SCOPE AND STRATEGIES OF INTERCROPPING GREEN MANURES CROPS IN RICE – A REVIEW

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ABSTRACT

Green manuring has been practiced by farmers and accepted as a potential source of organic manure especially in farms where there are not enough animal manures available. However, growing a crop of green manure exclusively for the purpose of green manuring, warrants farmers to set apart land, labour, time and inputs which is considered as a major constraint amongst them. Hence the practice of raising green manure crops as intercrops in rice would be appreciated as a viable alternative to overcome the difficulty. Past research available on the aspects of intercropping green manure crops with rice, the potential green manure crops for intercropping and their effect on rice growth and yield are reviewed here under.

Though intercropping is done from time immemorial, green manure intercropping in rice ecosystem is of recent origin, the main objective of which is to achieve a substantial increase in rice yield, with additional yield of green manure for building up the soil fertility (Somasundaram, 1991). The farmers are reluctant to use their land, water and other inputs for raising a crop exclusively for green manuring prior to rice (Ali and Narsico, 1993; Kundu et al., 1993). Under the conditions of intensive agriculture, in which land and time are the major constraints, green manure crops can be accommodated in the cropping calendar when the growth interval is short, or can be grown as an intercrop (Watanabe and Liu, 1992). This in addition to increasing trends of cropping intensity and burgeoning demands formed the basis for switching over to green manure intercropping (Zaman et al., 1991).

Status of green manuring

It is evident that the practice of green manuring has not been widely adopted by rice farmers, although its value for increasing rice production by supplying nutrients and maintaining soil productivity is well established (Abrol and Palaniappan, 1988; Kundu et al., 1993; Ramanathan, 1995).

The following are the constraints which stand in the way of green manuring:

1. In a high intensive cropping system, the situation may not induce the farmers to set apart six to eight weeks exclusively for a green manure with no direct benefit and revenue (Abrol and Palaniappan, 1988; Palaniappan and Siddeswaran, 1999). Requirement of sufficient irrigation also stands in the way (Becker et al., 1988).
2. Inadequate availability of quality seeds of preferred green manure species at reduced cost (Abrol and Palaniappan, 1988; Becker et al., 1988; Ramanathan, 1995; Palaniappan and Siddeswaran, 1999).
3. Benefits of green manure addition could not be seen very apparently as that of mineral fertilizer N (Abrol and Palaniappan, 1988; Ramanathan, 1995) because from the farmers’ point of view, organic sources are only complementary or synergistic to inorganic fertilizers and not essential for crop production (Palaniappan and Siddeswaran, 1999).
4. Incorporation of 5-8 t ha⁻¹ of wet bio-mass with given animal draft power and traditional implements is practically difficult on a large scale (Pandey and Morris, 1983). This suggests that the practices advocated must be agronomically manageable.
5. Benefits expected from green manure addition may not be always uniform in all the
crops because of the variation in the soils, green manicure species, environmental conditions etc. (Palaniappan and Siddeswaran, 1999).

6. The possibility of using green manure as intercrop has got its own limitations since it is believed that it may compete for nutrients with the main crop (Abraham Varughese and Sushama Kumari, 1993; Palaniappan and Siddeswaran, 1999).

7. Comparatively affordable price of N fertilizers, their ease of application and evenness in distribution in the field and predictable amount of the nutrient (N) availability from them won a place in production systems that will be difficult for the green manures to fill (Mathias Becker, 1996; Peoples et al., 1988).

Earlier reports of green manure intercropping in rice in India

In northern districts of Tamil Nadu, where rice was cultivated, incorporation of green leaf manure was done before or at sowing of semi-dry rice irrigated from tanks. The decomposition of incorporated green manure was non-uniform and incomplete. Under these conditions, simultaneous sowing of sunnhemp and dhaincha was tried along with rice. Trampling of green manure was done after two months when rice started receiving irrigation. This system of green manuring was found to be promising and increased yields up to 42 per cent have been reported. This practice was in vogue in fourteenth century itself (Subramanian and Dorairaj, 1952). Green manuring for the benefit of associate rice is practised in states like Orissa, where rice and dhaincha are sown simultaneously by the farmers. After about a month and a half, green manure is turned in with a light plough and farmers get beneficial effect out of this dual culture (Subbaiah Mudaliar and Subramania Sarma, 1965).

Principles behind green manure intercropping

Leguminous green manure has the greater advantage of transferring N to the main crop (Arunin et al., 1988). When legumes and non-legumes are intercropped, the non-legume species sometimes perform better than it could in monoculture, possibly because of the additional N supplied by the legume. N transfer by excretion from the nodules is occurred in a cereal-legume intercropping (Aggarwal et al., 1992).

Sesbania rostrata as green manure intercrop

Sesbania rostrata can be intercropped with rice to contribute N and increase rice grain yield. It will compete with rice for basally applied N fertilizer but the net result may not be completely negative because the N is reincorporated at a later date (IRRI, 1986). S.rostrata alley cropped with rice produced 3-4 t ha\(^{-1}\) of dry matter in two prunings and improved rice growth, yield and N uptake (Mulongoy, 1986). Sesbania rostrata seedlings transplanted at 1.5 m interval as intercrop in rice along with the application of 50 and 100 kg N ha\(^{-1}\) gave respectively 7 and 13 per cent more grain yield (Balasubramanian, 1989). Similar transplanting of S. rostrata with 100 kg N ha\(^{-1}\) recorded more rice grain yield than that of sole rice (Alagappan, 1990). Intercropping of S. rostrata in rice at 12:1 ratio produced 1.5 t ha\(^{-1}\) of biomass in 45 days without affecting rice growth and incorporating the same at pre-flowering stage recorded the highest rice yield of 6.3 t ha\(^{-1}\) (IRRI 1991; Palaniappan et al., 1991). Somasundaram (1991) on the other hand found 10:1 ratio being optimum for higher biomass and N accumulation and ultimately for higher rice grain yield. At 7:1 ratio, S. rostrata contributed 16.3 kg N ha\(^{-1}\) through 2 t biomass ha\(^{-1}\) (Purushothaman and Padmavathy, 1994).

Sesbania aculeata as green manure intercrop

The benefit of intercropping dhaincha was reported when 30 days old seedlings were transplanted about 30 days after transplanting rice (Lizhi, 1988). Interplanting one row of S. aculeata seedlings at a spacing of every 3 m between rice rows with 20 x 15 cm spacing
gave more profitable yield than sole crop of rice (Jha et al., 1989). *Sesbania aculeata* broadcast at 40 kg seed ha\(^{-1}\) increased the germination of rice by 24 per cent in the encrusted lateritic soils and with its incorporation, the yield of rice was enhanced in upland conditions (Hati, 1987). The highest rice yield was obtained when rice and dhaincha were grown at 2:1 ratio in 20 cm wide rows. The yield was, however, at par with the treatments where rice and dhaincha were grown in alternate rows at 15 cm spacing (Sharma and Das, 1994). Amongst the conventional intercrops, dhaincha has wide adaptability to even problem soils and has the ability to produce drymatter ranging from 2.8 to 9.9 t ha\(^{-1}\) accumulating 80-225 kg N ha\(^{-1}\) on 60 DAS (Lauren et al., 1996). The effectiveness of dhaincha in smothering weeds was reported when grown as intercrop in rice (Angadi, 1997). Intercropping dhaincha in between two rows of rice in additive series and incorporating 35 DAS proved superior to sole rice (Joseph, 1998).

**Effect of green manure intercrop on rice yield**

Intercropping *Sesbania* with suitable row (4-6 m) and plant (24-30 cm with 3-4 seedlings per hill) spacings will not affect the associate rice yield (Liu Chungchu, 1988). Intercropping *S.rostrata* did not cause any adverse effect on the yield of transplanted rice (Padmavathy, 1992; Purushothaman and Padmavathy, 1994; Grace et al., 1999) and wet seeded rice (Urkurkar et al., 1994; Jayapaul et al., 1995; Jayachandran and Veerabadran, 1996). Adverse effects of green manure intercropping have also been reported. The intercropped dhaincha decreased the grain yield of main crop (Aus rice) by 0.9 t ha\(^{-1}\) but can completely substitute fertilizer N for the following Aman rice (Zaman et al., 1996). Solaiappan and Veerabadran (1997) have also reported that the green manure intercrops had no effect on the yield of associate kharif rice but the yield of subsequent rabi rice increased.

**Dhaincha (*Sesbania aculeata*) the premier green manure**

Amongst all the green manure crops, *S. aculeata* has occupied a prime place in India from early times (Dommergues, 1982). *S. aculeata* can grow in saline soil without reduction in total N contribution to the soil (Saradharamani et al., 1989). *Sesbania aculeata* can grow in soils which are saline besides withstanding severe drought and capable of growing in poorly drained soils (Pandey, 1982).

**Ecological adaptation of *S. aculeata***

*S. bispinosa* (Jacq.) W.F is also known as *S. aculeata* (Wild.) Poir and *S. cannabina* (Retz.) Poir. and by the common name as dhaincha. It tolerates a range of climatic and soil conditions for its growth and N fixation (Ghosh et al., 1960; Bharadwaj, 1974). It is adapted to wet areas and heavy soils. It is viewed as a marsh plant and able to produce floating roots with a spongy parenchyma and withstands drought, with rainfall as low as 500 mm in the growing season (Brewbecker and Glover, 1988). *Sesbania* can be grown in saline soil without reduction in total N contribution to the soil (Saradharamani et al., 1989). *Sesbania aculeata* can grow in soils which are saline besides withstanding severe drought and capable of growing in poorly drained soils (Pandey, 1982).

**Superiority of *S. aculeata* over *S. rostrata***

For the green manure legumes, the ability to produce a high biomass and the N uptake per unit weight of ‘P’ applied are the best criteria to determine the efficiency of species. Accordingly the efficiency of legumes was in the following order: *S.cannabina* > *S.rostrata* > *Glycine max* (Mappanoa et al., 1995). Based on this criteria, *S.cannabina* and *S.rostrata* are found to be more promising in soils with low P levels. But the photoperiod sensitivity of *S.rostrata* limited its use to long day period (Becker et al., 1988). Further, the dormancy maintained by the extremely hard seedcoat of *S.rostrata* seeds often prevented the germination leading to poor stands resulting in low biomass production *i.e.*, 28.5 t ha\(^{-1}\) compared to 32.2 t ha\(^{-1}\) of *S. aculeata* at the time of incorporation (Thamizhvendan and Rajeswari, 1999). *Sesbania aculeata* recorded higher fresh biomass of 51.4 and 73.4 g plant
within 40 and 50 DAS respectively than *S. rostrata* due to its fast growth in the early vegetative phase besides recording higher nodule number and nodule dry weight (Kalidurai, 1998). It has already been reported that *S. aculeata* performed better than *S. rostrata* at all the stages of cutting *viz.*, 30, 45 and 60 DAS (Sivabal, 1989). *Sesbania rostrata* seemed to be sensitive to high soil pH (Thamizhvendan and Rajeswari, 1999), whereas *S. aculeata* can be grown in soils which are saline helping in lowering down the alkalinity of soils besides substituting N (Pandey, 1982).

**Biomass production and N contribution by dhaincha**

*Sesbania aculeata* could produce 21.1 t ha$^{-1}$ of green biomass and accumulate about 133 kg N ha$^{-1}$ (Sanyasi Raju, 1952). Thirty days old *S. aculeata* released an equivalent of 38 kg N ha$^{-1}$, while 45 and 60 days old plants released N equivalent to 60 and 120 kg N ha$^{-1}$, respectively (Khind et al., 1987). *Sesbania aculeata* at 24, 36 and 48 DAS recorded fresh matter yields of 2.2, 11.5 and 26.3 t ha$^{-1}$ respectively (Rajabhandari, 1984). It produces about 24 t ha$^{-1}$ of biomass with 106 kg N ha$^{-1}$ (Singh et al., 1987) and can produce in general 20 t ha$^{-1}$ of green matter yield in tropical conditions of Southern India (Abrol and Palaniappan, 1988). *S. aculeata* yields a dry biomass of 3.15 t ha$^{-1}$ with 1.45 per cent N concentration and accumulates about 42.5 kg N ha$^{-1}$ (Medhi, 1996) and is capable of contributing 224 kg N ha$^{-1}$ at 45$^{th}$ day (Thamizhvendan and Rajeswari, 1999).

About eight weeks old dhaincha plants have been found to contain 3 per cent N in addition to K, Ca, Mg, P, S and micronutrients and about 33 kg N, 1 kg P, 14 kg K, 14 kg Ca, 16 kg Mg and 2 kg S are added to the soil if a ton of dhaincha dry matter is applied (Bhuiyan et al., 1988). Besides being a deep rooted crop, dhaincha absorbs nutrients from the sub soil enriching the rice plough layer upon incorporation.

The leaflets of dhaincha degrade rapidly in moist soil and release 50 per cent of their N within four weeks of incorporation (IRRI, 1985).

From the foregoing review, it can be seen that dhaincha is a premier green manure crop since it fulfills the traits of an ideal green manure for lowland ecosystem which is further supported by FAO (1977); IRRI (1988); Ladha et al. (1988) and Cosico (1990) as described below.

1. early establishment and high seedling vigour
2. tolerance to flooding and drying
3. early onset of N fixation and efficient sustenance over varied climatic and edaphic conditions.
4. fast growth with an ability to accumulate large biomass and N within four to six weeks of growth.
5. quick decomposability.

**REFERENCES**


