JURNAL AGROEKOTEKNOLOGI TERAPAN
Applied Agroecotechnology Journal

Agroteknologi Universitas Sam Ratulangi e ISSN:2797-0647

The Effects of Substituting Straw Compost for NPK Fertilizer On Field Rice Growth and Yield Using The SRI (System of Rice Intensification) Method

Substitusi Pupuk NPK dengan Kompos Jerami Terhadap Pertumbuhan dan Produksi Padi Sawah Menggunakan Metode SRI (*System of Rice Intensification*)

Meity Rosadelly Rantung*, Jeanne M. Paulus , Paula C. Supit , Tommy B. Ogie, Edy F. Lengkong, Stanley A. F. Walingkas, Annatje E. B. Inkiriwang, Beatrix Doodoh, Ventje Pangemanan, Jemmy Najoan, Maria G. M. Polii, Stella Maria T. Tulung

Faculty of Agriculture, Sam Ratulangi University, Jl. Kampus UNSRAT, Manado 95115 Indonesia

*Corresponding author: meityrosadellyrantung@unsrat.ac.id

Manuscript received: 9 Oct. 2023. Revision accepted: 18 Dec. 2023.

Abstract

With an agroecological philosophy, the SRI (*System of Rice Intensification*) technique is a rice production technology approach that prioritizes soil, plant, and water management through local expertise and group empowerment based on environmentally beneficial activities. The purpose of this study is to investigate lowland rice growth and yield by using composted straw instead of NPK fertilizer. Implemented in Tara-Tara II village, West Tomohon sub-district for 5 (five) months with one-factor treatment, namely the ratio of NPK fertilizer dose and straw compost dose: 100% NPK + straw compost 0% straw compost (P0), 75% NPK + 25% straw compost (P1), 50% NPK + 50% straw compost (P2), 25% NPK + 75% straw compost (P3), and 0% NPK + 100% straw compost (P4). The variables observed included: plant height, number of fodder, number of panicles/clumps, weight of 100 harvested dry grains, number of grains/panicles, percentage of smooth grains/clumps, and harvested dry grain yield. Substitution of NPK fertilizer with compost straw has no effect on the height of lowland rice plants using the SRI (*System of Rice Intensification*) method but does affect the number of productive tillers. The highest number of productive tillers was found in P2 (50% NPK + 50% straw compost), P3 (25% NPK + 75% straw compost) and P4 (0% NPK + 100% straw compost), with an average value of 31, respectively. 27; 28.20 and 27.53 tillers, while treatment P3 (25% NPK + 75% straw compost) and lower values in treatments P0 (100% NPK + 0% straw compost) and P1 (75% NPK + 25% straw compost) with an average value of 25.83; and 25.67 offspring.

Keywords: System of Rice Intensification (SRI), rice, straw compost.

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most significant grain crops, and rice is eaten by more than three billion people globally (Zhao *et al*., 2021).

According to Mboyerwa *et al* (2022) for all levels of N application, rice grain yields under SRI increased by an average of 16.2% and 55.6% during the wet and dry seasons, respectively. With applications of 120 and 150 kg N ha^{-1} in the rainy season and 7.7 Tha^{-1} with 90 kg N ha^{-1} in the dry season, the maximum rice grain production under SRI was achieved. With an application of 120 kg N ha^{-1} in the rainy season and 90 kilogram N ha^{-1} in the dry season, the maximum rice grain yield under CP was 7.2 t ha^{-1}. The yields of rice grain obtained under CP with applications ranging from 90 to 120 kg N ha 1 during the dry season were comparable to the yields obtained under SRI with an application of 60 kg N ha^{-1}. The results of this study showed that nitrogen administration and crop management techniques both had an impact on rice grain yield, although their effects were interdependent. Additionally, for the rice variety TXD 306, the average grain production attained under SRI falls within the range of potential yield (7–8 t ha 1). The current study's findings concur with earlier research carried out elsewhere, where (Mati *et al*., 2021; Thakur *et al*., 2021; Sandhu *et al*., 2017; Reuben *et al*., 2016; Kahimba *et al*., 2013; Ashraf *et al*., 1999).

One approach that can support a sustainable green revolution program is *the System of Rice Intensification* (SRI). SRI is a production technology to increase the productivity of rice plants. According to Professor Norman Uphoff in an interview with Trubus, the SRI method is an agroecological concept that prioritizes the regulation of plants, soil, water and fertilizer. According to Anugrah et al (2008), the SRI method is an approach to rice cultivation practices that emphasizes land, plant and water management through group empowerment and local wisdom based on environmentally friendly activities. Purwasasmita *et al* (2012) further stated that several implementations of Indonesia's organic SRI mean that the country can save on urea fertilizer subsidies, bring benefits or benefits to the environment because it saves water use, eliminates greenhouse gas (methane) emissions, increases the productivity of rice plants thereby opening up opportunities for those who working on it.

Rice cultivation using the SRI method has several advantages compared to conventional methods, namely: 1) saves water, during growth from planting to harvest, a maximum of 1 cm of water is given, the best is about 5 mm and there is a drying period until the soil cracks (interrupted irrigation).), so it is suitable for application on land with low water availability; 2) save seeds because this method can save the use of rice seeds by up to 80% or only requires 8 - 10 kg of seeds/ha, whereas conventional cultivation requires around 50 kg of seeds; 3) save time because the seeds are planted at a young age, namely 10 – 12 days after sowing, and the harvest time will be earlier; 4) production increases due to more stems appearing in one clump so that more grains are produced from the panicles; 5) environmentally friendly because it gradually reduces the use of chemical fertilizers (urea, SP-36, KCl) and replaces them with organic fertilizers (compost, manure, liquid fertilizer) and also uses organic pesticides (Department of Agriculture and Food Crops, 2006; Sampoerna, 2009).

RESEARCH METHODS

Place and time of research

This research will be carried out in Tara-Tara II village, West Tomohon District, Minahasa Regency, for 5 months.

Materials and tools

The materials and tools used are: cigeulis variety rice seeds, NPK fertilizer, urea fertilizer, straw compost, vegetable pesticides, analytical scales, etc. The straw compost used comes from products that are made or processed by yourself.

Method

Treatments were assigned according to a Randomized Block Design (RAK). The factors studied were the comparison of the dose of NPK fertilizer and the dose of 100% NPK straw compost + 0% straw compost (P0), 75% NPK + 25% straw compost (P1), 50% NPK + 50% straw compost (P2), 25% NPK + 75% straw compost (P3), and 0% NPK + 100% straw compost (P4). Each treatment was repeated three times. The variables observed include: plant height, number of fodder, number of panicles/clumps, weight of 100 grains of dry harvested grain, number of grains of grain/panicle, percentage of grains of smooth grain/clump and yield of dry grain harvested.

RESULTS AND DISCUSSION

Plant height

The results of statistical analysis show that treatment substitution NPK fertilizer with compost straw has no influence real to tall plants 70 days old after planting (DAP) **Table 1.**

Table 1. Average plant height rice at the age of 70 days after plant

Treatments	Average Plant Height (cm)
P0 (100% NPK + 0% KJ)	77,47 a
P1 (75% NPK + 25% KJ)	80,60 a
P2 (50% NPK + 50% KJ)	80,73 a
P3 (25% NPK + 75% KJ)	79,47 a
P4 (0% NPK + 100% KJ)	79,53 a
LSD 0,05	3,92

The numbers that follow the same letter No different significant at the LSD test level of 0.05

Paulus, *et al* (2014) show their research about influence a number of type compost on growth and production rice The SRI method was obtained results grain dry harvest highest (0.03 tons ha^{-1}) in the treatment compost straw + 40% NPK and 8.62 tonnes ha^{-1}in the legume plant compost treatment straw + 40% NPK, supported by growth and plant yield components, such as plant height, number of tillers, and number grain per panicle, so produce production or results grain dry highest harvest _ compare with compost market trash. That matter caused by sufficient nitrogen content high in compost straw and compost legume plants (*Calliandra*). According to Mulyadi (2008), that in compost straw contains N $H_4$and N O_3respectively of 234 ppm and 7688 ppm, calliandra compost 144 ppm and 7750 ppm, while vegetable compost is 252 ppm and 2170 ppm.

Chapagain *et al* (2011) The implementation of specific modifications to management techniques for rice farming that improve the crop's growth environment is known as the system of rice intensification (SRI), which is a production system. This system was evaluated under organic and inorganic management and contrasted with traditional methods. The quantity of roots, the number of productive tillers per hill, the days until flowering, and the harvest index all significantly responded to SRI techniques. Furthermore, SRI was found to be beneficial in reducing the occurrence of pests and diseases, reducing the length of the crop cycle, and enhancing plant stand. The grain yield from the traditional method was the same.

Number of Productive Tillers

The results of statistical analysis show that, treatment substitution NPK fertilizer with compost straw influential to amount sapling productive 70 days old after tnam (HST) **Table 2**.

Table 2. The average amount of sampling productive plant paddy 70 days after planting

Treatments	Average Productive saplings
P0 (100% NPK + 0% KJ)	25,83 b
P1 (75% NPK + 25% KJ)	25,67 b
P2 (50% NPK + 50% KJ)	31,27 a
P3 (25% NPK + 75% KJ)	28,20 ab
P4 (0% NPK + 100% KJ)	27,53 ab
LSD 0,05	4,78

The numbers that follow the same letter no different significant at the LSD test level of 0.05

Treatment tall rice plant, no there is difference between treatment substitution NPK fertilizer with compost straw this show that good giving fertilizer chemistry (NPK) as well as komos straw in a way together donate Nutrients N, P and K needed by plants paddy for its growth and development .

Amount sapling productive is very important production plant paddy . Amount sapling high productivity will produces more panicles a lot, so grain produced will more lots too. Amount sapling productive highest achieved by P2 treatment (50 % NPK + 50% compost straw), P3 (25% NPK + 75% compost straw) and P4 (0% NPK + 100% compost straw), with the respective average value is 31.27; 28.20 ; and 27.53 offspring , meanwhile treatment P3 (25% NOK + 0% KJ) and P1 (75% NPK + 25% KJ), with average values of 25.83 and 25.67 tillers. Based on amount sapling productive seen that seems to be produced by plants, so production will the more increase.

According to Mboyerwa *et al* (2022) show this field study suggests that rice can achieve nitrogen usage efficiency under the system of rice intensification (SRI) management method because of better physiological performance and profuse root development. When the technology is used instead of the traditional method, the grain yield is increased. This suggests that alternating wetting and drying (water-saving irrigation) and/or N fertilization, along with reduced plant density (one seedling per hill), interact systematically. N application levels in SRI might be lowered from 150 to 60 kg Nha^{-1}, which would increase grain production and NUE. An additional advantage of SRI is a notable decrease in fertilizer input prices, which translates to environmental conservation from population growth. According to Kaya *et al* (2013), that giving compost straw together with NPK fertilizer can increase N uptake , high plants , and quantities sapling , giving compost straw with dose of 3 tons/ha together with NPK fertilizer 150 kg/ha provides highest N uptake amounting to 3.51%.

Kamara *et al* (2023) show their research this study brings to light the tensions that exist from the existing TOT models and AIS approaches that seem to be promoted at least in theory (e.g. a lack of consideration for local needs and existence of a demand centred approach). Future studies, in a similar context, that examine the extent to which AIS approaches have been integrated in the promotion of rice innovations such as SRI would also help to examine whether existing ToT models are pervasive or whether innovation systems are successfully transitioning to an AIS; able to stimulate innovation processes and thereby the contextual adaptation of agricultural innovations that fit well and are responsible at a wider ecosystem level.

This study draws attention to the discrepancies that exist between the present TOT models and AIS techniques such as a demand-centered approach and a disregard for local needs which are, at least theoretically, supported. Similarly, further studies assessing the extent to which AIS methodologies have been applied in the development of rice innovations, such as SRI, would also advance the inquiry into the general acceptance of ToT models now in use or the effectiveness of innovation systems in transitioning to an AIS. This later capacity to support innovation processes will make it possible for agricultural inventions to be contextually adapted in a way that fits well and is responsible across a wider ecosystem.

Zhao, *et al* (2021) show their research the synthesis of plant hormones and amino acids, as well as the acquisition of nutrients and water, are all facilitated by the roots of rice plants. The formation of grain yield and quality is significantly influenced by the morphological and physiological characteristics of rice roots. The links between the morphological and physiological characteristics of roots and how rice quality is formed were compiled in this review. Additionally, a few research priorities were presented about the future correlations between root characteristics and grain quality. Theoretical underpinnings for root modulation of high yielding and high quality rice cultivation are anticipated.

B D A Nugroho *et al* 2022 show principle of System of Rice Intensification (SRI) adapted to local conditions to increase productivity and be environmentally friendly. Single seedlings per hill, immature seedlings, greater spacing, inter-cultivation, intermittent irrigation, and organic fertilization are the primary elements of SRI. East Sumba Regency, East Nusa Tenggara, is the research region for the System of Rice Intensification. It features typical features such bulk density, rainfall, soil water content, and texture. The purpose of the study was to determine how plant densities in paddy fields using the System of Rice Intensification (SRI) method affected the water productivity. This research initially focused on transplanting very young rice seedlings of 14 days old in two treatments of plants. The densities are broad in a square pattern (30 x 30 cm) and a Jajar Legowo pattern (20 x 10 x 40 cm). The rice was not grown in flooded paddies but moist ground, with intermittent irrigation. When SRI was concerned at a different wider spacing, it discovered the effect on water productivity for paddy fields, especially in East Sumba, East Nusa Tenggara. So that it determined the best wider spacing of the System of Rice Intensification method can apply in the area. The results show that the Jajar Legowo pattern spacing (20 x 10 x 40 cm) has a higher water productivity value of 3,4% than the spacing treatment (30 x 30 cm). Jajar Legowo was 11.9% higher than the spacing treatment (30 x 30 cm

Enhancement results from rice plants as a response to giving a combination compost and fertilizer inorganic reported by Barus (2011), that treatment combination fertilizer compost and NPK 75% and 100% increase results real grain higher (1.05 cubed and 1.13 kg/ m^3) compared to the compost treatment without NPK fertilizer (0.83 kg/ m^3). Likewise, the results of Amrah's (2008) research show that treatment combination hay + 1 dose . Fertilizer inorganic give results grain highest compared to with control (without straw, without inorganic fertilizer).

CONCLUSIONS AND RECOMMENDATIONS

Conclusion

Substitution NPK fertilizer with compost straw no effect on height plant paddy fields with SRI method (*System of Rice Intensification*), however affect the amount sapling productive. Amount sapling productive highest achieved by P2 treatment (50% NPK + 50% compost straw), P3 (25% NPK =75% KJ) and (0% NPK + 100% KJ), with the respective average values are 31, 27; 28.20; and 27.53 offspring , meanwhile P3 treatment (25% NPK +75% KJ), whereas more value _ low in treatments P0 (100% NPK + 0% KJ) and P1 (75% NPK + 25% KJ), with the average values are 25.83 and 25.67.

Recommendations

Recommended to farmers lowland rice using the SRI Method to take advantage of compost straw as substitution NPK fertilizer at a dose of 50% NPK + 50% Compost straw, 25% NPK + 75% compost straw, and without NPK + 100% straw compost

REFERENCES

Kamara L.I., Lalani, B., Dorward, P. (2023). Towards agricultural innovation systems: Actors, roles, linkages, and constraints in the system of rice intensification (SRI) in Sierra Leone. *Elsevier*. *Scientific African* 19 (2023) e01576. https://doi.org/10.1016/j.sciaf.2023.e01576

Mboyerwa, P.A., Kibret K., Mtakwa, P., Aschalew, A. (2022) Lowering nitrogen rates under the system of rice intensification enhanced rice productivity and nitrogen use efficiency in irrigated lowland rice. *Science Direct*. *Heliyon* https://doi.org/10.1016/j.heliyon.2022.e09140

Zhao, C.; Chen, M.; Li, X.; Dai, Q.; Xu, K.; Guo, B.; Hu, Y.; Wang, W.; Huo, Z. Effects of Soil Types and Irrigation Modes on Rice Root Morphophysiological Traits and Grain Quality. *Agronomy* **2021**, *11*, 120.

Zhu, A.; Gao, J.; Huang, J.; Wang, H.; Chen, Y.; Liu, L.J. Advances in morphology and physiology of root and their relationships with grain quality in rice. Crops **2020**, 2, 1–8.

B D A Nugroho *et al* 2022. The Effect of Plant Densities in System of Rice Intensification (SRI) Method to Water Productivity of Paddy Field in East Sumba, East Nusa Tenggara. *IOP Conf. Ser.: Earth Environ. Sci.* **1038** 012003

Anugrah, I.S, Sumedi, dan I Putu Wardhana. 2008. Gagasan dan Implementasi System of Rice Intensification (SRI) Dalam Kegiatan Budidaya Padi Ekologis (BPE). Analisis Kebijakan Pertanian Vol. 16 No.1 Maret 2008 75-99

Paulus, J.M., Sondakh, T.D., Sumampouw, D.M.F. 2014. Kajian Penerapan Budidaya Organik Metode SRI (*System of Rice Intensification)*: Pengaruh Jenis Pupuk Organik Terhadap Pertumbuhan dan Produksi Padi Sawah. Laporan Penelitian Hibah Bersaing. Universitas Sam Ratulangi, Manado.

Purwasasmita, M., Sutaryat, A 2012. Padi SRI Organik Indonesia. Penebar Swadaya. Jakarta.

Chapagain, T., Riseman,A., Yamaji, E. 2011. Assessment of System of Rice Intensification (SRI) and Conventional Practices under Organic and Inorganic Management in Japan. *Elsevier*. *Rice Science*. Volume 18, Issue 4, December 2011, Pages 311-320..