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Weed Smothering in Jute (*Corchorus olitorius* L.) by its High Density Broadcast Sowing

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ABSTRACT

Jute being a C_3 crop, cannot compete with the C_4 weeds at its early stage and requires about 40 per cent of total cost of cultivation in weeding process alone. Scarcity of farm labours during weeding, spiraling labour cost, slow mechanization in jute and environment concern of herbicides encouraged us to smother weeds in jute field by its high density sowing. Experiments were thus conducted for three years at ICAR-CRIJAF, Barrackpore focusing smothering of composite weeds in jute field by its high density broadcast sowing (HDS, seed rate @ 6.0 kg/ha) and was compared with other weed management treatments. From the experiments it was found that fast growing dense jute canopy (200-348/m^2) at 25 days after sowing with mean height of 29 cm, reduces the light penetration at its canopy base by 90-95 per cent and dominated all C_4 weeds. It reduced the grass, broadleaf, sedges weed population and weed bio mass by 70, 98.5, 64.5 and 91.65 per cent, respectively over manual weeding twice. Remaining weeds were rudimentary, incapable of producing seeds and decomposed before jute harvest. Only 6.3 to 7.64 lakhs jute/ha *i.e.,* 16 to 23.5 per cent of total initial population could be harvested at maturity, 125 to135 DAS. This high density jute sowing eliminated weeding and thinning processes, saved 102 man days/ha over conventional manual weeding, produced 3.82 t fibre/ha and was cheaper by Rs. 25,500/ha. Weed smothering by intercropping green gram with jute (1:1) was also found economic, produced 0.5-1.0 t pulse grain/ha along with 2.7-2.9 t jute fibre and 1.7 to 2 t nitrogen rich (2.35%) pulse waste/ha. Pre emergence herbicides Pretilachlor 50 EC and Ipfencarbazone 22.8 per cent SC were found effective for weed control in jute. Spraying of Pretilachlor 50 EC @ 0.9 l a.i/ha on paira crop, immediately after rice harvest was found effective for weed control in piara crop. Thus, weed smothering by high density broadcast jute sowing will eliminate dependence on manual weeding, herbicides, and mechaninical weeding and make jute farming sustainable.

Key Words: Chemical, Economics, High density sowing, Light transmission, Mechanical, Smothering, Weed control,

INTRODUCTION

Jute crop, if not weeded at right time (within 25d) the yield loss is up to 67 per cent (Ghorai *et al*, 2016; Kumar *et al*, 2013). Furthermore, upsurge of new weed flora, labour scarcity during weeding, herbicidal resistance along with its environmental concern and its slow mechanized weed control process, encouraged us to control weeds in jute field by its smothering effect. A smother crop is a thick, rapidly growing crop that is used to suppress or stop the growth of weeds which have better root systems that help them compete with weeds for water and as a result, the root systems of weeds get weak. Meanwhile, the dense top growth of the smother crop suppresses the top growth of weeds. Effectively, smother crops successfully compete with weeds for vital resources (growth, space, water, light) and inhibit their germination and growth (Kumar, 2008). In cultural weed management, crop competitiveness could be one of several measures and is an important component in integrated weed control. Reduced row spacing, increased seeding rates, and selection of competitive cultivars can potentially manage crop–weed competition in

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cotton, soybean, wheat, and corn. These cultural weed management practices facilitate a more rapid development of crop canopy that adversely affect the emergence, density, growth, biomass, and subsequently the seed production of weeds during a growing season (Jha *et al.*, 2017).

In plots with the highest seeding rate (8 million/ ha) of spring wheat, weed biomass was significantly lower, however lodging problem, especially in early seeded plots occurred (Auskalniene *et al,* 2018) in Lithuania. Marin and Weiner (2014) reported on average, weed biomass was reduced (by 72% in the first year and 58% in the second year), and grain yield was increased (by 48% and 44%) at the highest density in the grid pattern compared with standard sowing practices (medium density, row pattern). Increased density and uniformity can contribute to weed management in maize in many cases, potentially reducing the need for herbicides or mechanical weed control. Weed suppression increased with increasing hemp plant population. Increase of plant density from 100 to 200 plants/ m^2 markedly reduced weed weight from 23.2 to 6.5 g/m^2. Further reductions in weed weights in hemp field were observed at 300 plants/m^2 (2.6 g/ m^2) and 400 plants/m^2 (1.5 g/m^2) Hall *et al* (2014). Preliminary information showed that high density broadcast jute sowing (6.75-7.5 kg/ha) coupled with improved agronomic practices, with an initial population of 268/m^2 at 25 days after sowing, can effectively smother weeds in jute field by restricting sunlight entry (>95%) below its canopy, un affecting its fibre production (38.37 q/ha) which saved 89-145 mandays /ha (Ghorai and Roy, 2020).

Field experiments were thus conducted at ICAR-CRIJAF, Barrackpore, WB with jute (cv. NJ-7010) to assess its smothering ability by its high density broadcast sowing (HDS) for controlling composite weeds, minimize weed control expenditure and make jute farming more profitable and ecofriendly in nature. Its performances were also compared with other weed management practices of jute *i.e.,* herbicides, intercropping and mechanical weed control etc.

MATERIALS AND METHODS:

Experiments were conducted in randomized block design with 11 treatment combinations

Table 1. Weed biometry (15 DAS and at 41 DAS for HDS) under different weed management practices in jute .

Treatment	Grasses No./m^2	Broad leaf weeds No./m^2	Sedges No./m^2	Dry weight of weeds (kg/ha)
T1	5 (41 DAS)	3.7 (41 DAS)	12 (41 DAS)	29.2 (41 DAS)
T2	268.00	249.33	35.83	350.00
T3	61.17	262.67	37.17	437.33
T4	32.00	13.33	1.33	52.17
T5	58.67	4.00	5.33	94.67
T6	16.67	90.67	26.60	170.83
T7	43.67	93.33	26.77	175.00
T8	19.00	65.33	29.43	129.33
T9	40.80	83.47	6.07	65.00
T10	222.67	417.33	30.37	350.33
T11	106.69	173.08	12.43	107.36
CD (5%)	92.70	125.76	13.90	96.81

replicated thrice at ICAR-CRIJAF, Barrackpore, WB for consecutive three years (2018 to 2020) using jute c. NJ 7010. The experimental soil was sandy clay loam in texture with 44 per cent sand, 28 per cent silt and 28 per cent clay. Its available nitrogen, phosphorus and potassium contents were 175, 32 and 130 kg/ha, respectively. The individual plot size was 4 m X 2 m. The treatment set up for 2018 & 2019 were T1: High density broadcast jute sowing (HDS, 6.0kg/ha) + no weeding and no thinning, T2: Jute (6 kg/ha) + two manual weedings -rice- khesari (paira crop), T3: Jute (6 kg/ha) + CRIJAF nail weeder (7 DAS) + Scrapper (15 DAS) + 1 HW – rice - field pea (paira crop), T4: Jute (NJ 7010, 2.2 kg/ha) + green gram intercropping (1:1, cv. TMB 37, 10 kg/ha)) + Pretilachlor 50 EC @ 0.9 l ai/ha (Pre-emergence herbicide) + 1HW – rice - bottle gourd (gunny bag columns) + spinach (mixed paira crop), T5: Jute (2.2 kg/ha) + green gram mixed crop (cv.TMB 37, 10 kg/ha,) + Pretilachlor 50 EC @ 0.9 l ai/ha +1HW – rice – rajmash (minimal tillage), T6 : Jute (2.2 kg/ha) + green gram intercropping (1:1, cv. Sukumar, 10 kg/ha) + Pretilachlor 50 EC @ 0.9 l ai/ha + 1HW- rice, T7: Jute (6 kg/ha) + Ipfencarbazone @ 68.43 g/ha (Pre-emergence herbicide) + 1HW- rice – lentil (paira crop), T8: Jute (6 kg/ha) and summer palak (mixed crop, cv. Haldi bari) **)** + Ipfencarbazone @ 91.24 g/ha + 1 HW - mustard (paira crop), T9: Jute (6 kg/ha) + Ipfencarbazone @ 114g/ha + 1 HW- rice, T10: Jute (6 kg/ha) + Haloxofop R methyl 10.5 % W/W EC @ 94.5 g (post -emergence herbicide) +1 HW+ rice – khesari (sown after ploughing), T11: Jute (6 kg/ha) + unweeded control. Except T1, all others were line sown.

For 2020, this promising high density broadcast jute sowing without weeding and thinning (6 kg/ha) was again compared and confirmed, testing it with another 10 treatments (total 11 numbers in RBD) which were as follows.: T1 : Jute (NJ 7010, HDS (6 kg/ha) + no weeding and thinning, T2: Jute (NJ 7010) @ 6 Kg/ha + 2 HW, T3: Jute (NJ 7010, 6

Table 2. Jute fibre and sequential crop yields under different weed management practices.

Treatment	Final Population /ha	Fibre yield (t/ha)	Jute equivalent yield (t/ha)	Jute Green Biomass (t/ha)	Rice yield (t/ha)	Paira crop yield (t/ha)
T1	6.30	3.837	3.837	7.436	6.096	--
T2	5.25	4.045	4.045	6.658	6.117	1.560
T3	4.88	3.799	3.799	6.642	6.051	2.712
T4	3.10	2.893 (0.990)	4.716	6.167	6.199	16.0 (3.75)
T5	2.99	2.713 (0.958)	4.479	6.375	6.342	0.547
T6	3.35	27.43 (0.994)	4.528	6.383	6.201	--
T7	2.58	2.800	2.80	6.541	6.218	1.485
T8	2.36	2.857	2.857	5.978	5.958	1.062
T9	2.60	2.95	2.95	6.20	5.888	--
T10	3.5	3.2	3.2	6.3	5.364	1.25
T11	3	1.500	1.500	2.900	6.198	--
CD (5%)	0.57	0.407	0.430	0.903	1.076	--

Photo 1: Light flux above and below jute canopy, dense canopy-25 DAS and final stand from left

kg/ha) + CRIJAF nail weeder (5-6 DAS) +1 HW, T4: Jute (JRO BA3, 2.2 kg/ha) + green gram (cv. Virat, 10 kg/ha) intercropping (1:1) + Pretilachlor 50 @ 0.9 kg a.i/ha +1 HW, and seven graded low jute seed rates for rest treatments T5, T6, T7, T8, T9, T10 &, T11 (@ 1.2, 1.5,1.9, 2.25,2.6, 3.0 & 3.75 kg/ha) + Pretilachlor 50 EC @ 0.9 kg a.i/ha +1 HW).

For high density sowing alone (T1, all three years) 45 cm wide strip around the jute plots were manually weeded to prevent weeds seed formation in boarder areas, the rest of the weeds were left out for smothering by high density jute crop canopy. Except T1, in all others treatment jute crops were line sown (25 spacing). Jute and green gram intercropping was arranged in 1:1 ratio at 20 cm intervals. Jute was sown (17th to 24th April) with one post sowing irrigation. For HDS (T1), the fertilizer dose was N:P:K::80:80:80. Basal fertilizer dose was N:P:K:: 20:80:80. To boost early jute growth, 2nd and 3rd irrigations were given on 7 DAS and 15-21 DAS. Thirty Kg nitrogen was top dressed at 3rd irrigation. Fourth irrigation was given at 35 days after sowing with 30 Kg N top dressing. For jute alone the fertilizer dose was N:P:K::60:30:30:30. For jute green gram intercropping the fertilizer dose was N:P:K::80:70:70. For jute and green gram intercropping (sown 15th March), 2nd irrigation was held up till green gram harvest. Basal fertilizer dose was N:P:K::20:70:70 and rest 60 kg nitrogen top dressed in jute after green gram harvest with irrigation. For composite weed control of rice and paira crops (sown rice 10 days before its harvest) in sequences after jute, Pretrilichlor 50 EC @ 0.9 l ai/ha was applied at 3 days after rice transplanting and 7 days after rice harvest on emerging young paira crops, respectively. Plant and weed counts were taken using quadrants at different times. Incident light above or base of jute canopy were measured by LX 102 Light meter (Lutron, L6220942) at 25 days after sowing in HDS. The incident solar radiation per cent below jute canopy = (Incident solar radiation at canopy base / incident solar radiation over crop canopy) x 100.To combat fungal attack in jute, it was sprayed with Tebuconazole @ 1.5ml/l at 15 and 21 DAS. The crop was harvested at 125 to 135 DAS. Standard statistical packages were used for data analysis.

RESULTS AND DISCUSSION

Major weed flora present in jute field were: Grasses: *Ecinocloa colonum, Cynodon dactylon, Brachiaria mutica etc;* Broad leaved weeds*: Trainthema spp, Physalis minima, Digera arvensis and Alternanthera spp etc;)* and Sedges: *Cyperus rotundus, Ceperus dformis, Cyperus iria etc*.

Reduction of incident light at the base of jute canopy and weed smothering

The dense jute canopy (200-348/m^{2,} Fig 1 and Photo 1)) of HDS (T1, Table 1) of 29 cm mean height at 25- DAS reduced the incident light at jute base by 90-95 per cent and dominated all C4 weeds. It reduced the grass, broadleaf weed, sedges

population and its bio mass by 98, 98.5, 67 and 91.65 per cent respectively over manual weeding twice (T2, Table 1), Remaining weeds were lanky and rudimetary in nature, incapable of producing seeds and were decomposed before jute harvest. In HDS (T1, Table 1), tall jute palnts reduced weed dry weght to 2.92 g/m^2 at 41 DAS. Manual weeding of 45 cm width strip around usual size jute field (1/3rd an acre or 1333 m^2) of farmers amounts to weeding of only 5 per cent of the total jute field. Rest 95 per cent area do not require any weeding and thinning which die or decomposes below the jute canopy due to internal competition (Ghorai and Roy, 2020). Reductions in weed weights in hemp field were observed at 300 plants m^2 (2.6 g/m^2) and 400 plants/m^2 (1.5 g/m^2), Hall *et al* (2014. A plant density of 1,11,111 plants/ha in normal planting (60 cm x 15 cm) produced significantly more kapas yield (3.134 t/ha), reduced weed dry matter with higher weed control efficiency (61.88 % as against high plant density of 1, 11,111 plants/ha paired row planting and 1,48,148 plants/ha), Madavi *et al* (2017). Thiem *et al* (2020) reported optimum yield of vegetable corn could be obtained at a planting higher density of 111,111 plants/ha over planting 79.4 to 92.6 thousands/ha, combined with hand weeding once at 3-4 leaf stage, with an increase of the cob yield by 2.01 t/ha and it saved weeding.

Field survey near experimental firm showed that the method is gradually being adopted by jute farmers to minimize cost of cultivation and avoid drudgery in weeding and thinning under hot sun (38-40 ^{0}C) under changing climatic scenario. Jute crop grown in this process will act as promising cover crop to weed control in other crops by its smothering ability (terminating its growth as required for different crops) and sequester carbon in soil adding organic matter.

Final population and jute fibre yield as affected by High Density Broadcast sowing (HDS)

Initial population of jute seedlings were counted in field using 0.5 m x 0.5 m quadrant for different treatments replicationwise. In three years out of initial jute population 20.7 lakh (40 DAS), 26.8 (15 DAS), 34.8 l lakh (15 DAS), only 3.3, 6.3 (Table 2) and 7.64 lakh effective jute plants/ha *i.e.,* 16, 23.5 and 22 per cent of total initial population could be harvested at maturity (125 to 135 DAS). Many jute plants became chads (<1.5m) or it died due to high internal competition for light, space, water and nutrition. High density broadcast jute sowing produced 3.837 to 3.798 t fibre/ha (Table 2 & 3) with a mean fibre yield of 3.82 t fibre/ha. Fibre yield of HDS were at par with low density juty jute sowing under different weed mangement practices which were economic too (Ghorai *et al*, 2020). HDS, eliminated weeding and thinning processes and consumed only 290 man days/ha (including 35 man days/ha for sorting after harvest) from sowing to fibre extraction over conventional method (382 man days/ha, Table 3) and saved 102 man days/ha (Rs.2550/-, Table 3). Relay/zero till paira crop of bottle gourd, lentil, mustard, rajmash, khesari and field pea recoded yields of 16 t, 1.485 t, 1.06 to 1.6 t/ha (2017-18), 0.55 t, 1.56 t, 2.7 t/ha, respectively (Table 3).

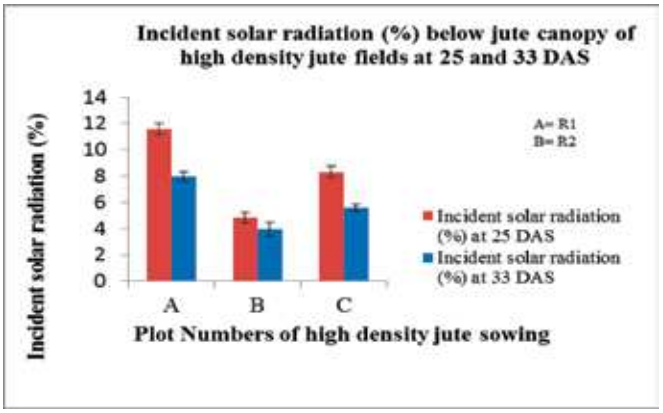

Figure 1. Incident solar radiation per cent below jute canopy at 25 and 33 days after jute sowing under high density sowing (6 kg/ha)

Jute fibre yield as affected other integrated weed management practices

Intercropping canopy (1:1), with jute and green gram (*Vigna radiata*) reduced more than 90 per cent sunlight entry below its base (40-45 DAS) and reduced weed biomass by 76 per cent at 25 DAS. Green gram yield (cv. TMB-37, Sukumar, and

Table 3. Jute fibre as affected by different integrated weed management treatments and its labour requirement/ha (2020)

Treatment	Final Plant population (Lakh/ha)	Individual fibre yield (g/plant)	Total fibre yield (t/ha)	Labour requirement (Man days/ha)
T1	7.64	5.58	3.798	290
T2	5.48	7.95	4.249	392
T3	5.41	7.13	3.840	311
T4	3.30	6.87	2.7 (0.5)*	272
T5	2.71	14.0	3.798	240
T6	3.65	11.0	3.867	242
T7	3.91	9.0	3.471	242
T8	3.97	10.13	3.950	259
T9	4.15	9.44	3.798	272
T10	3.72	9.81	3.629	252
T11	5.26	6.20	3.239	360
CD (1%)	1.20	2.53	0.588	29.56

Virat, 52-60 DAS) in intercrop and mixed crops were 0.5 t to 0.99 t/ha respectively (Table 2 & 3) with fibre yields of 2.7-2.9 t/ha (Table 2 &3) respectively. Higher weed control by jute and green gram intercropping has been reported by Ghorai *et al* (2016). Bilalis *et al* (2010) also reported that intercropping maize with legumes reduced weed density compared with pure stand of maize due to less availability of light for weeds germination and growth and weed smothering efficiency of legumes. In mixed crop, 30 jute and 6 green gram seedlings were maintained/m^2 and excess jute seedlings around 20 cm diameter of green gram plants were removed within 15 DAS. Low density jute sowing (1.2 to 2.6 kg/ha) reduced the cost of jute cultivation significantly (Table 3) Ghorai and Chakravorty (2020).

CONCLUSION

Fast growing dense jute canopy at 25 days after sowing with mean height of 29 cm, reduces the light penetration at base by 90-95 per cent and dominates all C4 weeds. Remaining weeds were rudimentary, incapable of producing seeds and decomposed after jute harvest below it canopies. Maximum 6.3 to 7.64 lakh jute plants/ha *i.e.,* 23.5 to 22 per cent of total population could be harvested (125 to135 DAS). This process of jute sowing eliminated weeding (95%) and thinning processes, saved 102-man days/ha which amounts to Rs. 25,500/ha over conventional manual weeding twice and produced 3.82t fibre/ha respectively. Weed smothering by high density broadcast jute sowing will eliminate dependence on costly manual weeding, questionable herbicides, mechanical weeding and will make jute farming more remunerative.

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