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Agronomic and yield characteristics of new superior lines of amphibious rice derived from paddy rice and local upland rice crossbreeding in konawe of indonesia

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The sustainability of rice production depends on the development of new rice cultivars with high yield and stable performance. The choice of cultivar more suited to a particular environment can contribute to increased productivity of this crop. The aim of the present study was to evaluate the agronomic and yield characteristics of some breeding lines of amphibious rice. The experiment was conducted in Konawe, Southeast Sulawesi, using a randomized block design with four replications. Eight breeding lines were used as single treatment. We evaluated the following agronomic characteristics: plant height, leaf area, tillering per hill, grains number per panicle, 1000 grain weight, and grain yield per hectare. Significant variation on agronomic and yield characteristics was observed among the amphibious rice lines. Greater tillering, higher grains number per panicle, and higher grains yield ha^{-1} were obtained on three amphibious rice lines, i.e., GS16-1, GS44-2, and GS11-2. Grain yield was observed to be positively associated with productive tillers, filled grains and number of grains per panicle.

Keywords: Agronomic characteristic, amphibious rice, crossbreeding, grain yield, superior lines

INTRODUCTION

Rice (*Oryza sativa* L.) is an important food crops commodity in Indonesia. Ninety-five percent of Indonesians consume rice. Rice is capable of sufficient 63% of the total energy sufficiency and 37% protein. Rice grain contains 70 to 80% starch, 12% water and 7% protein (Oko et al., 2012; Hossain et al., 2015, Konate et al., 2015). The rice demand is expected to increase in the future in line with the increase population. Many effort have been done to reach rice self-sufficiency (Muhidin et al. 2013, 2016; Syaiful et al., 2013; Sadimantara et al., 2016; Sutariati et al., 2017; Kadidaa et al., 2017).

Increasing the production of upland rice can be done through innovation of new superior varieties technology. According to Baihaki and Wicaksana (2005), the increase of productivity of crop commodity, 60%-65% is determined by the use of superior seeds. Efforts to increase production are done through improving the quality of rice crops such as the development of high yielding varieties that have high yields, good genetic quality, and the use of high quality seeds.

The appearance of a character within a population is determined by genetic variation, environment, genetic and environmental interactions (Fehr, 1987).

The productivity of upland rice can be improved by the development of improved varieties through plant breeding programs. In order to obtain amphibious rice varieties, Sadimantara et al., (2014, 2016) has assembled several promising lines of upland rice through crossbreeding between local upland rice and paddy rice cultivar. Furthermore, these amphibious crossbreed lines need to be tested in the adaptation area of rice production centers to assess the potential yield and the ability to adapt in upland and paddy field. According to Akter et al., (2014), in countries of increasing population consuming rice, high yielding stable cultivars with high adaptation capabilities to diverse environments need to be developed. Or otherwise, as stated by Anputhas et al., (2011), it is required to find out “which won where” pattern (Yan et al., 2001) by conducting multi-location trials in different locations or seasons.

Grain yield is a complex trait, quantitative in nature and a combined function of a number of constituent traits. Consequently, selection for yield may not be satisfying without taking into consideration yield component traits (Moosavi et al., 2015). Thus positives correlated between yield and yield components are requires for effective yield component breeding increasing grain yield in rice (Ogunbayo et al., 2014)

The objective of the present study was to examine agronomic and yield characteristics of the promising amphibious rice lines grown on dry land, and to determine the association between yield and yield components.

MATERIALS AND METHODS

Eight amphibious rice lines (GS12-2, GS11-2, GS12-, GS11-1, GS44-1, GS44-2, GS16- 1, GS16-2 lines) and two check varieties of upland rice, i.e., Lipigo-4 and Ngkari-Ngkari varieties were used as material in this study. The amphibious rice lines were obtained from crossbreeding of paddy rice and upland rice. The experiment was carried out in the field of Paku Jaya Village, Konawe Regency, Southeast Sulawesi during January to April 2017, lay out in Randomized Complete Block Design (RCDB) with four replications and ten plots. The eight amphibious rice lines and two check cultivars were randomly arranged in each plot (3 m × 4 m for each cultivar), separated by a distance of 50 cm between blocks and 40 cm between plots within a block. The following agronomic and yield characteristics were evaluated: plant height, leaf area, productive tiller per hill, grains number per panicle, filled grain number per panicle, 1000 grain weight, and grain yield per hectare.

The variances of the data were analyzed using analysis of variance (ANOVA) with the Statistical Package of Social Sciences (SPSS) program version 20 for Windows (Chicago, IL, USA)., the means were compared using Duncan’s Multiple Range Test (DMRT) at the 5% level. The correlation of yield components and yield was analysed using Pearson’s correlation coefficient analysis.

RESULTS AND DISCUSSION

1. Plant height and leaf area

The result showed that various amphibious rice lines and check varieties were differed significantly in the plant height and leaf area at 14, 28, 42, and 56 days after planting (DAP) which were grown in upland condition. The diagrams of plant height growth and leaf area shown in Figure 1. The check variety Lipigo-4 (LV4) observed as the tallest rice plant with the widest leaf area, followed by Ngkari-Ngkari variety (LM) at all observation times. Whereas, the plant growth development of amphibious rice lines was appeared similar.

The result of DMRT test indicated that the LV4 variety recorded as the tallest plant height with the widest leaf area at 28 and 56 DAP, and significantly different from all tested amphibious rice lines, but was not significantly different with LM check variety at 28 DAP. Eight amphibious rice lines presenting lower plant height compared with two check varieties at all observation times. Plant height as quantitative traits is considered to be affected by environmental factor. This is consistent with Aide and Beighly (2006) statement that plant height is affected by many factors, such as plantation method, plant density and fertilizer application. On the other hand, plant height has positive correlation to lodging, the displacement of culms from an upright position, which is often associated with yield loss (Navabi et al., 2006; Hui-jie et al., 2000). However, Hairmansis et al., (2010) found that plant height has negative effect on grain yield. Plant height was affected by many factors like plantation method, plant density and fertilizer application (Gozubenli, 1992; Beser and Genctan, 1999; Aide and Beighly, 2006).

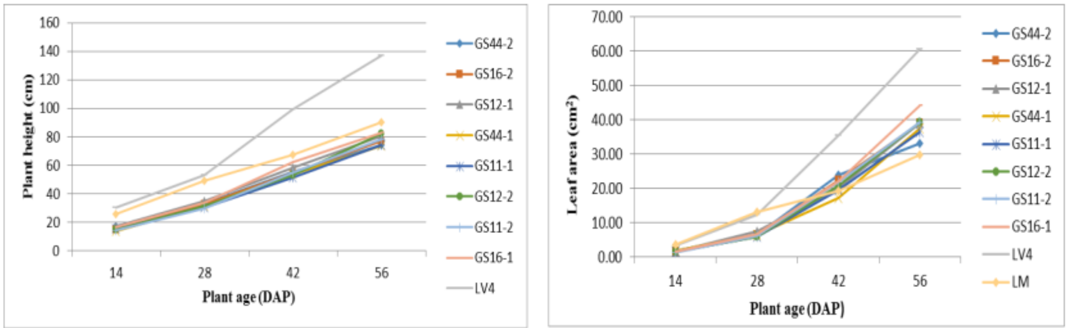

Figure 1. Diagrams of plant height growth and leaf area of amphibious rice plant at 14, 28, 42 and 56 DAP.

Taller plants tend to be more susceptible to lodging. Therefore, plant height reduction is a specific interesting in breeding programs to overcome the lodging problem (Nurhasanah et al., 2016).

2.Number of productive tillers and grain number per panicle

The result shows that amphibious rice lines and the check variety have high significant effect on the number of productive tillers and grain number per panicle. The diagrams of productive tillers number and grain number per panicle of amphibious rice lines tested, are shown in Figure 2.

The highest number of productive tillers was obtained in the GS11-2 lines which was not significantly different from the GS12-2, GS44-2, GS16-1, GS16-2, and GS44-1, but were significantly different from GS12-1, GS11-1, and LV4. On the other hand, the highest number of grain per panicle obtained from GS16-2 lines was not significantly different with rice lines of GS44-1, GS11-2, GS12-1, GS12-2, GS16-1, GS44-2, GS11-1, and LV4 check variety, but it was significantly different from the LM check variety.

The productive tillers are considered to be positively related to grain yield. Tillering is one of the most important agronomic characters for grain production in rice (Smith and Dilday, 2003; Wang et al., 2016). It was observed that number of productive tillers per plant exhibited significant positive association with panicle length, number of filled grains per panicle, spikelet fertility, biomass, harvest index, 1000 grain weight and grain yield per plant (Hasan et al., 2013; Aghamolki et al., 2015). Other researchers also reported a strong association between productive tillers per plant and grain yield per plant (Bhadru et al., 2011; Parimala and Rukmini, 2016). The formation of the number of grains per panicle is thought to be due to the genetic differences of each breeding lines or varieties. This is consistent with the statement that the nature of each genetic and the growing environment of the cultivars, will affect the density of each item, the number of grains per panicle will also affect the amount of filled grain (Prasad et al. 1988; Ranawake and Amarasinghe, 2014; Thippani et al., 2017).

3. Yield and yield components

The panicle length, number of filled grain per panicle, 1000 grain weight, and grain yield were differed among rice breeding lines and check varieties (Table 1). The longest panicle length was recorded by GS11-2 line which was 29.18 cm. The highest number of filled grain per panicle among amphibious rice lines was recorded by GS44-1 line and significantly different with check variety LM. The GS11-1 lines recorded as the highest weight of 1000 grains and significantly different from the GS44-2, GS16-2, GS12-1, GS44-1, GS12-2, GS11- 2, GS16-1 lines, and check variety LM. Furthermore, the GS16-1 recorded as amphibious rice lines with the highest grain yield and significantly different from both of varieties check LIPIGO4 and LV4.

Panicle length showed significant positive correlation with number of filled grains per panicle, spikelet fertility (%), biomass, harvest index, 1000 grain weight and grain yield per plant (Liu et al. 2016). Earlier researchers, Patel et al., (2014) for biomass, Ramanjaneyulu et al., (2014) for harvest index reported similar results.

The trait number of filled grains per panicle is considered as an important component for realizing high yield, because it exhibited significant and positive association with number of productive tillers per plant, panicle length, 1000 grain weight and seed yield per plant. Similar results were also reported by Gopikannan and Ganesh (2013) and Zhao et al., (2006).

The weight difference of 1000 grains of each treatment is genetically derived from each of the different lines or varieties. This is in accordance to those stated by Yoshida's (1981) that the weight of 1000 grains of pithy rice is more determined by its genetic properties. The studies of Aghamolki et al., (2015) found that the grain yield had a positive and significant correlation with the number of grains per panicle, the number of filled grains per panicle, and 1000-grain weight.

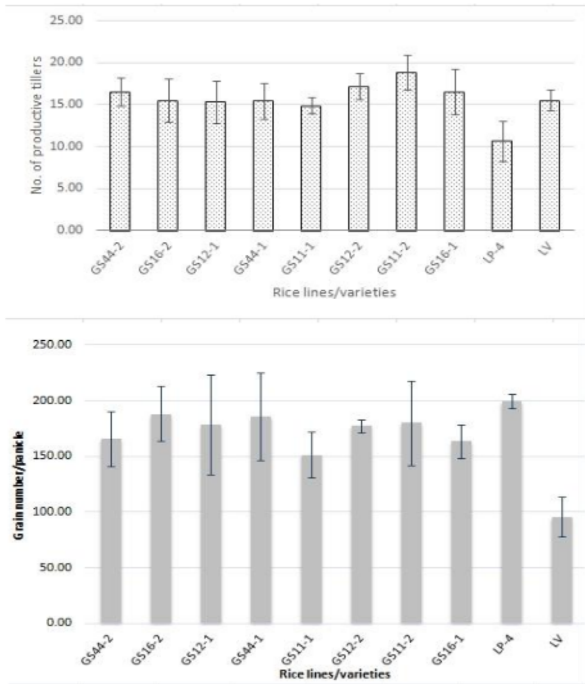

Figure 2. The average number of productive tillers and grain number per panicle of amphibious rice plant

Table 1. Yield and yield components of the amphibious rice lines and check varieties

Rice lines/varieties	Panicle length (cm)	Number of filled grain/panicle	1000 grain weight (g)	Grain yield ($t.ha^{-1}$)
GS44-2	28.19 a	103.63 bc	30.71 b	5.39 a
GS16-2	27.52 a	126.57 b	30.62 b	4.78 ab
GS12-1	29.11 a	129.30 ab	30.49 b	5.23 a
GS44-1	27.42 ab	133.63 ab	30.28 b	5.10 ab
GS11-1	27.16 ab	114.05 b	31.71 a	4.70 ab
GS12-2	27.46 ab	117.53 b	30.65 b	5.35 a
GS11-2	29.18 a	127.00 b	30.45 b	5.33 a
GS16-1	28.71 a	113.47 b	30.42 c	5.57 a
LIPIGO4	23.82 bc	158.22 a	31.47 ab	3.99 bc
LM	21.83 c	78.92 c	24.52 d	3.44 c

Remark: The numbers followed by the same letters in columns indicate no significant difference in the DMRT α = 0.05.

CONCLUSION

The present study highlighted the existence of agronomic and yield characteristic diversity among the eight superior amphibious rice lines which were cultivated as upland rice on dry land. Greater tillering, higher grains number per panicle, and higher grains yield ha^{-1} were obtained on three amphibious rice lines, i.e., GS16-1, GS44-2, and GS11-2. Grain yield was observed to be positively associated with productive tillers, filled grains and number of grains per panicle.

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

GRS designed and performleed the experiments and also wrote the manuscript. NWS, WN, MSS, SL and SG, performed field experiment and data analysis. MHD wrote and revised manuscript and also corresponding author. All authors read and approved the final version.

REFERENCES

Aghamolki MTK, Yusop MK, Jaafar HZ, Kharidah S, Musa MH, Zandi P, 2015. Preliminary analysis of growth and yield parameters in rice cultivars when exposed to different transplanting dates. Electronic J Biol 11(4):147-153.

Aide M, Beighley D. 2006. Hyperspectral reflectance monitoring of rice varieties grown under different nitrogen regimes. Transactions of Missouri Academy of Science 40: 6-11.

Akter A, Jamil Hassan M, Umma Kulsum M, Islam MR, Hossain K, Rahman MM, 2014. AMMI biplot analysis for stability of grain yield in hybrid rice *(Oryza sativa* L.*)*. J Rice Res 2: 126. doi: 10.4172/jrr.1000126

Anputhas M, Samita S, Abeysiriwardena DSDZ, 2011. Stability and adaptability analysis of rice cultivars using environment-centered yield in two-way ANOVA model. Communications in Biometry and Crop Science 6(2): 80-86.

Baihaki A, Wicaksana N, 2005. Interaction of genotype x environment, adaptation in the development of superior plant variety in Indonesia. Zuriat, 16: 1-8.

Beser N, Genctan T, 1999. Effects of different plantation methods on some agricultural features and productivity in the rice (*Oryza sativa* L.). Turkey Third Field Crop Congress 1:462-467.

Bhadru D, Lokanadha RD, Ramesha MS, 2011. Correlation and path coefficient analysis of yield and yield contributing traits in rice hybrids and their parental lines. Electronic Journal of Plant Breeding 2(1):112-116.

Gopikannan M, Ganesh SK, 2013. Investigation on combining ability and heterosis for sodicity tolerance in rice (*Oryza sativa* L.). Afr J Agric Res 8(32):4326-4333.

Gozubenli H, 1992. The effects of nitrogen doses and seeding rates on yield and some yield components of rice (*Oryza sativa* L.). Cukuova University Institute of Natural and Applied Science, Journal of Science and Engineering 6(1):39-48.

Fehr WR, 1987. Principles of Cultivar Development, Vol 1, Theory and Technique. Macmillan Publishing Co. New York.

Hairmansis A, Kustianto B, Supartopo, Suwarno, 2010. Correlation analysis of agronomic characters and grain yield of rice for tidal swamp areas. Indonesian J Agric Sci 11(1): 11-15.

Hasan MJ, Kulsum MU, Akter A, Masuduzzaman ASM, Ramesha MS, 2013. Genetic variability and character association for agronomic traits in hybrid rice (*Oryza sativa* L.). Oryza 8(3):110-115.

Hossain S, Maksudul Haque MD, Rahman J, 2015. Genetic variability, correlation and path coefficient analysis of morphological traits in some extinct local aman rice (*Oryza sativa*

L). J Rice Res 3:158. doi:10.4172/2375-4338.1000158

Hui-Jie Y, Ren-Cui Y, Yi-Zhen L, Zhao-Wei J, Jing-Sheng Z, 2000. The relationship between culm traits and lodging resistance of rice cultivars. Fujian J Agric Sci 15(2):1-7.

Kadidaa B, Sadimantara GR, Suaib, Safuan LO, Muhidin, 2017. Genetic diversity of local upland rice (*Oryza sativa* L) genotypes based on agronomic traits and yield potential in marginal land of North Buton Indonesia. Asian Journal of Crop Science 9(4):109-117.

Konata AK, Zongo A, Kam H, Sanni A, Audebert A, 2016. Genetic variability and correlation analysis of rice (*Oryza sativa* L.) inbred lines based on agro - morphological trait. Afr J Agric Res 11(35):3340-3346.

Liu E, Liu Y, Wu G, Zeng S, and Tran Thi TG, Liang L, Liang Y, Dong Z, She D, Wang H, Said IU, Hong D, 2016. Identification of a candidate gene for panicle length in rice (*Oryza sativa* L.) via association and linkage analysis. Frontiers in Plant Science *7:* 596. http://doi.org/10.3389/fpls.2016.00596

Moosavi M, Ranjbar G, Zarrini HN, Gilani A, 2015. Correlation between morphological and physiological traits and path analysis of grain yield in rice genotypes under Khuzestan. Biol Forum Int J 7(1):43-47.

Muhidin, Jusoff K, Syam'un E, Musa Y, Kaimuddin, Meisanti, Sadimantara GR, Baka LR, 2013. The development of upland red rice under shade trees. World Applied Sciences Journal 24(1):23-30.

Muhidin, Leomo S, Alam S, Wijayanto T, 2016. Comparative studies on different agroecosystem base on soil physicochemical properties to development of sago palm on dryland. International Journal of ChemTech Research 9 (8): 511-518.

Navabi A, Iqbal M, Strenzke K, Spaner D, 2006. The relationship between lodging and plant height in a diverse wheat population. Can J Plant Sci 86:723-726.

Nurhasanah, Sadaruddin, Sunaryo W, 2016. Diversity analysis and genetic potency identification of local rice cultivars in Penajam Paser Utara and Paser Districts, East Kalimantan. Biodiversitas 17(2):401-408.

Ogunbayo SA, Sié M, Ojo DK, Sanni KA, Akinwale MG, Toulou B, Shittu A, Idehen EO, Popoola AR, Daniel IO, Gregoria GB, 2014. Genetic variation and heritability of yield and related traits in promising rice genotypes (*Oryza sativa* L.). J Plant Breed Crop Sci 6(11):153-159.

Oko AO, Ubi BE, Fisue AA, Dambaba N, 2012. Comparative analysis of the chemical nutrient composition of selected local and newly introduced rice varieties grown in Ebonyi State of Nigeria. Int J Agric For 2(2):16-23.

Parimala K, Rukmini DK, 2016. Studies on interrelationship in rice (*Oryza sativa* L.). Journal of Progressive Agriculture 7(1):69-71.

Patel JR, Saiyad MR, Prajapati KN, Patel RA, Bhavani RT, 2014. Genetic variability and character association studies in rainfed upland rice (*Oryza sativa* L.). Electronic Journal of Plant Breeding 5(3):531-537.

Prasad GSV, Prasad ASR, Sastry MVS, Irinivasan TE, 1988. Genetic relationship among yield components in rice (*Oryza sativa* L.). Ind J Agric Sci 58:470-472.

Ramanjaneyulu AV, Shankar G, Neelima NI, Shashibhushan D, 2014. Genetic analysis of rice (*Oryza sativa* L.) genotypes under aerobic conditions on Alfisols. Journal of Breeding and Genetics 46(1):99-111.

Ranawake AL, Amarasinghe UGS, 2014. Relationship of yield and yield related traits of some traditional rice cultivars in Sri Lanka as described by correlation analysis. J Sci Res Rep 3:2395-2403.

Sadimantara GR, Muhidin, Cahyono E, 2014. Genetic analysis on some agro-morphological characters of hybrid progenies from cultivated paddy rice and local upland rice. Adv. Stud Biol 6:7-18.

Sadimantara GR, Muhidin, Ginting S, Suliartini NWS, 2016. The potential yield of some superior breeding lines of upland rice of Southeast Sulawesi Indonesia. Biosci Biotech Res Asia 13(4):1867-1870.

Smith CW, Dilday RH, 2003. Rice: Origin, History, Technology, and Production. John Wiley & Sons, New Jersey.

Sutariati GAK, Arif N, Muhidin, Rakian TC, Mudi L, Nuralam, 2017. Persistency and seed breaking dormancy on local upland rice of southeast sulawesi, indonesia. Pakistan Journal of Biological Sciences, 20(11):563-570.

Syaiful SA, Syam'un E, Dachlan A, Jusoff K, Haerani N, 2013. The effect of inoculating nitrogen fixing bacteria on production of rice.

World Applied Sciences Journal 26(26):94-99.

Thippani S, Kumar SS, Senguttuvel P, Madhav MS, 2017. Correlation analysis for yield and yield components in rice (*Oryza sativa* L.). Int J Pure App Biosci 5(4):1412-1415. Doi: http://dx.doi.org/10.18782/2320-7051.5658.

Wang Y, Ren T, Lu J, Ming R, Li P, Hussain S, Cong R, Li X, 2016. Heterogeneity in rice tillers yield associated with tillers formation and nitrogen fertilizer. Agron J 108: 1717-1725.

Yan W, Cornelius PL, Crossa J, Hunt LA, 2001. Two types of GGE biplots for analyzing multi-environment trial data. Crop Sci. 41:656–663.

Yoshida *S,* 1981. Fundamental of Rice Crop Science. International Rice Research Institute, Los Baños, Laguna, Philippines, 269.

Zhao BH, Wang P, Zhang HX, Zhu QS, Yang JC, 2006. Source-sink and grain filling characteristics of two-line hybrid rice Yangliangyou 6. Rice Sci 13:34-42.

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