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The Growth of Rice (Oryza Sativa L.) Ratoon System at Various Times Flooding Rice Stump from Conventional Cultivation and the System of Rice Intensification (SRI)

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Abstract

The research was carried out in the UPT of the experimental garden of the Faculty of Agriculture, Andalas University, in the form of using bucket media at an altitude of 350 MDPL from February to September 2017. The aim was to find out the best interaction when the flooding of conventional rice stumps and the System of Rice Intensification (SRI) was conducted. get good cultivation for the ratoon system and know the best flooding time for the growth of rice plants. To get good cultivation results for the ratoon system and find out the best flooding time for improving the ratoon system rice production. This study uses two-factor completely randomized design (CRD) of 3 replications. The first factor is the stump of cultivation (the origin of conventional cultivation stumps and the System of Rice Intensification (SRI)) and the second factor is the time to start flooding stump of 3 DAH (Day After Harvest), 6 DAH, 9 DAH, and 12 DAH. The data obtained were analyzed by variance with the F test and if the calculated F was large from the F table, it was continued with a 5% Honest Real Difference test. The results of observations that have been made, there is no interaction of conventional cutivation stumps and SRI method with various time flooding of the ratoon system rice growth.

Keywords: Ratoon; Conventional; System of Rice Intensification; Flooding.

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1. Introduction

Rice *(Oryza sativa L.)* is one of the major food crops in Indonesia because the majority of the population Indonesia consumes rice as the main ingredient of staple foods. Demand for rice continues to increase along with the increase in the population in Indonesia and the world and the changes in the basic diet in certain areas, from tubers to rice. Fulfilling food needs, it is necessary to increase production of rice crops more efficiently, the Ratoon system is one the methods that can be used.

Ratoon system rice cultivation is one of the businesses that can be developed by farmers as a crop after the first rice is harvested because ratoon rice is more resource efficient and shorter. Ratoon rice is a rice plant which is a bud that grows from a stump that has been harvested and produces new tillers that can be harvested. Generally, the growth and maturity rate of ratoon rice is not even, and the yield obtained is lower compared to the main crop. The ratoon rice production obtained from ranged from 2.1-5.6 tons ha^{-1}. [3]. As a comparison, the production of the ratoon system from conventional in China yields 4.05–5.83 tons / ha^{-1}, and the yield for one year is 12.4-14.7 tons ha^{-1} [4].

Farmers in Indonesia generally do the rice planting using the Tabela (Direct Seed Spreading) system and conventionally, very few of them use the SRI planting method, but the implementation of planting activities with the use of planting systems is different in terms of growth and yield. In terms of growth factors, rice plants using the SRI method obtained high values compared to the conventional and conventional methods [5]. Apart from the flooding planting system, which is very important in the development of rice plants, this system can also help the movement of nutrients in the soil, so that it can be easily absorbed by the roots. Ratoon which lacks water causes dry stumps and is unable to produce ratoon shoots. According to [6] flooding of water does not significantly influence the growth of rice plants. The purpose of this study was to obtain information on the exact time of flooding in spurring the growth of the ratoon system using conventional cultivation stumps and SRI method stumps.

2. Research methods

This research was conducted from February to September 2017 in the Faculty of Agriculture and Laboratory Experimental Gardens Agronomy Faculty of Agriculture Andalas University. Stage I planting season, namely Conventional planting - SRI method was carried out from February to June 2017 and the second planting season (ratoon) was carried out from June to September 2017. The varieties used in the study were Batang Piaman. The design used in the form of a Completely Randomized Design (CRD) of two factors. The first factor is Conventional planting and System of Rice Intensification (SRI) and the second factor is the time of floodingof rice plants after harvest which consists of 4 floodingtimes namely 3 Days after Harvest (DAH), 6 DAH, 9 DAH and 12 DAH. Each treatment was repeated 3 times so that there were 24 unit tests and each treatment unit consisted of 10 plants.

Observed data are Relative Growth Rate (RGR), Number of shoots connecting the top stump, Number of shoots connecting the bottom stump, Number of ratoon shoots 2 Weeks after Harvest (WAH), and Total number of tillers per clump (Stem). RGR was observed with a weekly period from the age of 4 WAH, this weekly-basis obeservation further illustrates the increase in the average dry weight of plants in several weekly periods calculated using formula [7] :

$$RGR = \frac{\ln W_2 - \ln W_1}{T_2 - T_1} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Data on growth rate relative to rice plants Ratoon is observed every week on the 4th week until the 7th week of WAH. Samples (leaves, stems, and roots) of each clump of plants were taken, the number of samples taken by 1 plant per plot. Samples were taken from destructive experimental plots, weighed dry weight every week. Data from periodic observations (weekly) of graphs are displayed in graphical form and data from the last observation and analyzed by Variance if F count is greater than 5% F table followed by BNJ test at 5% level.

3. Results and discussion

Relative Growth Rate (RGR) is an increase in the dry weight of plants in a time interval, closely related to the initial weight of the plant. The assumption used for the quantitative equation of the relative growth rate is that the increase in plant biomass per unit of time is not constant but depends on the initial weight of the plant. That all plants expressed in total plant biomass are considered as a unit to produce new plant material [8]. Based on Table 1. there is no interaction between conventional planting methods with various flooding times for RGR displayed at ages 6-7 WAH. The flooding of 12 DAH get 0.43 g/week. Differences in relative growth rates can occur between species due to differences in photosynthesis rate and biomass efficiency. Variations in growth rates for each treatment occur at various age levels. In addition, flooding modifies the relationship of water and plant carbon fixation, stomatal closure with or without leaf dehydration, reduced transpiration, and photosynthetic inhibition, these symptom is a responses seen as that can occur at that time or a few days after the flooding, depending on the tolerance of flooding of each plant species [9].

Table 1: Effect of flooding on waiting from conventional cultivation. (Transformation $\sqrt{x} + 0.5$)

Observation Variable	Time of Flooding			
	3 DAH	6 DAH	9 DAH	12 DAH
RGR (g /week)	0.26	0.25	0.13	0.43
Number of Shoots connecting the top (Shoots)	2.11	2.00	0.78	1.56
Number of LowerShoots (Shoots)	33.44	27.33	13.33	16.00

Description: The numbers on the rows and lanes are not significantly different according to the F test at the 5% real level.

Based on Table 2 there is no interaction between the SRI planting method and the various flooding times on the number of ratoon shoots that continue the upper stem. Not all of the remaining harvested rice stems can produce ratoon shoots. This difference may be closely related to the level of aging and the vigor of the remaining harvested rice stems (stumps) which are influenced by genetic characteristics (varieties), nutrients and phytohormones of plants whose existence is related to rice varieties, the main crop harvest time, cutting, pruning, irrigation and fertilization. Not all remaining harvested rice stalks can produce ratoon shoots. This difference may be closely related to the level of aging and the vigor of the remaining harvested rice stalks (stumps) which are influenced by genetic characteristics (varieties), nutrients and phytohormones of plants whose presence is related to rice varieties, the main crop harvest time, cutting, pruning, irrigation and fertilizing. The dry plant is a representation of the translocation of photosynthesis to all parts of the plant so that it can be said that the relative growth rate of plants is determined by the area of the leaves of plants that are able to intercept the sun's maximum and the subsequent photosynthetic rate of plants. Production of larger plant dry weight came from an enhanced leaf area, so that it was positively correlated with photosynthesis levels and higher transpiration efficiency [10].

The shoots connecting to the top is a bud that grows at the top coming out of the stump of rice stems while the number of shoots connecting the bottom is a bud that grows at the base of the stump. The number of shoots connecting the top part in conventional cultivation ranged from 0.78-2.11 shoots. Whereas for the lower connecting shoots ranged from 16.00-33.44 shoots. In the SRI method number shoot the top at ranged 0.44-1.56 Shoot, and Number of lower connected shoot ranged 23.00-33.89 shoot. [11] found the same results that the ratoon shoots that emerged from the base of the stem grew well compared to the upper part of the stem. Beside the cutting height, the variety is very also influential on the number of shoots formed in the ratoon system. The The cutting height varieties will also greatly affect the development of shoots and tillers from the ratoon system. This is in accordance with the opinion [12], the effectiveness of cutting height is not only influenced by the distance from the soil, but also by the growth of plant morphology such as the length of the rice plant and the varieties used for the ratoon system. In general, the main reason for flooding in lowland rice cultivation is that most wetland rice varieties grow better and produce higher when grown in stagnant soils compared to non-stagnant soils. Water affects the character of plants, nutrients and soil physical conditions [2].

Table 2: Effect of flooding on the waiting time of Cultivation of SRI Method (transformation $\sqrt{x} + 0.5$)

Observation Variable	Time of Flooding			
	3 DAH	6 DAH	9 DAH	12 DAH
RGR (g / week)	0.49	0.64	0.37	0.35
Number of Shoots connecting the top (Shoots)	0.67	1.56	1.11	0.44
Number of Lower Connected Shoots (Shoots)	33.89	33.89	27.00	23.00

Description: The numbers on the rows and lanes are not significantly different according to the F test at a significant level of 5%.

In Figure 1, it can be seen that the average rice RGR from conventional cultivation and SRI method from the 4-5 week observation until the 6-7 week observation shows the same pattern, the second RGR from the cultivation of the crop decreases from week 4-5 to weeks 5-6 and increases return from weeks 5-6 to weeks 6-7. This pattern can occur because of an increase in growth, especially the formation of seedlings that require assimilates or many new sinks are formed. Whereas at the age of 6–7 the formation of tillers has begun to decline and the leaves of the plant have grown so that photosynthesis is active and produces a lot of dry matter.

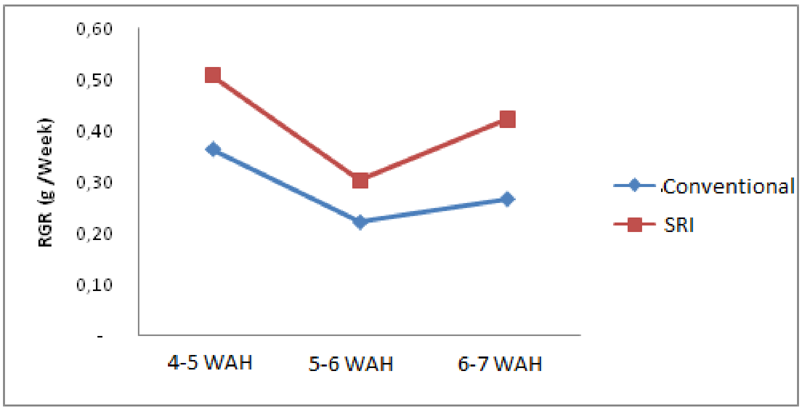

Figure 1: Development Relative Growth Rate (RGR) in 4 – 7 WAH (Week After Harvest) of Rice Plants Ratoon System from Stump Conventional and SRI method

In Figure 2, it can be seen that, flooding carried out 3, 9 and 12 DAH showed almost the same RGR pattern, but the three flooding times were different from the flooding of 6 DAH. On the one hand, flooding 3, 9 and 12 DAH shows a decrease in RGR from weeks 4-5 to weeks 5-6 and increases again from weeks 5-6 to weeks 6-7. On the other hand, flooding of 6 DAH increases RGR from weeks 4-5 to weeks 5-6 and there is a decrease in weeks 5-6 to weeks 6-7. This increase and decrease in RGR are thought to be due to the availability of carbohydrates in the rice stump. One of the determinants of success of Ratoon is the stump vigor after harvesting the main crop, which is closely related to the photosynthetic reserves. Photosynthetic activity determines the amount of energy entering and stored in the plant system that can be utilized. Storage of photosynthesis results to the roots and stems of rice plants, so that the stems of rice plants that have been harvested (stumps) remain green. Thus, the resulting assimilate can be used for ratoon shoot growth, and carbohydrate status at harvest and ratoon ability are very close unity [14].

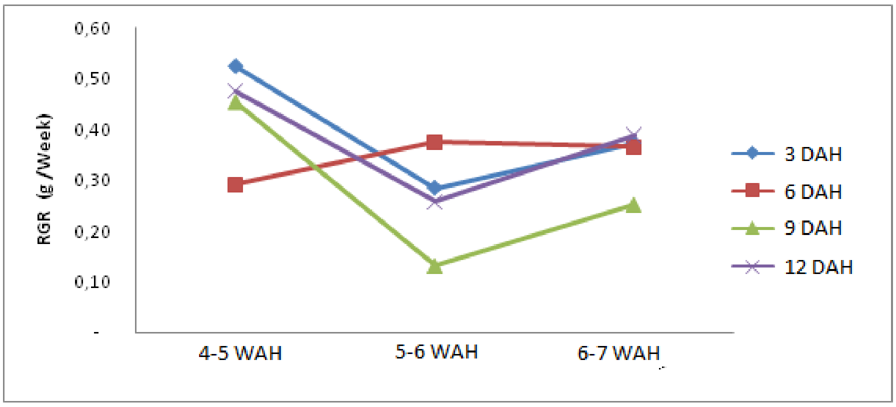

Figure 2: Development of Relative Growth Rate (RGR) at various flooding time.

Flooding in age 3 DAH, 9 DAH and 12 DAH shows the progression of RGR which decreases in the observation of 5-6 Week After Harvest (WAH) and increases in observation 6-7 Week After Harvest (WAH). Decrease in RGR in plants is due to the differences in the number of leaves and canopies that have been formed at this age. According to [15] canopy architecture is a factor that causes significant RGR differences between the genotypes of rice plants. Canopy structure affects the amount of light absorbed by the leaves, because the photosynthetic capacity at the canopy level does not only depend on the factors that influence photosynthesis rate at the leaf level but also the light distribution profile on the leaves [16]. the initial stage of growth will increase the source capacity which can meet sink capacity requirements, so that it will affect grain yield.

Flooding at age 6 DAH which shows an increase in RGR every week of observation. The developments that occur in flooding of are good growth charts. This development is due to the newly formed saplings that are flooded and will stop. Development of tiller is better in non-inundated conditions [17]. When the conditions are inundated, oxygen in the soil decreases so that plants use photosynthetic carbohydrates in the tissues as the main ingredient to overcome the flooding. [18] State that carbohydrates are a source of energy used to maintain metabolism during flooding .

Table 3: Effect of flooding on waiting for conventional cultivation (transformation $\sqrt{x} + 0.5$)

Observation Variable	Time of Flooding			
	3 DAH	6 DAH	9 DAH	12 DAH
Number of rat shoots age 2 WAH (Shoots)	35.53	29.33	14.13	17.57
Total number of tillers per clump (Stem)	77.00	69.77	58.97	61.77

Description: The numbers on the rows and lanes are not significantly different according to the F test at a significant level of 5%.

Increase in the number of tillers was also affected by the high and low carbohydrate reserves available in the remaining harvested rice stems. The number of ratoon tillers becomes higher at high carbohydrate concentrations at harvest [20];[19]. The condition of the plant after harvesting the main crop shows that the assimilateexcess which is arranged in the form of carbohydrates, lipids and proteins will be used by plants as food reserves and some will be translocated to the vegetative utilization area. Roots and stems on the stump are part of the utilization of photosynthesis during ratoon growth. The proportion of photosynthetic residues utilized by the roots and stems affects the growth of ratoon seedlings that will emerge from the stump [7]. The cutting back is done to stimulate shoot growth so that it can increase the number of tillers. The increase in the number of tillers will be followed by the number of productive tillers and vice versa, the small number of tillers will be followed by a small number of productive tillers.

The total number of tillers ratoon is affected by environmental factors, such as water availability, soil fertility, sunlight, temperature and circumstances of pests and diseases. From the physiological aspect, ratoon root activity is wider, morphological characteristics show stronger roots, with broad and strong rice roots so that the process of nutrient absorption is more efficient, this is very influential on rice seedlings when compared to conventional cultivation rice [13]. Another factor that can affect the ability of ratoon plants is the length of cutting, fertilizing and water management. Cutting lengths can affect the number of tillers, the period of growth, ratoon vigor and seed yield [1]. The condition of the plant after harvesting the main crop shows that the assimilate excess which is suspended in the form of carbohydrates, lipids and proteins will be used by the plant as a food reserve and some will be translocated to vegetative use areas. Roots and stems on the stump are part of the utilization of photosynthesis during ratoon growth. The proportion of photosynthetic residues utilized by the roots and stems affects the growth of ratoon seedlings that will emerge from the stump [7].

Table 4: Effect of flooding on the waiting time of Cultivation of SRI Method (transformation $\sqrt{x + 0.5}$)

Observation Variable	Time of Flooding			
	3 DAH	6 DAH	9 DAH	12 DAH
Number of rat shoots age 2 WAH (Shoots)	34.57	35.43	28.07	23.43
Total number of tillers clump (Trunk)	63.67	60.57	53.77	53.90

Description: The numbers on the rows and lanes are not significantly different according to the F test at a significant level of 5%.

4. Conclusion

The study highlight that there is no interaction between flooding in the ratoon system both in conventional cultivation and SRI method stumps. In general, flooding with different time periods in the ratoon system shows almost the same results on RGR parameters, the number of shoots connects the upper part, the number of shoots connects the bottom, the number of shoots is 2 WAH and the total number of tillers from both in conventional cultivated and SRI method. It is also found that in both SRI method and conventional cultivation more bottom shoots are growing compared to the upper ones.

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