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THE GROWTH RESPONSE AND RESULTS OF LOCAL UPLAND RICE CULTIVARS ON ULTISOL SOIL WEST SUMATERA

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ABSTRACT

Upland rice which is cultivated on dry land, has limited needs for growth and production. The low upland rice production is due to the lack of high-yielding varieties that can adapt, especially to marginal lands such as Ultisol. There are quite many local upland rice lines, but their potential has not been tested much. This study aimed to obtain the growth and yield of local upland rice cultivars of West Sumatra on the best Ultisol soil. The study used a completely randomized design (CRD) with four replications. The treatments were four upland rice cultivars, consisted of; Silayang (K1), Siarang (K2), Sirah (K3) and Sigudang (K4). This data observation was analyzed for variance, and if it had a significant effect, it was continued using DMRT at the 5% level. Observations were made on plant height, the maximum number of tillers, percentage of productive tillers, length of flag leaf, age of flowering, age of the first harvest, panicle length, number of grain per panicle, the weight of 1000 pithy grain seeds, and weight of pithy grain per clump. Based on the result of the study, the Sirah cultivar had better adaptation to growth and yield, it was recommended to use the Sirah cultivar on Ultisol.
Keywords: Cultivar, Upland Rice, Ultisol

INTRODUCTION

Rice one of the most important and strategic food crop communities in maintaining the stability of national food security. Rice is a basic need for most of Indonesia's population. Population growth is certainly followed by increasing demand for rice. Most of the demand for rice comes from lowland rice, and the rest comes from upland rice.

Rice needs are not only from lowland rice but also from upland rice. The contribution of upland rice in meeting the national demand for rice is still low, which is around 7-8 percent. (Badan Pusat Statistik, 2020) reported, national rice production in 2019 reached 54.604 million tons of dry milled grain with a planting area of 10,667 million ha without a productivity of 5,114 t/ha. In 2020, rice production will reached 54,649 million tons with a planting area of 10,657 million ha with the productivity of 5,127 t/ha.

Kementerian Pertanian, (2018) reported that upland rice production nationally in 2017 reached 3,782 million tons with a harvested area of 1,156. Million ha and productivity of 3,782 t/ha, while lowland rice production was 77,366 million tons of kg, with a harvested area of 14.556 million ha with productivity 5,315 Ku/ha. As an area that also develops upland rice, West Sumatra also contributes to the national upland rice production of 14,084 tons. The data showed that upland rice productivity was lower than lowland rice and a long harvest life. According to Gea et al., (2020) increasing rice production did not only rely on lowland rice but also on upland rice through the expansion of planting areas.

Centre of upland rice production in West Sumatra comes from Pasaman Regency, West Pasaman Regency, South Solok Regency, and Dharmasraya Regency. The area has highlands suitable for upland rice. (Badan Pusat Statistik, 2020) reported that, in 2017 the harvested area of upland rice plants in Pasaman Regency was 1,270 ha with a production of 2,120 tons, in West Pasaman Regency, a harvest area of 2,760 ha was recorded with production 9,326 tons, South Solok Regency recorded a harvested area covering an area of 717 ha with a production volume of 2,333 tons, while in Kab. Dharmasraya recorded an area of 117 ha of upland harvested crops, with production of 248 tons.

Upland rice productivity is still low compared to lowland rice. This is caused by several factors, including; not many high-yielding varieties have been developed due to limited genetic resources that tolerate various environmental factors and limited land suitable for upland rice cultivation. According to Maslaita, (2017) several factors cause low upland rice production, including the lack of adaptive hope lines with good rice quality and medium yield potential. Upland rice lines cultivated by farmers are generally of deep age, besides upland rice has good characters including resistance to pests and diseases, tolerance to minerals in the soil.

Upland rice production can be increased by intensification through productivity improvements. Upland rice cultivation is faced with various obstacles, including; low productivity, limited environmental adaptability, and long harvest life. On the other hand, upland rice has better disease resistance than lowland rice. Therefore, various efforts can be made to explore the potential of local upland rice genetic resources through various studies to obtain superior upland rice varieties that have high productivity, wide environmental adaptability, and early maturity to solve problems.

Upland rice is one type of rice that is grown on dry land or dry land. This land will generally be located in an area with hilly topography, so it has limited water availability. Farmers have done this for a long period with traditional cultivation, such as without fertilization. The land condition with limited nutrients and water causes the yield obtained by farmers to be still low. Upland rice requires relatively little water for growth and yield. Therefore upland rice has the potential to be developed on dry land. Upland rice is cultivated on dry land, so it does not require technical irrigation and intensive plant maintenance such as maintenance of lowland rice.

Upland rice production can be increased by intensifying by developing superior varieties with high productivity and can adapt to marginal land rice, which has limited nutrients. One of the strategies for obtaining superior upland rice varieties that have better environmental adaptability, especially on land with low fertility levels, is by testing local upland rice.

West Sumatra has the potential for high upland rice genetic resources, which has received the local community's attention, with and certain important characteristics that is necessary to be maintained. This can be seen from the various efforts made to preserve the genetic resources of upland rice using bleaching that can be released as a Local Superior Variety. Azis, (2013) stated that, in testing the cultivars Sigudang, Siranting, Maritik Nabara, Sikorojuik, Siordok Baor, and Situ Bagendit, generally the characters had high heritability estimates except for productive tillers. The high value of genetic progress and the wide coefficient of genetic variation were found in the character of the number of grains per panicle. (M. Q.

Malik, 2020) stated that West Sumatra has 11 superior local varieties, including; Red Caredek and Black Siarang varieties, Junjuang varieties, and congenital varieties. In addition to upland rice varieties, which have become superior varieties. West Sumatra still has many upland rice lines that still need to be studied for potential superior traits developed into new superior varieties such as; Guliang Tandai Hitam from South Solok, Siarang, Sirah, Kalupak Omeh from East Pasaman Regency, and Sigudang from East Pasaman.

Apart from having superior characteristics, the potential for upland rice lines is more important in terms of adaptability to various environmental factors. Malik, (2017) explained that superior varieties had the following criteria; high yield potential, resistant to biotic environmental stresses, such as pests and diseases, tolerant to abiotic environmental stresses, such as soil type and drought, early maturity (short), response to agricultural inputs, such as fertilization, and high-yield quality and quantity so that favored taste and had a high price. The superiority of upland rice has high suitability to environmental stresses (abiotic) in Ultisols. This is certainly expected to be able to explore the potential for better upland rice yields. Lestari et al., (2020) stated that Superior upland rice varieties that were adaptive to acid soils expected to increase production at a relatively low cost. The superior varieties development can increase the productivity without continuous lime application. The development of superior varieties that can adapt well to stressful environments (abiotic and biotic) through plant breeding needs to be done to obtain superior rice genotypes in acidic soil environments such as ultisols.

Increasing upland rice productivity by developing new superior varieties through the use of genetic resources, increasing upland rice production can also be done by extensification of agriculture through expansion of planting area. The available dry land has the potential for upland rice cultivation. The potential of the dry land is expected to support the national rice production increase program. The available dry land in upland rice cultivation has problems, including low fertility. Fertile, dry land has been converted to industry and infrastructure. The available land has a low fertility rate, such as the Ultisol type. Ultisol is one type of soil that is quite extensive in Indonesia and has good potential in upland rice cultivation.

Ultisols had a distribution of almost 25% of the total land area of Indonesia. The medium to high cation exchange capacity made this soil an important role in developing dry land agriculture in Indonesia (Prasetyo & Suriadikarta, 2006). According to Abdurachman et al., (2008) the Ultisol-type land in Indonesia reached 41.919 million ha, while in West Sumatra, the Ultisol-type land area was 1.224 million ha. According to Kasno, (2013), Ultisol land naturally included very low fertility potential. Productivity of food crops on acid dry land is generally low because the level of management was not based on soil characteristics.

Ultisol is a type of soil with the potential for plant cultivation but is faced with various problems. According to Fitriatin et al., (2014) Ultisols have problems including high soil acidity, low organic matter and low macronutrients and very low availability of P. Furthermore, Marwiyah et al., (2021) explained that Ultisols had a cation exchange capacity, base saturation, low to very low organic N, P, K and C retention, high aluminium content (Al saturation), and high soil pH. High (acid). Kusumastuti, (2017) stated this indicated that the soil had undergone advanced weathering so that soil fertility is low. According to Shanti, (2018), soil acidity is one of the important factors in overcoming soil fertility. Soil acidity can change the population and activity of micro-organisms that play a role in transforming N, S, and P in the soil. This indirect affected the availability of nutrients for plants. The potential of existing dry land with the adaptability of superior varieties developed is expected to increase upland rice production. Therefore, there is a need for a study to see the genetic potential of local upland rice in West Sumatra.

Based on this description, studies related to the growth response and yield of upland rice cultivars from West Sumatra have been carried out on Ultisols.

The study aimed to obtain the growth and yield of local upland rice cultivars from West Sumatra on Ultisols.

MATERIALS AND METHODS

The research was carried out in the Experimental Garden of the Faculty of Agriculture, Tamansiswa Padang University. The research was conducted from June to December 2020.

The materials used were upland rice cultivars (Silayang, Siarang, Sirah and Sigudang), Urea, SP-36, KCl, Ultisol soil, and polybags measuring 40 x 50 cm. The tools used were machetes, sickles, hand sprayers, analytical scales, meters, cameras and stationery.

The study used a completely randomized design (CRD) which was repeated four times. The treatment given was 4 upland rice cultivars, consisting of; Silayang (K1), Siarang (K2) , Sirah (K3) and Sigudang (K4). This resulted in 16 experimental units, and each experimental unit had 3 sample plants.

Seed Nursery

Seed selection was done by soaking the seeds in water, the good seeds sink. The seeds were soaked in water for 24 hours, and placed on sprout paper for 48 hours.

Preparation of planting media

Ultisol was used as a planting medium taken from dry land in Lubuk Minturun. The soil was crushed and sifted, then dried for one week. The 10 kgs soil were put into polybag. a placed planting media on the experimental field.

Planting

Up to five seeds of upland rice were planted in the media by planting holes as deep as 2 cm and closing the holes again.

Fertilization

The fertilizers given in this experiment were Urea 150 kg/ha or 0.75 g/clump, SP-36 135 kg/ha or 0.68 g/clump, and KCl 60 kg/ha or 0.3 g/clump. Fertilizer was given to the hole around the plant and closed again.

Harvest

Upland rice harvests were carried out after meeting the harvest criteria, including 80% of the flag leaves starting to turn yellow, the colour of the grain was yellow, the grain was hard, and the flag leaves were drooping.

Observations were made on plant height, the maximum number of tillers, percentage of productive tillers, flag leaf length, age of flowering, age of the first harvest, panicle length, number of grain per panicle, the weight of 1000 pithy grain seeds, and weight of pithy grain in a clump. The last observation data were analyzed for variance (ANOVA). If it had a significant effect, then proceed with DMRT at the 5% level. Data were analyzed using the Statistix ver. 8 program.

RESULTS AND DISCUSSION

Plant height, flag leaf length, maximum number of tillers, and number of productive tillers.

The analysis of variance had a significant effect on plant height and the maximum number of tillers of upland rice but had no significant effect on the percentage of productive tillers of local upland rice cultivars in Ultisol.

Table 1. Plant height, maximum number of tillers, percentage of productive tillers, and leaf length of local upland rice cultivars of West Sumatra in Ultisol

Cultivars	Plant Height (cm)	Maximum tiller (tiller)	Productive Tillers (%)	Flag leaf length (cm)
Sirah	154.34 a	23.25 a	90.03	58,30
Sigudang	153.69 a	19.33 b	81.01	53.00
Cross	147.75 b	16.67 b	71.96	51.32
broadcast	132.45 c	16.66 b	71.65	50.88

Numbers followed by the same letter are not significantly different according to DMRT at 5% significance level.

Table 1 shows that growth in height and a maximum number of tillers had significant differences between upland rice cultivars tested on Ultisol. The Sirah cultivar had a height growth of 154.34 cm, which was relatively the same as Sigundang (153 cm), and the plant height decreased in the Silayang (147.75 cm) and Siarang (132.45 cm) cultivars. Upland rice cultivar Sirah produced more maximum tillers (23.25 tillers), the fewer tillers were Sigudang (19.33 tillers), Silayang (16.67 tillers), and Siarang (16.66 tillers)). The percentage of tiller production and the flag leaf length from the tested upland rice cultivars were relatively the same. The percentage of tiller production ranged from 71.65 to 90.03%, while the length of the upland rice flag leaves ranged from 50.88 to 58.30 cm.

The plant height and the maximum number of tillers produced by upland rice cultivars on Ultisol were different. Upland rice cultivars Sirah and Sigudang showed better adaptability to Ultisol compared to Silayang and Siarang cultivars. This was due to differences in height growth and the maximum number of tillers of upland rice determined by genetic factors of each cultivar. Cultivars that had good adaptability grow better compared to those with narrow adaptability. Good adaptation to Ultisol of upland rice cultivars showed that Ultisol properties with various limitations could stimulate well-adapted cultivars.

Different plant heights were also determined by the interaction of genetic factors with environmental factors. Plants that were widely adapted had low interaction with the environment, while plants with narrow adaptability had higher interactions with the environment. Syahril, (2017) explained that plant genetic factors caused the real difference of all cultivars observed. Differences seen from plant height and a maximum number of tillers are expressions of genetic factors. Furthermore, Nazirah & Damanik, (2015) added that, differences in genetic composition were one of the factors that affected plant height growth.

The number of tillers reaches the maximum number if the plant has genetic factors that can interact with favorable environmental factors wich is for the growth of upland rice plants. Apart from being determined by the variety, the number of tillers is also influenced by environmental conditions. According to Sitinjak, (2015), different varieties had different genetic traits. This is in line with Anhar et al., (2016), who stated that the number of tillers and plant height were different because each variety had different gene properties. These genes will be expressed in plant growth. In addition to genetic factors and environmental factors, cultivation systems also affected plant growth and development. The difference in the maximum number of tillers of each upland rice cultivar was influenced by these factors. The planting height of upland rice cultivars ranged from 132 – 154 cm. According to the Agency for Agricultural Research and Development, the National Germplasm Commission (2003) classified upland rice plant height into three; short (< 90 cm), medium (90 ± 125) cm and high (> 125 cm). Based on these classifications, upland rice cultivars have a relatively high growth. In addition to plant height, the number of upland rice tillers can also be classified. According to Las, et al, (2004), the criteria for varieties with the number of tillers per clump were few (< 10), medium (11-15), many (16-20), and very many (> 20). Based on the number of tillers of upland rice, the Sirah cultivar was very large, while the number of tillers of the Sigudang, Silayang and Siarang cultivars was quite large.

The percentage of productive tillers is a component that affects the productivity of upland rice. Herawati, R, Masdar, (2019) stated that the number of productive tillers was one of the important agronomic characteristics and was a determinant of genotype identity. The percentage of productive tillers is closely related to the maximum number of tillers. The number of productive tillers was reduced because tillers could not form panicles, resulting in fewer productive tillers of upland rice cultivars. According to Atman and Yarda, (2006), the formation of productive tillers was closely related to the maximum number of tillers. The more the maximum number of tillers, the greater the number of productive tillers produced. According to Idawani et al., (2016), the vegetative phase, the tillers increase rapidly until were reached the maximum tiller.

Besides being closely related to the maximum number of tillers, the number of productive tillers was also influenced by environmental factors. The number of tillers is determined by solar radiation, mineral nutrients, water availability, and cultivation methods. Nutrients, water, and sufficient light during panicle formation will affect the number of productive tillers of upland rice cultivars. Furthermore, Manurung et al., (2017) concluded the process of forming productive tillers was strongly influenced by the availability of sufficient water. Sufficient water can dissolve the nutrients needed by plants to form productive tillers and the length of the flag leaf.

Differences do not influence the length of the flag leaf of upland rice cultivars in genetic factors. Still, it is also influenced by environmental factors such as nutrients, water, and light. Ultisol is soil that has one of the environmental factors that have various limiting factors and is less favorable for the growth of leaves of upland rice cultivars. This showed that the growth of upland rice flag leaves was influenced by environmental factors, especially those related to the availability of nutrients and water during growth. Based on research results.

Age of flower out, age of harvest, and length of panicles.

The analysis variance was significantly affected the flowering and harvesting ages of upland rice cultivars but had no significant effect on the panicle length of upland rice cultivars on Ultisol soil.

Table 2. Age of flowering, harvesting age, and panicle length of local upland rice cultivars on Ultisol

Cultivars	Flowering age (dap)	Harvest age (dap)	Panicle Length(cm)
Sirah	120.25 a	168.00 a	39.07
Sigudang	113.50 b	157.75 b	37.01
Cross	108.25 c	149.25 b	36.61
Broadcast	96.75 d	138.00 c	35,30

Numbers followed by the same letter are not significantly different according to DMRT at the 5% significant level.

Table 2 shows that the age of first flower released and the harvest of upland rice cultivars on Ultisols had a significant difference. The Siarang cultivar had a faster flowering time (96.75 dap), then the slower flowering age was followed by the Silayang cultivars (108.25 dap), Sigudang (113.50 dap), and Sirah the slower flowering age. (120.25 dap). The same thing happened to the harvest age of the tested upland rice cultivars. The Siarang cultivar harvested earlier on 138 dap, followed by the Silayang cultivar (149.25 dap), which was not significantly different from Sigudang (157.75 dap), and the Sirah cultivar the slowest harvest, which was 168.00 dap.

The flower yielding an age of upland rice cultivars tested on Ultisol was significantly different. The Siarang cultivar had a faster flower yielding ability compared to other cultivars on Ultisol. This was also in line with the harvest age of upland rice cultivars. Flowering age and harvest age were two variables that were strongly influenced by genetic factors. According to Muliarta et al, (2013), flowering was one of the variables that need to be observed because each plant line gave a different age response in each season. Flowering time is important in determining the time of sowing and planting to get synchronized flowering at the same time of harvest. The flowering age of the plant is determined by observing the number of flowers that have come out. According to the Badan Penelitian dan Pengembangan Pertanian, (2009), the criteria for harvesting age were divided into five, namely: internal age (harvest age > 151 dap), medium age (harvest age between 125-150 dap), early maturity (harvest age between 105-150 dap), 124 dap), very early age (harvest age between 90-104 dap) and ultra-early age (harvest age < 90). Based on the criteria for harvesting age, Siarang and Silayang cultivars are classified as medium age cultivars, while Sigudang and Sirah are included in the criteria for deep age cultivars. According to Yoshida, (1981) rice plants with a deeper age were a form of adaptation to a less fertile environment.

Panicle length is one of the components of rice yield that was influenced by genetic and environmental factors, so it is not dominated by genetic factors alone. Subekti, (2011) stated that the interaction between genotypes and the environment was real in the character of the number of productive tillers and panicle length. This, of course, resulted in the growth of panicle length that cannot be separated from environmental factors. Environmental factors strongly influence the formation and growth of panicles. Ultisol is one of the environmental factors that affect panicle growth.

Number of grain per panicle, weight of 1000 dry grain, and weight of grain per clump of upland rice cultivars on Ultisol.

The analysis of variance had a very significant effect on the weight of the grain per clump, but it had no significant effect on the number of grains per panicle and the weight of 1000 dry grains.

Table 3. Number of grain per amalai, weight of 1000 pithy grains, and weight of grain per clump of local upland rice cultivars in Ultisol

Cultivars	Number of grain per panicle (grain)	Weight of 1000 grain (g)	Grain Weight per clump (g)
Sirah	427.91	28.15	47.55 a
Sigudang	398.25	26.78	40.44 b
Cross	384.83	26.33	37.38 b
Broadcast	348.50	26.10	33.75 b

Numbers followed by the same letter are not significantly different according to DMRT at the 5% significant level

Table 3 shows that the weight of pithy grain per clump of upland rice cultivars gives a significantly different weight. The Sirah cultivar yielded 47.44 g of pithy grain weight, heavier than Sigudang, Silayang, and Siarang, which were relatively the same at 40.44 g, 37.38 g, and 33.75 g, respectively. The number of dry pith grains and the weight of 1000 dry pith seeds of the cultivars tested on Ultisol was relatively the same. The number of grains per panicle ranged from 348.50 to 427.91 grains. The weight of 1000 grains of the tested cultivars was also relatively the same, ranging from 26.10 to 28.15 g.

The different cultivars tested gave different responses to the weight of the grain per clump. This is inseparable from several growth components, such as the number of tillers. Grain weight per clump, of course, is related to the number of tillers capable of producing panicles and grain. According to Sitorus, (2014), the most important factor influencing the high grain weight per panicle was the number of tillers and the number of panicles formed. In addition to the number of tillers produced by each cultivar, differences in harvest age also affect grain weight. Harvest age affects grain filling. The longer the harvest age of the cultivar tested for grain filling, the better. The Sirah cultivar was able to produce a heavier weight of grain per clump compared to other cultivars.

Grain weight is a yield component that affects crop productivity. Differences in cultivars affect the weight of upland rice grains. Idawanni et al., (2016) stated that differences in genetic factors of each variety were also the cause of differences in yield or production. Besides that, not only genetic factors, environmental factors also affect crop production. Environmental factors that affect crop yields are sunlight, rainfall and nutrients in the soil, and other factors that also affect the increase in grain yields are plant yield components.

Table 4. Correlation coefficient of yield components and yield of upland rice cultivars

Variable	**ST**	**AM**	**AP**	**GDP**	**PM**	**UB**	**UP**	**JGB**	**B1000**	**BGP**
ST	1.00									
AM	-0.7938	1.00								
AP	-0.3173	0.6830	1.00							
GDP	-0.2425	0.2486	-0.0536	1.00						
PM	-0.2925	0.2394	0.0274	0.6010	1.00					
UB	-0.7865	0.6938	0.1921	0.3456	0.0830	1.00				
UP	-0.7708	0.7110	0.2679	0.3111	0.0057	0.9539	1.00			
JGB	-0.0568	0.1457	-0.0445	-0.0346	-0.0307	0.1121	0.1455	1.00		
B1000	0.2006	-0.3067	- 0.3072	-0.1185	0.0215	-0.4579	-0.4372	-0.5200	1.00	
BGP	-0.2415	0.3222	0.2992	0.3451	0.0172	0.4978	0.4383	-0.5498	-0.0957	1.00

Description: TT = plant height, AM = maximum tiller, AP = productive tiller, PDB = flag leaf length, PM = panicle length, UM = age of first flower out, UP = harvest age, JGB = number of grain per panicle, B1000 = weight 1000 dry grain, BGP = weight of grain per clump

Correlation between yield components and yield of several local upland rice cultivars of West Sumatra on Ultisol soil. Plant height did not positively correlate with almost all of the observed variables, except for the weight of 1000 dry grains, maximum tillers, and flag leaf length, which were positively correlated with the weight of grain per clump. Still, it did not correlate with the weight of 1000 dry grains. This indicated that the yield component variables that including the maximum number of tillers and productive tillers, flag leaf length, flowering age, and harvest age had an important role in determining grain weight per clump in local upland rice cultivars West Sumatra on Ultisol soil. Grain weight per cultivar clump must consider the character of plant height, number of tillers, flowering age, and harvest age. Herawati, et al (2019) found that the number of tillers was positively correlated with filled grain. The more the number of tillers of rice, the more the amount of grain in it. In addition, a large amount of filled grain in the G3 genotype was due to the higher plant height compared to other genotypes. Plant height indicated a large proportion of crown or biomass as a source. The canopy is part of the plant that plays a role in the photosynthesis process. The more photosynthate produced, the greater the effect on grain yield. Correlation test of yield components and crop yields of upland rice.

CONCLUSION

Based on the result of the study, the Sirah cultivar had better adaptation to growth and yield, it was recommended to use the Sirah cultivar on Ultisol.

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