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Performance of Fifteen F5 Pedigree Upland Rice Lines in Ultisol

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ABSTRACT

Rice (Oryza sativa L.) is the main food source for most of Indonesia's population. Although rice production increases need to be maintained. One of the efforts in maintaining rice production is by creating superior rice varieties that are adaptive to Ultisol. This study aims to compare the appearance of fifteen lines of upland rice grown in Ultisol and select the best lines based on several characters by index selection. The research was conducted in August 2015 until January 2016 at Field Experiment of Bengkulu University, Kandang Limun, Bengkulu City. The experimental design was Randomized Block Design (RBD) with 3 replications. Upland rice selected were G1, G2, G3, G5, G8, G13, G16, G24, G30, G32, G35, G40, G44, G45, and G50. From the fifteen upland rice tested showed that the generative and vegetative variables did not significantly affect number of leaves, number of productive tillers, number of grains per panicle, weight of the grain per panicle, weight of 100 grains, and weight of grain.

INTRODUCTION

The rice plant (*Oryza sativa* L.) is the staple food of most Indonesians. Therefore rice becomes one of the strategic commodities in determining national food security. The government continues to make efforts to increase rice production from year to year (Maulana and Rachman, 2011). Rice production in Indonesia in 2014 was 70.83 million tons. In 2015 rice production increased to 75.36 million tons or an increase of 4.51 million tons (6.37%) (BPS, 2015). The increased of production have to be sustained done to meet the national food needs.

One way to elevate rice production is by extending the planting area. As the fertile land tends to decrease due to land conversion to non-agricultural uses, the expansion of planting area have to use marginal less fertile land. In Indonesia, one of marginal lands potential for expansion of rice planting area is Ultisol. It reached 108.8 million hectares or about 69.4% of the total dry land area in Indonesia. It spreads mostly outside Java, especially in Kalimantan (41.3 million ha), Sumatra (29.4 million ha), Maluku and Papua (21 million ha), and Bali and NTT (220 thousand ha) (BBSDLP, 2012).

Ultisol is a type of soil that has undergone further weathering so it becomes low in fertility. According to Prasetyo and Suriadikarta (2006), Ultisol is poor nutrient content especially P, Ca, Mg, Na and K, but high content of Al, low cation exchange capacity encouraged by high soil erosion. The fertility of ultisol soil can be improved by calcification, alley cultivation system, as well as organic and inorganic fertilizer application. However, all of the mention approaches were expensive.

The use of tolerant varieties is a less expensive and environmentally friendly to cope with the production period of plants in Ultisol. The local varieties which have been adaptive to acid land are germplasm of acid-tolerant source genes. Local rice crops grown by farmers are varieties that have been for decades of natural selection, but some local rice landras have low production level and longer to maturity (Sudaryono, 2009).

Various studies to obtain Ultisol tolerant rice varieties have been done. Suhartini et al. (2009) tested the genotype of low tolerant phosphorus

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tolerant rice on Ultisol and obtained the tolerant genotypes K36-5-1-1, Limboto, Batur, and NIL-C433, based on the number of tillers with a 50-60% tolerance ratio. Santika (2011) tested 63 hybrid upland rice for tolerance to Al toxicity. From the research, there were 11 tolerant hybrids: B 11577, TB 490, B 11580, B 11576, B 11587, BP 1970, B 11582, BP 1976, B 11178, B 11352, and B 11598.

In order to increase the local rice production of Bengkulu for adaptifvity of acid land has been done short X Short IR-78581. Short is a local cultivar that is collected from North Bengkulu Regency while IR-78581 is a high production of rice production of Indonesian Rice Research Institute of Muara Bogor. The formation of the homozygous strain has been carried out to the F5 generation. Therefore, to evaluate the potential of these strains in the acidic soil is required for field testing in Ultisol. This study aimed at comparing the performance of 15 lines of upland rice in Ultisol.

MATERIALS AND METHOD

The research was conducted on August 2015 until January 2016 at New Field Experiment Garden of Agriculture Faculty of Bengkulu University, Kandang Limun Sub-District, Muara Bangkahulu Sub -district, Bengkulu City. The experimental design used was Completely Randomized Block Design with 3 replications. As the treatments were 15 pedigree lines of F5 generated from a cross of local landrace “Pendek” X IR 78581. The fifteen lines tested were G1, G2, G3, G5, G8, G13, G35, G40, G44, G45, and G50.

Research field is processed twice. The first stage soil treatment is done by digging the soil as deep as approximately 15 cm. The second soil treatment is done to ground the soil and make a plot with a plot size of 80 cm x 5 m. Distance between beds 50 cm and distance between replicates 100 cm. Distance of plant used is 20 x 20 cm (Bilman, 2010). In one plot there are 4 rows and each row has 25 plants. Making the planting hole done with ditugal as deep as 5-7 cm. Each hole planted two rice seeds and given insecticide with active ingredient carbofuran 5-7 grains. The hole then closed the ground. Fertilizer is given as much as 250 kg / ha Urea, 175 kg / ha SP36, and 125 kg / ha KCL (Busyra and Firdaus, 2010). All SP36 and KCL fertilizers are given at the time of planting by grooving at the edge of the planting hole. Urea is administered three times each one-third the dose at planting, 4 and 7 weeks after planting (MST).

Plant maintenance includes embroidery at the age of 1 MST. Thinning is done at the age of 2 MST. Weed control is done manually by removing weeds. Watering is done when there is no rain in the afternoon. Control of plant-disturbing organisms is carried out chemically and mechanically. The dosage and concentration of pesticide used is adjusted to the recommendation stated on the pesticide packaging. Harvesting is done after the plant shows the harvest criteria. The characteristics of ready-to-harvest crops are 85% of the panicle is golden yellow, the leaves have yellow flags, the panicles of rice droop, the grains of hard grain if pressed by using nails and leave no traces.Variabel observed refers to the descriptive list of vareitas listed in the guidance of characterization system and evaluation of rice crops (Departemen Pertanian, 2003) includes plant height, number of leaves, number of productive tillers, panicle length, number of grains per panicle, number of grains per panicle, weight of 100 grains, weight of grain per panicle, weight of grain per hill. Data were analyzed statistically with F test at 5% level. If there is effect of treatment proceed with Duncan's Multiple Range Test (DMRT) at 5% level.

The observed variables refer to the descriptive list of varities listed in the guidelines of the characterization and evaluation system of rice plants (Departemen Pertanian, 2003) covering plant height, number of leaves, number of productive tillers, panicle length, number of grains per panicle, number of grain per panicle, weight 100 grains, weight of grain per panicle, weight of grain per hill. Data were analyzed statistically with F test at 5% level. If there is effect of treatment proceed with Duncan's Multiple Range Test (DMRT) at 5% level. The selection of strains is based on the selection index value according to Knight (1979). Selection index can be calculated by the formula:

$$I=W1X1+W2X2+W3X3+...+W15X15.$$

where I, W and X was selection index, the weight assigned to each character, and a standardized mean value, respectively. Standardized mean of variables were defined as having an average of 0 and a standard deviation of 1. The weight for each variables were plant height = 1, number of leaves = 1, number of productive tillers = 1, panicle length = 2, weight of 100 grains = 2, number of grains per panicle = 3, the number of grains per ticker per panicle = 3, the weight of the pungent grain per panicle = 3, the weight of grain per hill = 3.

RESULTS AND DISCUSSION

The location of the study was situated at latitude of 15 mdpl. Soil characteristic of that location was sandy clay loam with pH(H_2O) of 4.3 (very low). At low pH, the P element can not be absorbed by plants because it is bound by Al. The micro elements also become easily soluble in acid soils. Micro elements are needed in very small quantities so that if they are too abundant in the soil they can be toxic to plants. The C-organic content of the research field is 1.51% (low) and K-dd of 0.77 me/100g (high) and Al-dd of 1.03 me/100g (high). The low C-Organics decreases the quality of soil structure. High Al-dd causes Ca, Mg, and K cations were not adsorbed by the soil. They remain in the soil solution and are easily washed from the soil. In addition, high al-dd can result in very low P availability (Hardjowigeno, 2007).

Plant growth is generally influenced by genetic and environmental factors. Environmental factors that affect growth are temperature, rainfall, solar irradiance and air humidity. The average temperature per month during the study was 27.19°C. The temperature was higher than the temperature required by rice plants. According to Utama (2015), the optimal temperature for growth of upland rice is 22-27°C. Temperature is very influential on the vegetative and generative growth process (Jumin, 2005). High temperatures cause damage and disturbance of photosynthesis and respiration balance (Sopandie, 2014).

In addition to temperature, other agroclimate components that affect growth are the intensity of solar exposure. The average solar irradiance reached 71.50 cal/cm^2/day (high). The high radiation intensity causes high evapotranspiration. Plants showed the symptoms of rolled leaves during the day as the monthly average rainfall during study was 40.55 mm which was very low. According to Utama (2015), the rice growing phase requires an average rainfall of between 200 mm to 875 mm / month. To overcome the water shortage was done by watering every day.

Dry and hot climatic conditions led to higher insect attacks than diseases. The pungent-smell releasing insects suck the seed fluid during the milk stage resulting empty rice seed (Qomarodin, 2006). Application of insecticides with active ingredient of profenofos 500 g/L with a dose of 20 ml/L was done intensively every three days until the pest was controlled.

The result of variance analysis showed that the lines had significant effect on plant height, panicle length and number of grain per panicle. However, the strains did not significantly affect the number of leaves, the number of productive tillers, the number of pithy grains per panicle, the weight of grain per panicle, the weight of 100 grains and the weight of grain per hill (Table 1). The value of the coefficient of variation (CV) varies from 4.68% to 29.72%. The variable with the highest CV was the weight of full grain per panicle. The lowest CV value was in the weight of 100 seeds. Number of full grains per panicle and grain weight per hill was square root transformed because they had abnormal data distribution. The CV value indicates the degree of accuracy of a variable to the treated treatment. The CV value also states the experiment error as a percentage of the average. The higher the CV the lower the accuracy of experiment (Hanafiah, 2012). The weight of the pine-grain per panicle had the highest CV compared to other variables expected because the variable was strongly influenced by environmental factors.

Table 1. Ftest on the effect of lines on vegetative and generative variables of upland rice

Variable	Fcal		Prob	CV (%)
Plant height	11.16	**	<.000	9.63
Number of leaf	1.49	ns	0.180	18.16
Number of productive tiller	0.89	ns	0.580	24.58
Panicle length	5.04	**	0.000	4.68
Number of grain per panicle	2.27	*	0.032	22.43
Number of full grain per panicle	1.15	ns	0.359	16.45
Full grain weight per panicle	1.30	ns	0.267	29.72
Weight of 100 grains	1.85	ns	0.081	10.60
Grain weight per clump	1.31	ns	0.264	20.49

Note : * = significant difference at a=5%. ** = significant difference a=1%. ns = non significant difference at a=5%. CV : coefficient of variation.

Fifteen lines of upland rice that were tested on Ultisol showed adaptability to sub optimum conditions of Ultisol. The highest plant was shown by genotype G32 (124.27 cm), while the lowest plant shown by genotype G13 (69.90 cm) (Table 2). Differences in the appearance of each line were thought to be determined by genetic factors. According to Tasliah et al. (2002), each plant has different capabilities in dealing with differences in an environment. According to the Departemen Pertanian (2003) the preferred gogo rice genotype have short to moderate plants (<125 cm). Rice crops that grew too tall was easily to lodge. This was in line with the results of this study. All that lines tested have plant height less than 125 cm. The results of Yamin and Moentono (2005) showed that plant height was positively correlated with the level of lodging. Rice plants with short stems are expected to be the most resistant rice crop.

The longest panicle was owned by the G24 line (25.24 cm), while G2 line had the shortest panicle with an average of 20.71 cm. Appearance of the G2 line was not significantly different from the G5, G16, G45, and G50 lines. According to Nazirah and Damanik (2015), long panicles highly associated with rice yields. The longer the panicle, the more total grain produced. The total number of grains per panicle is indicated by the G1 line (163.9 grains). According to the Departemen Pertanian (2003) most

Table 2. Vegetative and generative growth of 15 line of upland rice grown in Ultisol

Line	Plant height (cm)	Number of leaf (g)	Number of productive tiller (tiller)
G1	74.37 e	82.0	12.5
G2	74.20 e	89.7	18.7
G3	81.30 cde	67.4	16.7
G5	84.67 cde	98.5	19.4
G8	74.17 e	91.0	20.8
G13	69.90 e	85.0	13.3
G16	92.07 bcd	100.5	16.4
G24	103.93 b	94.1	17.0
G30	102.70 b	100.7	19.0
G32	124.27 a	90.5	17.6
G35	97.33 bc	75.2	17.1
G40	105.37 b	76.1	15.9
G44	92.80 bcd	76.2	16.1
G45	71.07 e	86.5	17.8
G50	71.00 e	107.3	20.4

Note : Numbers in the same column followed by the same letter were not significantly difference based on DMRT at a=5%

of the strains tested were classified as having good grain per panicle except G2 and G45 strains. The average number of grains per panicle produced was more than 100 grains. Subekti (2011) reported that Jatiluhur varieties had the number of grains per panicle of 133 grains.

The status of ground water affected the number of grains per panicle (Makarim and Suhartatik, 2009). Jumin (2002) stated that less water when generative growth can affect the ability of upland rice plants to form grains. Number of productive tillers, number of pithy grains per panicle, average weight of empty grains per panicle, weight of 100 grains, and grain weight per clump were not significantly different between lines (Table 3). The highest number of leaves of line G50 was 107.3 leaves, while the lowest leaf number was that of line G3 (67.4 leaves). Line G3 was not significantly different from the other lines tested. The highest number of productive tillers was G8 (20.8 tillers) and G50 (20.4 tillers). Based on the standardization of the Departemen Pertanian (2003) good rice plants have more productive tillers of more than 25 tillers. Factors that affect the formation of the number of tillers are environmental conditions. According to Riyanto et al. (2011), the number of productive tillers illustrated the ability of plants to form panicles. The number of productive tillers is a yield component that directly affects the yield. Thus all the lines tested did not have good production potential in Ultisol.

Line G13 showd the highest number of full grains per panicle (133.8 grains) and line G2 was the lowest one (59.9 grains). The results were not significantly different from the other lines. This, of course, affected the weight of the pithy grain per panicle. The highest grain yield per panicle obtained in line G8 (3.17 g) and the lowest one obtained in line G2 (1.48 g). Fifteen lines tested showed no significant difference each other with respect to weight of 100 grains. The highest weight of 100 grains was shown by line G44 (2.81 g), and the lowest one was that of line G40 (2.14 g).

The highest grain weight per clump was obtained in line G8 (41.07 g), while the lowest one was shown by line G2 (12.88 g). According to Supriadin et al. (2013), weight of grain is determined by the number of leaves. High efficiency of sunlight usage through photosynthesis process influences the shape and size of grain.

The selection of acid tolerant rice line was conducted by index selection involving all observed variables. Each of which was weighted differently depending on its magnitude effect on production. The results showed that the best lines with positive selection index values over 10 were G8, G24, and G30 (Table 4). The line accumulatively has the best growth and yield in Ultisol.

CONCLUSION

Fifteen lines of upland rice grown on Ultisol showed good growth ability. The best growing line significantly different from other lines was G32. The best line with the highest number of grains was line G1. Other variables observed were not able to differentiate between lines. The best lines based on vegetative and generative variables with the highest selection index values were G8, G24 and G30.

REFERENCE

BBSDLP (Balai Besar Litbang Sumberdaya Lahan Pertanian). 2012. Sub-Optimal Land: Potential, Opportunity and Problems of Utilization to Support Progaram Food Security. Presented in Sub-Optimal Land Seminar, Palembang March 2012. Kemeterian Riset dan Teknologi. (In Indonesian)

Tabel 3. Yield component of upland rice grown on Ultisol.

Line	Panicle length (cm)		Number of grain per panicle (grain)		Number of full grain per panicle (grain)	Full grain weight per panicle (g)	Weight of 100 grains (g)	Grain weight per clump (g)
G1	23.81	abc	163.9	a	111.2	2.56	2.32	23.62
G2	20.71	e	79.6	d	59.9	1.48	2.30	12.88
G3	24.36	ab	111.3	abcd	89.2	2.07	2.59	24.50
G5	22.09	cde	114.9	abcd	111.0	2.72	2.51	23.33
G8	24.56	a	119.6	abcd	115.2	3.17	2.80	41.07
G13	24.68	a	145.4	abcd	133.8	3.04	2.38	21.42
G16	22.47	bcde	103.6	bcd	91.0	1.94	2.42	27.10
G24	25.24	a	155.2	ab	121.3	2.87	2.59	33.17
G30	24.67	a	141.3	abc	116.6	2.89	2.59	30.97
G32	25.08	a	112.9	abcd	101.1	2.23	2.31	25.81
G35	23.41	abcd	107.8	bcd	74.0	1.93	2.80	23.49
G40	23.23	abcd	141.7	abc	114.9	2.43	2.14	22.70
G44	24.80	a	127.0	abcd	100.7	2.80	2.81	35.98
G45	21.41	de	90.0	cd	81.7	2.16	2.77	21.18
G50	22.34	bcde	112.0	abcd	99.9	2.34	2.57	29.89

Note : Numbers in the same column followed by the same letter were not significantly difference based on DMRT at a=5%

Tabel 4. Nilai terboboti beberapa variabel pertumbuhan dan komponen hasil yang sudah distandarisasi serta nilai indeks galur padi gogo yang ditanam pada Ultisol

Lines	Plant height	Number of leaf	Number of productive tiller	Panicle length	Number of grain/ spike	Number of full grain per panicle	Full grain weight per panicle	Weight of 100 grains	Grain weight per clump	Index
G1	-0.83	-0.54	-2.05	0.20	1.78	0.50	0.24	-0.97	-0.41	0.54
G2	-0.84	0.14	0.63	-1.97	-1.78	-2.12	-2.02	-1.08	-1.97	-23.28
G3	-0.41	-1.84	-0.23	0.59	-0.44	-0.62	-0.79	0.30	-0.29	-6.49
G5	-0.20	0.93	0.93	-1.01	-0.29	0.49	0.59	-0.07	-0.46	2.79
G8	-0.84	0.26	1.52	0.73	-0.09	0.70	1.52	1.30	2.12	12.90
G13	-1.10	-0.27	-1.70	0.81	1.00	1.65	1.26	-0.71	-0.73	7.15
G16	0.25	1.11	-0.36	-0.74	-0.77	-0.53	-1.04	-0.50	0.09	-8.84
G24	0.98	0.54	-0.10	1.20	1.41	1.02	0.89	0.30	0.97	14.26
G30	0.90	1.12	0.76	0.80	0.82	0.77	0.93	0.30	0.65	13.32
G32	2.22	0.22	0.16	1.09	-0.37	-0.02	-0.44	-1.02	-0.10	0.42
G35	0.57	-1.14	-0.05	-0.08	-0.59	-1.40	-1.06	1.30	-0.43	-7.40
G40	1.07	-1.06	-0.59	-0.21	0.84	0.69	-0.02	-1.82	-0.55	-0.69
G44	0.30	-1.05	-0.52	0.89	0.22	-0.04	0.75	1.35	1.38	5.49
G45	-1.03	-0.13	0.22	-1.48	-1.33	-1.01	-0.60	1.14	-0.77	-10.22
G50	-1.04	1.71	1.38	-0.83	-0.41	-0.08	-0.20	0.19	0.50	0.07

Bilman, W. S. 2010. Substitution of Tithonia diversifolia and Modification of Cropping Distance to Gogo Rice Weed Growth and Gogo Rice Product Component. Jurnal Penelitian Unib 16(1):54-70. (In Indonesian)

BPS. 2015. Indonesian rice production . http://www.bps.go.id/linkTable. dinamis/view/id/864. Diakses pada tanggal 5 Juni 2016. (In Indonesian)

Busyra dan Firdaus. 2010. Recommendation of Fertilization of Rice and Palawija on Dryland in Jambi Province. Balai Pengkajian Teknologi Pertanian Jambi. Jambi. (In Indonesian)

Departemen Pertanian. 2003. Guide of Characteristics and Evaluation System of Rice Crops. Departemen Pertanian. Bogor. (In Indonesian)

Hanafiah, K.A. 2012. Experimental Design. Theory and Applications. Raja Grafindo Persada. Jakarta. (In Indonesian)

Hardjowigeno, S. 2007. Soil Science. Akademika Pressindo. Jakarta. (In Indonesian)

Jumin, H.B. 2002. Basic Agronomy. Raja Grafindo Persada. Jakarta. (In Indonesian)

Knight, R. 1979. Selection for one or more character. Plant Breeding. A course Manual in Plant Breeding. Australian Vice-Chancellors Committee. Brisbane. p. 63-67

Makarim A.K. dan E. Suhartatik. 2009. Morfologi dan Fisiologi Tanaman Padi (Rice Morphology and Physiology). Balai Besar Penelitian Tanaman Padi. p.295-330. (In Indonesian)

Maulana, M. dan B. Rachman. 2011. Government Purchase Price (GPP) of rice-grain in 2010: efectiveness and its implications for quality and procurement by Bulog. Bogor. (In Indonesian)

Nazirah, L. dan B.S.J Damanik. 2015. Growth and outcome of three upland rice varieties on fertilizer treatment. Jurnal Floratek 10:54-60. (In Indonesian)

Prasetyo, B.H., dan Suriadikarta, D.A. 2006. Characteristics, Potential, and Technology of Ultisol Soil Management for Dryland Agricultural Development in Indonesia. Balai Besar Penelitian dan Pengembangan Sumberdaya Lahan. Jurnal Litbang Pertanian. Bogor. (In Indonesian)

Qomarodin. 2006. Walang Sangit Control (Leptocorisa oratorius F) Environmentally Friendly at Farmer Level in Lebak Rawa Land. Jurnal Pusat Penelitian dan Pengembangan Peternakan. 377-380. (In Indonesian)

Santika, A. 2011. Technique of Rice Testing of Gogo Rice Against Aluminum Poisoning at Greenhouse. Buletin Teknik Pertanian. Bogor. (In Indonesian)

Sopandie D. 2014. Fisologi Adaptasi Tanaman Terhadap Cekaman Abiotik Pada Agroekosistem Tropika (The Physiological Adaptation of Plants to Abiotic Constriction at Tropical Agroecosystem). IPB Press. Bogor. (In Indonesian)

Sudaryono. 2009. Tingkat Kesuburan Tanah Ultisol Pada Pada Lahan Pertambangan Batubara Sangatta, KalimantanTimur (The Soil Fertility Rate of Ultisol on The Land of Sangatta Coal Mining, East Kalimantan). Peneliti Pusat Teknologi Lingkungan. Jakarta. (In Indonesian)

Suhartini T., J. Prasetiyono, M. Bustaman dan I.H. Somantri. 2009. Appearance of Rice Genotype of Gogo Tolerant Rice of Phosphorus in Ultisol Soil. Jurnal Penelitian Pertanian Tanaman Pangan 28(2):109-117. (In Indonesian)

Utama Z. H. 2015. Budidaya Padi pada Lahan Marjinal (Rice Cultivation on Marginal Land. Andi. University of Jambi). Andi. Universitas Jambi. http/GoogleBook. Diakses pada tanggal 2 Mei 2016. (In Indonesian)