# EFFECTS OF THE SYSTEM OF RICE INTENSIFICATION (SRI) WITH GREEN MANURE ON GROWTH AND YIELD OF SOME COMMERCIAL RICE *ORYZA SATIVA* L. VARIETIES FROM KAWA TOWNSHIP, BAGO REGION

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## Abstract

This study was carried out to study the performance of the System of Rice Intensification (SRI) on the growth and yield of selected rice varieties by comparing the traditional cultivation method and SRI method. This study also determined the SRI and green manure application on three commercial rice varieties: Sinthukha, Shwewharhtun and Manawthukha. In traditional method, the spacing of 20 × 15 cm was followed and 25 day-old seedlings were used whereas in SRI cultivation method, the wider spacing of 25 × 25 cm was followed and the 8 to12 day-old seedlings were used. Although large numbers of seedlings were needed for traditional method, a small amount of seedlings were needed for SRI method. The results indicated that all the plant characters and grain yields were significantly affected by the seedling ages. The maximum grain yields, 6912.71kg $ha^{-1}$ were observed in 8 day-old seedlings ($T_3$) under SRI method and the minimum, 4561.05 kg ha $ha^{-1}$ were observed in 25 day-old seedlings ($T_1$). Among the three varieties, Shwewharhtun ($V_2$) gave the highest grain yields. There were no interaction between the seedling ages and the rice varieties.

**Key words:** System of Rice Intensification (SRI)

## Introduction

Rice which is to be transplanted into lowland puddle soil must first be nursed on seedbeds. In traditional rice cultivation, 25 to 30 day-old seedlings were used to transplant (Soe Paing Oo and Mar Mar Kyu, 2012). The traditional method of paddy cultivation demanded for more water, increased cost of inputs including heavy amount of chemical fertilizers, pesticides and less returns producing negative effect on the livelihoods of the farmers.

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In the traditional paddy cultivation method, farmers adopt unscientific methods to address some of the problems in the paddy cultivation. Methods like aged nursery, difficult way of relocating seedlings, transplanting bunch of seedlings, less spacing, stagnating water and applying more chemical inputs were basically have behavior on yield and productivity. The tendency to apply less time for cultivation also has contributed to the problem (Upendra, 2015).

SRI is a sort of management method that raises productivity of land, labor and capital. Researchers have demonstrated that SRI is a model of sustainable agriculture that reduces inputs, conserves water, improves soil structure and increases yield. It mainly emphasizes on careful transplanting of younger seedling at a wider spacing, which ensures more root growth and profuse tillering (CARM-DAKSH, 2008).

The SRI method seems to solve the problems with the traditional method of paddy cultivation. The SRI method allows paddy plant to have normal growth with less water. SRI makes use of the naturally available organic manure as inputs. This allowed farmers to use organic manures available on the farm at low cost, and thus be able to meet a significant portion of the crops nutrient demand and to improve soil fertility (Pandian *et al*., 2011).

The utility of green manure for increasing soil productivity has been recognized from early times in some rice-growing areas, particularly China, India, and Southeast Asia. The potential benefits are many. Green manure can increase soil nitrogen content, concentrate phosphorous and significantly increase the available phosphate content in the soil, maintain and renew soil organic matter, and improve soil structure and physical characteristics (Bin, 1983).

This study was carried out with the following objectives: to study the performance of the System of Rice Intensification (SRI) on growth and yield of selected rice varieties; to compare traditional cultivation method and SRI method; to determine the appropriate seedlings age of three commercial rice

varieties and to minimize the chemical fertilizer by using the green manure and distribute the effective knowledge of SRI method for rice cultivation.

## Materials and Methods

### Experimental site and materials

The tested varieties which were grown from July to October 2017 as monsoon rice at the Farm of Thabyu Village, Kawa Township, Bago Region, by using SRI method and traditional rice cultivation method. The three commercial rice varieties used in the experiment were: $V_1$ = Sinthukha, $V_2$ = Shwewarhtun and $V_3$ = Manawthukha.

### Collection and Preparation of green manure plants

The well-ripen seeds of *Samanea saman* (Jacq.) Merr. (Kalarkokko) were collected around the Thabyu village, Kawa Township. After treating the pre-germination test, 300 seeds for each plot were soaked in water for 24 hours and incubated 12 hours. Then, the seeds were broadcasted into ploughed experimental plots. Sprinkling water was using to be succeeded the germination.

### Preparation of the experimental plot

The split plot design with 4 replications was used in this experiment. Individual plot size was 3.35 square meters and it consisted of 7 rows with 7 plants at the spacing of 25 × 25 cm under SRI and 20 × 15 cm under traditional method. The spacing between each block was 3 feet and each replication was 2 feet.

### Preparation process of green manure fertilizer

After 45 days of planting, *Samanea saman* (Jacq.) Merr. (Kalarkokko) plants which used as green manure were thoroughly mixed and buried in the pots for monsoon rice cultivation. Application of 10 days interval, the green manure plants have already been decomposed into organic matter for nitrogen sources.

### Seedbed preparation for raising seedlings

To transplant different seedling ages of three rice varieties at the same date, nine seedbeds for each seedling age were separately prepared in July 2017. The size of one seedbed was 1.5 × 1.5 sq. ft and raise above the original soil level. Seedbed was covered with plastic sheet and then lay down the mixture of cow dung manure and soil to get the soil layer of 5 cm. Seed rate on each seedbed was 2.5 g for SRI method and 7.5 g for traditional method. Seeds were covered by rice ash to prevent moisture losses and birds. Irrigation was done whenever necessary.

### Methods

### Transplanting procedure

In the field experiment, seedlings were transplanted with the age of 25 days for traditional method, the 10 and 8 days for SRI (System of rice intensification method). One single seedling per hill was used for SRI method and a bunch of three seedlings per hill were used for traditional method. Weed control was done on each 15 days interval of hand weeding and the weeds buried in soil as biomass organic matter. Adequate protection measures were given against pest and diseases.

### Data collection

Four random plants of each variety were taken from each plot and the collected data were plant height (cm $plant^{-1}$), root length (cm $hill^{-1}$), number of tillers $hill^{-1}$, number of effective tillers $hill^{-1}$, number of spikelet $panicle^{-1}$, filled grain percent (%), 1000 grains weight (gm $hill^{-1}$) and grain yield (kg $ha^{-1}$).

### Statistical analysis

The data were subjected to analysis of variance designed in two factors factorial in RCBD (Split-plot Design) by using the IRRISTAT (Version 4.0.2). Factor A was assigned in three rice varieties ($V_1$ = Sinthukha, $V_2$ = Shwewharhtun and $V_3$ = Manawthukha) and Factor B was assigned in

treatments ($T_1$ = 25 day-old seedlings, $T_2$ = 10 day-old seedlings and $T_3$ = 8 day-old seedlings). Treatment means were separated and compared with Least Significant Difference (LSD) test at 5 % level of significant.

***Grain yield***

Grain yield (t/ha) = panicle number $m^{-2}$ × spikelet number $panicle^{-1}$ ×Percent of filled spikelet × 1000 grains weight (g) × $10^{-5}$

(Yoshida, 1981)

## Results

### Plant height

There was highly significant on rice varieties at transplant stage and reproductive stage (Table 1). In vegetative stage, there was no significant effect on varieties. Means plant height of Shwewharhtun ($V_2$) was higher than those of Sinthukha ($V_2$) and Mannawthukha ($V_3$) rice varieties. According to the seedling ages, plant height was observed from 97.93 cm to 101.73 cm at vegetative stage and 133.8 cm to 135.4 cm at reproductive stage. And reproductive stage, the 8 day-old seedlings was the highest plant height in reproductive stage. The 10 day-old seedlings and the 25 day-old seedlings were the same in plant height. At the same seedling ages, plant height was the highest in Shwewharhtun variety.

### Root length

Root lengths were highly significant different among the varieties at their transplant and reproductive stages (Table 2). Maximum average root length was achieved in Shwewharhtun variety 140.70 cm at all three stages while the minimum root length was observed in Sinthukha variety 130.22 cm. Highly significant differences were found in root lengths of all seedling ages at the vegetative stage. Root lengths of the 8 day-old seedlings were higher than those of the 10 and 25 day-old seedlings. There was no interaction between varieties and seedling ages on root length at reproductive.

**Number of tillers and effective tillers**

Tiller number was no significantly differences among varieties (Table 3). But among the seedling ages, there was highly significant. Maximum tiller numbers 27.08 were achieved in the 8 day-old seedlings while minimum tiller numbers 16.95 were observed in the 25 day-old seedlings at their vegetative stages. Effective tiller numbers were observed ranged from 11 to 16 among treatments. The 8 day-old seedlings had the highest effective tillers and followed by the 10 day-old seedlings. The 25 day-old seedlings had the lowest effective tiller numbers. In all treatments, effective tiller numbers of young seedling ages were higher than old seedling ages. There was no interaction between varieties and seedling ages on number of tillers.

**Numbers of spikelets**

Numbers of spikelet per panicles were not significantly differences in all varieties. Shwewharhtun variety was the lowest spikelet numbers although spikelet numbers of Sinthukha and Manawthukha varieties were not considerably different. Spikelet numbers ranged from 128.23 to 136.51 among the different seedling ages. The spikelet numbers per panicle of the 8, 10 and 25 day-old seedlings were not significantly different. Although, the maximum spikelet numbers were obtained from the 8 day-old seedlings, the 25 day-old seedlings had the minimum spikelet numbers. No interaction was observed between varieties and seedling ages (Table 4).

**Filled grain percent**

Mean effect of varieties and seedling ages on filled grain percent were shown in Table 5. Filled grain percent were not significantly differences among varieties and seedling ages. The highest filled grain percent (93.28%) was resulted from Manawthukha variety and the second highest (92.06%) was found in Sinthukha variety. According to the seedling ages, filled grains percent was found to be ranged from 91.15 % to 93.12% in all seedling ages. The higher filled grains percent was resulted from the10 day-old seedlings and the lower filled grains percent was found in the 25 day-old seedlings. There

was no interaction between varieties and seedling ages on filled grains and unfilled grains percent.

**1000 grains-weight**

Mean effect of varieties and seedling ages on the 1000 grains-weight were highly significant differences in Table 6. The highest 1000 grains-weight were observed in Shwewharhtun and followed by Manawthukha variety. There was no significantly difference among seedling ages. The1000 grains-weight ranged from 22.16 to 22.58 gm. The 1000 grains-weight of all seedling ages were nearly the same. In this study the 8 and 10 day-old seedlings were observed maximum 1000 grains-weight (22.58 gm) and the 25 day-old seedlings achieved minimum 1000 grains-weight (22.16 gm). No interaction between variety and seedling age was detected.

**Grain yield**

There was no significant effect of varieties on grain yield (Table 7). The average yield of Shwewharhtun variety was significantly higher than those of Sinthukha and Manawthukha varieties. Grain yield ranged from 4561.05 kg $ha^{-1}$ to 6912.71 kg $ha^{-1}$. It was observed that maximum grain yield in each variety was resulted from the 8 day-old seedlings. Grain yield were generally decrease as the seedling ages were increased. The second highest grain yield was observed in the 10 day-old seedlings and the lowest was the 25 day-old seedlings. There was no interaction between the seedling ages and varieties.

**Table 1.** Mean effects of seedling ages on plant height of three rice varieties

| Factors | Plant height (cm plant$^{-1}$) | | |
|---|---|---|---|
| | Transplant stage | Vegetative stage | Reproductive stage |
| Factor A: Varieties | | | |
| $V_1$ | 22.74 | 93.65 | 130.22 |
| $V_2$ | 24.36 | 109.73 | 140.70 |
| $V_3$ | 22.09 | 95.44 | 132.13 |
| F-test | ** | ns | ** |
| LSD (5%) | 0.66 | 11.78 | 4.53 |
| CV (%) | 3.40 | 14.10 | 4.40 |
| Factor B: Seedling ages | | | |
| $T_1$ | 30.77 | 101.73 | 133.80 |
| $T_2$ | 20.19 | 97.93 | 133.80 |
| $T_3$ | 18.27 | 99.15 | 135.43 |
| F-test | ** | ns | ns |
| LSD (5%) | 0.66 | 11.78 | 4.53 |
| CV (%) | 3.40 | 14.10 | 4.40 |
| Factor A × Factor B Varieties × Seedling ages | | | |
| $V_1T_1$ | 31.80 | 86.88 | 127.20 |
| $V_1T_2$ | 19.28 | 94.94 | 132.20 |
| $V_1T_3$ | 17.15 | 99.13 | 140.90 |
| $V_2T_1$ | 30.45 | 116.50 | 138.75 |
| $V_2T_2$ | 22.17 | 105.31 | 142.45 |
| $V_2T_3$ | 20.45 | 107.38 | 133.32 |
| $V_3T_1$ | 30.05 | 101.81 | 131.40 |
| $V_3T_2$ | 19.03 | 93.56 | 131.65 |
| $V_3T_3$ | 17.20 | 90.94 | 130.11 |
| F-test | ** | ns | ns |
| LSD (5%) | 1.15 | 20.40 | 7.84 |
| CV (%) | 3.40 | 14.10 | 4.40 |

**$p \leq 0.01$, ns = non significant.

**Table 2.** Mean effects of seedling ages on root length of three rice varieties

| Factors | Root length (cm hill$^{-1)}$ | | |
|---|---|---|---|
| | Transplant stage | Vegetative stage | Reproductive stage |
| Factor A: Varieties | | | |
| $V_1$ | 2.27 | 39.42 | 14.81 |
| $V_2$ | 3.22 | 63.60 | 14.83 |
| $V_3$ | 2.70 | 57.63 | 14.78 |
| F-test | ** | ** | ns |
| LSD (5%) | 0.29 | 2.72 | 1.689 |
| CV (%) | 12.7 | 6.10 | 13.60 |
| Factor B: Seedling ages | | | |
| $T_1$ | 2.84 | 40.73 | 13.79 |
| $T_2$ | 2.78 | 60.30 | 14.69 |
| $T_3$ | 2.56 | 59.63 | 15.95 |
| F-test | ns | ** | ns |
| LSD (5%) | 0.29 | 2.73 | 1.69 |
| CV (%) | 12.70 | 6.10 | 13.60 |
| Factor A × Factor B Varieties × Seedling ages | | | |
| $V_1T_1$ | 2.78 | 58.00 | 14.43 |
| $V_1T_2$ | 1.66 | 59.38 | 14.19 |
| $V_1T_3$ | 2.38 | 58.88 | 15.81 |
| $V_2T_1$ | 2.92 | 64.50 | 13.44 |
| $V_2T_2$ | 3.38 | 62.44 | 14.88 |
| $V_2T_3$ | 3.38 | 63.88 | 16.19 |
| $V_3T_1$ | 2.85 | 57.69 | 13.50 |
| $V_3T_2$ | 3.33 | 59.62 | 15.00 |
| $V_3T_3$ | 1.93 | 56.13 | 15.86 |
| F-test | ** | ** | ns |
| LSD (5%) | 0.50 | 4.72 | 2.93 |
| CV (%) | 12.70 | 6.10 | 13.60 |

**$p \leq 0.01$, ns = non significant.

**Table 3.** Mean effects of seedling ages on tillering of three rice varieties

| Factors | Number of Tillers and Effective tillers (hill$^{-1}$) | | |
|---|---|---|---|
| | Vegetative stage | Reproductive stage | |
| Factor A: Varieties | tiller | Tiller | effective tiller |
| $V_1$ | 22.28 | 22.29 | 15.16 |
| $V_2$ | 25.34 | 23.39 | 13.59 |
| $V_3$ | 20.79 | 21.27 | 13.45 |
| F-test | ns | ns | ns |
| LSD (5%) | 4.13 | 3.67 | 1.75 |
| CV (%) | 21.60 | 19.70 | 15.00 |
| Factor B: Seedling ages | | | |
| $T_1$ | 16.95 | 15.5 | 11.12 |
| $T_2$ | 24.39 | 24.81 | 15.15 |
| $T_3$ | 27.08 | 26.6 | 15.95 |
| F-test | ** | ** | ** |
| LSD (5%) | 4.13 | 3.67 | 1.75 |
| CV (%) | 21.60 | 19.70 | 15.00 |
| Factor A × Factor B Varieties× Seedling ages | | | |
| $V_1T_1$ | 13.36 | 16.56 | 11.56 |
| $V_1T_2$ | 24.87 | 21.38 | 15.50 |
| $V_1T_3$ | 28.62 | 28.94 | 18.43 |
| $V_2T_1$ | 21.43 | 16.06 | 12.00 |
| $V_2T_2$ | 26.31 | 27.62 | 14.88 |
| $V_2T_3$ | 28.31 | 26.50 | 13.88 |
| $V_3T_1$ | 16.06 | 14.00 | 9.78 |
| $V_3T_2$ | 22.00 | 25.43 | 15.07 |
| $V_3T_3$ | 24.31 | 24.37 | 15.60 |
| F-test | ns | ns | ns |
| LSD (5%) | 7.15 | 6.37 | 3.05 |
| CV (%) | 21.60 | 19.70 | 15.00 |

**$p \leq 0.01$, ns = non significant

**Table 4.** Mean effects of seedling ages on number of spikelets panicle $^{-1}$ of three rice varieties

| Factors | Number of Spikelets (panicle$^{-1}$) |
|---|---|
| Factor A: Varieties | |
| $V_1$ | 134.25 |
| $V_2$ | 128.61 |
| $V_3$ | 135.19 |
| F-test | ns |
| LSD (5%) | 7.95 |
| CV (%) | 7.20 |
| Factor B: Seedling ages | |
| $T_1$ | 128.23 |
| $T_2$ | 133.31 |
| $T_3$ | 136.51 |
| F-test | ns |
| LSD (5%) | 7.95 |
| CV (%) | 7.20 |
| Factor A × Factor B Varieties × Seedling ages | |
| $V_1T_1$ | 129.41 |
| $V_1T_2$ | 138.75 |
| $V_1T_3$ | 134.60 |
| $V_2T_1$ | 120.29 |
| $V_2T_2$ | 127.25 |
| $V_2T_3$ | 138.31 |
| $V_3T_1$ | 135.02 |
| $V_3T_2$ | 133.96 |
| $V_3T_3$ | 136.61 |
| F-test | ns |
| LSD (5%) | 13.76 |
| CV (%) | 7.20 |

ns = non significant

**Table 5.** Mean effects of seedling ages on filled grains percent of three rice varieties

| Factors | Filled grains (%) |
|---|---|
| Factor A: Varieties | |
| $V_1$ | 92.06 |
| $V_2$ | 91.69 |
| $V_3$ | 93.28 |
| F-test | ns |
| LSD (5%) | 1.70 |
| CV (%) | 2.20 |
| Factor B: Seedling ages | |
| $T_1$ | 91.15 |
| $T_2$ | 93.12 |
| $T_3$ | 92.77 |
| F-test | ns |
| LSD (5%) | 1.70 |
| CV (%) | 2.20 |
| Factor A × Factor B<br>Varieties × Seedling ages | |
| $V_1T_1$ | 89.37 |
| $V_1T_2$ | 92.69 |
| $V_1T_3$ | 94.14 |
| $V_2T_1$ | 91.77 |
| $V_2T_2$ | 92.82 |
| $V_2T_3$ | 90.50 |
| $V_3T_1$ | 92.32 |
| $V_3T_2$ | 93.85 |
| $V_3T_3$ | 93.66 |
| F-test | ns |
| LSD (5%) | 2.94 |
| CV (%) | 2.20 |

ns= no significant

**Table 6.** Mean effects of seedling ages on 1000 grains-weight of three rice varieties

| Factors | 1000 Grains-weight (gm) |
|---|---|
| Factor A: Varieties | |
| $V_1$ | 21.00 |
| $V_2$ | 24.17 |
| $V_3$ | 22.17 |
| F-test | ** |
| LSD (5%) | 0.95 |
| CV (%) | 5.10 |
| Factor B: Seedling ages | |
| $T_1$ | 22.16 |
| $T_2$ | 22.58 |
| $T_3$ | 22.58 |
| F-test | ns |
| LSD (5%) | 0.95 |
| CV (%) | 5.10 |
| Factor A × Factor B: Varieties × Seedling ages | |
| $V_1T_1$ | 21.12 |
| $V_1T_2$ | 21.13 |
| $V_1T_3$ | 21.11 |
| $V_2T_1$ | 23.00 |
| $V_2T_2$ | 23.00 |
| $V_2T_3$ | 25.01 |
| $V_3T_1$ | 21.02 |
| $V_3T_2$ | 23.11 |
| $V_3T_3$ | 21.16 |
| F-test | ns |
| LSD (5%) | 1.65 |
| CV (%) | 5.10 |

**$p \leq 0.01$, ns = non significant.

**Table 7.** Mean effects of seedling ages on grain yield of three rice varieties

| Factors | Grain Yield (kg $ha^{-1}$) |
|---|---|
| Factor A: Varieties | |
| $V_1$ | 6090.93 |
| $V_2$ | 6157.25 |
| $V_3$ | 6039.04 |
| F-test | ns |
| LSD (5%) | 531.36 |
| CV (%) | 10.40 |
| Factor B: Seedling ages | |
| $T_1$ | 4561.05 |
| $T_2$ | 6813.46 |
| $T_3$ | 6912.71 |
| F-test | ** |
| LSD (5%) | 531.36 |
| CV (%) | 10.40 |
| Factor A × Factor B: Varieties × Seedling ages | |
| $V_1T_1$ | 4428.32 |
| $V_1T_2$ | 6972.73 |
| $V_1T_3$ | 6871.73 |
| $V_2T_1$ | 4993.80 |
| $V_2T_2$ | 6536.56 |
| $V_2T_3$ | 6941.40 |
| $V_3T_1$ | 4261.03 |
| $V_3T_2$ | 6931.08 |
| $V_3T_3$ | 6925.01 |
| F-test | ns |
| LSD (5%) | 920.35 |
| CV (%) | 10.40 |

**$p \leq 0.01$, ns = non significant

## Discussion and Conclusion

The maximum mean plant height was observed in Shwewharhtun variety at vegetative and reproductive stages. The plant height of young seedling ages was higher than those of old seedlings. The maximum means root length, 63.60 cm was observed in 10 day-old seedlings under SRI method and the minimum means length 59.63 cm was observed in 25 day-old seedlings under traditional method. Rabenandrasana (2000) reported that the success of SRI is based on the synergistic development of both the tillers and root system where there is vigorous root growth, the plant grows fuller and taller; consequently more access to nutrients and water for tiller and seed development.

The maximum tiller and effective tiller were observed in the 8 day-old seedlings at their vegetative and reproductive stages. The minimum tiller and effective tiller were observed in the 25 day-old seedlings. The result indicated that tiller performance in young seedling is higher than in old seedling. Thit Thit Soe (2008) stated that the tiller numbers were greater in spacing of 25 × 25 cm than spacing of 15 × 15cm at the same seedling ages.

Filled percent in SRI method was greater than in traditional method. Under SRI, the average filled grain percent was 93.12 % while 91.15 % was observed in traditional method. Enhanced growth parameters might have helped in better filling of spikelets. In the present study, 1000 grains weight was not significant among treatments. Aidei and Beighley (2006) reported that cultivation methods didn't have such effect on 1000 grains weight.

According to the results, SRI plots produced significantly higher grains yield than traditional cultivated plots. At the spacing 25 × 25 cm, the 8 day-old seedlings ($T_3$) had achieved the maximum grain yield and followed by the 10-day old seedlings ($T_2$) and the 25-day old seedlings ($T_1$). It is therefore recommended that for rice variety under SRI practice, the optimum transplanting spacing that gives maximum yield is 25 × 25 cm (Reuben *et al.*, 2016).

By comparing the growth and yield of the three commercial rice varieties, under SRI and traditional method, Shwewharhtun variety gave the highest grain yield. Measurements of crop performance, SRI practice were significantly more successful than non-SRI practice (traditional method). It is concluded that the SRI method of cultivation is more advantageous to the paddy farmers than compared to traditional method as the reduction in cost of cultivation, higher yields obtained per acre and lesser seed rates used in sowing.

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