DUAL CROPPING IN SEMIDRY RICE-A REVIEW
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ABSTRACT
Semidry rice cultivation is growing rice under rainfed condition and later turning to lowland crop when rainwater is available from the tanks and/or from similar sources. The semidry rice cultivation is prevalent in twenty per cent of rice area of our country with low productivity of one t ha⁻¹ which indicates an imminent need to raise the level of productivity to narrow down the wide disparity. Crop and weed seed germinate simultaneously in semidry rice and weed competition during critical period of crop growth is more severe. Loss in yield due to the absence of weed control measures in direct sown upland rice culture has been estimated to be upto 97 per cent. Cultural method such as growing intercrop also provides greater scope to control weeds. Dual cropping of Crotalaria juncea, Vigna sinensis, Glycine max, Sesbania in lowland rice combined with intercultivation, suppressed the weeds effectively. The scope of introducing legume crop as dual crop in rice is more, because of its efficiency to control weeds by way of smothering during the early period of weed emergence. It increases the fertility status of the soil by legume effect thereby increases crop yield. The literature revealed that green manure dual cropping resulted in reduced weed flora, higher weed smothering efficiency, lower nutrient removal by weeds, higher growth and yield of rice, nutrient uptake and improved soil fertility status.

Green manure
Green manure dual cropping
The growing concerns about the sustainability of tropical agriculture systems necessitates the use of soil improving organic manures. Organic manures are valued and stressed to be included in integrated nutrient management in rice. Sesbania aculeata (daincha) as green manure crop had wider acceptance among farmers and it occupies prime place in India from early times (Dommergues, 1982). Rajbhandari (1984) obtained fresh biomass yields of 2.2, 11.5 and 26.3 t ha⁻¹ from Sesbania aculeata on 24, 30 and 48 DAS, which were superior to cowpea as green manure. Meelu et al. (1985) obtained maximum biomass production in 45 days old Sesbania aculeata (33.4 t ha⁻¹) among the green manure crops. Saradhamani et al. (1989) reported that daincha accelerated the rate of reclamation, besides increasing the productivity status of the soil. Increasing trends of cropping intensity and burgeoning demands formed the basis for switching over to green manure intercropping. Sesbania aculeata accumulated the higher amount of biomass (26.3 t ha⁻¹) followed by Sesbania rostrata (24.9 t ha⁻¹) but in terms of N contribution, both were comparable contributing 145 and 146 kg ha⁻¹ respectively (Siddeswaran, 1992).

Saravana Pandian and Rani Perumal (1994) had observed higher response in rice for green manures than for other organics such as farmyard manure and biofertilizers like Azosprillium. Green manure substituted about 100 per cent of N requirement of rice crop (Matiwade and Sheelavantar, 1994). Bindra and Thakur (1995) reported that Sesbania aculeata was a better green manure than other green manures.

Daincha could withstand under drought conditions and grow in poorly drained soils, which are slightly saline (Pandey, 1996). Kalaidurai (1998) reported that daincha is fast growing and produced dry matter of 2.0 t ha⁻¹ within 45 days. Among Sesbania sp., Sesbania aculeata recorded higher biomass on 40 DAS followed Sesbania rostrata on 60 DAS. Joseph (1998) reported that intercropping daincha in between two rows of sole rice in additive series and incorporating at 53 DAS proved superior
to sole rice crop. Increase in yield was observed with intercropping *Sesbania rostrata* under wet seeded rice as compared to sole cropping (Bayan, 2000). *Sesbania rostrata* has proved to be a more efficient green manure crop for intercropping in semidry rice (Kalpana et al., 2002 a).

**Green manure incorporation**

The conventional practice is to trample the green manure prior to rice transplanting. The time gap between green manure trampling and rice transplanting varies depending on the tenderness of the green manure (Budhar and Palaniappan, 1996). The trampling of green manure is done manually or by Burmese satum. The tractor and tiller drawn cage wheels are also used for trampling or incorporation of green manure. The intercropped green manure was pulled out and buried in the inter rows manually on 30 DAS (Vennila, 2007).

The herbicide, 2,4-D at 1.0 kg ha⁻¹ applied at 30 DAS of green manure caused gradual wilting of green manures such as cowpea and daincha. Due to incorporation, they added organic matter to the soil with good selectivity to rice (Mathew et al., 1991). Selvi (2001) reported that trampling of green manure in lowland rice could be obtained using IRRI conoweeder.

**Dual cropping on weed control**

**Dual cropping on weed flora**

Weeds belonging to various species of grasses, sedges and broadleaved weed are associated with rice crop. Occurrence of weed flora varies widely due to season, environment and soil condition. Under intercropping situation, the weed spectrum and intensity may vary due to competition for light, nutrients, moisture, space etc.

The major weed flora of upland rice were *Echinochloa colona*, *Elusine indica*, *Ageratum conyzoides*, *Cyperus rotundus*, *Cynodon dactylon*, *Commelina benghalensis*, *Richardia brasiliensis*, *Physalis minima* and *Setaria glauca* (Rafey and Prasad, 1995). Green manure as an inter crop partially shifted the rice weed flora (Torres et al., 1995). Sharma *et al.* (1995) reported that major weed spectrum under upland condition were *Cyperus iria*, *Ageratum conyzoides*, *Cyperus rotundus*, *Eugeron linifolium*, *Imperata cylindrica* and *Spergula arvensis*. Weed flora in dry seeded rice consisted of monocots (54%) and dicots (46%). Kandasamy (1996) reported that the dominant graminaceous weeds were *Echinochloa colona*, *Echinochloa crusgalli*, and *Chloris barbata*. The common Cyperaceous weeds, *Cyperus rotundus*, *Cyperus iria* and *Fimbristylis miliacea*. and broadleaved weeds, *Ludwigia adscendens*, *Marsella quadrifolia* and *Eclipta alba* under lowland conditions.

Under direct seeded upland rice condition *Echinochloa colona*, *Eragrostis japonica*, *Dactyloctenium aegyptium*, *Cyperus rotundus*, *Cleome isocandra*, *Amaranthus viridis*, *Digera arvensis* were found to be dominant (Ramamoorthy *et al.*, 1997). *Echinochloa colona*, *Cyperus rotundus*, *Cyperus difformis*, were the major weed flora under lowland dry seeded condition reported by Rajendran *et al.* (1999). Selvam *et al.* (2001) reported that *Echinochloa colona*, *Cyperus rotundus*, *Cyperus difformis*, *Cynodon dactylon*, *Eclipta alba*, *Trianthea portulacastrum* were the major weeds in semidry rice.

**Dual cropping on weed smothering efficiency**

Growing of green manure along with rice as intercrop suppresses weeds due to faster canopy cover. Cowpea intercropping suppressed the weed population and minimized the weed infestation. In rice + cowpea intercropping system, weed density and weed dry matter were minimum when intercrop was harvested at 45 DAS compared to 25 or 35 DAS (Dutta and Gogoi, 1994).
Intercropping Sesbania in semidry rice and manual incorporation at 35 DAS recorded lower weed dry matter compared to sole paddy crop with weed control efficiency of 77 per cent in the former (Mathew and Alexander, 1995). Dual cropping of green manure as smother intercrop in rice to reduce weed growth (Ravisankar, 2002).

Angadi and Umapathy (1997) reported that intercropping of Crotalaria juncea, Vigna sinensis, Glycine max and Sesbania aculeata in low land rice combined with inter cultivation at 15 DAT and hand weeding at 40 DAT suppressed the weeds effectively. Ramamoorthy et al. (1997) found that in the rice + blackgram intercropping system the increased level of yield attributes and yield were due to lesser crop weed competition, reduced nutrient depletion by weeds and increased uptake by crops have resulted in better grain filling and better weed control efficiency. Masuinas (1998) observed that intercrops suppressed weeds more effectively and for longer time than dried mulches.

**Nutrient removal by weeds**

Weeds are competing with crop plants for their nutrition. It is found that weeds take nearly one third of fertilizer nutrients applied to the crop in three weeks of their growth. This causes severe setback in the plant growth and significant reduction in yield.

Removal of nutrients by weeds was estimated as 26 kg N, 4 kg P₂O₅, and 21 kg K₂O ha⁻¹ (Ramamoorthy, 1991). Weeds usually grow faster than crop plants and absorb added nutrients more rapidly and in larger quantities than crops and thus deprive the supply of nutrients to crop plants (De Datta and Baltazar, 1996). Madhu and Nanjappa (1996) observed a nutrient drain of 57.7 kg N, 50.9 kg P₂O₅, and 72.8 kg K₂O ha⁻¹ by weeds in wet seeded rice.

Weeds deplete considerable amount of applied costly fertilizer nutrients and result in poor crop growth and lower grain yield (Pandey et al., 1997). Bhuvaneswari (1998) reported that weeds being vigorous competitors use greater portion of the fertilizer applied to the rice crop.

**Dual cropping on rice grain yield**

Intercropping Sesbania rostrata at 12:1 ratio produced 15 t ha⁻¹ of biomass in 45 days without affecting the rice growth and incorporating the same at pre flowering stage recorded the highest rice grain yield of 6.3 t ha⁻¹ (IRRI, 1991). Grain yield of rice was increased with green manuring of Sesbania rostrata (Matiwade and Sheelavantar, 1994). Ramamoorthy et al. (1997) observed that intercropping of rice with blackgram gave an increased filling of grains resulting in higher rice grain equivalent and rice + black gram (4:1) intercropping system recorded the highest total yield due to higher grain yield of rice. Further, they reported that grain equivalent yield of rice was significantly higher in intercropping combination than sole cropping. Jeyachandran and Veerabadran (1996) observed that intercropping Sesbania rostrata with semidry rice and application of 75 kg N ha⁻¹ to rice crop recorded higher grain yield. Green manuring with daincha improved the productivity of rice (Thakur et al., 1999). The intercropping of daincha in drum seeded rice for in-situ incorporation at 30 to 40 DAS between paddy rows and application of 75 per cent to 100 per cent recommended N recorded higher yield and yield attributes with moderate to higher daincha biomass incorporation into the soil (Denesh et al., 2004).

Rice + green gram intercropping system recorded significantly higher number of effective tillers resulting in higher grain yield as reported by Mandal et al. (1990). Anandhakrishnan et al. (2001) observed that intercropping of Sesbania rostrata along with four splits of N and K nutrients recorded higher grain yield. Intercropping of rice + Sesbania rostrata in semidry rice produced...
higher biomass and dry matter of 9078 kg ha$^{-1}$ and 1389 kg ha$^{-1}$ respectively (Kalpana et al., 2002b). Similarly, Premi et al. (2003) recorded higher grain yield under 25 per cent recommended dose of N + daincha in rice.

**Dual cropping on nutrient uptake**

Significant increase in nutrient accumulation due to green manuring was reported by Tiwari et al. (1980). He observed increased N content at rice tillering, from 1.58 to 1.88 per cent and that of P and K from 0.45 to 0.69 and 2.73 to 3.48 per cent, respectively, because of green manuring. Higher rice yield in intercrop was associated with 66 per cent increase in rice N uptake per unit area of intercrop (Aggarwal and Garrity, 1987).

Thangaraju and Kannaiyan (1990) reported that N uptake in rice grain and straw was significantly higher with *Sesbania aculeata*. Haroon et al. (1992) reported that N uptake and apparent N recovery of green manured plots were comparable with prilled urea in three major rice growing seasons. *Sesbania rostrata* incorporation resulted in higher uptake of N, P and K in semidry rice (Jayachandran, 1994). Nitrogen uptake by rice crop increased by 40 per cent in *Sesbania cannabina* applied plots compared to control (Tiwari et al., 1995). Pattanayak et al. (2001) observed higher N, P and K uptake in rice due to incorporation of daincha as green manure.

**Dual cropping on soil fertility**

Green manuring increases soil organic matter besides higher supply of N and other plant nutrients (Allison, 1973). Green manure could increase soil N, and available P$_2$O$_5$ in the soil, maintained and renewed soil organic matter and improved soil structure and physical characteristics (Jiao Bin, 1983). The utility of green manures for increasing soil productivity has been recognized from early times in some rice growing countries, particularly China, India and countries of North-East Asia (Singh, 1984). Hundal (1985) found that in waterlogged soils, green manures increased the availability of P through the mechanism of reduction, chelation and favourable changes in soil pH.

Higher accumulation of organic matter and N was observed by the incorporation of 65 days old *Sesbania* green manure (Bhardwaj and Dev, 1985). Anand Swarup (1987) reported that the increase in organic matter was due to green manuring in rice.

Green manures were readily decomposable and resulted in faster aggregates stability (Lekha Sreekanthan, 1987). Green manures not only supply N, but also improve soil physical and chemical properties (Buresh and De Datta, 1991; Becker et al., 1995; Mishra et al., 1996). *Sesbania aculeata* recorded higher organic carbon and available nitrogen, phosphorus, potassium, zinc, iron and manganese (Sriramachandrasekaran et al., 1996). Growing of green manure along with rice as intercrop enriched the soil organic matter thus reducing weeding cost and additional grain yield (Bhan and Sushil Kumar, 1996). *Sesbania aculeata* improved soil structure by virtue of high aggregate stability and avoidance of soil degradation problems such as crushing and compaction (DRR, 1998). There is considerable build up of soil organic carbon content due to the addition of organic N sources, especially green manures (Siddeswaran, 1992; Singh et al., 1999; Kumar et al., 1999). Thakur et al. (1999) observed that continuous green manuring over years increased the organic carbon content of the soil.

Addition of green foliage of *glyricidia* increased the organic carbon, total N, P and K and also water holding capacity (Chaphale et al., 2000). Incorporation of daincha green manure increased the organic carbon content of the soil. The N, P and K uptake of rice was higher in the treatment, which received daincha as green manure (Pattanayak et al., 2001). The availability of N in the soil was increased due to the incorporation of organic source (Singh
et al. 2001). Similarly, Selvi (2001) reported intercropping green manure in wet seeded rice as an effective alternative to basal incorporation in maintaining higher status of organic carbon and available N and P in the soil.

**CONCLUSION**

From the aforesaid review, it is evident that weed control measure and nutrient management for semidry rice is possible by dual cropping. Further dual cropping in semidry rice results in higher growth and productivity.

**REFERENCES**


