

SHORT COMMUNICATION

Rice Yields At Different Dosages of Kieserite and Planting Systems

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Abstract

Rice stands as an important staple crop in Indonesia and Asia, prompting endeavors to enhance its production. One such technology, aimed at intensifying rice cultivation, involves optimizing plant density utilizing the “*jajar legowo*” system. This research was conducted within community rice fields located in Pasar Ambacang, Kuranji District, Padang City, West Sumatra, Indonesia, spanning from February 2020 to June 2020. The primary objective of this study was to assess the potential of the *jajar legowo* planting system, in conjunction with varying dosages of kieserite, to increase lowland rice yields. The study employed a two-factor experiment in a completely randomized design. The first factor is the *jajar legowo* types: A (25 cm x 12.5 cm x 50 cm) and B (25 cm x 25 cm x 50 cm). The second factor involved different kieserite dosages, comprising three levels (0, 150, 300 kg.ha⁻¹). Each treatment combination was replicated four times. Our investigation unveiled that rice panicle length reached 27.20 cm under the influence of *jajar legowo* type A with a kieserite dosage of 150 kg.ha⁻¹. Conversely, with the application of *jajar legowo* type B alongside a kieserite dose of 300 kg.ha⁻¹, the rice panicle length increased to 27.88 cm. The highest yield was obtained with *jajar legowo* type A at a dose of 300 kg.ha⁻¹, producing 5.35 tons.ha⁻¹. It is recommended to implement the *jajar legowo* type A cropping pattern with the addition of 150 kg.ha⁻¹ of kieserite, or *jajar legowo* type B with the addition of 300 kg.ha⁻¹ of kieserite.

Keywords: *jajar legowo*, kieserite, lowland rice, SRI, yield

Introduction

Rice is a major staple foods in Indonesia and Asia and efforts are underway to increase its production.

Various methods have been employed to increase rice yields, including the utilization of superior varieties, balanced fertilizers, optimizing the planting methods, and integrated pest and disease control. One planting method that has proven effective in increasing rice yields is the System of Rice Intensification (SRI) with ‘*jajar legowo*’ planting system, i.e., optimizing rice productivity through increased plant density. In the *jajar legowo* planting system, rice population reach 213,000 clumps per ha, in contrast to 160,000 clumps per ha in the traditional *tile* planting system (25 cm x 25 cm; Rawung et al., 2021).

The *jajar legowo* planting system offers several advantages over the traditional planting systems (Asaad et al., 2017). Firstly, in the *jajar legowo* planting system, all plant clusters are positioned on the edges, which typically results in higher yields. Secondly, it facilitates easier control of pests, diseases, and weeds. Thirdly, the system allows for better water management, easier control of snails, and the establishment of ‘*mina padi*’, i.e., combination of fish and rice farming. Planting rice in *jajar legowo* system promotes more efficient fertilizer usage, as reported by the Agricultural Research and Development Agency (2007), resulting in optimized lowland rice growth and yields.

Research conducted by Rozen et al. (2011) demonstrated that using the SRI method in combination with the application of organic straw compost can produce up to 10 tons per ha of rice grains in the Sicincin area of Padang Pariaman Regency. Furthermore, Rozen et al. (2016) reported that incorporating organic matter such as *Tithonia* and organic fertilizer can enhance the yield of irrigated lowland rice. Organic materials contribute to improved water absorption, enhance the chemical, physical, and biological properties of the soil, and provide additional nutrients. By incorporating organic matter, ionic bonds between Fe-P or Al-P can be

broken, releasing the bound phosphorus and making it available to plants (Rozen et al., 2016).

The land in the Pasar Ambacang area is characterized as sub-optimal, with low soil pH resulting in acidic soil and low nutrient content. Additionally, the Fe and Al content is exceptionally high (Rozen et al., 2019), leading to stunted growth in rice plants. The suboptimal land conditions, coupled with frequent rainfall in the area, also result in nutrient leaching, including magnesium (Kasno and Nurjaya, 2011). Kieserite ($MgSO_4 \cdot H_2O$), is commonly used as a source of magnesium. Given the challenges in this area, this study aims to determine if the planting system, in this case the *jajar legowo* and kieserite application can increase growth and yield of lowland rice.

Materials and Methods

The research was conducted in the Pasar Ambacang area, Kuranji District, Padang City, West Sumatra, from February 2020 to June 2020, on the community rice fields. The study land exhibit suboptimal characteristics, including low soil pH and nutrient content, high Fe and Al content.

A factorial design within a completely randomized design was employed, consisting of two factors. The first factor was the *jajar legowo* type, comprising two levels: type A (spacing of 25 cm x 12.5 cm x 50 cm) and type B (spacing of 25 cm x 25 cm x 50 cm). The second factor was the dose of kieserite, consisting of three levels: 0 $kg \cdot ha^{-1}$, 150 $kg \cdot ha^{-1}$, and 300 $kg \cdot ha^{-1}$. Each treatment was replicated four times. Data analysis involved performing an analysis of variance with the F-test at a significance level of 5%. If significant differences were found, a DMRT was conducted at a significance level of 5%.

The experiment began by plowing and preparing the fields, followed by transplanting rice “Batang Piaman” seedlings. One seedling was planted per hole, with a seedling age of 14 days and spacing of 25cmx12.5cmx50cm for *jajar legowo* type A and spacing of 25cmx25cmx50cm for *jajar legowo* type

B. A week before planting, 10 $t \cdot ha^{-1}$ of cow manure and kieserite according to the treatment were applied. Moist land conditions were maintained until the vegetative phase, after which the land was flooded to a height of 3cm-5cm until 20 days before harvest. Recommended doses of urea, TSP, and KCl fertilizers were applied. Mechanical weed control was implemented, and pest and disease control measures were taken using homemade natural ingredients. Rat pest control involved applying camphor around the plants and along the rice field bunds; golden snails were controlled manually.

Results and Discussion

There was no significant interaction between planting patterns and dosages of kieserite in affecting the number of productive tillers and panicle length (Table 1). However, across kieserite dosages, there are significantly more productive tillers in type B than in type A planting (Table 1). Type B planting has wider spaces between plants, i.e., 25cm x 25cm x 50 cm. According to Guslim (2007), implementing the *jajar legowo* cropping pattern offers numerous benefits, including increased clumps of rice plants as edge plants, higher plant population through adjusted spacing, elongated spaces facilitating plant maintenance, and improved circulation of light, sun, and air around the edges, enhancing the photosynthesis process.

There was a significant interaction between the type of planting and the application of kieserite in affecting panicle length. For *jajar legowo* type A, the optimal dose of kieserite is 150 $kg \cdot ha^{-1}$ while for *jajar legowo* type B, a dose of 300 $kg \cdot ha^{-1}$ is preferable. Type B exhibits longer panicle length, which directly influences grain production. Research conducted by Kasno and Nurjaya (2011) demonstrated that the addition of kieserite increased soil and plant magnesium levels, leading to improved crop production. Kieserite contains magnesium, which can activate the key enzymes that allow the glycolytic and Krebs cycles to turn sugar and fat into ATP bio-

Table 1. Number of rice productive tillers and panicle length at different planting patterns and kieserite rates

<i>Jajar legowo</i>	Kieserite fertilizer dosage ($kg \cdot ha^{-1}$)						Average productive tillers
	0		150		300		
	Productive tillers	Panicle length (cm)	Productive tillers	Panicle length (cm)	Productive tillers	Panicle length (cm)	
Type A	13.03	26.49 a	13.72	27.20 a	15.75	25.71 bB	14.17 b
Type B	23.00	26.50 a	22.34	27.14 a	22.63	27.88 aA	22.66 a

Note: Values followed by the same lowercase letter according within one column and the values followed by the same uppercase letter within one row were not significantly different according to the DMRT at $\alpha=0.05$.

energy in the mitochondria of the cells. This process is necessary for the stabilization and storage of ATP energy.

According to Rebekka et al. (2018) implementing the *jajar legowo* planting system allows more optimal growth and increased yield through increased plant density, and optimizing the direction of the crops towards the sunlight, enabling all edge plants to receive the maximum light.

Planting systems affected the grain yield (Table 2); type B resulted in a greater total grain yield compared to type A. There was no significant interactions between planting systems and kieserite dosages in affecting rice yields.

The longer panicles with *jajar legowo* type B contributed to the higher grain production. Additionally, Sari et al. (2014) reported that plants positioned at the edges of the plot tend to have better growth and development, leading to higher yields per clump compared to plants in the middle of the plot. Therefore, increasing the number of plants at the edges can create a border effect in paddy fields and result in increased grain production.

Jajar legowo type B yielded significantly more grain weight and grain number (Table 2). The weight of filled grains is influenced by panicle length and the number of grains per panicle. A longer panicle leads to a higher number of grains. *Jajar legowo* type B provides wider spacing, allowing for better light, air,

water, and nutrient absorption. This facilitates better photosynthesis and ultimately results in a greater weight of the filled grains. Rice grown with narrow spacing exhibit reduced growth quality, including fewer tillers and panicles, shorter panicle length, and a decreased number of grains per panicle compared to plants grown with wider spacing (Rebekka et al., 2018).

The number of rice empty grains is presented in Table 4; there was no significant effects of planting systems, kieserite, and their interaction in affecting the number of empty grains. This lack of significance can be attributed to the application of the SRI method, where the crops receives sufficient amount of water to ensure optimal seed filling, hence the production of filled grains amongst treatments were not significantly different.

The weight of 1000-grains was not affected by the planting pattern and kieserite application, alone or in combination (Table 4). This is presumably because the weight of 1000-grains is primarily influenced by genetic factors.

There was no significant interaction between planting systems and kieserite application in affecting grain weight per plot and rice yields in terms of ton per ha (Table 5). *Jajar legowo* type B resulted in higher grain weight compared to type A and this is related to the superior growth and development of rice plants in type B, facilitated by wider spacing that allows

Table 2. Total rice grain number and grain weight at different planting patterns and kieserite rates

Planting systems	Kieserite fertilizer dosage (kg.ha ⁻¹)						Average	
	0		150		300			
	Grain number	Grain weight (g)	Grain number	Grain weight (g)	Grain number	Grain weight (g)	Grain number	Grain weight (g)
Type A	161.82	3.84	152.34	3.70	15.75	165.47	159.87b	3.72 b
Type B	170.31	3.94	186.42	4.42	22.63	184.18	180.30 a	4.26 a

Note: Values followed by the different lowercase letter within a column were significantly different according to the DMRT at $\alpha=0.05$.

Table 3. Total filled grain number and filled grain weight at different planting patterns and kieserite rates

<i>Jajar legowo</i>	Kieserite fertilizer dosage (kg.ha ⁻¹)						Average	
	0		150		300			
	Filled grain number	Filled grain weight (g)	Filled grain number	Filled grain weight (g)	Filled grain number	Filled grain weight (g)	Filled grain number	Filled grain weight (g)
Type A	135.55	3.64	128.20	3.51	143.58	3.48	135.78b	3.54b
Type B	143.24	3.75	161.92	4.33	157.98	4.29	154.39a	4.12a

Note: Values followed by the different lowercase letter within a column were significantly different according to the DMRT at $\alpha=0.05$.

Table 4. Rice empty grain number and filled grain weight at different planting patterns and kieserite rates.

<i>Jajar legowo</i>	Kieserite fertilizer dosage (kg.ha ⁻¹)						Average	
	0	1000	150	1000	300	1000	Empty grain number	1000 grain weight (g)
Type A	26.27	28.23	24.14	27.98	25.98	3.48	24.10	27.40
Type B	24.60	26.78	25.26	27.97	27.97	4.29	25.87	27.57

Note: Values followed by the same lowercase letter according to the column and the values followed by the same uppercase letter according to the row were not significantly different according to the DMRT at $\alpha=0.05$.

Table 5. Grain weight per plot and rice yields at different planting patterns and kieserite rates

<i>Jajar legowo</i>	Kieserite fertilizer dosage (kg.ha ⁻¹)						Average	
	0	1000	150	1000	300	1000	Grain weight per plot (kg)	Rice yield (ton.ha ⁻¹)
Type A	3.10	3.10	3.53	3.53	5.35	5.35	3.99	3.99
Type B	2.70	2.70	3.03	3.03	3.50	3.50	3.08	3.08

for efficient photosynthesis. This finding aligns with Sari et al. (2014) that *jajar legowo* cropping pattern improved plant growth and yield by ensuring optimal air circulation, light absorption, water flow, and nutrient distribution.

Conclusion

Planting pattern and kieserite dosages significantly affected panicle length. In *jajar legowo* type A the optimal dose of kieserite is 150 kg.ha⁻¹, resulting in a panicle length of 27.20 cm. For *jajar legowo* type B, the optimal dose of kieserite is 300 kg.ha⁻¹ with a panicle length of 27.88 cm. The highest yield was obtained with *jajar legowo* type A at a dose of 300 kg.ha, producing 5.35 tons.ha⁻¹. It is recommended to implement the *jajar legowo* type A cropping pattern with the addition of 150 kg.ha⁻¹ of kieserite, or *jajar legowo* type B with the addition of 300 kg.ha⁻¹ of kieserite. Further studies are required to examine if these results are applicable in different environments.

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References

- Agricultural Research and Development Agency. (2007). "Field Technical Guidelines for Integrated Crop Management (PTT) for Irrigated Lowland Rice". Agricultural Research and Development Agency, Ministry of Agriculture. 40 p
- Asaad, M., Bananiek, S.S., Warda, and Abidin, Z. (2017). Analisis persepsi petani terhadap penerapan tanam *Jajar legowo* padi sawah di Sulawesi Tenggara. *Jurnal Pengkajian dan Pengembangan Teknologi Pertanian* **20**,197-208.
- Guslim. (2007). "Agroclimatology". 145 p. USU Press, Medan.
- Kasno A, and Nurjaya N. (2011). Effect of kieserite fertilizer on oil palm growth and soil productivity. *Journal of Industrial Plant Research* **17**, 133-139.
- Rebekka L, J. Ginting, and Haryati. (2018). The effect of the *jajar legowo* cropping pattern on the growth and production of several lowland rice varieties (*Oryza sativa* L.). *Journal of Agrotechnology* **6**, 576-581.
- Rawung, J.B.M., Indrasti, R., and Sudolar, N.R. (2021). The impact of technological innovation of *Jajar legowo* planting system on rice

- business income. *IOP Conference Series Earth and Environmental Science* **807**, 032052. DOI:10.1088/1755-1315/807/3/032052
- Rozen N, Yaherwandi, and Anwar, A. (2011). "Community Service in Padang Pariaman Report". IBW scheme. 43 p.
- Rozen, N, Hakim, N., and Gusnidar. (2016). Response of lowland rice plants to the addition of *Tithonia* organic fertilizer plus microelements. Seminar Nasional dan Lokakarya Perhimpunan Agroteknologi Indonesia (PAGI) pp. 409-412. Surakarta.
- Sari D.N., Sumardi, E., and Suprijono. (2014). Testing various types of planting *jajar legowo* on lowland rice yields. *Agrosia* **17**, 115 – 1.