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Increasing Rice Production of Local Rice Genotypes from Kuantan Singingi Regency Through Plant System Technology

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ABSTRACT

Rice is Indonesians' main source of nourishment. Farmers get the seeds for growing their paddy crops from both non - local rice genotypes and local genotypes. The two main consideration factors influencing the decision to use the seed varieties are high production of the varieties and customer preferences. Local rice genotypes in Kuantan Singingi Regency have potential to fulfill the requirements. This study aimed to ascertain the response the regional rice genotypes in Kuantan Singingi Regency to planting system technology. The experiment was designed in Split Plot Design in a Completely Randomized Design (CRD), the main plot consisted of multiple cultivation systems (Factor S) as follows: Tile system, Jajar legowo system (2:1), and Rice Intensification systems. The following genotypes were then employed in subplots using a completely randomized design (CRD): Kuning Umur Panjang (G07), Samo Putiah (G09), Limbayang (G10), Singgam Putih (G14), Pulut Kari (G16) and Kuning (G18). The findings showed that.local rice genotypes responded differently to the planting system technology. Limbayang genotype had dry milled grain weight per clump of 105.57 grams, while the Singgam Putih genotype had plant height of 141.00 cm. The rice intensification system (SRI) gave the best growth and production to Limbayang and Singgam Putih. The findings of the study can be taken into consideration for future research, such as plant breeding efforts to enhance the traits of local rice genotypes. .

INTRODUCTION

Indonesia's primary staple meal is rice, which is produced by the paddy plant. Due to the fact that the population of Indonesian is steadily increasing, enhancing rice productivity should be a primary focus. Information on the characteristics of wetland rice fields and geographical of every region of Indonesia is also important because of the diverse region characteristics could be the constrains in implementing a certain rice planting system. In general, Indonesian government develops intensification and extensification to drive agricultural production.

Kuantan Singingi is one of agricultural areas in Riau Province. Farmers have tradition

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to grow wetland rice from generation to generation using rainfed rice system as well as irrigation system, but the last system does not support the amount of water requirement for optimum rice growth and development. The result is low harvest yield.

Low rice productivity in some cases may be also due to environment conditions in conjuction with unappropriate rice varieties grown on specific areas. Drought, flooding, and other issues make it difficult for most high yielding rice varieties to adapt. As a result, for years farmers prefer to use local varieties. Ezward *et al.* (2019) discovered 26 native rice genotypes in the Kuantan Singingi area as a consequence of their exploration. The degree of kinship, resistance to abiotic limiting variables, and tolerance to abiotic factors were determined by Ezward *et al.* (2021) and Ezward *et al.* (2022). Several genotypes were found to have two to four attributes of resistance and tolerance to biotic and abiotic stressors, according to the results. According to the most recent statistics from 2023, there are currently only 23 local genotypes left.

Knowing this genotype's level of responsive-ness to planting system technology is important after learning about its resistance and tolerance traits. Planting/crpping system technologies for local rice genotypes is expected to be useful to increase plant productivity. Cropping system technology is an environmental modification technology that aims to improve the productivity of paddy fields by considering the conditions of the paddy fields. For example, the "system rice intensification" (SRI) planting system has the advantages in reducing seed and seedling usage and earlier plant harvest times. In addition, Jajar Legowo's planting system technology is an attempt to increase the number of plants per unit area. Therefore, increasing the number of plant populations is expected to increase plant production. This research was aimed to determine the effects of planting system techniques, i.e. SRI, Jajar Legowo and Tile planting system to several local of rice genotypes.

MATERIALS AND METHODS

Tests on the response of local rice genotypes to crop systems include the System of Rice Intensification (SRI) trial, Jajar legowo 2:1 and the Tile growing system. This experiment was carried out on technically irrigated rice fields in Toar village, district. Mount Toar, regent of Kuantan Singeri, Riau province. This experiment was conducted from November 2021 to May 2022. Materials used in this study were local rice genotypes including:genotype: Kuning Umur Panjang (G07), Samo Putiah (G09), Limbayang (G10), Singgam Putih (G14), Pulut Kari (G16) and Kuning (G18). In addition, the materials used were: manure, urea, SP-36, KCl, pesticides and other carriers.

The method used was an experiment using Split Plot Design in a Completely Random Design (CRD) consisting of main plots, specifically different cropping systems (S-Factor), as follows : S1=Tile system, S2=Jajar legowo (Jarwo) 2:1, S3 = System of Rice Intensification (SRI). The subplots used completely random design (CRD) that included the genotypes: Kuning Umur Panjang (G07), Samo Putiah (G09), Limbayang (G10), Singgam Putih (G14), Pulut Kari (G16) and Kuning (G18). Each experimental plot was repeated three (3) times. Each plot consists of 16 plants of which 12 are sampled. The research data was analyzed using the formula:

$$Ytpn = \mu + Kn + Tt + Bnt + Pp + (TP)tp + \Sigma tpn$$

The practice on planting system technology used in this experiment referred to the previous studies. The Jajar Legowo system, known as type 2:1 (two rows of rice plants interspersed with a bare space) (Figure 1.), referred to the study of Sari *et al*. (2014). The System of Rice Intensification (SRI) referred to the method from Rozen and Kasim in 2018. The rice field for SRI treatment was kept in shallow flooding (Figure 1). The organic fertilizer from cow manure with a dosage of 20 tons/ha was spread to the fields.

Figure 1. Seedling beds (left), Jajar Legowo System (center) and SRI Planting Systems (right).

The seeds were soaked for ± 12 hours before they were sown (seeded) on nursery beds (Figure 1.). The seedlings of 10 days old were transplanted on fields of Jajar Legowo and SRI systems, while seedlings of 21 days old were transplanted on fields of Tile system. One seedling was transplanted in each planting hole. Water management was adjusted according to planting system and water requirement at growth stage of plants.

Inorganic fertilizer application referred to recommendation of Rice Research Center (2021). Urea, SP-36 and KCl fertilizers were applied at the plant age of 7 to 10 days after planting at the dose of 75 kg/ha, 100 kg/ha, and KCl 50 kg/ha respectively. At 21 days after planting, plants were fertilized for Urea 150 kg/ha. At 42 days after planting, plants were fertilized for Urea 75 kg/ha and KCl 50 kg/ha. Crop maintenance involving replanting for the dead plants, weeding and pest control was carried out.

The observed parameters on agronomic characteristics, both growth and yield components, including plant height (cm), time to flowering (dap), time to harvest (dap), total number of tiller per clump, number of productive tiller per clump, dry weight harvested per clump (grams).) and dry weight milled-grain per clump (g). The study data were then processed using the STAR program. If the calculated F is greater than the F in the table, another test is performed using a 5% DMRT level.

RESULTS AND DISCUSSION

Plant Height (cm)

The analysis of variance (ANOVA) for plant height showed a significant effect of the interaction treatment. Table 1 showed the mean of plant height observation. We find that the interaction between planting system and genotype treatment produced resulted significant difference in plant height. The best results were seen with the System Rice Intensification (SRI) system and Jajar Legowo 2:1 for G14 genotype (Singgam Putih Rice).

These results indicate that there is a positive relationship between genotype and environment. Planting system technology is able to provide better plant growth. Magfiroh *et al.* (2017), the growth of a plant is determined by several growth factors. There are two important factors that affect plant growth, they are genetic factors and environmental factors.

Genotype G14 (Singgam putih) was the best growth in rice plant height. The difference in plant height in each genotype is due to differences in genetic traits. So that the ability of plants to express plant height is also

Table 1. Plant height of 6 local rice genotypes on 3 types of planting systems

Planting System	Genotype					
	G07	G09	G10	G14	G16	G18
Tile	126.00 A c	116.84 B d	130.00 A b	138.61 A a	106.99 B e	102.00 B f
Legowo	126.00 A c	119.00 AB d	132.00 A b	141.00 A a	109.00 AB e	103.99 AB f
SRI	128.00 A c	122.96 A d	131.99 A b	141.00 A a	112.99 A e	108.00 A f

Note: Numbers followed by the same lowercase and uppercase letters are not significantly different based on the DMRT (α = 5%).

different. This is in line with the opinion of Yulina *et al*.(2021) stating that high diversity in the generative phase indicates that character is more influenced by genetic factors.

In addition to genotype characteristics, differences in plant height are also caused by environmental factors. An appropriate environment will provide better plant growth. In the planting system the best treatment was found in the SRI system, namely 141.00 cm. The good results obtained in the SRI system are caused because the SRI system has a wide spacing, this is done so that the plant roots can freely absorb nutrients. With the flexibility of plant roots to absorb unclean elements, it will provide good growth in vegetative growth of plants, especially plant height. Herawati (2012) states that the SRI system has several principles, namely young seedling plants less than 12 days old when the seedlings still have 2 leaves, seedlings are planted singly or one seed per planting hole with a distance of 30x30 cm, water application in the SRI method is a maximum of 2 cm (shallow flooding) intermittently, and the roots are made to form the letter L in the rice fields at the time of planting.

Younger seedlings at the time of transfer to the field have a faster adaptation effect than other cropping systems. This faster adaptation greatly affects the increase in the height of rice plants. Planting by making the letter L roots can maximize root growth and in the absorption of nutrients.

Whereas the Jajar legowo system is a cropping system with the same as the SRI system. This is because the jajar legowo planting system provides a wide space so that there is no competition between plants to get more nutrients. In addition, in the jajar legowo planting system, each plant is made as a side plant so that it is maximal in lighting and the number of plants in a stretch. According to Kurniawan *et al.* (2021), the Jajar Legowo spacing has advantages, namely: it will be better for plants to obtain sunlight, nutrients, pest control as well as the opportunity to increase plant productivity due to the large number of the population increases.

Time to Anthesis (day after planting)

The results of analysis of variance on anthesis age showed that the interaction treatment had a significant effect. The results of observing the age of panicle exit showed that the interaction between the planting system and genotype treatment gave a significant difference to the age of panicle exit. The best was seen in Genotype G18 (Kuning) in the SRI system with a value of 93.67 days after planting (Table 2).

The interaction relationship between genetics and the environment gives rise to a relationship that affects the shorter phase of anthesis. Genetic factors can provide a response from the environment that is either negative or positive. The appearance of the research results is a genetic response to the SRI system which has a positive value.

The difference in the age of panicle release from the tested genotypes is influenced by genetics. Suryanugraha *et al.*(2017), there are two important factors that influence the growth and development of a plant, namely genetic factors and environmental factors.

Environmental factors influence the age of anthesis as can be seen from the results of this study. In the SRI system, where seeds are planted at a young age. This makes the seedlings adapt more quickly in the field. This gives effect to the growth and age of plants. The short anthesis is related to plant

Table 2. Time to anthesis of 6 local rice genotypes on 3 types of planting systems

Planting System	Genotype					
	G07	G09	G10	G14	G16	G18
Tile	128.67 A ab	127.33 A b	130.33 A a	110.00 A c	107.34 A d	98.00 A e
Legowo	126.67 B b	125.00 B b	129.01 A a	109.67 A c	106.67 A d	97.33 A e
SRI	121.01 C b	117.33 C c	126.01 B a	104.33 B d	103.00 B d	93.67 B e

Note: Numbers followed by the same lowercase and uppercase letters are not significantly different based on the DMRT (α = 5%)

physiological processes. The better the physiological process of the plant, the better the plant will be in forming panicles, so that it will accelerate the emergence of panicles. When the plant begins to flower, almost all photosynthetic results are allocated to the generative part of the plant (panicle).

Time to Harvest (day after planting)

The results of the analysis of variance on harvesting age showed that the single genotype treatment had a significant effect. Observations of harvest age showed that the single genotype treatment gave a significant difference to the age of harvest. The best was seen in Genotype G14 (yellow rice) with a value of 154.00 days after planting (Table 3).

The results showed that the fast or long emergence of panicles did not always affect the harvest time of the plants. Because each genotype has different genetic characteristics. Each genotype has a different phase of growth and development (maturation).

Suspidayanti and Rokhmana (2021), the growth of rice plants is grouped into 3 main stages, namely vegetative, reproductive and maturation. Although it quickly enters the reproductive phase, the maturation phase is different, it can be fast or long. From the results of this study, although Genotype G18 (Kuning) was the fastest growing age of panicles, it was not the fastest at harvesting. Because the fastest harvesting age is found in Genotype G14 (Singgam Putih).

The results showed that the planting system had no significant effect on harvest time. However, the SRI cropping system is harvested faster than other cropping systems (Table 3). This means that the factor of planting younger seeds can affect the age of the harvest.

Number of productive tillers per clump

The results of the analysis of variance on the number of productive tillers per clump showed that the interaction treatment had a significant effect. The best combination treatment was seen in Genotype G18 (yellow rice) in the System Rice Intensification (SRI) system with a value of 48.05 tillers (Table 4). Furthermore, the discussion on the number of productive tillers will be discussed at once on the total number of tillers.

Total number of tillers per clump

The results of the analysis of variance on the total number of tillers per clump showed a significant interaction effect. The best was seen in Genotype G18 (kuning) in the System Rice Intensification (SRI) system with a value of 73.40 tillers (Table 5. Both the number of productive tillers and the best total number of tillers were found in G18 (Kuning). Judging from the research results, the number of panicles is the highest, so it requires a longer time for the ripening phase.

Genetically each genotype has different genetic characteristics and different responses to the environment. So that both growth, development and physiological processes will also be different. Suparwoto *et al.* (2017) explained that one of the factors that affect the production of rice plants is the large number of productive tillers. The number of productive tillers of a clump is determined not only by the growing environment, but also by the genetic characteristics of the plants that are passed on to a rice variety. Nazirah and Damanik (2015), stated that differences in genetic makeup are one of the factors that cause the appearance of plants to vary, in this case, plant height, number of tillers, flowering age and others.

Table 3. Harvest age of 6 local rice genotypes on 3 types of planting systems

Planting System	Genotype					
	G07	G09	G10	G14	G16	G18
Tile	162.66	159.00	167.34	160.67	163.67	164.00
Legowo	160.33	159.67	167.67	153.33	161.66	163.33
SRI	156.67	152.34	161.00	148.00	158.67	158.00
Mean G	159.89 bc	157.00 c	165.34 a	154.00 d	161.33 b	161.78 b

Note: Numbers followed by the same lowercase and uppercase letters are not significantly different based on the DMRT (α = 5%)

Table 4. Number of productive tillers per clump of 6 local rice genotypes on 3 types of planting systems

Sistem Tanam	Genotipe					
	G07	G09	G10	G14	G16	G18
Tile	34.81 A c	31.17 B d	23.47 A e	24.11 B e	40.53 A b	45.70 A a
Legowo	36.86 A b	33.02 B c	25.45 A d	26.69 B d	39.78 A b	46.35 A a
SRI	37.81 A b	38.54 A b	26.00 A d	31.96 A c	40.47 A b	48.05 A a

Note: Numbers followed by the same lowercase and uppercase letters are not significantly different based on the DMRT (α = 5%)

Table 5. Observation results for the total number of tillers per clump

Planting System	Genotype					
	G07	G09	G10	G14	G16	G18
Tile	47.47 B c	53.49 B b	52.41 C b	50.65 C b	51.62 A b	68.88 B a
Legowo	62.46 A b	53.86 B c	59.98 B b	53.72 B c	50.72 A d	70.27 B a
SRI	63.56 A b	59.08 A c	64.72 A b	57.65 A c	50.51 A d	73.40 A a

Note: Numbers followed by the same lowercase and uppercase letters are not significantly different based on the DMRT (α = 5%)

The SRI method produces the highest number of tillers because it is influenced by the wide spacing and the use of the number of seeds. So that the plants can develop properly and produce more productive clumps. Prayatna (2007) revealed that the number of tillers of rice with a shorter seedling period will be more optimal than rice with a longer seedling period.

Rois *et al.*(2017) stated that the factors that influence tiller formation are spacing, fertilizer, variety and planting season. Besides that, a good environment such as the availability of sufficient water, fertile land, the age of the seedlings can also affect the number of tillers of rice plants.

Weight of Grain Per Clump (grams)

The results of the analysis of variance on the weight of harvested grain per clump showed that the single genotype had a significant effect. The results of observing the weight of harvested grain per clump showed that the single genotypic treatment gave a significant difference to the grain weight harvested in the clump. The best was seen in the G10 genotype (Limbayang rice) with a value of 118.62 grams (Tab;e 6). Furthermore, the discussion on the weight of the harvested grain in the clump will also be discussed at the same time on the weight of the dry milled grain in the clump.

Dry Weight of Milled - Grain (grams)

The results of the analysis of variance on the milled dry weight per clump showed that genotype alone had a significant effect. The results of observations of the dry weight of the mill per clump showed that the single genotype treatment gives a significant difference to the weight of dry milled grain in the clump. The best was seen in the G10 genotype (Limbayang rice) with a value of 105.57 grams (Table 7).

The results of this study show that genetic diversity displays different indicators of growth and development of rice plants. Starting from the indicators of plant height, age of panicle emergence, harvest age, number of productive tillers and total number of tillers to harvested grain weight and dry milled grain weight found in different genotypes.

For plant height indicators, the best genotype G14 (Singgam Putih) was obtained in the System Rice Intensification (SRI) system and the Jajar Legowo 2: 1 system with a value of 141.00 cm. The best panicle exit age indicator was found in Genotype G18 (Kuning) in the System Rice Intensification (SRI) system with a value of 93.67 days after planting.

For harvesting age indicators, genotype G14 (Singgam Putih) is best with a value of 154.00 days after planting. The best indicator for the number of productive tillers was genotype G18 (Kuning) in the System Rice Intensification (SRI) system with a value of 48.05 tillers. The best indicator for the total number of tillers

Table 6. Harvested grain weight per clump of 6 local rice genotypes on 3 types of planting systems

Sistem Tanam	Genotype					
	G07	G09	G10	G14	G16	G18
Tile	82.99	107.36	115.40	70.51	101.27	88.57
Legowo	86.39	115.65	118.57	75.14	106.27	91.45
SRI	90.88	122.44	121.88	122.45	110.97	95.17
Rerata G	86.76 e	115.15 b	118.62 a	75.67 f	106.17 c	91.73 d

Note: Numbers followed by the same lowercase and uppercase letters are not significantly different based on the DMRT (α = 5%)

Table 7. Observation results of dry weight of milled- grain per clump of 6 local rice genotypes on 3 types of planting systems

Planting System	Genotype					
	G07	G09	G10	G14	G16	G18
Tile	73.87	95.55	102.71	62.75	90.12	78.83
Legowo	76.89	102.93	105.53	66.88	94.58	81.39
SRI	80.89	108.98	108.47	72.42	98.76	84.69
Rerata G	77.21 e	102.49 b	105.57 a	67.35 f	94.49 c	81.64 d

Note: Numbers followed by the same lowercase and uppercase letters are not significantly different based on the DMRT (α = 5%)

was Genotype G18 (Kuning) in the System Rice Intensification (SRI) system with a value of 73.40 tillers.

As for the indicator of grain weight harvested for clumps, the best was Genotype G10 (limbayang rice) with a value of 118.62 grams, and for the indicator weight of dry milled grain per clump, Genotype G10 (Limbayang) with a value of 105.57 grams.

So, genetically, plants actually regulate internal physiological processes within their bodies. Environmental factors will also affect these physiological processes. Whether the environmental factors support it or not. Then it will be displayed by plants as a plant response to environmental factors.

The planting system tested, although it had no effect on the paddy weight indicator, it can be seen that the implementation of the Jajar legowo and SRI systems gave better results than the tile system. Saeroji (2013) states that the application of the legowo row cropping system will provide maximum results by paying attention to the direction of the plant rows and the direction of sunlight. According to Sari *et al*. (2014) argued that the jajar legowo planting system provides empty space for plants so as to provide air circulation, absorption of sunlight, and absorption of nutrients that are evenly distributed so that they have an impact on better plant growth and yields.

The SRI planting system is a planting system that produces the most number of tillers because SRI has the advantage that the seeds used are young seeds, the seeds planted amount to one seed per planting hole, with the planting of young seeds and one seedling planting hole it will be able to provide a large number of tillers, because plant roots can develop well in terms of absorbing nutrients. In addition, plants will be easy to develop in terms of forming the number of tillers. Because easy plants are more dominant to develop better compared to old plant ages. In accordance with the opinion of Herawati (2012), states that the SRI system has several principles, namely young seedling plants less than 12 days old when the seedlings still have 2 leaves, seedlings are planted singly or one seed per planting hole with a distance of 30x30 cm, water application in the SRI method ie a maximum of 2 cm intermittently. Muyassir (2012), the faster the seedlings move to the field, the more adequate they are to adapt to the new environment, so that the more adequate they are in the development of tillers and roots.

The tile planting system is a cropping system with poor results. In this case, of course, this planting system still has many shortcomings, one of which is the removal of old seeds. According to Muyassir (2012) the extension of time for transferring seedlings to the field results in stress for the seedlings due to disruption of the root system and requires time for the healing period, so that the development time for tillers is shorter and the number of tillers produced is less.

In addition, this cropping system has dense plant spacing, resulting in crop competition in terms of grabbing nutrients. Abdulrachman *et al.*(2013) stated that rice varieties in narrow spacing conditions will experience a decrease in growth quality, such as fewer tillers and panicles.

CONCLUSION

Based on the research results, it is concluded that the local rice genotypes of Kuantan Singingi Regency responded to the planting system technology. Judging from the increased in the treatment of Jajar legowo and SRI cultivation techniques proved increasing growth and yield of all genotype tested, whereas in the Tile system resulted in lower yield. Rice Intensification System (SRI) gave the best growth to the Singgam Putih genotype with a plant height of 141.00 cm, while the best results for dry weight of milled-grain per clump ((105.57 grams) was achieved from Limbayang genotype.

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