SYSTEM OF RICE INTENSIFICATION - A REVIEW

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ABSTRACT

Rice is one of the most important cereal crops in Asian countries. But now a day water is in scarcity. Rice requires more water to grow. So to solve this scarcity problem, one of the method is a system of rice intensification (SRI). This review is based on the SRI components of young seedlings, wider spacing, Cono weeding, intermittent wetting and drying.

Key words: SRI components, Growth attributes, Yield attributes.

INTRODUCTION

Rice is the staple food for about 2.7 billion people, almost half of the total population of the world. There is always a growing demand for rice in India due to ever growing population. So to sustain present food sufficiency and also to meet future food requirements, India has to realize an annual growth rate of at least three per cent in productivity of rice. So increasing the growth rate and productivity. There is a method of rice farming known as System of Rice Intensification (SRI). In SRI there are five major components which are use of young seedlings at the two leaf stage (8–15 days) with one seedling hill⁻¹, wider spacing, minimum of three weedings after transplanting, intermittent wetting and drying for soil aeration during the vegetative stage and addition of organic matter (Makarim et al., 2002). The review is based on the SRI components.

System of rice intensification in growth attributes

Age of the seedling

Raising seedlings and transplanting is the common practice of rice culture. Padalia (1981) reported that age of seedling at the time of transplanting was an important factor for uniform stand and establishment of rice. Constraints like late onset of monsoon scarcity of agricultural labour and non availability of inputs and financial credit in time, force the farmers to resort to planting aged seedlings (Reddy and Reddy, 1992a). Delayed transplanting of rice reduced the crop yield and delayed the sowing of the succeeding crop (Kamdi et al, 1991).

The normal age of seedlings recommended for transplanting in Tamil Nadu is 18-22 days for short, 25-30 days for medium and 35-40 days for long duration varieties (Anonymous, 1994), the extension in total field duration of rice crop planted with aged seedlings was reported in many studies. The total duration of short duration rice variety IE1444 planted with 55 days old seedlings was extended from 115 to 141 days, while in medium duration rice variety Co 40; it was extended from 170-221 days with 65 days old seedlings. Theetharappan (1983), Reddy and Reddy (1992b) observed that both number of days required to 50 % flowering and crop duration were increased with aged seedlings where as Roy and Sattar (1992) reported that
the crop planted with older seedlings required less time to reach booting stage than the younger one in rice cv.BR14 and IR50 at Joydebpur, in several other studies conducted earlier also, it was noticed that when the seedling age increased, the days to 50% flowering also increased (Reddy et al (1987), Raju et al (1989), Bhagat et al (1991) and Joseph (1991)). An increase in the field duration by 14-15 days due to planting of aged seedlings during wet season was also reported by Nayak et al, (1994).

**Age of seedling on growth and yield components**

Theetharappan and Palaniappan (1984) reported a height reduction of 6 cm in aged seedling at Coimbatore. Decreasing in plant height with increasing in the age of seedling was also reported by Murthy and Sahu (1979). Islam and Ahmed (1983), Koshta et al, (1987) and Paraye and Kandalkar (1994). According to Das et al, (1988) the critical growth component leaf area index was very sensitive to age of seedling at transplanting. At flowering stage it was highest with 4 weeks old seedlings compared to 2, 3, or 5 week old seedlings. Enyi (1991) estimated the reduction in total leaf area due to delayed planting to be 40%.

The growth analysis made by Mandharan (1981) in kharif and summer rice crops revealed that 25 days old seedling accumulated more dry matter and successive delay in planting resulted in concomitant reduction in dry matter production. Mandal et al, (1984) also observed similar results however; Reddy and Reddy (1994) observed maximum dry matter accumulation m-2 and hill-1 with 60 days old seedling compared to 35 and 45 days old seedling of rice cv. Surekh paddy at Warangal.

Koshta et al, (1987) obtained maximum number of tillers/plant with younger seedlings. Similar results were obtained by Mohapatra et al, (1990) and Kamdi et al (1991). Reduction in number of panicles/m2 with increasing seedling age was reported by many workers Datt and Gautam, 1988, Ashrat and Mahmood 1989 and Reddy and Reddy 1994. The grains /panicle were not affected by transplanting age (Mejos and Para, 1980). Better development of panicles with more fertile spikelets was observed with younger seedlings by Tsai and Lai (1987). Ayyasamy et al (1991) recommended dry method of nursery involving broad casting of dry seeds and covering with shallow ploughing to maintain more number of grains per panicle with aged seedlings. Mohapatra and Kar (1991) reported higher grain weight with 30 days old seedling compared to 45-60 days old seedling in rice cv.CR1009, but, age of seedlings did not affect the grain weight appreciably (Om et al, (1989) and Raju et al, (1989)). Higher thousand grain weight was observed with the seedlings of day nursery by Ayyasamy et al, (1991). Yield of rice crop decreased as the age of seedlings planted was more (Balasubramaniyan and Palaniappan (1983), Rao and Raju (1987), Singh et al (1989), Chandra and Manna (1989) and Saikia et al (1989) and Setty et al (1987) stated that seedling age had no significant effect on grain yield. Joseph (1991) and Paul (1994) also observed similar results though seedling age did not influence the grain yield, there was a trend of higher straw yield and lower harvest index with younger seedlings Venugopal and Singh, (1985). Similar increased straw yield with 30 days old seedling over that at 60 days old seedlings was reported by Suiyender Reddy and Bucha Reddy (1991) from Warangal.

Kharuhan seedlings (30 days in first nursery and 45 days in second nursery) gave higher crop yields compared to conventional nursery seedlings (transplanted once) when planted at a density of 6.6 lakh hills/ha in north eastern India (Singh ,1989). Experiments at
Rajendra Nagar in sandy loam soil indicated that 25 day old seedlings planted at 6.6 lakh hills/ha gave higher grain yield than the crop grown 4.4 lakh hills/ha (Rao and Raju 1987). Chandrakar and Chandravanshi (1988) observed in rice cv. Sastri 17 that 45 days old seedling at 10 lakh hill/ha and 25 days seeding at 5.00 and 10.0 lakh hill/ha at Raipur on clay loam soil. Reddy and Reddy (1992a) reported that rice seedlings at 30 days with 1 million hills/ha gave higher yields compared to 45 and 60 days seedings at the same density.

**Number of seedlings hill**⁻¹ on growth attributes

**Plant height**

Paraye and Kandalkar (1994) found that planting of six seedlings hill⁻¹ gave higher plant height than three seedlings hill⁻¹ during rainy season in Alfisol of Waraseoni (Madhya Pradesh). Shrirame *et al.* (2000) opined that the number of seedlings hill⁻¹ did not affect the plant height of hybrid rice grown in silty clay loam soil at Nagpur during kharif season under lowland condition. However, Nayak *et al.* (2003) reported that one seedling hill⁻¹ resulted in taller plant than two seedlings hill⁻¹ with hybrid rice during rainy season (kharif) in loamy sand and slightly acidic soil of Bhubaneswar.

**Tillering**

Ramasamy and Babu (1997) stated that planting less number of seedlings hill⁻¹ enabled the plant to produce new tillers which undergoes normal physiological growth and field duration resulting in more healthy panicles. Shrirame *et al.* (2000) observed that planting of two seedlings hill⁻¹ produced higher number of total tillers hill⁻¹ than three seedlings hill⁻¹ in hybrid rice grown in silty clay loam soil of Nagpur during kharif season under lowland condition.

**Dry matter production (DMP)**

The DMP of MTU 5293 was not significantly influenced by the number of seedlings hill⁻¹ (2, 4, 6 and 8 seedlings hill⁻¹) in sandy loam soil of Bapatla during kharif season (Varma *et al.*, 1991). Shrirame *et al.* (2000) opined that the DMP, maximum number of functional leaves, leaf area hill⁻¹ were unaffected due to seedlings number hill⁻¹ in hybrid rice grown in silty clay loam soil of Nagpur during kharif season under lowland condition.

**Physiological attributes**

Obulamma and Reddy (2002) observed that the hybrid rice planted with one seedling hill⁻¹ recorded significantly higher CGR and NAR while two seedlings hill⁻¹ recorded significantly higher LAI and LAD in sandy loam soil of Tripathi during Rabi season.

**Number of seedlings hill**⁻¹ on yield and yield attributes

Studies at Shalimar (Jammu and Kashmir) during rainy season in silty loam soil with three seedling rates (3, 6 and 9 seedlings hill⁻¹) revealed that increased number of seedlings hill⁻¹ increased the panicles m⁻² but had detrimental influence on all other yield attributes (Bali *et al.*, 1995). Studies at Raipur revealed that the crop planted with three seedlings hill⁻¹ produced significantly more productive tillers, with a high harvest index compared with the planting of one or two seedlings hill⁻¹ (Verma *et al.*, 2002). Nayak *et al.* (2003) stated that none of the yield attributes except effective tillers clump⁻¹, varied significantly due to seedlings hill⁻¹, although planting of two seedlings hill⁻¹ recorded more fertile and sterile spikelets ear⁻¹, sterility percentage and 1000 grain weight during rainy season in hybrid rice. Rajarathinam and Balasubramaniyan (1999) was reported that the planting of one seedling hill⁻¹ gave more grain yield and it was comparable to that of two seedlings hill⁻¹, while two seedlings hill⁻¹ gave higher straw yield and it was at par with single seedling hill⁻¹ in hybrid rice grown in sandy clay loam soil of Madurai during Samba (Rabi). Shrirame *et al.* (2000) reported that
transplanting of two seedlings hill\(^{-1}\) produced the highest grain yield and recorded significantly higher straw yield over single seedling hill\(^{-1}\) in rice hybrids in silty clay loam soil of Nagpur during kharif under low land condition. Studies at West Bengal revealed that two seedlings hill\(^{-1}\) significantly gave higher grain yield than single seedling hill \(^{-1}\) (Molla, 2001). Single seedling hill\(^{-1}\) performed equal to that of two seedlings hill\(^{-1}\) in hybrid rice at Bhandara, Maharashtra during kharif season (Dongarwar et al., 2002).

**Number of seedlings hill\(^{-1}\) on nutrient uptake**

Srinivasalu et al. (1999) reported that planting of two seedlings hill\(^{-1}\) of Chaitanya (cultivar) and APHR-2 (hybrid) recorded significantly higher nitrogen and potassium uptake than that of one seedling hill\(^{-1}\). However in case of hybrid APHR-1 both the treatments were at par in sandy clay loam soil of Bapatla during wet season.

**Spacing on growth attributes**

**Plant height**

Kandasamy and Ramasamy (1998) revealed that closer planting (15 x 8 cm spacing) resulted in taller plants with longer leaves than that of wider spacing (15 x 10 cm) in sandy clay loam soil of Madurai during kharif and Rabi seasons with short duration rice variety (ADT 36). The rice cultivar Jinongda 7, plant height was found to decrease significantly at narrow spacing of 30.0 x 13.2 cm as compared to wider spacing of 30.0 x 39.6 cm and 30.0 x 19.8 cm (Fu et al., 2001).

**Tillering**

Balasubramaniyan and Palaniappan (1991) found in clay loam soil of Coimbatore during kharif and Rabi season that the total number of tillers plant\(^{-1}\) was more with low population (15 x 10 cm) in 'IR 50' and 'IR 64' rice varieties due to greater space available for individual plants to put forth more tillers.

**Dry matter production (DMP)**

Reddy and Reddy (1994) observed that DMP hill\(^{-1}\) was significantly higher with low population density (4.4 lakh hills ha\(^{-1}\)) than high population density (10 lakh hills ha\(^{-1}\)) of Surekha rice in clay loam soil of Warangal during kharif season. Obulamma and Reddy (2002) found that higher DMP was obtained from closer spacing (15 x 10 cm) against wider spacing of 20 x 10 cm, 15 x 15 cm and 20 x 15 cm in hybrid (DRRH-1 and APHR-2) during Rabi season in sandy loam soil of Tripati.

**Physiological attributes**

Balasubramaniyan and Palaniappan (1991) stated that Leaf Area Index (LAI) increased with high population due to more number of leaves produced in a unit area.

**Spacing on yield and yield attributes**

**Number of panicles**

Kanungo and Roul (1994) found that lower plant density (15 x 15 cm) produced higher panicles hill\(^{-1}\). The number of panicles hill\(^{-1}\) was more under wider spacing (30 hills m\(^{-2}\)) than under narrow spacing (50 hills m\(^{-2}\)) (Jagannath et al., 1998). At Raipur, in clay loam soil, the number of panicles m\(^{-2}\) was more with closer spacing (20 x 10 cm) than with 20 x 20 cm and 20 x 15 cm (wider spacing) during kharif season (Patel, 1999). Chopra and Chopra (2000) stated that during rainy season the scented rice variety (Pusa Basmati 1) recorded significantly higher panicles hill\(^{-1}\) with wider spacing of 20 x 15 cm and 30 x 15 cm than with narrow spacing of 15 x 15 cm in clay loam soil, which may be due to more space and nutrient availability for the individual plant. Obulamma and Reddy (2002) found that closer spacing (15 x 10 cm) produced more panicles m\(^{-2}\) against wider spacing (20 x 10, 15 x 15 and 20 x 15 cm) in hybrids (DRRH-1 and APHR-2) during Rabi season in sandy loam soil of Tripati.
Panicle characters

Dhiman et al., (1996) stated that wider spacing (20 x 15 cm) recorded more panicle weight than closer spacing (15 x 15 cm), whereas number of grains panicle-1 was not affected due to spacing in Haryana Basmati 1 during rainy season at Haryana. Nayak et al. (2003) opined that in loamy sand and slightly acidic soil of Bhubaneshwar, sterile spikelets ear-1 and sterility percentage were minimum with wider spacing (20 x 15 cm) in hybrid ‘Pro Agro 6201’ during rainy season.

Yield

Chopra and Chopra (2000) found that seed and straw yield did not differ significantly due to different spacings (15 x 15, 20 x 15 and 30 x 15 cm) in Pusa Basmati 1 during kharif in clay loam soil of Karnal. Similarly, Shrirame et al. (2000) found non significant difference in grain and straw yield ha-1 due to different spacings (20 x 15 and 20 x 10 cm) in hybrid (TNRH 10, 13 and 18) and variety (Jaya) during kharif in silty clay loam soil. Dongarwar (2002) also reported that grain and straw yield were not significantly affected by spacing during kharif season in hybrid rice KJTRH –1. Shivay and Singh (2003) during kharif season in sandy clay loam soil of New Delhi with three plant geometries of 20 x15 cm, 25 x12 cm and 30 x10 cm with the population density of 33 hills m-2 revealed that plant geometry of rice did not influence significantly the grain and straw yields of rice. Nayak et al. (2003) opined that closer planting at 20 x 10 cm with higher plant population registered significantly more grain yield than that of wider spacing (20 x 15 cm) with lower plant population in hybrid ‘Pro Agro 6201’ during rainy season in loamy sand with slightly acidic soil.

Spacing on nutrient uptake

Rajarathinam and Balasubramaniyan (1999) opined that planting of 50 hills m-2 (20 x 15 cm) significantly increased the N uptake than planting of 33 and 25 hills m-2 during Rabi season in hybrid rice CORH 2. Sahoo and Rout (2004) observed that wider spacing (20 x 15 cm) showed higher utilization efficiency of nitrogen than closer spacing (20 x 10 cm) during kharif season in hybrid (PRH III) and varieties (Konark and Bhoi) of medium duration.

Spacing on weed population

Studies at Aliyar Nagar (Tamil Nadu) in a sandy clay loam soil with three rice cultivars (IR 20, ADT 38 and CO 45) with four spacings (20 x 10 cm and 14.1 x 14.1 cm, 20 x 15 cm and 17.4 x 17.4 cm) revealed that weed count and weed dry weight were higher under wider planting with 33 hills m-2 as compared to closer planting with 50 hills m-2. This was attributed to availability of more land area between two rice hills under wider spacing, which facilities weed emergence and growth. In case of closer planting, the rice seedlings would have exercised a smothering effect reducing weed number and dry weight (Lourduraj et al., 2000).

Spacing on pest and disease occurrence

Closer spacing has been reported to increase the incidence of leaf folder. Leaf folder infestation was more in closer spacing (10 x 10 cm) as compared to wider spacing viz., 20 X 15 cm 20 X 20 cm and 30 X 30 cm (Saroja and Raju, 1982). Subsequently the disease was more severe in the wider planting. Viswanathan and Narayanasamy (1989) reported that closer spacing resulted in higher incidence of brown leaf spot than wider spacing in rice variety ASD 16.

Weed management

Chander and Pandey (1997) reported that N, P and K depletion by weeds were maximum under weedy check. The average uptake by weeds was 42.7 kg N, 4.5 kg P and 63.1 kg K ha-1. The yield loss in rice due to weeds was up to 64 per cent during Rabi and 26 per cent during Kharif
in farmers fields of Karaikal region (Chellamuthu and Rammohan, 2005). The weed menace in general is reduced by cultural, chemical, physical, mechanical and Integrated Weed Management (IWM) practices. The review has been restricted to hand weeding and mechanical weeding aspects relating to the treatments in the present experiment.

**Hand weeding**

Prasad et al. (2001) reported that hand weeding twice at 20 and 40 DAS was superior to the chemical weed control treatments for all the growth and yield attributes, reflecting the higher yield in silty loam and calcareous soil at Pusa, Bihar during rainy season. Laxminarayanan and Mishra (2001) reported that hand weeding at 15, 30 and 45 days after transplanting and pre emergence application of Anilofos @ 0.04 kg a.i. ha\(^{-1}\) proved equally effective in reducing weed population and dry weight of weeds. Chander and Pandey (2001) observed that hand weeding significantly increased grain as well as straw yields compared with herbicides and weedy check because of frequent elimination of weeds that resulted in the reduced weed competition. Hand weeding twice at 21 and 42 DAS produced more dry matter and increased grain and straw yield of rice crop. Hand weeding twice was the most effective in augmenting growth and yield of rice crop followed by application of Butachlor at 1.25 kg ha\(^{-1}\) as pre-emergence herbicide. The highest weed control efficiency was recorded under hand weeding treatment, which recorded the lowest dry matter of weeds (Dutta et al., 2005).

**Mechanical weeding**

Uphoff (2001) emphasized that early and frequent weeding was essential in rice when fields were not covered with standing water. In his view, using a rotary hoe that churns up the surface soil, removes weeds and provides additional aeration compared to hand weeding or use of herbicides. Uphoff (2002) reported that the mechanical hand weeder used with SRI, by pruning some of the upper roots, encourages deeper root growth. Thiyagarajan et al. (2002) observed that the use of conoweeder resulted in 10 per cent yield increase (661 kg ha\(^{-1}\)) during wet season while in dry season the yield increase was only three per cent (210 kg ha\(^{-1}\)) higher than conventional method of weeding. The mechanical weeding using rotating hoe with small toothed wheels, following a square or rectangular pattern of transplanting in lines, increased the number of soil pores so that roots and microbes could more easily gain access to oxygen. The tiller production was significantly high when rotary weeder was used four times (Randriamiharison, 2002).

**CONCLUSION**

It is concluded that the influence of seedling age and number of seedling hill\(^{-1}\), crop geometry and weed management practices on growth and yield of rice were significantly higher. The practices of SRI were found to be varying according to the local conditions. Hence with a view to evaluate the individual and combined effects of all the components of SRI and the relative contribution of individual components and their combination to the growth and yield of rice. In view of above it may be stated that the SRI practices were good compared to the conventional methods.

**REFERENCES**


