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Research Article

Response of Two Rice Varieties Grown using SRI Method in Two Different Locations

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Abstract

Background and Objective: Application of system of rice intensification (SRI) method has been considered as one of powerful efforts to increase the harvested yield by modifying the plant and its surrounding environment. This study was aimed to determine the effect of different environment towards the response of rice varieties grown using SRI method. **Materials and Methods:** Two rice varieties, *Batang Piaman* and *IR-42* were grown in District of Tanjuang Barulak (Regency of Tanah Datar) and District of Saniang Baka (Regency of Solok). Plant height and several yield parameters, such as productive tillers, panicle length, grain number per panicle, and yield per plot were assessed from both varieties and locations. Statistical analysis was conducted using block randomized design and significance was further evaluated using Duncan's New Multiple Range Test (DNMRT) with a $p<0.05$. **Results:** Batang Pariaman appeared in taller performance than *IR-42*. Regarding the number of productive tiller, *Batang Piaman* resulted more productive tillers in Solok, while *IR-42* was dominant in number of productive tiller compared to *Batang Piaman* in Tanah Datar. Unlike *IR-42*, *Batang Piaman* exhibited longer panicle, more grain amounts per panicle, and higher yield per plot than *IR-42* in both locations.

Key words: *Batang Piaman*, *IR-42*, response, rice, SRI

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Introduction

Rice is the most consumed staple crop in most countries worldwide, including Indonesia. Since most of the people in the society tend to be highly dependent on consuming rice as their daily meals, the rice production has to be maintained strictly in order to ensure its availability for the society. Due to this habit, the demand for this crop in Indonesia nearly never decreases. However, as the human population rises, the rice production is hardly to be fulfilled, particularly due to the land limitation. Therefore, the rice availability has to be supported by importing it from another rice-producing countries, such as Thailand and Vietnam. The increasing of functional shift of lands annually is automatically caused the decreasing of productive lands. This policy were unavoidable due to the rapid development. To overcome this land limitation problem, rice production could be optimized through intensification program.

One of intensification program in rice farming, known as system of rice intensification (SRI), has been reported for its ability to stimulate doubled yield production. This method was adopted from Madagascar and begun to be applied in Indonesia since 2000. However, this method has not been evenly implemented yet by all farmers. Some farmers tended to be hesitate to adopt this technology as it required more complicated weed control leading to higher production cost.

The implementation of SRI method are emphasized in several major components where seedling is transplanted earlier (7-15 days after germination) and planted singly per clump with wider spacing (25 cm x 25 cm is recommended). In addition, during vegetative phase, the fields are suggested to be maintained under muddy state compared to continous flooding one (Uphoff *et al.*, 2002). For better result, it is also recommended to apply organic fertilizers followed by regular weeding to minimize the competition between rice and weed. As proposed by Rozen *et al.* (2011), earlier weeding at 7-10 days after planting would reduce weeding cost. Additional weedings at 21 and 42 days after planting were performed together with the application of additional fertilizer. Regarding the transplanting age, higher yield could be achieved when 9 to 13-days-aged seedlings were transplanted into dry seedbed covered with banana leaves or plastic (Rozen *et al.*, 2016). Previous studies also mentioned the importance of phyllochron duration which determined the resulted yields. SRI practice enabled the formation of phyllochron would take 3-7 days depended on temperature, seeding method, and age of seedling transplantation (Veeramani, 2012). It also had been recorded that this method could stimulate 12 times of phyllochron resulting in two-folds yields due to the elevated number of exponential tillers (Bakelaar, 2001).

Materials and Methods

Two rice varieties, *Batang Piaman* and *IR-42*, were planted using SRI method in District of Saniang Baka (Regency of Solok) and District of Tanjuang Barulak (Regency of Tanah Datar). Several parameters were observed, such as plant height, total number of tillers, number of productive tillers, age of flowering, age of harvesting, panicle length, total number of grains per panicle, number of filled grains per panicle, dry weight of grains per panicle, weight of filled grains per panicle, weight of 1000 grains, and yields per plot. Data were analyzed statistically using block randomized design with four groups and significance was then further subjected using *Duncan's New Multiple Range Test* with a $p<0.05$.

Results

Plant Height

Both varieties exhibited different performance in term of plant height. Compared to *IR-42*, *Batang Piaman* showed taller phenotype in both locations with the tallest height obtained when this variety was planted in Saniang Baka (Fig. 1a). Like *Batang Piaman*, *IR-42* grown in Saniang Baka also exhibited taller size than in Tanjung Barulak (Fig. 1a). The tallest phenotype was obtained from *Batang Piaman* grown in Saniang Baka which reached 76 cm. These results implied that both varieties displayed better response with the environmental condition of Saniang Baka rather than Tanjuang Barulak. These results also showed clear interaction between variety and location factors (Table 1) where the height of varieties were taller with the decreasing altitude of planting location.

Table 1. Analysis of variance showing several parameters influenced by the interaction between locations and varieties applied in this study.

Parameters	Variety	Location	Variety x Location
Plant height	*	*	**
Total number of tillers	-	*	--
Number of productive tillers	-	*	--
Age of flowering	-	-	--
Age of harvesting	-	-	--
Panicle length	-	-	--
Total grains per panicle	*	*	**
Weight of total grains per panicle	*	*	--
Weight of filled grains per panicle	*	*	--
Weight of 1000 grains	*	*	**
Yields per plot	*	*	**

Single asterix (*) indicated significantly affected; single minus (-) indicated insignificantly affected; double asterix (**) indicated the presence of interaction between variety and location; double minus (--) indicated no interaction between variety and location.

Number of Tillers

Difference in planting locations resulted in different number of resulted tillers in each variety. Both varieties exhibited similar number of total tillers in both locations, although Saniang Baka resulted larger amount of total tillers compared to Tanjuang Barulak (Fig. 1b). However, Tanjuang Barulak revealed significantly higher number of productive tillers from both varieties than Saniang Baka (Fig. 1c). This contradict relationship suggested that productive tillers resulted did not depend on the amount of total tillers.

Flowering and Harvesting Ages

Regarding the flowering and harvesting ages, IR42 exhibited longer flowering and harvesting age compared to *Batang Piaman* in both locations (Fig. 1d and e). However, the difference of planting location did not show any significant effect towards these two parameters in both varieties. As seen in Fig. 1d, IR42 grown in Saniang Baka begun flowering earlier compared to Tanjuang Barulak, so did the harvesting age. Unlike IR42, flowering age of *Batang Piaman* planted in Tanjuang Barulak were earlier than Saniang

Baka (Fig. 1d). But uniquely, its harvesting age were longer in Tanjuang Barulak compared to Saniang Baka (Fig. 1e). Both flowering and harvesting age were basically determined by the duration of vegetative phase.

Panicle Length

Both varieties in both locations exhibited similar length of panicle. The longest panicle was obtained from *Batang Piaman* planted in Saniang Baka with 25.5 cm (Fig. 1f). This result implied that different agroclimate did not affect this parameter.

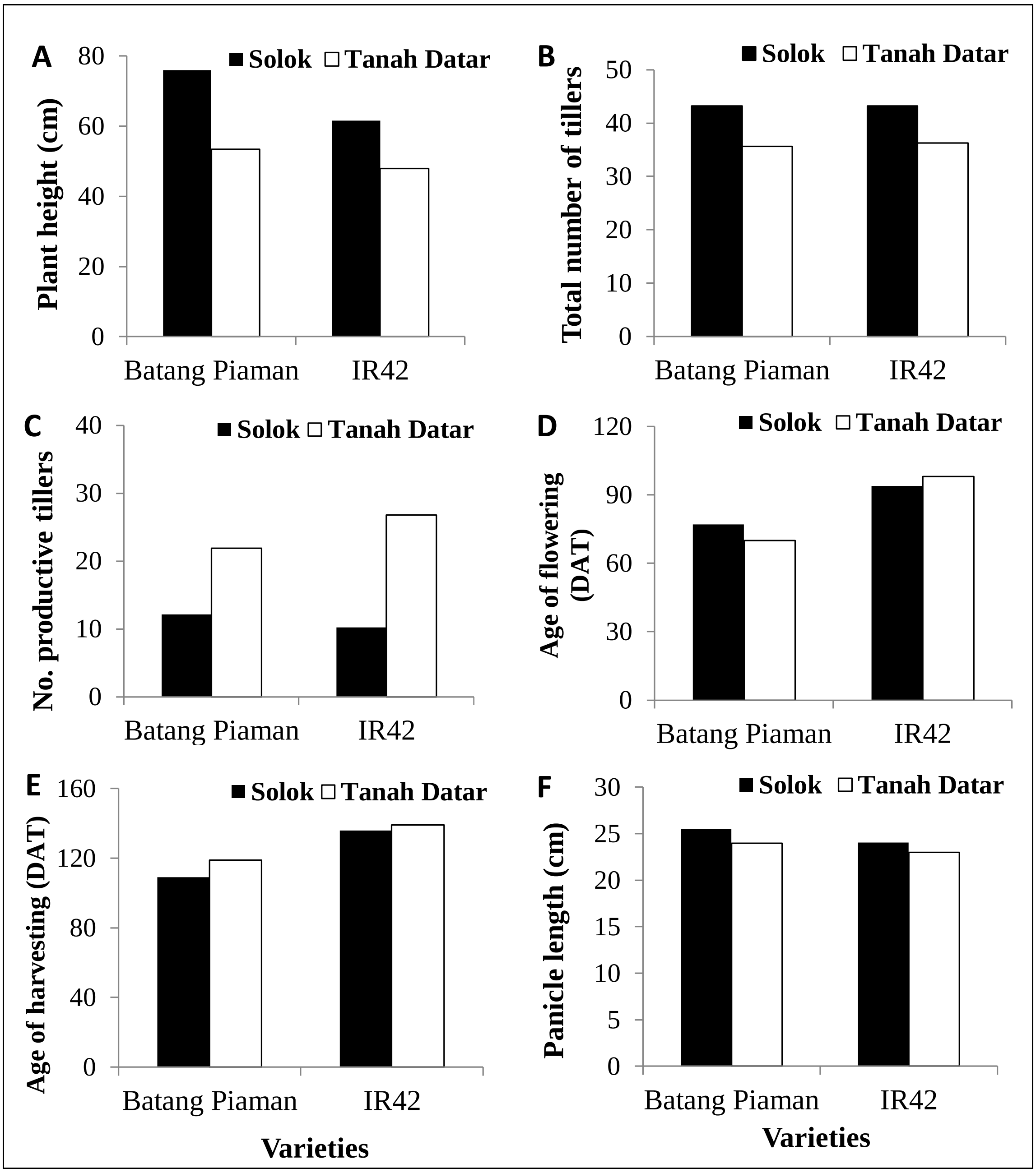

Figure 1. Response of two rice varieties grown using SRI method in different planting locations resulted in different perfomance of several vegetative parameters, such as height (a), total number (b) and number of productive tillers (c), flowering (d) and harvesting ages (e), as well as panicle length (f).

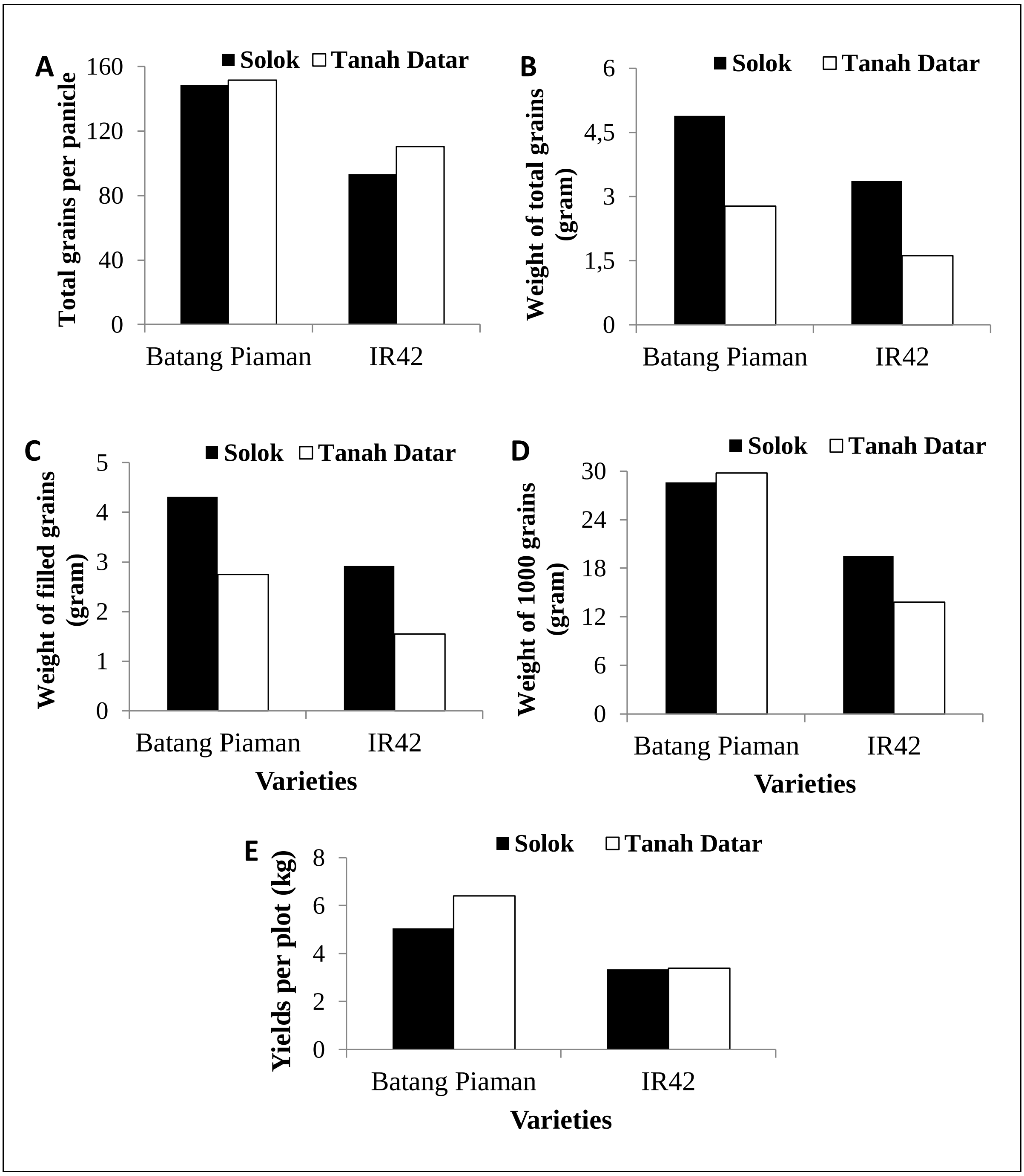

Figure 2. Effect of SRI method implementation towards various yield parameters of Batang Piaman and IR42 rice varieties, such as total grains (a), weight of total (b) and filled grains (c), weight of 1000 grains (d), as well as resulted yields per plot (e).

Grain Yields

Several yields related parameters, such as grains number per panicle, grain total weight per panicle, filled grains weight per panicle and yields per plot varies among both varieties and locations. *Batang Piaman* produced similar number of grains per panicle in both locations, but remained higher than the amount of IR42 grains per panicle (Fig. 2a). IR42 planted in Tanjuang Barulak produced more grains compared to the one planted in

Saniang Baka (Fig. 2a). Regarding the grain weight, both varieties revealed heavier total grains and filled grains per panicle when grown in Saniang Baka (Fig. 2b). Of two varieties tested, *Batang Piaman* showed the heaviest weight of grains per panicle, particularly when grown in Saniang Baka. Even its filled grains had the same weight as its total grains per panicle (Fig. 2b).

Other yield parameter, weight of 1000 grains, displayed relatively similar weight in *Batang Piaman*, but significantly different weight in IR42 from both locations. The heaviest weight of 1000 grains of *Batang Piaman* could reach 29.7 gram obtained from Tanjuang Barulak area. In contrast, 1000 grains of IR42 showed maximum weight at 19,5 gram obtained from Saniang Baka (Fig. 2c). The interaction of variety and location factors in this parameter was clearly seen and statistically verified (Table 1). In addition, this parameter was strongly correlated to grain weight. As seen in Fig. 2b, grains of *Batang Piaman* were heavier compared to IR42, so that the weight of 1000 grains of this variety must be higher.

Similar to previously explained yield parameters, the resulted yield per plot varied due to response difference of each variety towards different environmental condition. Based on the performance of each variety evaluated, *Batang Piaman* appeared as a variety with the best response in both location, including for this parameter. The highest yield per plot of this variety could reach 6.4 kg achieved from the one planted in Tanjuang Barulak region (Fig. 2d). Unlike *Batang Piaman*, the resulted yield of IR42 in both locations were nearly the same confirming its less adaptive characteristic.

Discussions

Regarding the locations used, both locations conferred different agroclimate condition. District of Saniang Baka is typically lowland located near Singkarak Lake with high rainfall and humidity. This region also had more fertile black soil with sufficient water supply. In contrast, District of Tanjuang Barulak is a rain shadow highland with slope elevation approx. 30 degrees resulting in less rainfall, warmer temperature and relatively dry condition compared to Saniang Baka. This kind of agroclimate condition affects the soil condition directly where the soil become less fertile due to water deficit. Based on these facts, it was strongly suggested to grow these varieties in lowland area such as Saniang Baka as the geographical condition was well supported for the plant growth.

Number of productive tillers was determined based on number of tiller having filled panicles. The process of panicle filling was greatly influenced by weather condition where high rainfall might cause the incomplete panicle filling, thus resulting in empty panicle. Agroclimate of Tanjuang Barulak, which was drier with less rainfall, enabled the fertilization and panicle filling processes occurred perfectly. Unlike Tanjuang Barulak, high intensity of rainfall found in Saniang Baka restricted the tiller to produce filled panicle since most tillers acted as sink. Therefore, although rice planted in Saniang Baka produced more number of total tillers (Fig. 1b), but the environmental condition in that area was unfavorable for panicle filling so that less filled panicle and productive tillers could be obtained. This condition was undesirable in rice farming since it could reduce the resulted yield.

The grain weight were influenced by either genetic and environment. However, parameters described previously were not statistically proven showing any interaction between varieties and locations (Table 1), except on the total grains per panicle. The plant response towards its surrounding environment would affect plant metabolism, including photosynthesis which determines the resulted assimilates. The amount of assimilates stored inside the plant would also affect the result grain weight.

To produce maximum yield, rice should be maintained with sufficient water availability according to the requirement of each growth phase. During vegetative phase, water supply should be regulated to create moist condition for the rice growth. More water were required during generative phase, particularly at panicle filling stage, and maintained until the rice become yellow-ripened.

Conclusions

The result of this study confirmed that response of both varieties (*Batang Piaman* and IR42) varied based on its compatibility with the planting location, thus resulting in different performance. *Batang Piaman* was considered as more responsive and adaptive rice variety compared to IR42. Regarding the locations, the agroclimate of Saniang Baka was preferable for better rice growth, while environmental condition in Tanjuang Barulak enabled higher yield. Genetic-environment interaction (GxE) only affected several parameters, such as plant height, total grains per panicle, weight of 1000 grains, and yield per plot.

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