SRI practice and adaptability in China

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1 The principal practices of SRI in China

Compared to traditional rice cultivation (TRC), the following principal items of the System of Rice Intensification (SRI) for Chinese rice ecosystem can be identified, based on the SRI developed in Madagascar.

- Transplant young seedlings, preferably 12-15 days old. The young seedling are best raised in upland conditions with intermittent moisture soil. Soil in seedbed is not submerged.
- Plant seedlings with optimally wide spacing, 1 seedling per hill and 7.5-15 hills per m^2. Planting density of SRI is usually lower than traditional rice cultivation by about 50%. Seedlings are transplanted with soil and root sac to avoid root injury. Plant in a rectangle pattern to facilitate air movement and light penetration.The common SRI planting space is from 25x25 cm up to 40x40 cm. Wider planting space leads to greater root growth, increases productive tiller rate, and decreases humidity in canopy to control diseases.
- Keep the soil moist and aerobic without a water layer after the recovery from transplanting to promote tiller growth and root development. However, in the period of panicle formation, intermittent shallow irrigation should be kept.
- Add nutrients to the soil, preferably in organic form such as compost or mulch. This is traditional practice to increase the yield of rice in China. In general, the rate of compost is about 10-15 t/ha. That will improve soil fertility and microbial activity.
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2 Vegetative and reproductive growth in SRI

2.1 Comparison of tiller development and growth between traditional rice cultivation and SRI

In the different planting densities of 6.9, 11.1 and 15.3 hill per m2 with one plant per hill, total leaf number on the main stem with SRI wide spacing (6.9 and 11.1 hill/m2) is higher than control (15.3 hill/m2) (Figure 1). Leaf emergence rate at 50 days after sowing was higher than for the control plot, giving more productive tillers per plant.

Data from Zhejiang, Sichuan, Hunan and Heilongjiang provinces show that, a 5-leaf seedling with SRI already has 2 to 3 tillers. There is transplanting shock after transplanting. Tillers in SRI plants emerge earlier than in controls (Figure 2).Tiller numbers per hill in SRI are almost two times more than that of the control. Total stem number per area in SRI is similar to the control in maximum tiller stage. However, earlier emergence of tiller in SRI results in higher productive tiller rate in different type hybrids and in various environments (Figure 3 and 4).

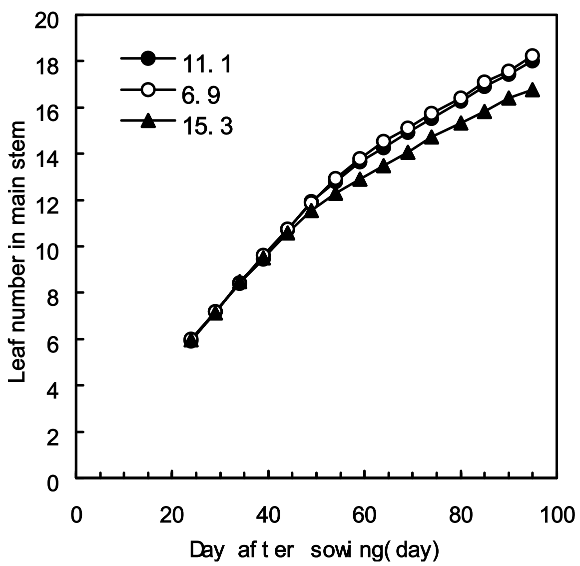

Figure 1 Comparison of tiller growth in traditional rice cultivation and SRI

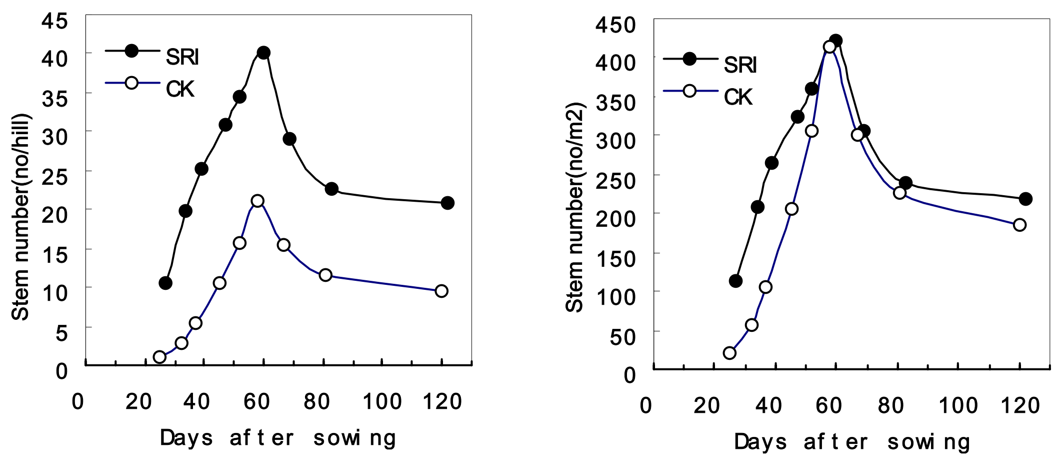

Figure 2 Comparison of stem numbers in SRI and control with Liangyoupeijiu variety

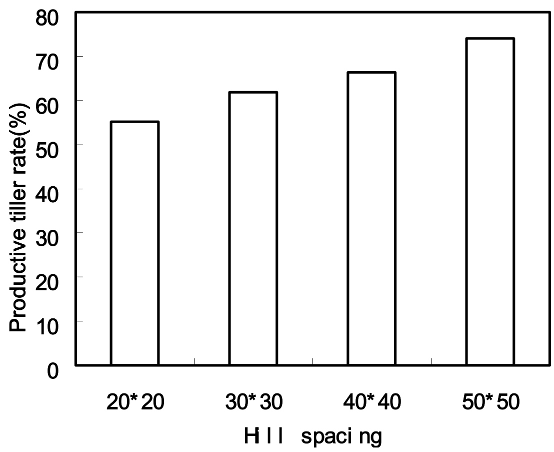

Figure 3 Effects of plant spacing on productive tiller rate in hybrid rice Gangyou22 (Sichuan, 2001)

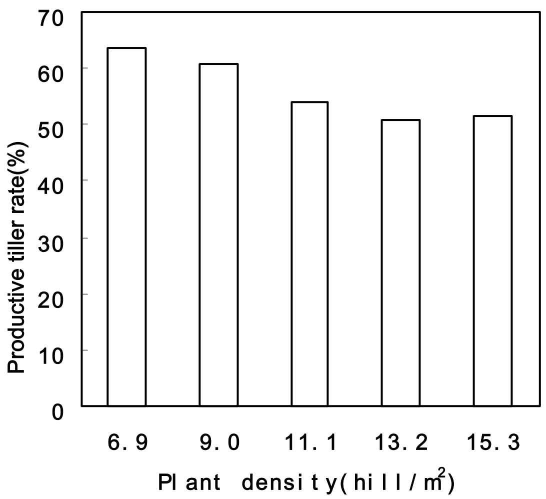

Figure 4 Effect of plant spacing on productive tiller rate in hybrid rice Xieyou9308 (Zhejiang, 2001)

Young seedlings and aerobic water management are used in SRI. However, in traditional rice cultivation, 30-day seedlings and flooding water management in tillering period are used. In the same density of 15.5 hill/m^2 with one plant per hill, heterosis of more tillers in SRI maintains to maturity (Figure 5).

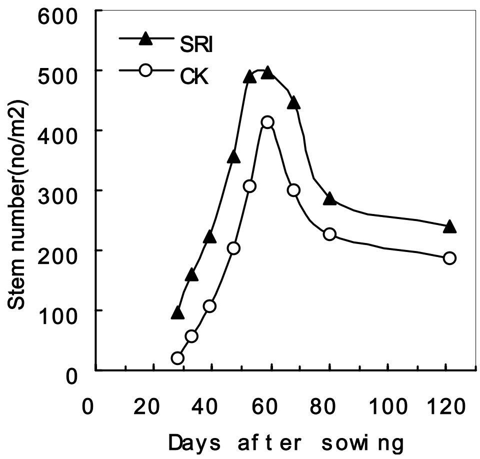

Figure 5 Effects of water management on tiller growth in same density with one plant per hill (15.5 hill/m2) in Liangyoupeijiu

2.2 Light distribution in canopy in SRI

Comparison of light penetration rate on the ground of canopy in different density of 7.5 hill/m2 (D1) and 13.5 hill/m2 (D2) with one plant in SRI and in the density of 19.5 hill/m2(check) is listed in Figure 6. Light penetration rate on the ground increases with the density before 11 am and after 1 pm under the similar leaf area. But light penetration rate in different densities is similar in the period around noon time due to direct light at that time (Figure 6). Sparse planting improves the light distribution in rice canopy, which increases biomass production.

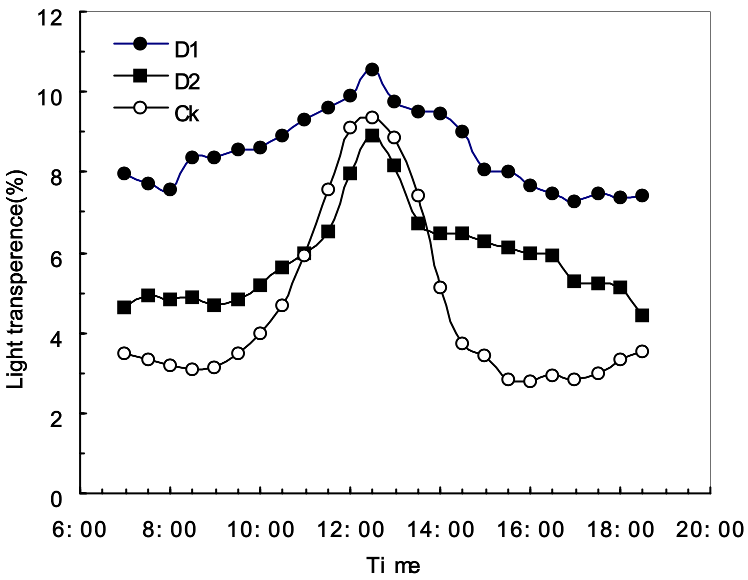

Figure 6 Change of photosynthetically active radiation in the ground of rice canopy during daytime in different densities (Liangyoupeijiu, 2001)

2.3 Yield and yield components in SRI

In the experiment with SRI methods using Liangyoupeijiu in Anqing Research Insititute of the Academy of Agricultural Sciences at Anqing, Anhui, 6 plants per m2 (SRI 1) and 9 plants per m2 (SRI 2) were transplanted. 12.15 t/ha grain yield was obtained with SRI 1. This was 21.3% higher than traditional rice cultivation (TRC) , and 11.25 t/ha in SRI 2 was 12.3% more than TRC. In Zhejiang, Sichuan, Hunan and Heilongjiang, some experiments with SRI also indicated that SRI shows heterosis of yield over TRC (Table 1). However, experiments also show that density in SRI is related to yield. In very low density with SRI, yield decreases due to grain number per panicle (Table 1). The relationship of panicle number and spikelet number in different densities is inconsistent (Table 1s and 2). That may be influenced by panicle number per area and nitrogen application time and water management pattern.

Table 1 Yield and its components of Xieyou9308 in SRI(Xinchang, Zhejiang,2000)

Type	Density	Panicle (no/hill)	Panicle (no/m2)	Spikelet (no/panicle)	Fertility (%)	Grain weight (mg)	Yield (t/ha)
SRI	6.9	29.4	202.6	165.3	91.7	27.5	8.45d
	9.0	23.5	211.4	181.7	90.9	27.5	9.60c
	11.1	18.7	207.8	190.8	90.8	27.5	9.90b
	13.2	15.3	209.2	201.9	88.5	27.5	10.28a
	15.3	14.3	218.0	198.4	88.0	27.3	10.39a
CK	21.0	9.9	208.4	182.3	90.0	27.4	9.37c

In SRI, one plant per hill is recommended. However, one to two plants per hill for hybrids and three or more plant per hill for conventional rice are usually used in TRC. Experiments with different plant number per hill indicated that no yield difference in different plant numbers per hill. Grain yield with one plant per hill at lower level of nitrogen application is higher than with more plants per hill having higher level of nitrogen application (Table 7).

Table 2 Effects of planting spacing on spikelet number per panicle and yield (Sichuan, 2001)

Density (hill/m^2)	Spikelet (no/panicle)	Yield (t/ha)
25.0	169.9c	685.5a
11.1	196.0bc	680.3a
6.3	216.4ab	629.0b

4.0	234.3a	617.8b

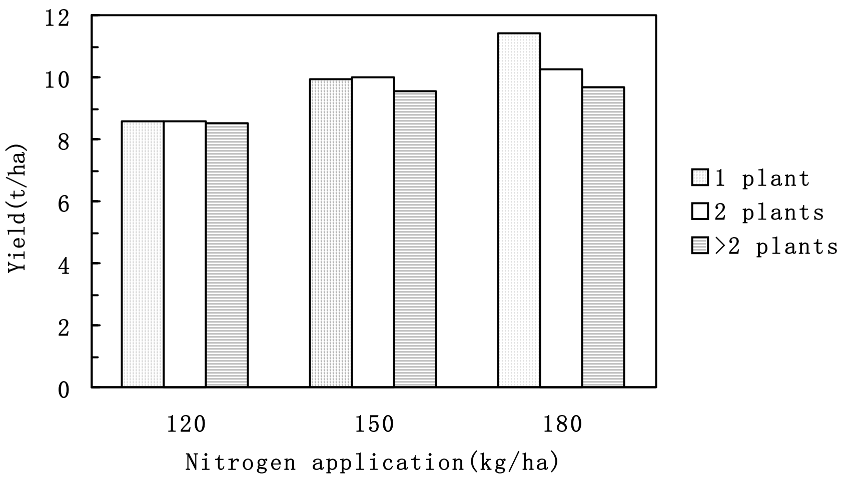

Figure 7 Effect of number of plants transplanted on yield along a range of nitrogen application in Heilongjiang

In different densities of SRI, there is no significant difference in brown rice rate, head rice rate, whole head rice rate, chalkiness rice rate and chalkiness, though chalkiness rice rate and chalkiness size decreased with growing density. This shows that sparse planting could improve rice quality.

Table 3 Effects of planting space on rice quality in SRI

Density	Brown rice rate (%)	Head rice rate (%)	Whole head rice rate (%)	Chalkiness rice rate (%)	Chalkiness size
20cm*20cm	81.12	66.36	56.30	83.83	39.11
30cm*30cm	79.88	65.91	57.13	79.67	38.11
40cm*40cm	79.47	65.58	56.72	78.00	36.93
50cm*50cm	79.96	66.71	58.79	70.00	30.17

3 Resource use efficiency and environmental considerations with SRI

3.1 Water Saving Technology: With SRI one applyies only a minimum of water during the vegetative growth period and then maintains only a thin layer of water on the field during the grain production stage. Alternatively, to save labor time, some farmers flood and drain off (dry) their fields in 5-7 day cycles with good results. The best water management practices depend on soil type, labor availability and other factors, so farmers should experiment with how best to apply the principle of having moist but well-drained soil while plants are growing. SRI reduces water requirements for the same rice production by about 50%. Usually, SRI produces more yield, so this gives higher water use efficiency compared to TRC.

3.2 Saving Seed: Young seedlings are transplanted and sparse planting is practiced with SRI. Seed requirement is reduced in SRI by 50% to 200%. That is advantage in a region where hybrid rice is planted.

3.2 Environmental Benefits: SRI is environmentally-friendly. Reduced demand for water frees up water for other uses; soil that is not kept saturated has greater biodiversity. Unflooded paddies do not produce methane, one of the major "greenhouse gases" that are contributing to global warming. There can be more nitrous oxide from unflooded paddies, which offsets to some extent the gains from reducing methane emissions, but when nitrogen fertilizer application is reduced, this effect should be small. On balance, SRI should improve environmental conditions.

3.3 Equity Considerations: SRI also has the benefit of being particularly accessible for farmers who have small landholdings and need to get the highest yields possible from their available land. Since poorer households have relatively more labor compared to land, SRI is one of the few agricultural innovations that has a bias in favor of equity. It is true that very poor households may find it difficult to invest labor in SRI because they need to be earning daily incomes, even if their returns to labor would be higher from SRI. However, since returns to land, labor and water are all higher with SRI, any household that grows rice and is labor-constrained will do better by using SRI methods on just a part of its landholding, using its other land for production of other crops when labor is available.

3.4 Sustainable rice production: Keeping soil moist but well-drained and aerated, with good structure and organic matter to support biological activity should enhance the quality and health of the soil, which is the key to best production. SRI recommends soil nutrient supplies preferably with compost, made from any available biomass with some combination of chemical fertilizer, though better quality compost such as with manure gives yield advantages. It contributes to good soil structure and active microbial communities in the rhizosphere, which also improve soil fertility and make rice production more sustainable.