sowing of crop has also been reported by Kumar *et al.* (2015a). SSB+ glyphosate at 1.75 kg/ha+butachlor at 1.0 kg/ha significantly reduced the grass weeds density compared to farmers' practices and SSB+glyphosate at 1.25 kg/ha, though it was at par with SSB+glyphosate at 1.75 kg/ha with pretilachlor and butachlor at 1.0 kg/ha treatments. Overall grass weeds density was comparatively lower where glyphosate mixed with butachlor and pretilachlor than SSB + glyphosate alone.

On contrary broad leaved weeds (BLW) was significantly ($P < 0.05$) reduced by SSB + glyphosate +pretilachlor 1.0 kg/ha compared to famers practices and SSB + glyphosate 1.25 and 1.75 kg/ha alone and SSB+ glyphosate + butachlor 1.0 kg/ha. *Cyperus rotundus* density was higher when glyphosate tank mix with butachlor and pretilachlor compared to glyphosate alone (Table 1).

Table 1: Effect of stale seed bed (SSB) with herbicides on weed density in jute

Treatments	*Cyperus rotundus* (No./m²)		Grass weeds (No./m²)		Broad leaved weeds (No./m²)	
	2015	2016	2015	2016	2015	2016
T1: Farmers' practice	11.97 (150.0)	10.91 (122.0)	4.95 (25.3)	6.45 (42.0)	5.8 (37.3)	6.40 (41.3)
T2: SSB# + glyphosate 41% SL at 1.25 kg/ha	5.15 (26.7)	5.05 (26.7)	5.05 (25.3)	4.51 (20.0)	5.32 (29.3)	5.31 (29.3)
T3: SSB+ glyphosate 41% SL at 1.75 kg/ha	2.59 (8.0)	2.56 (8.0)	3.41 (12.0)	3.95 (15.6)	10.6 (121)	9.69 (97.3)
T4: SSB+ glyphosate 41% SL at 1.25 kg/ha + pretilachlor 50% EC at 1.0 kg/ha	4.90 (24.0)	3.23 (13.3)	2.38 (6.7)	1.64 (4.0)	1.64 (4.0)	2.91 (8.0)
T5: SSB + glyphosate 41% SL at 1.75 kg/ha + pretilachlor 50% EC at 1.0 kg/ha	4.25 (24.0)	3.78 (18.6)	3.09 (12.0)	2.85 (8.0)	2.65 (6.7)	2.76 (8.0)
T6: SSB+ glyphosate 41% SL at 1.25 kg/ha+ butachlor 50% EC at 1.0 kg/ha	5.87 (34.7)	5.74 (33.3)	2.85 (8.0)	2.29 (6.66)	5.37 (29.3)	6.53 (42.6)
T7: SSB+ glyphosate 41 % SL at 1.75 kg/ha + butachlor 50% EC at 1.0 kg/ha	7.49 (58.7)	5.88 (34.7)	1.91 (4.0)	1.98 (6.66)	5.64 (33.3)	4.38 (22.6)
SEm (±)	1.18	1.03	0.70	0.85	0.99	0.96
LSD (P<0.05)	3.62	3.16	2.1	2.63	3.06	2.96

SSB-Stale seed bed, Data in parentheses is original value, Data was transformed by square root transformation $\sqrt{(x + 0.5)}$ before statistical analyses

It did not mean that tank mixed butachlor and pretilachlor had antagonistic affect. It was mainly because pretilachlor and butachlor at 1.0 kg/ha treated plot killed germinating broad leaved and grass weeds but not *Cyperus rotundus,* resulted in lower density of grass and BLW weeds (Table 1) which posed lower interference for emerging *Cyperus rotundus*. Moreover, C*yperus rotundus* emerged during crop season was its secondary flush, as the first flush was killed on SSB. As glyphosate has only post-emergence activity it enters in plant through stomata and inhibits enzyme 5-enolpyruvyl shikimate-3-phosphate (EPSP) synthase responsible for formation of aromatic amino acids like tryptophan, tyrosine and phenylalanine. It deactivated in soil matrix (Dong-Mei *et al.,* 2004) and prone to rapid microbial degradation (Giesy *et al.,* 2000), hence, unable

to control germination second flushes of weeds as first flushes were already killed on SSB. Butachlor and pretilachlor applied pre-emergence and had killed the germinating weeds as it absorbed by radicle during root initiation, the broad weed more effectively controlled by pretilachlor as compared to butachlor (Bindra *et al.*, 2002; Ghorai 2013). Butachlor and pretilachlor at 1.0 kg/ha effectively controlled grass weeds in jute has been reported by Ghorai *et al.* (2013). The effect of weed management treatments on weed dry weight followed the same trend as weed density (Table 2) because weed dry biomass is function of weed density hence the trend were same.

Table 2: Effect of stale seed bed (SSB) with herbicides on weed dry biomass in jute

Treatments	*Cyperus rotundus* (g/m^2)		Grass weeds (g/m^2)		Broad leaved weeds(g/m^2)	
	2015	2016	2015	2016	2015	2016
T1: Farmers' practice	5.49 (30.9)	5.69 (32.6)	2.18 (4.4)	2.76 (7.3)	2.44 (6.3)	2.87 (7.8)
T2: SSB + glyphosate 41% SL at 1.25 kg/ha	2.45 (5.65)	3.36 (11.0)	2.23 (4.6)	1.97 (3.4)	2.37 (5.5)	2.44 (5.73)
T3: SSB+ glyphosate 41% SL at 1.75 kg/ha	1.39 (1.7)	2.70 (6.9)	1.56 (2.0)	1.80 (2.8)	4.48 (21.3)	4.40 (19.9)
T4: SSB+ glyphosate 41% SL at 1.25 kg/ha + pretilachlor 50% EC at 1.0 kg/ha	2.33 (5.0)	2.89 (8.0)	1.20 (1.1)	1.03 (0.77)	1.01 (0.72)	1.43 (1.54)
T5: SSB + glyphosate 41% SL at 1.75 kg/ha + pretilachlor 50% EC at 1.0 kg/ha	2.05 (4.8)	3.05 (9.1)	1.49 (2.0)	1.38 (1.50)	1.22 (1.0)	1.35 (1.44)
T6: SSB+ glyphosate 41% SL at 1.25 kg/ha+ butachlor 50% EC at 1.0 kg/ha	2.80 (7.6)	3.60 (12.6)	1.31 (1.3)	1.22 (1.25)	2.34 (5.2)	2.96 (8.5)
T7: SSB+ glyphosate 41 % SL at 1.75 kg/ha + butachlor 50% EC at 1.0 kg/ha	3.54 (12.9)	3.65 (12.9)	1.06 (1.1)	1.18 (1.36)	2.39 (5.5)	2.07 (4.5)
SEm (±)	0.49	0.31	0.24	0.31	0.42	0.41
LSD (P<0.05)	1.53	0.96	0.76	0.95	1.31	1.27

SSB-Stale seed bed, Data in parentheses is original value, Data was transformed by square root transformation $\sqrt{(x+0.5)}$ before statistical analyses

Effect on crops:

Stale seedbed influenced the yield attributes i.e. plant height (PH) and basal diameter (BD) of jute (Table 3). However, significant effects were observed in 2016 only. The greatest PH and BD was recorded in SSB with glyphosate 1.75 kg/ha+pretilachlor1.0 kg/ha and it was significantly higher as compared to farmers' practice. It might be SSB with subsequent application of herbicides provided almost weed free microclimate and avoided the early weed competition to crop resulted in higher PH and BD of jute. When pretilachloror butachl or applied with glyphosate it controlled second flushes of weeds but glyphosate alone had infestation of grass and BLW which cause small reduction on yield attributes. Significantly higher fibre yield was recorded

Table 3: Effect of stale seed bed (SSB) with herbicides on yield attributes and fibre yield of jute

Treatments	Plant height (cm)		Basal Diameter (cm)		Fibre yield (q/ha)	
	2015	***2016***	***2015***	***2016***	***2015***	***2016***
T1: Farmers' practice	282.3	293.3	1.99	1.97	25.4	27.3
T2: SSB + glyphosate 41% SL at 1.25 kg/ha	283.3	313.6	2.05	2.09	31.5	33.5
T3: SSB+ glyphosate 41% SL at 1.75 kg/ha	281.6	315.3.0	2.00	2.09	30.7	34.0
T4: SSB+ glyphosate 41% SL at 1.25 kg/ha + pretilachlor 50% EC at 1.0 kg/ha	287.0	323.3	2.06	2.17	34.3	37.8
T5: SSB + glyphosate 41% SL at 1.75 kg/ha + pretilachlor 50% EC at 1.0 kg/ha	293.3	335.6	2.14	2.19	34.9	38.9
T6: SSB+ glyphosate 41% SL at 1.25 kg/ha+ butachlor 50% EC at 1.0 kg/ha	279.3	316.6	2.05	2.15	32.1	34.5
T7: SSB+ glyphosate 41 % SL at 1.75 kg/ha + butachlor 50% EC at 1.0 kg/ha	282.67	320.0	2.00	2.15	34.0	36.5
SEm (±)	6.76	6.32	0.07	0.04	1.23	1.54
LSD (P<0.05)	NS	19.4	NS	0.12	3.78	4.75

SSB + glyphosate 1.75 kg/ha + pretilachlor 1.0 kg/ha compared to farmers' practice and it was at par with remaining treatments during both year of experimentation. The reason as mentioned above that good growth of plant/crops in weed free situation resulted in higher fibre yield, weed management practices increased jute fibre yield reported by many researchers (Ghorai, 2008, Ghoari *et al*., 2013 and Sarkar, 2006).

ECONOMICS

The highest cost of cultivation was incurred in farmers' practices (Table 4) because in this treatment two manual weeding were practiced and it is well established fact that manual weed control method comparatively costly than chemical weeding. However, it also depends upon type of weeds and their density.

The lowest cost of cultivation was recorded in SSB with glyphosate at 1.25 kg/ha. While, net income was the highest in SSB + glyphosate 1.75 kg/ha + pretilachlor 1.0 kg/ha followed by SSB + glyphosate 1.25 kg/ha + pertilchlor 1.0 kg/ha.This is only because higher fibre yield and also comparable cost of cultivation with other treatments. Benefit-cost ratio was also higher SSB + glyphosate 1.75 kg/ha + pretilachlor 1.0 kg/ha treated plot.

Table 4: Effect of stale seed bed (SSB) with herbicides on economics of jute

Treatments	Cost of production (Rs/ha)		Net Income (Rs/ha)		Benefit-Cost ratio	
	2015	***2016***	***2015***	***2016***	***2015***	***2016***
T1: Farmers' practice	47799	58384	25302	34708	0.53	0.59
T2: SSB + glyphosate 41% SL at 1.25 kg/ha	43579	52424	47174	61810	1.08	1.17
T3: SSB+ glyphosate 41% SL at 1.75 kg/ha	44099	52984	44373	62955	1.00	1.18
T4: SSB+ glyphosate 41% SL at 1.25 kg/ha + pretilachlor 50% EC at 1.0 kg/ha	44429	53324	54182	75687	1.22	1.41
T5: SSB + glyphosate 41% SL at 1.75 kg/ha + pretilachlor 50% EC at 1.0 kg/ha	44949	53884	55464	78991	1.23	1.46
T6: SSB+ glyphosate 41% SL at 1.25 kg/ha+ butachlor 50% EC at 1.0 kg/ha	44219	53124	45288	64520	1.02	1.21
T7: SSB+ glyphosate 41 % SL at 1.75 kg/ha + butachlor 50% EC at 1.0 kg/ha	44739	53684	53010	71007	1.18	1.32

CONCLUSION

Form this study it may be concluded that SSB with glyphosate at 1.25 and 1.75 kg/ha alone cannot control secondary flushes of weeds in jute. SSB +glyphosate1.75 kg/ha + pretilachlor 1.0 kg/ha can effectively controlled *Cyperus rotundus*, secondary flushes of grass and broad leaved weeds in jute. This weed control practices also recorded higher jute fibre yield, net income and benefit-cost ratio from jute cultivation. Therefore, stale seedbed with glyphosate 41% SL 1.75 kg/ha tank mixed with pretilachlor 1.0 kg/ha may be practised for broad spectrum and long term weed control method in jute cultivation.

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