1. Introduction

Cultivation of inundated paddy systems or conventional systems so far their productivity is still low and wasteful in water use. Irrigated rice production requires large amounts of water, with 1 kg of rice grain requiring 2500 L of water [1]. Rice cultivation with a furrow irrigation system is a system that saves water use. The furrow irrigation system, as an aerobic culture, has many advantages. According to [2], rice cultivation in unsaturated soil conditions can continuously maximize water use efficiency and minimize labor requirements and greenhouse gas emissions. The results of [3] in Brazil, rice productivity, water productivity, and efficient use of N all increase in aerobic systems compared to continuous flooding systems or other alternative irrigation regimes. Experimental results in temperate climates can produce grain more than 9 t ha\(^{-1}\) even in central Japan reaching 11.4 t ha\(^{-1}\), but in the tropics, the grain yield is still below 8 t ha\(^{-1}\) [2]. Furthermore, [4] wider spacing and proper soil aeration with furrow irrigation are better than inundated irrigation, where the paddy fields flooded with water have better soil aeration during the vegetative growth phase. The wet and dry alternation waterlogging technique saves water usage during the growth period, with a range between 13-16\% compared to the continuous irrigation technique [5].
The SRI (The System of Rice Intensification) method includes water-efficient and high-productivity lowland rice cultivation systems. The basic strategy of the SRI method is to create soil, water, and nutrient conditions for young plants that are more suitable for their growth [4]. Then, to accelerate the development of tillers and replenishment of seeds stimulated by the use of young seedlings and the condition of non-flooded land that results in a healthy root system. To form canopy architecture is more open because the puppies originate from one parent, which will allow more excellent sunlight interception so that photosynthesis will be more active and maximum grain filling [6]. The success of the SRI method based on a synergistic relationship between seedling development and roots. With more vigorous root growth, plants can become fuller and taller. They can have better access to the nutrients and water they need to produce more tillers and more yields [7]. Root distribution in the SRI method is higher than conventional systems [8], root growth and dry weight are much higher than traditional methods, root distribution ranges from 0-20 cm soil depth, roots are 10-15 cm deeper than conventional methods, increasing leaf area, and leaf area distribution are mostly at the height of 50 and 100 cm, and at an the height of 75 and 100 cm in conventional systems, better light distribution, higher total plant dry weight, and biomass accumulation at panicle exit about 40% of the entire duration [9].

The use of a higher number of seedlings clump with tight spacing in the conventional system causes competition, which will suppress the growth of tillers and panicle production. Conversely, the use of one seedling clump-1 with wider spacing in the SRI method encourages the formation of tillers and more yields because there is no lagging period of formation of multiple tillers and relatively small competition. For aerobic cultivation, seedling densities higher than 50 m-2 plants are a way to get high yields [10].

The application of the SRI method has been able to increase the productivity of lowland rice significantly, but the use of one seedling clump-1 has not produced the maximum number of productive tillers and is at risk of seedling death. A pot experiment with 2-3 seedlings clump-1 and a one-one planting system can accelerate the age of tillers. It also can increase the number of tillers, root distribution, shoot ratios, number of panicles, number of grains per panicle, grain yield clump-1, and harvest index because this system prevents earlier competition [11]. The pattern of four seedlings clump-1 with a one-one planting system has been tried on several varieties in new openings paddy fields with higher grain yields than the yield of the conventional method [12, 13, 14]. However, this pattern has never been compared with the use of 1-3 seedlings clump-1 and five seedlings clump-1 with a one-one planting system.

Reports [15] states that if one seedling clump-1 is replaced with two seedlings clump-1, the number of tillers in productive tillers and panicle counts increases markedly. And, with N fertilization according to the yield of seeds with two seedlings clump-1 with SRI method are higher than conventional systems. Attached planting systems both in traditional systems or SRI methods can cause competition early in plants clump to get nutrients, water, and sunlight. The attached cropping system will form a tight canopy structure with low sunlight interception because the stem tillers of plants are dense. Whereas if the inter-plant seedlings are separated (one-one planting system), the crown architecture will be more effective in absorbing sunlight because the stem tillers of plants are more tenuous, so sunlight interception will more easily occur [11].

The rate of tillering appears an effect on the level of tiller productivity, while the rate of tillering seems related to the number of parent plants [8]. The use of one seedling clump-1 has the potential to reduce the number of productive tillers [7]. To increase the number of productive tillers and grain yields, it is necessary to increase the number of parent plants by increasing the number of seedlings clump-1 with a one-one planting system, and to increase the population of parent plants and main tillers, and to prevent early competition between tillers within the clump. This experiment aims to study the effect of seedling number clumps-1 in a one-one planting system and furrow irrigation systems in the SRI method.
2. Materials and methods

The experiment used materials and tools such as rice seeds of Cisokan varieties, NPK fertilizer (16-16-16), compost, granular insecticides, fungicides, wereng, and soil treatment equipment. The experiment was carried out in the irrigated paddy fields of Padang Pariaman Regency at the first planting season in 2019, consisting of two treatment factors placed in a Split Plot Design (SPD) with three replicated. Factor I, furrow irrigation system (A) as the main plot with two levels, there are: intermittent irrigation systems during the vegetative phase and flooded in the generative phase to maturation phase (A1), and flooded irrigation system during the vegetative phase (A2). Factor II, the number of seedlings clump\(^1\) with one-one planting system (B) according to [11] placed in sub-plots with five levels, there are 1 seedling clump\(^1\) (B1), 2 seedlings clump\(^1\) distance between seedlings 7 cm (B2), 3 seedlings clump\(^1\) spacing between seedlings 7 cm equilateral triangle (B3), 4 seedlings clump\(^1\) square relationship between seedlings 7 cm (B4), and 5 seedlings clump\(^1\) with 4 seedlings clump\(^1\) were planted in square relationship with a distance between seedling 7 cm and 1 seedling planted at the midpoint (B5) (figure 1). Observation in the form of components of growth and yield of rice. The observational data were analyzed with ANOVA and DNMRT \(α = 5\%\) or \(1\%\). The soil is finely plowed, made beds as high as 10 cm, 1.10 m wide, and 12 m long, given cow dung compost at a dose of 15 Mg ha\(^{-1}\), NPK fertilizer (16:16:16) at a dose of 300 kg ha\(^{-1}\). Seedlings are planted 12 days after seedling (DAS) according to factor B. Harvesting is done when the panicles have matured physiologically. Observation variables were in the form of components of growth and yield of rice plants, such as plant height, the number of tillers and productive tillers, weight of 1000 grains of rice, the weight of grains clump\(^1\), and production of rice grains acre\(^1\).

![Diagram](a)

![Diagram](b)
3. Results and discussion

3.1. Plant height, number of tillers and productive tillers

The height plant of Cisokan rice variety is not affected by the furrow irrigation system, and the number of seedlings clump\(^1\) with one-one planting system, both in terms of single factors and their interactions. While the total number of tillers and productive tillers clump\(^1\) is influenced by the number of seedlings clump\(^1\) with a one-one planting system, but it is not affected by the furrow irrigation system and its interaction with the number of seedlings clump\(^1\). Plant height data is presented in table 1, while total and productive tillers data are presented in table 2 and table 3. Use of

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{Planting scheme with one-one planting system: (a) 1 seedling, (b) 2 seedlings, (c) 3 seedlings, (d) 4 seedlings, and (e) 5 seedlings clump\(^1\)}
\end{figure}
3-5 seedlings clump⁻¹ with one-one planting system increases the number of total tillers and productive tillers, increasing total tillers about 43.37 - 61.73%, while the increase in the number of productive tillers reached 14.13-27.02% compared to the use of 1-2 seedlings clump⁻¹. The number of productive tillers differs if the rice is planted with a conventional system (a system of planting seedlings attached in one clump). An increase of 3 and 4 clump⁻¹ can increase the number of tillers but cannot increase the number of productive tillers due to inter- and intra-competition [16;17], but the results of other studies showed an increase in the component of growth and yield of plants in the use of three seedlings clump⁻¹ [18].

**Table 1.** High of paddy rice in the SRI method with treating by the number of seedlings clump-1 with one-one planting system and furrow irrigation system: sections, subsections, and subsubsections

| Furrow Irrigation System | Number of Seedling clump⁻¹ With One-one Planting System (seedling clump⁻¹) | Average |
|--------------------------|-----------------------------------------------------------------------------|---------|
|                          | 1                             | 2       | 3       | 4       | 5       |         |
| Intermittent             | 84.4                          | 81.2    | 83.8    | 84.2    | 83.9    | 83.5    |
| Flooded                  | 97.8                          | 93.6    | 94.4    | 95.0    | 98.9    | 95.9    |
| Average                  | 91.1                          | 87.4    | 89.1    | 89.6    | 91.5    | 89.7    |

In this one-one planting system culture, the increase in the total number of tillers is related to the use of young seedlings aged 12 DAS and the increase in the number of parent plants by increasing the number of seedlings clump⁻¹. The presence of a wide enough space because planting seedlings spaced in one clump (one-one planting system), which can prevent or reducing early competition and forming larger clump structures, will stimulate the formation of productive tillers [11]. And, also supported by aerobic conditions because they use furrow irrigation to stimulate the formation of productive tillers, as reported by [19] that tillering is higher in intermittent irrigation conditions (AWD). Seedling number clump⁻¹ affects the tillering time, tiller number, heading time, and panicle size on each nodal tiller [20].

**Table 2.** Total tillers clump⁻¹ of paddy rice in the SRI method with treating by the number of seedlings clump⁻¹ with one-one planting system and furrow irrigation system.

| Furrow Irrigation System | Number of Seedling clump⁻¹ With One-one Planting System (seedling clump⁻¹) | Average |
|--------------------------|-----------------------------------------------------------------------------|---------|
|                          | 1                             | 2       | 3       | 4       | 5       |         |
| Intermittent             | 52.4                          | 67.7    | 78.9    | 78.85   | 81.7    | 71.9    |
| Flooded                  | 54.4                          | 61.9    | 74.2    | 80.65   | 91.0    | 72.4    |
| Average                  | 53.4C                         | 64.8B   | 76.5A   | 79.8A   | 86.3A   | 72.2    |

The numbers in the same row followed by the same uppercase letters do not differ according to DNMRT α = 0.01
Table 3. The number of productive tillers clump\(^1\) of paddy rice in the SRI method with treating by the number of seedlings clump\(^1\) with one-one planting system and furrow irrigation system.

| Furrow Irrigation System | Number of Seedling clump\(^1\) With One-one Planting System (seedling clump\(^1\)) | Average |
|--------------------------|---------------------------------|---------|
|                          | 1                               | 2       | 3       | 4       | 5       |
| Intermittent             | 26.0                            | 26.5    | 28.2    | 29.2    | 32.9    | 28.6    |
| Flooded                 | 23.6                            | 25.4    | 27.1    | 30.3    | 30.1    | 27.3    |
| Average                 | 24.8C                           | 25.9BC  | 27.6ABC | 29.7AB  | 31.5A   | 27.9    |

The numbers in the same row followed by the same uppercase letters do not differ according to DNMRT \(\alpha = 0.01\).

3.2. The weight of 1000 grains of rice, grain yield clump\(^1\), and grain production hectare\(^1\)

The weight of 1000 grains of rice was not affected by the irrigation system and the number of seedlings clump\(^1\) with one-one planting system or the interaction of the two factors, the weight of 1000 grain rice ranged from 20.19 - 21.87 g dry milled grain (DMG) (table 4). While the weight of grain yield clump\(^1\) is influenced by the number of seedlings clump\(^1\) with one-one planting system, but it is not affected by the furrow irrigation system and its interaction with the number of seedlings clump\(^1\). Data on the weight of grain clump\(^1\) are presented in table 5.

The weight of grain yield clump\(^1\) is influenced by the number of seedlings clump\(^1\) with a one-one planting system, but it is not affected by the furrow irrigation factor and its interaction with the number of seedlings clump\(^1\). Weight of grain yield clump\(^1\) increased in the use of 2-5 seedlings clump\(^1\) with a one-one planting system compared to the use of one seedling clump\(^1\) (table 5), this increase reached 11.36%. Higher grain production in plants with a higher number of seedlings clump\(^1\) with a one-one planting system is related to the high population of parent plants that produce more main tillers in the initial phyllochron period. And, are supported by one-one planting system to provide enough space for tillers to avoid early competition and with the environmental conditions of aerobic roots, so that both of them have more potential to produce productive offspring [11;8;21]. This condition is in accordance with the report of [10] that grain yield was significantly higher at higher plant densities (6-cm and 10-cm plant spacing) and correlated with higher tillering densities. Increasing the number of seedling 2-5 clump\(^1\) with one-one planting system results in higher plant population density because the number of total tillers formed is higher (table 2). Then, the weight of grain rice produced will be higher than the use of one seedling clump\(^1\). Increasing the number of seedlings clump\(^1\) is important to increase grain yield because in order to optimize the density of plant populations and plant panicles needed to produce maximum production. Control of spikelet density and management of N fertilizer in the aerobic system cultivation is necessary to achieve an appropriate source-sink balance [2].

Furthermore, grain production hectare\(^1\) is influenced by the interaction of furrow irrigation factors and the number of seedlings clump\(^1\) with a one-one planting system. Grain production hectare\(^1\) increases with the use of 5 seedlings clump\(^1\) with furrow intermittent irrigation system. In the flooded furrow irrigation system, there was also an increase in grain production by increasing the number of seedlings clump\(^1\) with a one-one planting system. The highest grain production was obtained from the use of 5 seedlings clump\(^1\) with a one-one planting system, both with intermittent furrow irrigation systems and with flooded furrow irrigation systems (table 6). This increase in production of grain hectare\(^1\) can occur because of an increase in the number of seedlings clump\(^1\) resulting in a higher number of productive tillers and producing higher grain yield clump\(^1\) (table 5). However, grain production in all treatments, the number of seedlings clump\(^1\) with one-one planting system did not differ among intermittent systems and flooded systems. This condition occurs because the rice plant is planted in beds, so that both furrow irrigation systems are in aerobic conditions, especially in the
vegetative phase. This condition is similar to [22] founded that alternate wetting and drying and shallow water depth with wetting and drying increased the grain yield by 22.9% and 17.9%.

**Table 4.** Weight of 1000 grains (MC = 11.81%) of paddy rice in the SRI method with treating by the number of seedlings clump-1 with one-one planting system and furrow irrigation system.

| Furrow Irrigation System | Number of Seedling clump\(^1\) With One-one Planting System (seedling clump\(^1\)) | Average |
|--------------------------|----------------------------------------------------------------------------------|---------|
| Intermittent             |                                                                                                                                 |         |
| 1                        | 21.79                                                                             | 21.2    |
| 2                        | 21.89                                                                             |         |
| 3                        | 21.41                                                                             |         |
| 4                        | 20.19                                                                             |         |
| 5                        | 20.94                                                                             |         |
| Average                  | 21.82                                                                             |         |
| Flooded                  |                                                                                                                                 |         |
| 1                        | 21.88                                                                             | 21.8    |
| 2                        | 22.60                                                                             |         |
| 3                        | 21.66                                                                             |         |
| 4                        | 21.26                                                                             |         |
| 5                        | 21.49                                                                             |         |
| Average                  | 21.82                                                                             |         |

**Table 5.** Weight of grain yield clump-1 (MC = 11.81%) of paddy rice in the SRI method with treating by the number of seedlings clump-1 with one-one planting system and furrow irrigation system.

| Furrow Irrigation System | Number of Seedling clump\(^1\) With One-one Planting System (seedling clump\(^1\)) | Average |
|--------------------------|----------------------------------------------------------------------------------|---------|
| Intermittent             |                                                                                                                                 |         |
| 1                        | 41.6                                                                              | 45.8    |
| 2                        | 46.4                                                                              |         |
| 3                        | 49.8                                                                              |         |
| 4                        | 44.0                                                                              |         |
| 5                        | 47.1                                                                              |         |
| Average                  | 44.9B                                                                             |         |
| Flooded                  |                                                                                                                                 |         |
| 1                        | 48.2                                                                              | 48.9    |
| 2                        | 46.3                                                                              |         |
| 3                        | 50.2                                                                              |         |
| 4                        | 49.9                                                                              |         |
| 5                        | 50.1                                                                              |         |
| Average                  | 46.3AB                                                                            |         |

The numbers in the same row followed by the same uppercase letters do not differ according to DNMRT \( \alpha = 0.05 \)

**Table 6.** Production of rice grain hectare\(^1\) (MC = 11.81%) of paddy rice in the SRI method with treating by the number of seedlings clump\(^1\) with one-one planting system and furrow irrigation system.

| Furrow Irrigation System | Number of Seedling clump\(^1\) With One-one Planting System (seedling clump\(^1\)) | Average |
|--------------------------|----------------------------------------------------------------------------------|---------|
| Intermittent             |                                                                                                                                 |         |
| 1                        | 3.671Ba                                                                          | 4.975   |
| 2                        | 4.329Ba                                                                          |         |
| 3                        | 4.252Ba                                                                          |         |
| 4                        | 4.033Ba                                                                          |         |
| 5                        | 5.146Aa                                                                          |         |
| Average                  | 4.368                                                                             |         |
| Flooded                  |                                                                                                                                 |         |
| 1                        | 3.701Ba                                                                          | 4.890   |
| 2                        | 4.169Ba                                                                          |         |
| 3                        | 4.769Aa                                                                          |         |
| 4                        | 4.513Aa                                                                          |         |
| 5                        | 4.804Aa                                                                          |         |
| Average                  | 4.511                                                                             |         |

Numbers in the same row followed by the same uppercase letters and numbers in the same column followed by the same lowercase letters do not differ according to DNMRT \( \alpha = 0.05 \)

4. Conclusions

Furrow irrigation systems with intermittent or flooding do not affect the growth and yield components of the paddy rice in the SRI method. Still, growth and yield are affected by the number of seedlings clump\(^1\) with a one-one planting system. An increase in the number of seedling 3-5 clump\(^1\) with one-one planting system was produced to increase the total number of tillers, the number of productive tillers, and the yield of grain rice clump\(^1\), but did not affect the weight of 1000 grains rice. While grain
production hectare\textsuperscript{1} is influenced by the interaction of the furrow irrigation system and the number of seedlings clump\textsuperscript{1} with a one-one planting system. In intermittent irrigation systems, grain production increased with the use of five seedlings clump\textsuperscript{1}, while in the furrow irrigation by the flooded system, rice fields increased by the use of 3-5 seedlings clump\textsuperscript{1} with one-one planting system. In general, the best grain production is obtained from the use of five seedlings clump\textsuperscript{1} one-one planting system with flooded or intermittent irrigation.

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