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The Organic Fertilizer Application Effect on Yield and Quality of Two Introduced Rice Varieties in Timor Leste

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ABSTRACT

The Lahoten Musan Kabuar and Lahoten Musan Lotuk Naruk varieties are two introduced rice varieties from Timor Leste. Optimization of cultivation techniques using organic fertilizers with different doses is carried out to obtain the best growth and yield quality. The research was carried out from December 2021 to April 2022 using the CDAST laboratory greenhouse at the Universitas Jember. The experimental design used a completely randomized design (CRD) with two factors. The main factor is the type of rice varieties which consists of 2 levels, namely the Lahoten Musan Kabuar variety (V1) and the Lahoten Musan Lotuk Naruk variety (V2). The second factor is the dose of organic fertilizer application, which consists of 4 levels, namely 0 tons ha^{-1} (P0), 2 tons ha^{-1} (P1), 4 tons ha^{-1} (P2), and 6 tons ha^{-1} (P3). The results showed an interaction between the use of organic fertilizer and the type of varieties on plant height, chlorophyll content, protein content, fat content, and amylose content. Whereas the application of organic fertilizer had no significant effect on the parameters of the number of tillers, number of panicles per plant, number of seeds per panicle, the weight of 100 seeds, carbohydrate content, and water content. The results of DMRT on interaction parameters show that the organic fertilizer dose factor has a more dominant influence than the variety factor.

1. Introduction

Optimization of yield and quality in rice plants can be done through modification of cultivation techniques, for example through fertilization techniques. Fertilization techniques can be done using chemical fertilizers, organic fertilizers, or a combination of chemical and organic fertilizers. Fertilizer application with a combination of chemical fertilizers and organic fertilizers has the opportunity to increase rice production and quality sustainably (Padmanabha *et al*., 2014).

Organic fertilizers are fertilizers produced from the decomposition process of organic matter. Some forms of organic materials that are often used include livestock manure, rice straw, food processing organic waste and leaf litter. The process of decomposition of organic matter can run with the help of microbes. Through the decomposition process, minerals and macro-micronutrients are produced which can be utilized by plants. In addition, the content of organic matter in organic fertilizers can be used to improve physical properties (Kakar *et al*., 2020; Siwanto *et al*., 2015).

The rice quality is one of the important parameters that rice varieties must have. It is influenced by four main factors, namely the grinding process, ripening, appearance and rice nutritional quality. In addition, the supply of nutrition sources during the life cycle of rice also has an important role in the physicochemical quality produced (Li *et al*., 2003). The application of organic fertilizers can improve the physicochemical quality of rice and the quality of cooked rice (Saha *et al*., 2007). Aside from being a source of nutrients, organic fertilizers have the benefit of increasing soil aeration, increasing soil microorganisms' activity and improving soil structure (Padmanabha *et al*., 2014). On the other hand, the application of organic fertilizers is also more economically attractive because it can increase rice yields without having to increase nitrogen input (Zhang *et al*., 2018; Tustiyani *et al*., 2014).

Introduced variety is one of the plant breeding techniques to obtain new sources of genetic variability by bringing in varieties from other countries. The different microclimate conditions and cultivation techniques are the main challenges in developing introduced varieties (Jumakir & Endrizal, 2015). One of the factors that can affect the growth and production of introduced rice plants is fertilization techniques. Several studies have provided information on the effect of organic fertilizer application on the yield and quality of local rice varieties. Therefore, we attempted to examine the effect of organic fertilizer application on introduced varieties from Timor Leste on the yield and physicochemical quality of the rice produced.

2. Methodology

The research was carried out from December 2021 to April 2022 in the greenhouse of the Universitas Jember CDAST laboratory. The experimental design used a completely randomized factorial design (CRFD). The main factor was the type of rice varieties which consisted of 2 levels, namely the Lahoten Musan Kabuar Variety (V1) and the Lahoten Musan Lotuk Naruk Variety (V2). The second factor is the dose of organic fertilizer (Pupuk Petroganik) application which consists of 4 levels, namely 0 tons ha^{-1} (P0), 2 tons ha^{-1} (P1), 4 tons ha^{-1} (P2) and 6 tons ha^{-1} (P3). There were 8 treatment combinations and 3 repetitions to obtain 24 experimental units.

The planting medium used is soil weighing approximately 10 kg which is placed in a plastic bucket. Rice seeds were sown using tray pots and transplanted into the planting medium after 14 days. Organic fertilizer application was given twice, the first application was 1 day before transplanting. While the second application was done 30 days after transplanting. Organic fertilizers were given according to predetermined treatment doses. The measured parameters in this study included plant height (cm), total leaf chlorophyll content (µg/ml), number of tillers, number of panicles per plant, number of seeds per panicle, the weight of 100 seeds (g), physicochemical rice (fat, protein, carbohydrates, and water content).

Total leaves chlorophyll content

100 mg of the third leaf was homogenized using 5 ml of 95% ethanol. Then centrifuged at 12,000 rpm for 10 minutes. The absorbance of the supernatant formed was measured using a spectrophotometer with a wavelength of 664 nm and 649 nm.

$$\text{Chlorophyll A} = (13.36 * Abs.664) - (5.19 * Abs.649)$$
$$\text{Chlorophyll B} = (27.43 * Abs.649) - (8.12 * Abs.664)$$

The weight of 100 seeds

The weight of 100 rice grains was measured using an analytical balance on rice grains that already had a moisture content of 14% (Salawati *et al*., 2021).

Water content

The water content measurement of rice seeds used the guidelines from ISTA 2022. 100 rice seeds were dried in an oven at 130OC for 2 hours. The procedure for measuring the rice water content was carried out using 3 repetitions (Ista, 2022).

Fat level

2 g of rice seed samples were soaked in a flask containing hexane solution and boiled for 1 hour. Then, put it in the 105OC oven until the hexane dries and then weighed (National Standardization Agency, 1992).

Protein content

The analysis of protein content using the Kjeldhal semi-micro method which was optimized according to the instructions of the National Standardization Agency for food and beverages (National Standardization Agency, 1992).

Carbohydrate content

The analysis of the carbohydrate content of rice seeds used the by-difference method involving ash, protein, fat, and water content (Astawan *et al*., 2013).

The data analysis for each parameter used analysis of variance (ANOVA) at 1% and 5% levels. If there are significantly different values between the two factors, then proceed with the 5% DMRT Test.

3. Results and Discussion

The results of the statistical analysis showed that the organic fertilizer and a variety of factors produced a very significant interaction with the plant height parameters (Table 1). The combination of the V2P3 treatment gave the highest plant height, namely 213.67 cm, V2P2 of 208 cm, V1P3 of 202 cm and V1P2 of 199 cm. The results of Duncan's further test showed that the organic fertilizer treatment factor was more dominant than the variety factor. A higher dose of fertilizer can increase the value of plant height. On the other hand, these results are also supported by the genetic factors of the two varieties. The Lahoten Musan Kabuar variety (V1) and the Lahoten Musan Lotuk Naruk variety (V2) have plant height characteristics of 150 – 180 cm. Plant growth is strongly influenced by varieties because each variety has differences in terms of genetic, morphological, and physiological characteristics (Yugi Rahayu & Harjoso, 2011; Barokah *et al*., 2020). This results in the variability of plant appearance. Genetic factors play a role in the phenotypic appearance of a plant (Azra, 2012).

Table 1. ANOVA Test Results on All Observation Parameters.

Variable	F-Values			KK (%)
	Varieties (V)	Organic Fertilizer (P)	Interaction(VP)	
A. Vegetative component				
1. Plant height	33.50**	116.47**	8.52**	1.20
B. Physiological component				
1. Chlorophyll content	50.37**	146.49**	15.38**	1.26
C. Yield component				
1. Number of tillers	46.29**	1.62tn	0.29tn	10.45
2. Number of panicles per plant	29.04**	1.28tn	0.10tn	10.79
3. Number of seeds per panicle	0.16tn	0.86tn	0.03tn	14.48
4. Weight 100 seeds	0.62tn	13.01**	0.25tn	5.60
D. Quality components				
1. Fat content	1.66tn	211.49**	12.50**	0.11
2. Protein content	29.40**	1726.58**	49.18**	0.53
3. Carbohydrate content	4.77*	0.76tn	1.42tn	4.04
4. Water content	5.26*	1.26tn	1.43tn	7.69
5. Amylose	4.17tn	42.38**	7.38**	4.67
6. Amylopectin	2.83tn	2.97tn	1.19tn	5.15

Description: **=very significantly different; *=significantly different; tn= not significantly different

The combination of fertilization and a variety of factors also gave very significant interaction results on the parameters of leaf chlorophyll content (Table 1). The combination of V2P3 and V1P3 treatments gave the highest chlorophyll content, namely 2.53 µg/mL and 2.49 µg/mL. The influence of the organic fertilizer factor is more dominant than the variety factor based on the results of Duncan's advanced test. The leaf chlorophyll content is affected by the availability of nitrogen and phosphorus nutrients (Arifiansyah *et al*., 2020). The research data showed that the higher the dose of fertilizer given was able to increase the leaf chlorophyll content of the two rice varieties used.

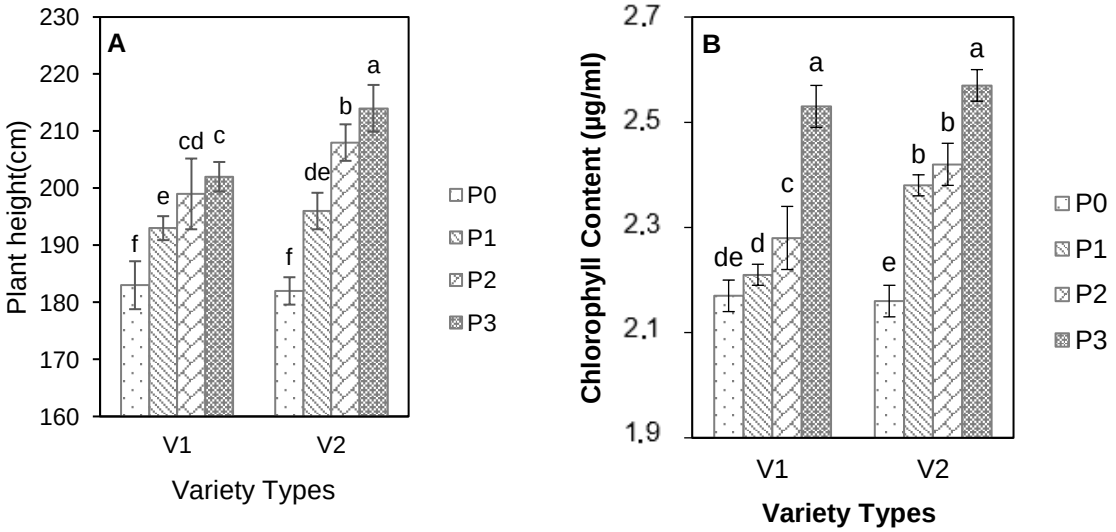

Figure 1. Organic Fertilizer Affects Plant Height (A) and Rice Leaf Chlorophyll Content (B). P0 = 0 tons ha^{-1}; P1 = 2 tons ha^{-1}; P2 = 4 tons ha^{-1}; P3 = 6 tons ha^{-1}.

Based on the results of statistical analysis, the yield parameters which included the number of tillers, the number of panicles per plant, the number of seeds per panicle and the weight per 100 seeds, based on the results of statistical analysis, showed that the results were not significantly different from a single factor or the interaction between the dosing factor of organic fertilizer and the type of variety (Table 1). The results of other studies show that organic matter in organic fertilizer can increase the number of tillers, the number of panicles per plant and the number of seeds per panicle (Salam *et al*., 2021).

In this study, the application of organic fertilizer showed non-significant results on the parameter of weight per 100 seeds. This result could be caused by several factors, one of which is the slow-release nature of organic fertilizer compared to inorganic fertilizer. This property can cause plants to not receive sufficient and timely nutrient intake to increase their production. Furthermore, the form of organic fertilizer and its complete nutrient content can produce different results (Arianti *et al*., 2022).

Quality components related to physicochemical properties include fat content, protein content, carbohydrate content, water content, amylose content and amylopectin content. The content of protein, fat and amylose is related to the quality of the taste of the rice produced. In general, the quality of rice that has a good taste for Indonesian people contains protein below 7% and has a water content between 15-16%. The protein value in rice has a positive correlation with the rubbery texture. So, when the protein value in rice is high, the quality of the rice will become rubbery (Fitriyah *et al*., 2020; *Salawati et al*., 2021).

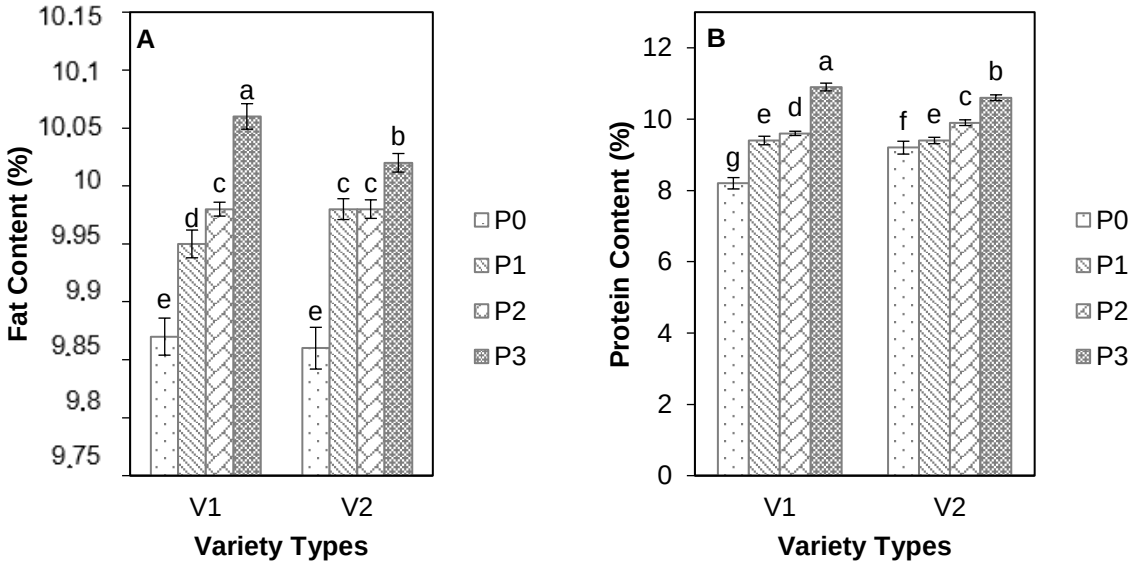

Figure 2. The Organic Fertilizer Affects Fat Content (A) And Protein Content (B) Of Rice Plants Introduced from Timor Leste. P0 = 0 tons ha^{-1}; P1 = 2 tons ha^{-1}; P2 = 4 tons ha^{-1}; P3 = 6 tons ha^{-1}.

The results indicated variance that there was an interaction between the varietal factor and the dose of organic fertilizer on the parameters of protein and fat content. The V1P3 treatment combination gave the highest protein content value of 10.78% and the smallest protein content was produced by the V2P0 treatment combination, which was 8.91%. Regarding the fat content parameter, the V1P3 treatment combination gave the highest yield, which was 10.06%, and the lowest fat content value was produced by the V2P0 treatment combination, which was 9.87% (Figure 2).

Further test results of each factor showed that the organic fertilizer dose factor was more dominant than the variety factor for the parameters of protein and fat content. Thus, every difference in the dose of organic fertilizer given gives a significant difference in yield on each parameter of protein and fat content. The quality components related to physicochemical properties are closely related to cultivation practices, fertilization techniques, microclimatic conditions, and genetic characteristics of rice plants. The different techniques or inputs used in rice cultivation will provide different quality results (Indrawan *et al*., 2017).

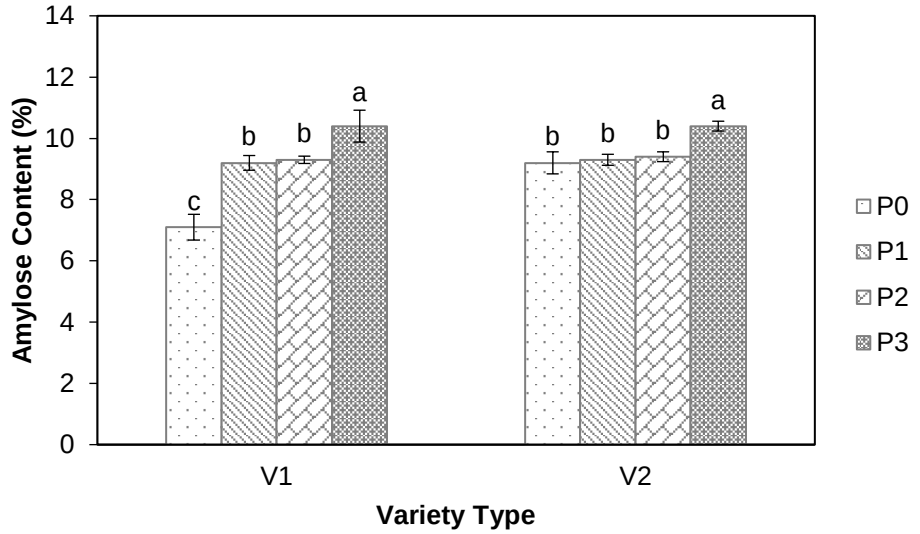

Figure 3. The Effect of Different Doses of Organic Fertilizer on Amylose Content of Introduced Rice Plants From Timor Leste. P0 = 0 tons ha^{-1}; P1 = 2 tons ha^{-1}; P2 = 4 tons ha^{-1}; P3 = 6 tons ha^{-1}.

The carbohydrate content is an important factor in the physicochemical properties of rice. Starch is the main constituent of carbohydrates in rice. Starch is composed of two main components, namely amylopectin and amylose. The amylose content in rice is closely related to the textural properties of the resulting rice. A high amylose content value will produce a non-sticky (pera) rice texture, while a low amylose content will produce a fluffier rice texture. According to Juliano (1992), amylose content is divided into 5 groups, namely glutinous rice at levels 0-5%, very low at levels of 5-12%, low at levels of 12-20%, medium at levels of 21-25%, and high at levels of 25-33% (Bienvenido O. Juliano, 1992). The results of variance indicated that there was an interaction between the variety factor and the dose of organic fertilizer used. The combination of V1P3 and V2P3 treatments gave very low amylose levels, namely 10.83% (Figure 3).

4. Conclusion

The different doses of organic fertilizer on the introduced varieties had a significant effect on the parameters of plant height, chlorophyll content, protein content, fat content and amylose content. The organic fertilizer factor has a more dominant influence than the variety types factor on the parameters showing interaction. The value of variance showed that there was no interaction between the organic fertilizer factor and the type of variety on the parameters of the number of tillers, the number of panicles per plant, the number of seeds per panicle and the weight of 100 seeds.

References

Arianti, F. D., Pertiwi, M. D., Triastono, J., Purwaningsih, H., Minarsih, S., Kristamtini, Hindarwati, Y., Jauhari, S., Sahara, D., & Nurwahyuni, E. (2022). Study of Organic Fertilizers and Rice Varieties on Rice Production and Methane Emissions in Nutrient-Poor Irrigated Rice Fields. Sustainability, 14(10), 5919. https://doi.org/10.3390/su14105919

Arifiansyah, S., Nurjasmi, R., & Ruswadi, R. (2020). Pengaruh Pupuk Organik terhadap Pertumbuhan dan Kandungan Klorofil Wheatgrass (Triticum Aestivum L.). *Jurnal Ilmiah Respati 11*(2),82–92.https://doi.org/10.52643/jir.v11i2.1099

Astawan, M., Wresdiyati, T., Widowati, S., Bintar, siti harnina, & Ichsani, N. (2013).Karakteristik Fisikokimia dan Sifat Fungsional Tempe yang Dihasilkan dari Berbagai Varietas Kedelai. *Jurnal Pangan*, *22*(3), 241–252.

Azra, I. (2012). *Sifat Agronomis , Heritabilitas dan Interaksi G x E Galur Mutan PadiGogo (Oryza sativa L .) Agronomic Traits , Heritability and G x E Interaction of Upland Rice (Oryza sativa L .) Mutant Lines*. *40*(2), 105–111.

Badan Standarisasi Nasional. (1992). Cara Uji Makanan dan Minuman SNI 01- 2891-1992. In *Sni 01-2891-1992* (p. 36).

Barokah, U., & Susanto, U. (2020). Respon Berbagai Varietas Padi pada Lahan Organik dengan System of Rice Intensification (SRI) di Sragen. Jurnal Agrinika : Jurnal Agroteknologi Dan Agribisnis, 4(2), 130. https://doi.org/10.30737/agrinika.v4i2.1065

Bienvenido O. Juliano. (1992). Structure chemistry and function of the rice grain and its fraction. *Cereal Foods World*, *37*(June), 772–774.

Fitriyah, D., Ubaidillah, M., & Oktaviani, F. (2020). Analisis Kandungan Gizi Beras dari Beberapa Galur Padi Transgenik Pac Nagdong/Ir36. *ARTERI : Jurnal Ilmu Kesehatan*, *1*(2), 153–159. https://doi.org/10.37148/arteri.v1i2.51

Ista. (2022). International rules for seed testing. *International Rules for Seed Testing. Zurich, Switzerland.*, *12*(ISTA International rules for seed testing. Zurich, Switzerland.), 345.

Jumakir, & Endrizal. (2015). Peningkatan Produktivitas Padi Melalui Introduksi Varietas Unggul Baru Dan Sistem Tanam Jajar Legowo Di Lahan Sawah Irigasi – Jambi Rice Productivity Improvement Through the Introduction of New Varieties and Jajar Legowo Cropping Systems In Irrigated Land. *Prosiding Seminal Nasional*, *April*, 246–251.

Kakar, K., Xuan, T. D., Noori, Z., Aryan, S., & Gulab, G. (2020). Effects of organicand inorganic fertilizer application on growth, yield, and grain quality of rice. *Agriculture (Switzerland)*, *10*(11), 1–11.https://doi.org/10.3390/agriculture10110544

Padmanabha, I. G., Arthagama, I. D. M., & Dibia, I. N. (2014). Pengaruh Dosis Pupuk Organik dan Anorganik terhadap Hasil Padi (Oryza Sativa L.) dan SifatKimia Tanah pada Inceptidol Kerambitan Tabanan. *E-JurnalAgroekoteknologi Tropika*, *3*(1), 41–50. https://simdos.unud.ac.id/uploads/file_penelitian_1_dir/01070a399b28f61188423f4ae6982bf1.pdf

Salam, M. A., Sarker, M. N. I., & Sharmin, S. (2021). Do organic fertilizer impact on yield and efficiency of rice farms? Empirical evidence from Bangladesh. *Heliyon*, 7(8), e07731. https://doi.org/10.1016/j.heliyon.2021.e07731

Salawati, S., Ende, S., Basir, M., Kadekoh, I., & Thaha, A. R. (2021). Peningkatan Kadar Zn Beras Pecah-Kulit pada Sistem Penggenangan Berselang Melalui Aplikasi Pupuk Kandang Diperkaya Zn Heptahidrat. Jurnal Ilmu Pertanian Indonesia, 26(4), 630–638. https://doi.org/10.18343/jipi.26.4.630

Saha, S., Pandey, A. K., Gopinath, K. A., Bhattacharaya, R., Kundu, S., & Gupta, H. S. (2007). Nutritional quality of organic rice grown on organic composts. *Agronomy for Sustainable Development*, *27*(3), 223–229. https://doi.org/10.1051/agro:2007002

Salawati, S., Ende, S., & Suprianto, S. (2021). Pengaruh Sistem Tanam TerhadapBerat 1000 Butir Padi Sawah Varietas Cigeulis Dan Ciherang. *Agrifor*, *20*(1), 113. https://doi.org/10.31293/agrifor.v20i1.5026

Siwanto, T., Maya Melati, dan, Studi Agronomi dan Hortikultura, P., Pascasarjana, S., Pertanian Bogor, I., Pelaksana Penyuluhan Pertanian Perikanan dan Kehutanan, B. B., Halmahera Timur, K., Maluku Utara, P., Raya Soagimalaha, J., & Maba, K. (2015). Peran Pupuk Organik dalam Peningkatan Efisiensi Pupuk Anorganik pada Padi Sawah (Oryza sativa L.) The Role of Organic Fertilizer in Increasing Efficiency of Inorganic Fertilizer on Paddy Rice (Oryza sativa L.). J. Agron. Indonesia, 43(1), 8–14.

Tustiyani, I., Maya, M., & Sugiyanta. (2014). Morphophysiology and Physicochemical Characters of Rice with Various Rates of Organic and Biological Fertilizer under Organic Farming System. Indonesia, 42(3), 187–194.

Yugi Rahayu, A., & Harjoso, T. (2011). Aplikasi Abu Sekam pada Padi Gogo (Oryza sativa L.) terhadap Kandungan Silikat dan Prolin Daun serta Amilosa dan Protein Biji. *Biota : Jurnal Ilmiah Ilmu-Ilmu Hayati*, *16*(1), 48–55. https://doi.org/10.24002/biota.v16i1.58

Zhang, M., Yao, Y., Tian, Y., Ceng, K., Zhao, M., Zhao, M., & Yin, B. (2018). Increasing yield and N use efficiency with organic fertilizer in Chinese intensive rice cropping systems. *Field Crops Research*, *227*(August), 102– 109. https://doi.org/10.1016/j.fcr.2018.08.010