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RESEARCH ARTICLE

Assessment of the organic-based system of rice intensification (SRI) under coastal rice field ecosystem

Eleanor L Cacacho[1]*, **Shirly O Agcaoili**[1], **Shella B Cacatian**[1], **Narcitas B Ouano**[1]

1 Faculty Researchers, Cagayan State University, Sanchez Mira, 3518, Cagayan Valley, Philippines

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***Corresponding author**.
Eleanor L Cacacho

Faculty Researchers, Cagayan State University, Sanchez Mira, 3518, Cagayan Valley, Philippines
eleanor_cacacho@yahoo.com

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Abstract

Objectives: The effects of different levels of organic fertilizers on the growth and yield of rice were investigated in a coastal field ecosystem under the systems of rice intensification (SRI) technology. **Methods/Statistical Analysis:** The study was conducted in a coastal rice field with 8.38 pH. It was laid out in a split-plot design with four treatments replicated thrice. Different amounts of organic fertilizer were applied as basal fertilizer. Data were statistically analyzed using analysis of variance (ANOVA). The significance of the treatment effect was determined using the F-test. Least significant difference (LSD) determined which means are statistically different at the 5% probability level. **Findings:** Results showed that the filled grains and yield increase were 35.6% and 45%, respectively, when applied with an organic fertilizer at the rate of 6 ton/ha compared with the control. Other parameters measured like the height of plants at maturity and the number of unfilled grains were all comparable with the control group. **Applications:** SRI technology is a potential option for growing inbred rice in coastal rice fields.

Keywords: Coastal rice field; Organic-based; Rice crop; System of rice intensification

1 Introduction

Intensifying agricultural outputs to fulfill the continuously growing demands on food is the focus of a conventional system of producing foods supported by the advancement of science and technology. With the advent of new technologies, the traditional method has multiplied the yielding of crops. However, it has adverse consequences on human health and the environment [1]. The system of rice intensification (SRI) was developed in the 1980s by a French priest Father Henri de Laulani [2]. The purpose of the technology is to find sustainable agricultural practices that lead to higher productivity, optimum use of capital and labor, less input cost, and less requirement of water. According to [3], SRI is a way of matching the elements of soil, water, light, and crop to allow crops to receive their fullest potential that is often hidden when inappropriate techniques are used.

Several studies in different tropical countries have shown SRI techniques as productive resource-saving and environment-friendly when compared to traditional or conventional rice production [4–6]. The traditional rice production requires 30-60 kg of seeds to plant a hectare of rice field while in SRI, only 4-10 kg off seeds is required for a hectare [7]. Therefore, SRI reduces input costs and drudgery for the farmers. Some other benefits in using SRI methods have found in various researches as compared with the conventional way, like reduction in crop cycle with a higher yield [8]. Better yield and economic return of using the SRI method compared to the conventional method have been reported by various researches. [9] said that the average rice yield with SRI is 8t/ha, whereas the yield is three t\ha under conventional paddy. Due to the adoption of this technology, farmers are getting a 25-50 % higher return than traditional methods of paddy cultivation in the area [10].

SRI is showing that in many cases, farmers' income can be increased by using less rather than more external inputs. The fact that SRI can give higher yields with a lower investment of capital making it attractive and beneficial for poorer households. One of the benefits identified in the GTZ Cambodia evaluation was that SRI farmers could make less cash outlay at the start of the planting season when their cash reserves were lower [11]. Another direct benefit of using SRI is the reduction in water requirement by 25-50% while raising yield up to 50-100% [12]. Various researchers from different countries report similar results [13–16]. The environmental benefits of using SRI methods were also reported. Reduction in fertilizer application by 43%-50% and agro-chemicals by 80% [17,18]. These benefits can contribute to better human health and the conservation of biodiversity [18].

Meanwhile, despite these advantages of using SRI technology, no researches have reported for its adoption to the coastal rice field ecosystem and have not considered the environmental concerns, SRI with the use of organic fertilizers. Recent works of literature highlighted the importance of acquiring new technologies to increase rice production [19,20].

The present study, therefore, aimed to assess the yield potential of inbred rice fertilized with organic fertilizer using the systems of rice intensification grown under the coastal rice field ecosystem.

2 Methodology

The study was conducted in a coastal rice field in Pamplona, Cagayan, situated at 18.4266° N latitude, 121.3313° E longitude and 20 m altitude, with a mean maximum temperature of 29°C, mean minimum temperature of 23°C and annual precipitation of 1664 mm. The soil was coastal sandy soil with a pH of 8.38.

Generally, the study followed the SRI methods for crop establishment and management. Nurseries were started the same day using the same variety. Young seedlings (12-day old) were transplanted 1-2 cm deep into a saturated puddle field without ponding water. During the vegetative growth phase, plots were kept saturated (not flooded). After the panicle initiation stage, 2-3 cm of standing water was maintained on the field and drained 15 days before harvest. One plant per hill, with a spacing of 25 cm x 25 cm on a square grid, and organic fertilizer was applied to the soil (base from treatments). The land was levelled, and the irrigation schedule was the same for all the set-up.

The study was laid-out in a split-plot design with four (4) treatments replicated three (3) times. Different amount of organic fertilizer (commercial organic fertilizer) were applied, viz. T_0 = control; T_1 = 2 tons/ha; T_2 = 4 ton/ha; T_3 = 6 tons/ha, applied as basal fertilizer.

Growth parameters like the number of tillers and plant height were recorded, and yield parameters like the number of grains (filled grains and unfilled grains), and grain yield were documented. The number of tillers was observed from 43 days-after-transplanting (DAT) until 72 DAT by counting the number of tillers that emerged with a 7-day interval. The plant height was measured from the base of the plant to the tip of its longest part. All plants in an area of 1 m x 1 m for each replicate (1m2) were harvested (excluding border rows) for determination of yield per unit area, and grain yield was adjusted to 14% seed content. All the data were statistically analyzed using analysis of variance (ANOVA) procedure of excel 2007, and the significance of the treatment effect was determined using the F-test and significance between the means of the treatments differentiated based on the least significant difference (LSD) at 5% probability level.

3 Results and Discussion

3.1 Height at maturity of the rice test crop as affected by different levels of organic fertilizer

The result of the study on the assessment of the organic-based systems of rice intensification (SRI) under the coastal rice field ecosystem is revealed in Figure 1. It appears that the performance of inbred rice in SRI varied with the amount of organic fertilizer applied. An insignificant difference in the height at maturity of the rice test crop grown under SRI technology exists. The control registered a mean height of 90cm, while the mean height of T_1, T_2, and T_3 is 89 cm, 87 cm, and 88 cm, respectively. This result, however, is in contrast to the findings of [21] that rice crop grown under SRI recorded significantly higher plant height compared to the conventional method (CM). The insignificant difference between the two cultivation systems is also a negation of the report of[22]. According to them, SRI has improved the photosynthesis efficiency of the plant, which in turn resulted in significantly higher plant height.

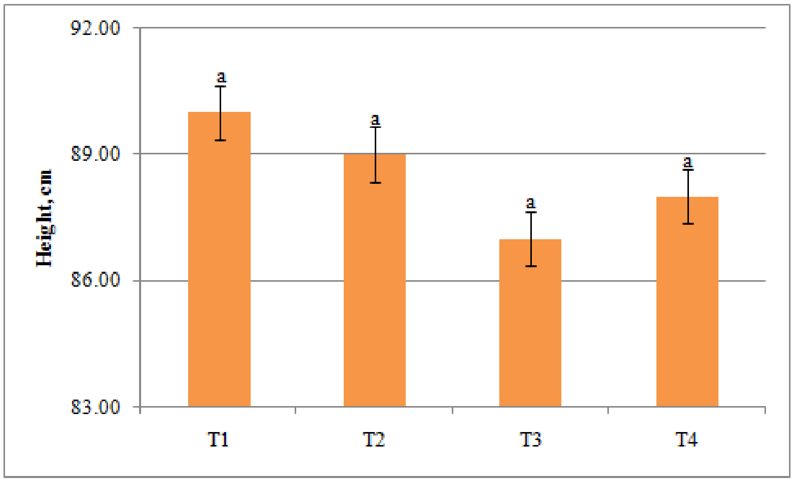

Fig 1. Height at maturity of the rice test crop as affected by different levels of organic fertilizer

3.2 Number of tillers produced by the test crop grown under SRI

The number of tillers produced by the test crop as shown in Figure 2 ranges from 19 to 22 tillers, 25 to 28 tillers, 31 to 37 tillers, 34 to 41 tillers, and 34 to 40 tillers at 43 DAT, 50 DAT, 57 DAT, 64 DAT, and 72 DAT, respectively. The test crop applied with organic fertilizer produced more tillers than the control group; however, the analysis of variance revealed insignificant difference between the numbers of tillers produced by the test. Although the effect of the treatment is insignificant in terms of the number of tillers produced by the test crop, there are reasons to believe that applying organic fertilizer on rice grown under SRI, positively improves the production of tillers. In [23] compared the number of effective tillers produced in the planting method of SRI and the CM. They found 250.04% higher number of effective tillers using the SRI method than CM. In [24] likewise found 217% higher number of effective tillers under SRI than CM. The increase might be due to the wider spacing provided for the plants and the efficient use of nutrients from the soil, as the root system developed well under the SRI method. Similarly, [25] observed that the effect of SRI on the growing plant itself, in terms of the significant difference in phenotype and in the tillering potential of the plant itself which is between 30-80 or even more.

3.3 Number of grains produced per panicle of the test crop grown under SRI

Figure 3 presents the number of grains produced per panicle of the test crop grown under SRI as affected by different levels of organic fertilizer. Among the different levels of organic fertilizer applied to rice grown under SRI, T_3, T_2, and T_1 outperformed the control group by 20.2%, 10.7%, and 8.8% higher, respectively, in terms of grain production. A significant effect of the treatment was recorded on the number of filled grains per panicle (Figure 3). The number of filled grains per panicle was highest (51) in T_3, followed by T_2 (46) and T_1 (38). The control produced the least filled grains per panicle. In T_3, T_2, and T_1, filled grains increased by 35.6%, 23.4%, 14.0%, respectively, more than the control. The results prove that the cultivation systems affect grain production per panicle. In [26] significantly higher number of filled grains per panicle under SRI than under the CM was observed and in [27] a similar result of filled grain per panicle with SRI was revealed. The higher number of filled grains per panicle grown under SRI might be due to maximum utilization of solar radiation, availability of nutrients on the root zone, better uptake of nutrients by the roots [23].

In terms of unfilled grains, an insignificant effect of the treatment was recorded (Figure 3). The number of unfilled grains in T_3, T_2, T_1, and T_0 are 38, 35, 37 and 36, respectively. An insignificant effect of the treatment was recorded on the total number of grains per panicle (Figure 3); however, the total number of grains per panicle in T_3, T_2, and T_1 is 20.2%, 10.7% and 8.8%, higher, respectively, when compared with T_0 (control). The result of ANOVA discloses that the effect of the different levels of organic fertilizer used in the present study is insignificant in terms of grain production. However, there are grounds for considering that the increasing levels of fertilizer application to rice grown under SRI positively affects crop as manifested by the percent

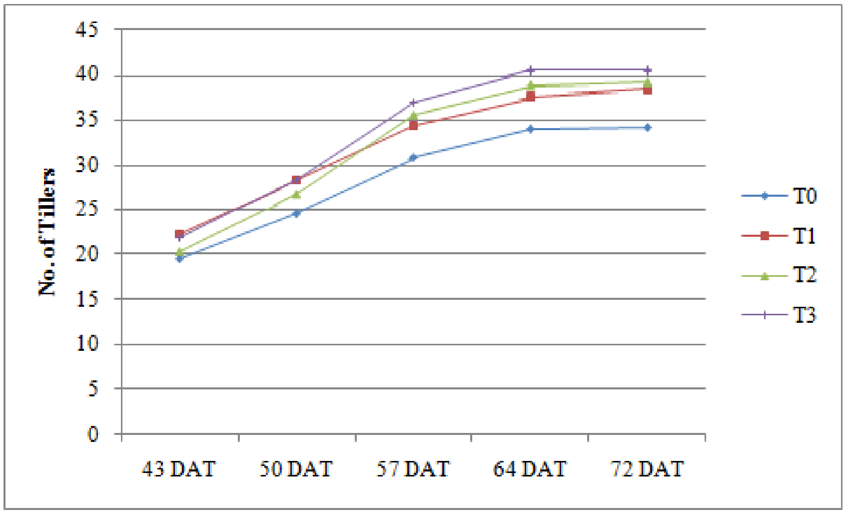

Fig 2. Number of tillers produced by the rice test crop as affected by different levels of organic fertilizer for five (5) weeks of observation

increase in grain production.

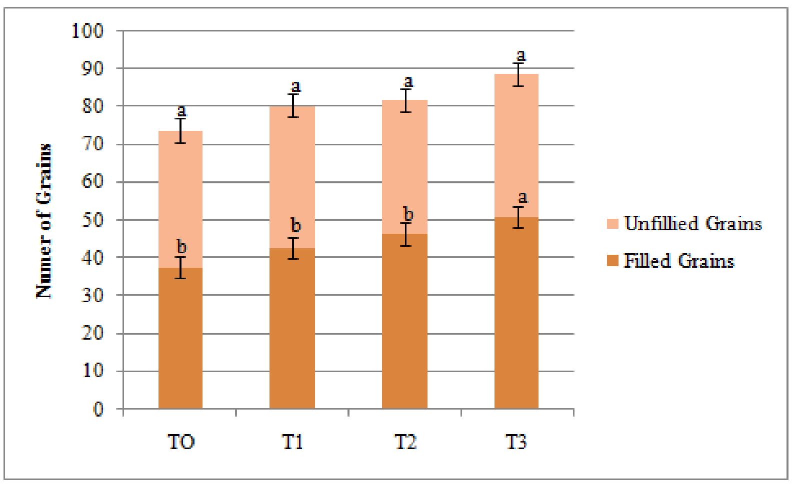

Fig 3. Number of grains (filled and unfilled) produced per panicle as affected by different levels of organic fertilizer

3.4 Yield in ton/ha of rice grown under SRI technology

A significant effect of treatment was recorded on the yield in ton/ha of rice grown under SRI technology (Figure 4). The yield per ton was highest (7.50 ton/ha) in T_3, followed by T_2 (6.34 ton/ha) and T_1 (6.12 ton/ha). The control produced the least yield of 5.17 tons/ha. In T_3, T_2, and T_1, the yield increased by 45%, 23%, and 18%, respectively, higher than the control. The higher number of effective tillers and the higher number of filled grains per panicle grown under SRI than under CM, might be the reason for higher yield from the former. The results are in agreement with the findings of[(28)], who reported that the highest grain yield was from the SRI method (7.62 t ha $^{-}$1), whereas the lowest was from the traditional method (6.59 t ha $^{-}$1). In[23] also proved that SRI produced significantly higher (10.17%) yield (9.10 ton/ha) than CM (8.26 ton/ha). Besides,[(24,25)] observed that rice cultivation adopting SRI produced higher grain yield over the traditional method.

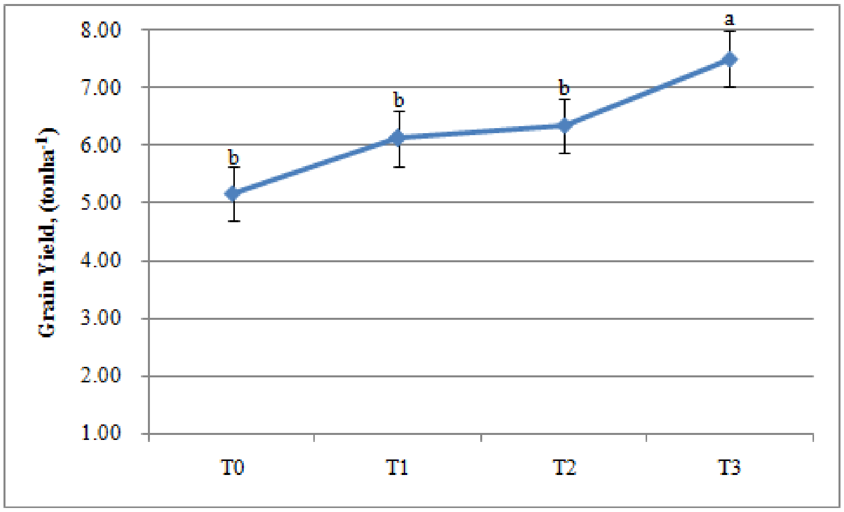

Fig 4. Grain yield (ton/ha) of the rice test crop as affected by different levels of organic fertilizer

4 Conclusion

The beneficial effects of applying organic fertilizer on inbred rice products grown in the coastal rice ecosystem could be achieved through SRI technology. In this study, the application of organic fertilizer at the rate of 6 tons/ha could improve the production of organically produced inbred rice. The SRI is a potential option for growing in-bred rice in coastal rice fields.

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