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27 Growth And Yield Of Local Variety Of Rice As Affected By Planting Systems In Highland Ecosystem

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ABSTRACT

One of the recommended packages of technology to increase rice production is spacing or Planting Systems. This research was conducted from September to December 2015 in the Village Tikala, Tikala District of North Toraja Regency, aimed to determine the effect of Planting System on growth and yield of local variety of rice. Location research was on the altitude of 750 m above sea level with climate type B (Schmidt & Fergusson) and soil pH 6. The experiment was arranged in a randomized block design consisting of six treatments where each treatment was repeated three times so, there are 18 experimental plots, each plot with an area of $4m^2$. The Planting Systems were tested is a Tile Planting System with a size of 25 cm x 25 cm, Planting System 2: 1, Planting System 3: 1, Planting System 4: 1, Planting System 5: 1 as well as the Randomly Planting System.

Results showed that treatment of Planting Systems 2: 1(PS-2-1) provided the best rice production (6.75 tons ha-1). While the lowest production was obtained with the treatment of PS-5-1 (Planting Systems 5: 1) was 4.58 tons ha^{-1}. Pattern of the relationship between plant populations with LAI showed an exponential relationship expressed by the equation $Y = 0{,}9682e^{0{,}0117x}$ and coefficient of determination was 0.7845. In the other hand the pattern of relationship between plant populations with Crop Growth Rate (CGR) showed an exponential relationship with the equation $Y = 8{,}2915e^{0{,}0113x}$ and coefficient of determination was 0.8011. The pattern of the relationship between plant populations with Harvest Index showed a linear relationship with regression equation $y = -0.0066x + 1.353$ and the coefficient of determination was 0.9331.

Keywords: rice, growth analysis, planting systems, tile systems.

1. INTRODUCTION

Rice (*Oryza sativa* L.) is a commodity that is still given high priority in agricultural development. In line with population growth, demand for rice continues to increase and is projected to increase each year (CBS, 2004). The increase in the demand for rice if it is not offset by an increase in the production of an adequate, Indonesia will experience a shortage of rice in the future (Karim et al., 2005).

In line with growth of mankind population, it is necessary to increase the production of rice. Both rice intensification and diversification were not optimal due to the management of the recommended technology package has not been fully implemented (Sam, 2008). Success or failure of efforts to increase rice production is largely determined by the farmers in adopting the technology. One of the recommended packages of technology which can increase production is the spacing or Planting Systems. Spacing in rice cultivation is very important in order to increase production. There are various kinds of plant spacing that is often used by farmers such as a spacing of size 20 cm x 20 cm and at random. Close spacing reduced the number of shoots per clump, increasing pests and diseases, and increased empty grain. Thus to enhance the growth and yield of rice we needs to manage planting system.

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Local varieties of Toraja were grown for generations by farmers generally use Randomly planting system with relatively low production and can only be harvested once per year, so the lower efficiency of solar energy utilization and nutrient causes relatively low productivity.

This report described the 23 effect of Planting System on growth and yield of rice. The results can be expected not only a source of information for farmers in order to develop and increase the production of rice plants, but it can also be used as a comparison for subsequent research.

2. 18 MATERIALS AND METHODS

The research was conducted in the Village Tikala, District Tikala, North Toraja Regency. Location Research is at an altitude of 750m 2 above sea level with climate type B (Schmidt & Fergusson) and soil pH 6.0. The study took place from September to December 2015. Materials needed in this experiment consisted of seeds of local variety Paddy Lea, fertilizers 35 (Urea, SP-36 and KCl), and some organic fertilizer. Tools used include hand tractor, drying oven, hoes, ticks, buckets, sickles, digital scales, leaf area meter, plastic strap, and peg labels. 2 Experiment was arranged in a randomized block design (RBD) consisting of six Planting Systems. Treatments were repeated three times, totaling 18 experimental plots, each with an area of $4m^2$. The Planting Systems were tested treatment were tiles planting 8 system with a size of 25 cm x 25 cm, Planting System 1 2: 1, Planting System 3: 1, Planting System 4: 1, Planting System 5: 1 as well as randomly spacing.

Paddy field were plowed thoroughly using hand tractor followed by watering and harriwing to produce mud and finally leveling the mud. Prior to sowing in the nursery, rice 30 seeds soaked for 24 hours, drained and cured for 48 hours. Urea (66,6 kg ha-1) were given once the seeds germinated and evenly 3-day after sowing (DAS).

Seedlings were transferred at the age of 21 days after sowing. Before planting, water was drained leaving sturdy mud ready for lining. Marking ticks were used as lining ruler according to the spacing used 1 Tile Planting System (25 cm x 25 cm), Planting System 2: 1 (2 rows - 25 cm:12,5 cm:50 cm), Planting System 3 : 1 (3 rows - 25 cm:12,5 cm:50 cm), Planting System 4: 1 (4 rows - 25 cm:12,5 cm:50 cm), Planting System 5: 1 (5 rows - 25 cm:12,5 cm:50 cm) and randomly spacing. Two seedlings per hole were planted. Fertilizers were given three times 19 at a total dose of 200 kg urea ha^{-1}, 100 kg ha^{-1} SP-36 and 50 kg ha^{-1} KCl. First fertilization was at 14 day after planting with 1/3 dosage of urea, ½ dosage of KCl and full dosage of SP-36. Second fertilizing was done at 35 DAP at 1/3 dosage of urea and ½ dosage of KCl. The third fertilization depend on observation of N requirement performed using urea (the leaf color chart). Organic fertilizer was given at the time of transplanting.

Maintenance included replanting, weeding and irrigation as well as pest and disease control. Water level was maintained depending on the growth period of the rice plants. In the vegetative growth phase required considerable water supply while in the generative growth phase, namely the formation of flower panicles,

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required improved irrigation for a moment, and then the water is reduced gradually. Harvesting was done when the panicle has yellowed at around 90-95%. Variables measured during parameter observation included the growth and production components, namely: (1) Plant height, measured from the ground to the tip of the highest leaf. (2) Number of vegetative tillers, calculated at the age of 35 DAP. (3) number of productive tillers, calculated from all tillers that produce panicles and observed once at the time of harvest. (4) Leaf area, i.e. total leaf area measured by the means of all the leaves were pruned, weighed. Mature plants were measured at 35 and 65 DAP. (5) Dry weight of the plant (roots, stems, leaves) weighed at 35 and 65 DAP. (6) Weight of 1000 grains (g). (7) Weight of dry grain harvest per plot.

2.1 ANALYSIS OF PLANT GROWTH

$$\text{Leaf Area Index (LAI)} = \frac{\text{Leaf Area}}{\text{Land Area}}$$

$$\text{Crop Growth Rate (CGR)} = \frac{(W_2 - W_1)}{(T_2 - T_1)}$$

$$\text{Harvest index} = \frac{\text{Economic Biomass}}{\text{Total Biomass}} \times 100\%$$

Remarks:

W_1 = dry weight of plants at T_1.

W_2 = dry weight of plants at T_2.

A_1 = leaf area at T_1.

A_2 = leaf area at T_2.

3. RESULTS AND DISCUSSION

Observation on the average plant height and Analysis of variance (ANOVA) is shown in Table 1. Analysis of variance showed that the Planting Systems significant on plant height. DMRT (Duncan Multiple Range Test) results show that the highest value achieved on the treatment of plant Planting Systems. Planting System 2: 1 was significantly different from the treatment of Planting System 5: 1 and randomly Planting System, but were not significantly different with tiles Planting System (25 x 25 cm), Planting System 3: 1 and Planting System 4 : 1.

Observation of maximum number of tillers could be seen in Table 1. The Analysis of variance showed that the system was highly significant planting on the maximum number of tillers. DMRT results showed that the highest number of tillers was achieved in the treatment plant system Planting System 2: 1, significantly different

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from the treatment Planting System 3: 1, tile Planting System and Randomly Planting Systems, but not significantly different to Planting System 4: 1 and Planting System 5: 1.

Table 1. Average Plant Height and Number of Maximum Tiller, and Number of Productive Tillers in various Planting Systems.

Planting Systems	Plant Height (cm)	Number of Maximum Tillers	Number of Productive Tillers
25 x 25 cm	176,00 ab	16,5 a	13,5 ab
PS- 2-1	177,38 b	19,1 b	15,9 b
PS-3-1	176,55 ab	15,6 a	12,2 a
PS-4-1	176,78 b	17,4 ab	13,5 ab
PS-5-1	173,92 a	17,6 ab	13,1 a
Randomly PS	175,82 a	15,6 a	11,8 a
MS Error	0,84 *	0,85**	1,09**

Description: The average value followed by the same letter are not significantly different means at the level of 0.05 DMRT.

Observation of the average number of productive tillers and prints manifold are presented in Table 1. Results of analysis of variance showed that the treatment plant system very significant effect on the number of productive tillers. DMRT results show that the highest number of productive tillers was achieved in the treatment of Planting System 2: 1, significantly different from the treatment Planting System 3: 1, Planting System 5: 1 and Randomly Planting System, but not significantly different to Planting Systems 4: 1 and tile Planting Systems. Observations pithy weight of 1000 grains and prints manifold can be seen in Table 2. Analysis of variance showed that treatment of Planting systems very significant effect on the weight of 1000 grains.

Planting System was significantly affecting the agronomic component plants, except at plant height. Against the yield components and the yield also showed a marked influence on the percentage of empty grains unless and 1000 grain weight. "Planting System" row planting system can increase the yield of dry grain harvest around 19.90 to 22%. This experiment suggests that in order to obtain optimum productivity of lowland rice is recommended to use of "Planting System" (Purwanto, 2008).

Table 2. The average weight of 1000 grains and dry grain crop production.

Planting Systems	1000 grain weight (g)	Yield (ton/ha)
25 x 25 cm	27,0 ab	5,92 b
Planting System 2:1	29,3 b	6,75 c
Planting System 3:1	26,0 a	5,58 b
Planting System 4:1	28,3 ab	4,83 ab
Planting System 5:1	27,0 a	4,58 a
Randomly Spacing	28,0 ab	4,78 b
MS Error	2,24**	0,16**

Description: The average value followed by the same letter are not significantly different means at the level of 0.05 DMRT.

DMRT results showed that the highest weight of 1000 grains achieved by planting system Planting System 2: 1, and was significantly different from the treatment of plant system Planting System 3: 1 and Planting System

5: 1, but not was significantly different from irregular (random planting distance) Planting Systems, Planting System 4: 1 and the tiles Planting Systems.

Observations of dry grain crop production manifold and prints can be seen in Table 2. Analysis of variance showed that treatment of Planting Systems very significant effect on the production of dry grain harvest. DMRT results showed that the highest production achieved in the treatment of Planting Systems Planting System 2: 1, significantly different from all other treatments Planting Systems. This is because the principle of Planting System row planting system is to increase the number of populations of plants with spacing. The amount of increase in the population of plants with row planting system implementation Planting System can we know the formula: 100% x 1 / (1 + number Planting System). Thus, for each type of row planting system Planting System we can calculate addition / increase in population is as follows; Planting System row (2: 1) an increase in the population is 100% X 1 (1 + 2) = 30% Planting System row (3: 1) an increase in the population is 100% X 1 (1 + 3) = 25% Planting System row (4: 1) an increase in the population is 100% X 1 (1 + 4) = 20% Planting System row (5: 1) an increase in the population is 100% X 1 (1 + 5) = 16.6% (Haryanto et. al., 2014). The application of row planting system Planting System will provide maximum results with regard to the direction and the crop row direction of the sun. Row crop rows facing the direction of the sunrise made so that the entire row of roadside plants can obtain optimum solar radiation and thus no edge of the row of plants, especially plants that are blocked by other plants in the sun. The results of this study show several things backing. First, the type of plant spacing affects the number of productive tillers only on the basis of agronomic varieties have many puppies as Aromatic varieties. In contrast, the varieties that have relatively few number of tillers, the type of plant spacing does not affect the number of productive tillers. Secondly, the type of spacing of the triangle gives the number of productive tillers were more consistent than the spacing of the rectangle. Third, the type of plant spacing is more suitable to be applied to varieties that are genetically have a number of inbred varieties that have less than the number of tillers that much. The number of productive tillers also related to the outcome. The number of chicks that little can reduce results. The same research results by Limbongan (2009) and Limbongan et. al. (2009).

This is in accordance with the opinion of Gardner et al. (1985) which states that the use of spacing of the meeting is one way to increase crop yields, but farmers should look for varieties that are appropriate for the spacing of the meeting. This situation allegedly by the two goals, the number of productive tillers and number of the population. The number of productive tillers and number of populations are extremely due to rice yield. If the results of the other components remain, the greater number of productive tillers and the number of populations, the higher the yield of rice. High yield given by the type Planting System mainly due to the population size. As mentioned earlier that the type Planting System gives the population of 33 percent more than the rectangular type.

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According to Gardner et al. (1985) that while not lowering the yield per plant, the increase in the number density of the population will be able to increase crop yields per hectare. 4 Compared with a conventional tile cropping system, systems of simultaneous rice cultivation and Pisciculture Jajar Planting System and SRI in this experiment were proven to be able to increase of rice yield. The increase is ranged between 150 percent to 200 percent. Rice Farmers WHO utilize SRI and Jajar Planting System-similar Planting 4 Systems can reach a yield increase of rice in with one condition that they use right rice seeds, fertilizer, tillage systems, crop and pest combating system. The highest grain yield of rice cv. BRRI 11 the highest grain yield of rice cv. BRRI dhan45 could be obtained by planting at 25 cm × 15 cm spacing under aerobic system of cultivation in *boro* season (Sultana, *et. al*., 2012).

3 The data from this preliminary study suggest that RiceTec XL723 may produce higher grain yield when drill-seeded using 7-in. row spacing. However, the differences in row widths were not significant. More data are needed on multiple soil conditions to further evaluate the effects of row widths of hybrid rice. These data also suggests a seeding rate of approximately 30 lb/acre to maximize grain yield (Frizzell *et. al*., 2006).

According to Baloch *et. al*. (2002) 13 that the spacing of 22.5 x 22.5 cm between hills and rows most suitable for obtaining optimum grain yield in the rice crop. Planting 5 System and dipping P application increased rice yield and P efficiency. Rice yield in Planting System and P-dipping system ranged from 5,08 to 6,39 ton ha^{-1}, whereas in farmers practice only 4,69 ton ha^{-1}. Yield increase of Planting System 2:1, 4:1 Planting System 6:1 and 8:1, 35,5, 12,8 and 8,3% (Azwir, 2008).

Leaf Area Index (LAI) data and variance analysis can be seen in Table 3. 17 Analysis of variance showed that the treatment of various Planting Systems very significant effect on Leaf Area Index (LAI). DMRT results show that the highest LAI achieved on treatment with Planting Systems Planting System 2: 1, significantly different from all other treatments Planting Systems. Observations Crop Growth Rate (CGR) and analysis of variance can be seen in Table 3. 1 Analysis of variance showed that treatment of Planting Systems provide a very significant on Crop Growth Rate (CGR). The results showed that the CGR maximum achieved on Planting Systems Planting System 2: 1, real different to Planting System tiles, Planting System 5: 1 and Planting Systems of irregular but not significantly different Planting Systems Planting System 3: 1 and Planting System 4: 1.

Table 3. Data of 34 *Leaf Area Index, Crop Growth Rate and Harvest Index.*

Planting Systems	LAI	CGR (g cm-^{1}day^{-1})	Harvest Index
25 x 25 cm	4.59 b	28.01 a	4,77 d
Planting System 2:1 (1)	8.95 c	61.20 c	5.60 e
Planting System 3:1	5.45 b	51.72 bc	4.77 d
Planting System 4:1	4.43 b	44.54 bc	4.33 b
Planting System 5:1	4.89 b	38.36 ab	3.74 a
Randomly Spacing	1.76 a	15.29 a	4.41 c
MS Error	0,01**	75,39**	0,0018**

Description: The average value 12 followed by the same letter are not significantly different means at the level of 0.05 DMRT.

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Observations on Harvest Index and Variance Analysis could be seen in Table 3. Analysis of variance showed that treatment of Planting Systems had very significant effect on harvest index (HI). DMRT results showed that the highest harvest index was achieved in the treatment plant system Planting System 2: 1 and was significantly different from the value of harvest index in all other the Planting Systems tested. The growth and yield of a crop is influenced by genetic factors and environmental factors (Basri, 1996). Environmental factors including climate, soil, water and nutrients were of great influence on the growth and activity in the plant. According Suparyono and Agus Setyono (1993) the yield loss at harvest was influenced by several factors, i.e : socio-cultural, behavioral maturity level harvesters, tools and how to harvest. The greater the yield loss at harvest, then the resulting production is also diminishing and vice versa, the smaller the yield loss at harvest, the resulting production would also higher.

The pattern of the relationship between plant populations with LAI is presented in Figure 1. Figure 1 shows that increasing plant populations showed an exponential relationship with the pattern of leaf area index by the equation Y = 0,9682e0,0117x and coefficient of determination 0.7845. This suggests that the addition of plant population will increase to some extent LAI where excessive leaf will be competing that it could not grow and develop properly. As a result the leaves could not obtain photosynthate intake so that the leaves become deciduous.

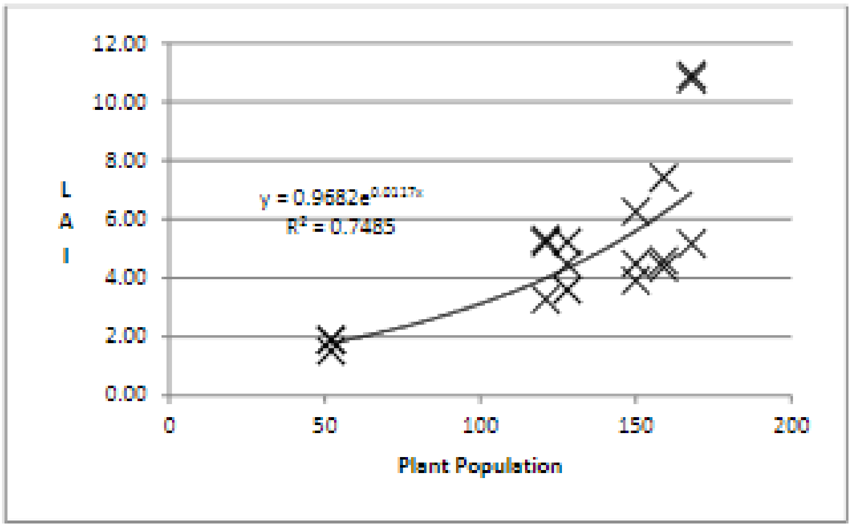

Figure 1. The pattern of the relationship between plant populations with LAI.

The pattern of the relationship between plant populations with Crop Growth Rate (CGR) is presented in Figure 2. Figure 2 shows that increasing plant populations showed an exponential relationship with the CGR patterns with the equation Y= $8{,}2915e^{0{,}0113x}$ and coefficient of determination 0.8011. This suggests that the addition of plant population will increase to some extent CGR where excessive leaf will be competing so it can no longer carry out the process of photosynthesis is mainly due to the limited sunlight intercepted by the leaves.

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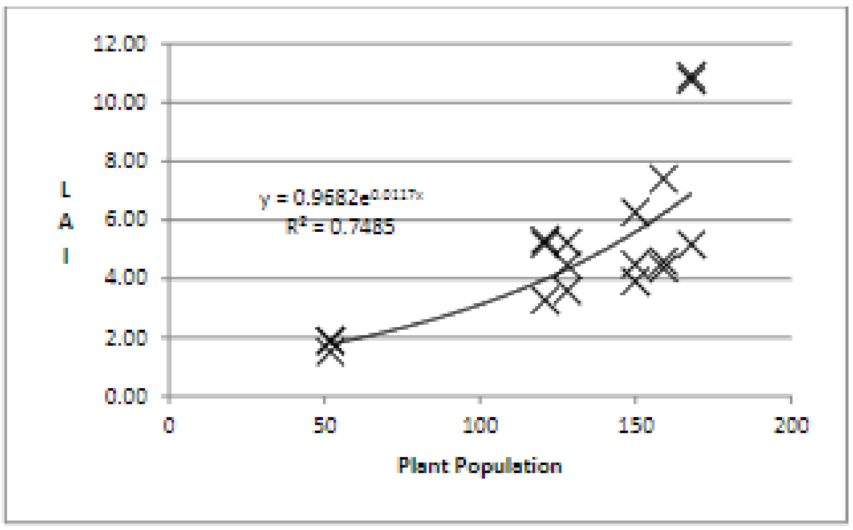

Figure 2. The pattern of the relationship between plant populations with Crop Growth Rate (CGR)

The pattern of the relationship between plant populations with Harvest Index are presented in Figure 3. Figure 3 shows that increasing plant populations showed a linear relationship with the pattern of harvest index with regression equation y = -0.0066x + 1.353 and the coefficient of determination 0.9331. This suggests that the addition of plant population will decrease due to the addition of the harvest index. Plant population will increase the yield of biological / dry matter is relatively constant while the economic results.

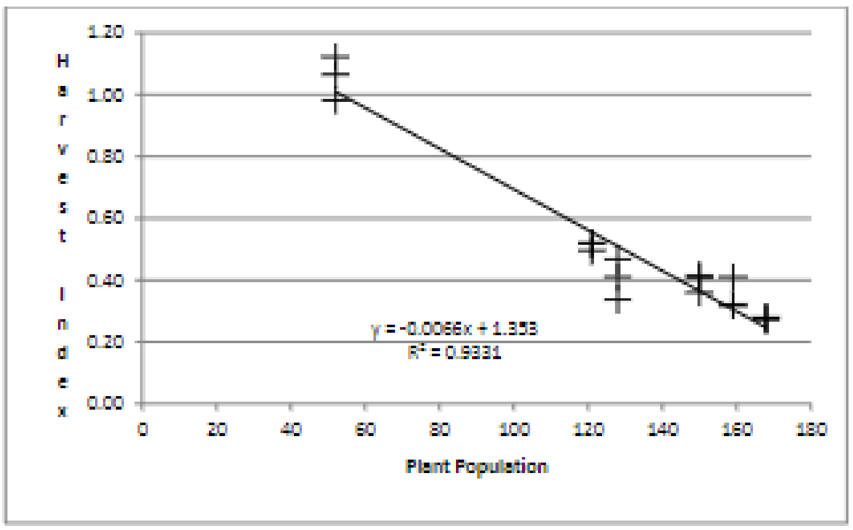

Figure 3. The pattern of the relationship between plant populations with Harvest Index

Planting System Planting System is a way of planting rice paddy with a pattern of some row crops are interspersed with empty rows. Plants that should be planted in an empty row of plants transferred as inserts in the ranks. At first row Planting System commonly applied to areas that many pests and diseases. On the blank line between Planting System unit, can be made shallow trench. Trenches can serve to collect snails, pressing iron toxicity in rice plants or for the maintenance of small fish (young). But then this cropping pattern evolved to provide higher yields as a result of increasing population and growing space for plant optimization (Haryanto et. al., 2014).

4. CONCLUSIONS

Based on observations obtained in this study, both observations of the components of growth and yield components can be concluded that the treatment of Planting Systems Planting System 2: 1 to provided

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highest production (6.75 tons 9 ha-1). While the lowest production was obtained with the treatment of Planting Systems Planting System 5: 1.

The pattern of the relationship between plant populations with LAI showed an exponential relationship with the pattern of leaf area index by the equation $Y = 0{,}9682e^{0{,}0117x}$ and coefficient of determination 0.7845. The pattern of the relationship between plant populations with Crop Growth Rate (CGR) showed an exponential relationship with the CGR patterns with the equation $Y = 8{,}2915e^{0{,}0113x}$ and coefficient of determination 0.8011. The pattern of the relationship between plant populations with Harvest index showed a linear relationship with the pattern of harvest index with regression equation $y = -0.0066x + 1.353$ and the coefficient of determination 0.9331.

In order to obtain growth and better production of lowland rice Planting System it is advisable to use Planting System 2: 1. In addition it should be fixed other cultivation techniques to obtain maximum production. Multilocation trials need to be conducted to test the stability of the results on the high plains of rice fields.

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