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Influence of prickly sesban (*Sesbania cannabina*) intercropping in wet-seeded rice *(Oryza sativa)* on productivity, profitability, energetics and nitrogen balance under island ecosystem

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ABSTRACT

Experiments were conducted during 2005 and 2006 at Port Blair, to evaluate prickly sesban [*Sesbania cannabina* (Retz.) Pers.] intercropping in wet-seeded rice under island ecosystem. The results revealed that though rice + *dhaincha* or prickly sesban registered higher yield when *dhaincha* is incorporated mechanically with cono weeder (4.24 tonnes/ha), it is on par with manual and manual + conoweeder incorporation. In terms of economics and energetics, rice+ *dhaincha* incorporation using cono weeder recorded higher net returns (Rs 15 876/ha) and higher energy ratio (8.38). Significant increase in available soil N was observed at harvest in rice + *dhaincha* (254.7 kg/ha) compared to sole rice (226.8 kg/ha). N loss was maximum in sole and unweeded conditions compared to rice + *dhaincha* incorporation through manual or conoweeder or its combination.

Key words: Green manure intercropping, Nitrogen balance, Wet seeded rice

Transplanting is the traditional system of crop establishment of rice (*Oryza sativa* L.) accounts for 21% of operational cost and takes energy of 30 persons/ha. As the rice production system in Asia undergoes major adjustments in response to the rising scarcity of labour, capital and water, the major adjustments to be ushered are the method of establishment. Wet seeding can be practised as an alternative to transplanting in irrigated and rainfed lowlands as it holds promise for saving labour time, energy, minimizes drudgery, ensures efficient water use and increases benefit : cost ratio (Ravisankar *et al.* 2007a). Rice farmers in the tropics practice wet seeding by broadcasting or line seeding of germinated seeds on the puddled soil surface and this gives an opportunity of intercropping green manures during early stage of line-sown rice crop with less interference on rice growth (Milberg and Hallgren 2004). The situation can be effectively capitalized by raising *dhaincha* or prickly sesban [*Sesbania cannabina* (Retz.) Pers.] as a green manure crop conjointly with wet-seeded rice and incorporating it at 35–40 days after sowing using cono weeder. *Dhaincha,* being a leguminous, fixes atmospheric nitrogen and information on nitrogen balance of rice + *dhaincha* intercropping is lacking which warrants investigation in these directions. Against this backdrop, the present study was planned to elicit information on the influence of cropping of *dhaincha* in wet-seeded rice intercropping on productivity, profitability, energetics and N balance in wet-seeded rice.

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MATERIALS AND METHODS

Field experiments were conducted during rainy *(kharif)* seasons of 2005 and 2006 at field crops research farm, Bloomsdale of Central Agricultural Research Institute, Port Blair to evaluate the influence of *Sesbania* intercropping in wet-seeded rice on yield, economics, energetics and nitrogen balance. The soil was sandy loam in texture, medium in organic carbon (0.63%), low in available N (245 kg/ha), medium in P (19 kg/ha) & high in K (294 kg/ha) and had a *p*H of 6.2. The experiment was laid out in randomized block design with three replications. The treatments consisted of wet-seeded sole rice with manual weeding (T_1), wet-seeded sole rice with cono weeding (T_2), wet-seeded rice + *dhaincha* (manual incorporation) (T_3), wet-seeded rice + *dhaincha* (cono weeder incorporation) (T_4), wet-seeded rice + *dhaincha* (manual + conoweeder incorporation) (T_5), wet-seeded sole rice (unweeded check) (T_6) and wet-seeded rice + *dhaincha* (unweeded check) (T_7). Field preparation was done by puddling the field twice, followed by levelling with tractor.

'Taichung-sen-Yu' rice was sown in 24th standard week and harvested in 43rd standard week of 2005 and 2006. Pre-germinated rice seeds (seeds soaked in water overnight and incubated for 24 hr) were used @ 75–80 kg/ha (wet weight basis) for wet seeding. Rice and *dhaincha* were sown simultaneously using manually-operated by Single wheel rice-cum-green manure seeder developed by the Tamil Nadu Agricultural University, Coimbatore. For the intercrop, the seed rate of *Sesbania aculeata* was 25 kg/ha. Intercropped *dhaincha* was incorporated *in situ* at 37 days after sowing manually or by using cono weeder as per treatment. No spraying of pesticide was resorted as all the pest and disease were below the economic threshold level. Growth and yield parameters were recorded as per the standard procedures. Economics and energetics were also worked out. Soil samples at presowing and after harvest were analyzed for available nitrogen using prescribed analytical method (Tandon 1993). Similarly, N content of *dhaincha* at incorporation and rice crop at maturity were also estimated.

RESULTS AND DISCUSSION

Growth and yield attributes

Green manure intercropping of *dhaincha* gave 3 tonnes of green biomass having 2.4% N. Weeding in sole rice as well as in *dhaincha* intercropped rice either manually or with cono weeder significantly increased plant height of rice over unweeding. Similarly, intercropping of *dhaincha* in rice resulted in a significant increase in the plant height of rice. Wet-seeded rice + *dhaincha* (cono weeder incorporation), registered higher yield attributes, viz productive tillers m^{-2} which is at par with wet-seeded rice + *dhaincha* (manual incorporation) and wet-seeded rice + *dhaincha* (manual + cono weeder incorporation) (Table 1). Din *et al.* (2004) also reported similar findings.

Yield

In general intercropping of *dhaincha* in wet-seeded rice and incorporating it with either manual/cono weeder/ manual + cono weeder led to higher grain yield in wet-seeded rice compared to sole wet-seeded rice. It is also observed that, though rice + *dhaincha* registered higher grain yield when *dhaincha* is incorporated mechanically with cono weeder (4.41 tonnes/ha), it is at par with manual (4.24 tonnes/ ha) and manual + cono weeder (4.32 tonnes/ha). Unweeded check of sole rice registered only 0.72 tonnes/ha which is far lesser than the unweeded check of sole rice + *dhaincha* (Table 1). Straw yield also registered similar trend. The finding corroborates the results of Ravisankar *et al*. (2007b).

Economics

In terms of economics, net returns (Rs 15 876) and B:C ratio (1.28) was higher with rice + *dhaincha* (cono weeder incorporation) (Table 2) compared to other methods of incorporation which is due to the saving in labour cost for incorporation of *dhaincha*. Sole rice registered lesser net returns and B : C ratio compared to *dhaincha* intercropping.

Table 1 Influence of *dhaincha* intercropping on yield parameters and yield of wet-seeded rice (pooled over two years)

Treatment	Plant height (cm)	Productive tillers/m^2	Grain yield (tonnes/ha)	Straw yield (tonnes/ha)	Harvest index
Sole rice (unweeded check)	78.2	64	0.72	0.93	0.44
Sole rice (manual weeding)	92.8	198	3.56	5.09	0.41
Sole rice (cono weeding)	92.1	232	3.36	4.71	0.42
Rice + *S.aculeate* (unweeded check)	82.3	128	2.22	3.11	0.42
Rice + *S.aculeate* (manual incorporation)	95.3	246	4.24	6.02	0.41
Rice + *S.aculeate* (cono weeder incorporation)	98.4	258	4.41	6.22	0.41
Rice + *S.aculeate* (manual + cono weeder incorporation)	96.8	241	4.32	6.13	0.41
CD (*P*=0.05)	6.6	14	0.27	0.35	NS

Table 2 Influence of *dhaincha* intercropping on economics of wet-seeded rice (pooled over two years)

Treatment	Cost cultivation (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	B: C ratio
Sole rice (unweeded check)	11 096	4 516	–6 580	–0.59
Sole rice (manual weeding)	14 082	22 904	8 822	0.63
Sole rice (cono weeding)	12 400	21 523	9 123	0.74
Rice + *S.aculeate* (unweeded check)	11 496	14 195	2 699	0.23
Rice + *S.aculeate* (manual incorporation)	13 920	27 208	13 288	0.95
Rice + *S.aculeate* (cono weeder incorporation)	12 418	28 294	15 876	1.28
Rice + *S.aculeate* (manual + cono weeder incorporation)	13 300	27 722	14 422	1.08
CD (*P*=0.05)		2 049	519	0.05

Table 3 Influence of *dhaincha* intercropping on energetics of wet-seeded rice (pooled over two years)

Treatment	Energy Input (MJ/ha)	Energy Output (MJ/ha)	Energy Ratio	Specific energy (MJ/kg)
Sole rice (unweeded check)	14 234	22 132	1.55	19.82
Sole rice (manual weeding)	16 728	1 16 032	6.94	4.7
Sole rice (cono weeding)	16 328	1 08 289	6.63	4.86
Rice + *S.aculeate* (unweeded check)	15 030	71 420	4.75	6.78
Rice + *S.aculeate* (manual incorporation)	17 630	1 37 523	7.8	4.16
Rice + *S.aculeate* (cono weeder incorporation)	17 030	1 42 683	8.38	3.86
Rice + *S.aculeate* (manual + cono weeder incorporation)	17 424	1 40 119	8.04	4.04
CD (*P*=0.05)	12.3	11.4	1.43	1.24

Table 4 Nitrogen balance of rice + *dhaincha* under wet-seeded condition (pooled over two years)

Treatment	Pre sowing N (kg/ha)	N addition (kg/ha)	Uptake (kg/ha)	Balance (kg/ha)	Post harvest N (kg/ha)
Sole rice (unweeded check)	248.1	90	44.3	293.8	182.1
Sole rice (manual weeding)	248.1	90	85.6	252.5	213.4
Sole rice (cono weeding)	248.1	90	83.8	254.3	240.2
Rice + *S. aculeate* (unweeded check)	248.1	162	51.6	358.5	223.4
Rice + *S.aculeate* (manual incorporation)	248.1	162	97.2	312.9	278.6
Rice + *S.aculeate* (cono weeder incorporation)	248.1	162	95.6	314.5	301.4
Rice + *S.aculeate* (manual + cono weeder incorporation)	248.1	162	94.3	315.8	288.3
CD (*P*=0.05)			6.52	28.1	10.8

Energy ratio was higher with wet-seeded rice + *dhaincha* (cono weeder incorporation).

Energetics

The energy required to produce one kg of grain (specific energy) was lower for wet-seeded rice + *dhaincha* and its incorporation using cono weeder compared to other methods of incorporation (Table 3). Specific energy (energy required to produce one kg of grain) is higher in unweeded check of wet seeded sole rice. Similar results were earlier reported by Balakrishnan *et al.* (2007).

Nitrogen balance

Nitrogen balance indicates that significant increase in available N after rice when *dhaincha* is intercropped and incorporated using cono weeder/manual or manual + cono weeder compared to sole wet-seeded rice (Table 4). This might be due to the addition of N through green manure decomposition. Uptake of N by rice was also higher when *dhaincha* is intercropped and incorporated. Incorporation of *dhaincha* using cono weeder might have increased the depth of incorporation (reduced zone), thereby reduced the loss through leaching and volatilization (Ravisankar *et al.* 2003).

Thus, it can be concluded that *dhaincha* can be recommended for intercropping in wet-seeded rice under island conditions for realizing better productivity, profitability and energetic of rice.

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