AGRIVITA Journal of Agricultural Science. 2017. 39(2): 137-144

Response of Two Local Rice Cultivars to Different Doses of Nitrogen Fertilizer in Two Paddy Fields

Rusdiansyah*) and Muhammad Saleh

Agroecotechnology Department, Faculty of Agriculture, University of Mulawarman
Jl. Pasir Balengkong No.1 Gunung Kelua, Samarinda 75123, East Kalimantan, Indonesia
*) Corresponding author E-mail: rrida_rusdi@yahoo.co.id

Received: May 5, 2015 /Accepted: February 17, 2017

ABSTRACT

The study aimed to determine the response of two local rice cultivars subjected to different doses of nitrogen (N) fertilizer in two paddy fields, namely Petung and Gunung Makmur in Penajam Paser Utara, East Kalimantan. The research was arranged in Nested Design with five doses of N fertilizers, two cultivars, and two locations as treatments. The doses of N fertilizers were 0, 25, 50, 75 and 100 kg N.ha^{-1} nested in two cultivars (Nanung and Pance Kuning) and two locations (Petung and Gunung Makmur). Each treatment was conducted in three replicates. The result showed that the Pance Kuning cultivar was superior than Nanung in Petung location in terms of the number of tillers per hill, number of productive tillers per hill, percentage of filled grain per panicle, weight of 1000 grains and potential yield. A different effect of N fertilizer was observed on the number of tillers per hill, percentage of filled grain per panicle and weight of 1000 grains. Nanung and Pance Kuning showed positive responses to the application of 75 kg N.ha^{-1} in Petung for the parameters of tiller number and weight of 1000 grains.

Keywords: local rice cultivars; Nanung; nitrogen fertilizer; Pance Kuning

INTRODUCTION

The role of swampy and rain-fed land outside Java in the future has significance as a center of food crops production, especially rice, due to the shrinking of productive paddy fields in Java. The main problems of cultivating paddy in swamp land (tidal, valley and peat) are higher sulfuric acid content that significantly reduce land fertility, the abiotic characteristic of commercial paddy that cannot withstand acidic soil, high pirite, Al, Fe, Mn, and organic acid contents. It was also observed that swamp land has a tendency of having lower basic cation i.e. Ca, K, Mg and microbial activity to support most commercial paddy cultivars (Arsyad, Saidi, & Enrizal, 2014).

High acidic content of swamp land causes the availability of nutrition and minerals required to grow rice cultivars, in this case related to phosphorous (P) (Wahdah, Langai, & Sitaresmi, 2012; Arsyad, Saidi, & Enrizal, 2014). The high Fe ions may present in toxic level to rice cultivars (Helmi, 2015). On the other hand, the insignificant amount of micro minerals i.e. Zn, Cu and Bo hinder the growth of commercial rice cultivars (Suhartini, 2001).

Rice cultivation on soil conditions as above has generally low productivity because of poor plant growth, tillering inhibition, a high percentage of empty grains, and vulnerability to be attacked by organisms that can cause crop failure. One way to overcome the problems of farming on land with less optimal is by utilizing adaptive local rice cultivars. Kurniawan & Widodo (2009) stated that local paddy cultivars are preferable options to farmers in the swamp area, since the cultivars show good adaptability to abiotic hurdles. The local cultivars generally produces pleasant taste and aroma, and has a better overall quality of the grains. Regardless, the productivity of local cultivars is normally lower than that of common commercial cultivars. Local cultivars have advantage of withstanding local pests and diseases. The cultivars have higher tolerance to Fe ions but generally has a lower response to fertilizer (Ifansyah & Priatmadi, 2003; Suhartini, 2004).

East Kalimantan with its specific climate has abundant local paddy cultivars and they already adapted to specific environmental conditions. Lowland rice is generally cultivated by local communities in tidal marshland for generations. There are many local paddies found in East Kalimantan. Two of which are Nanung and Pance Kuning cultivars. The local rice cultivars have a competitive advantage because they have a delicious flavor and are adaptive to acidic soil conditions. The purpose of this study was to determine the response of two cultivars of local rice to different doses of nitrogen fertilizer in two paddy fields.

Cite this as: Rusdiansyah, & Saleh, M. (2017). Response of two local rice cultivars to different doses of nitrogen fertilizer in two paddy fields. *AGRIVITA Journal of Agricultural Science, 39*(2), 137–144. http://doi.org/10.17503/agrivita.v39i0.572
Accredited: SK No. 60/E/KPT/2016

MATERIALS AND METHODS

The study was conducted in Petung and Gunung Makmur paddy fields, from September 2013 to March 2014, in Penajam Paser Utara, East Kalimantan. Petung is rain-fed areas, while Gunung Makmur is peatland and inundated throughout the growing season. The plant material used two local rice cultivars, *i.e.*, Nanung and Pance Kuning, Urea, SP-3 6, KCl, insecticides and fungicides. Prior research, analyses were conducted to determine the nutrient status of the soil in each study site. The research design was Nested Design with five doses of N fertilizers, two cultivars, and two locations as treatment. The dose of N fertilizers were 0 kg N.ha^{-1} (n_0), 25 kg N.ha^{-1} (n_1), 50 kg N.ha^{-1} (n_2), 75 kg N.ha^{-1} (n_3), and 100 kg N.ha^{-1} (n_4) nested in two cultivars, that are, Nanung (c_1) and Pance Kuning (c_2) and two locations of paddy fields, namely Petung (l_1) and Gunung Makmur (l_2). Each treatment was conducted in three replicates.

Rice seedlings were grown in the research plot size of 4 x 6 m with a spacing of 20 x 20 cm and each planting hole had 2 seeds planted. The variables observed were the number of tillers per hill, the number of productive tillers per hill, the number of grains per panicle, the percentage of filled grains per panicle, the weight of 1000 grains, and yield potential per hectare. Data were analyzed by analysis of variance at 5% level and for a significant effect followed by LSD at the 5% level of significance (Steel & Torrie, 1981).

RESULTS AND DISCUSSION

Nutrient Content of the Soil

The results of soil analysis prior research on Petung and Gunung Makmur paddy fields showed that both had low pH (acidic), total N was moderate, P_2O_5 availability was rated high to very high, K was available and CEC was rated moderate to high, base saturation was rated low to moderate, Al saturation was rated high, Fe was rated very high, and Mn was rated high to very high (Table 1).

The results of soil analysis above show that the wetland Gunung Makmur has low pH and base saturation, but it has P_2O_5, K, CEC, and Fe is higher compared to Petung wetland. Despite that there was significant difference in P and K contents, the acidic soil condition, saturated Al, Fe, and Mn have caused sub-optimal absorption of nutrition from the observed rice cultivars. This has an implication of reducing productivity of the cultivars. Baligar & Fageria (2005) stated that saturation of Al, Fe, and Mn in a wetland reduces nutrition absorption and causes toxicity to the root of paddy. When a susceptible rice cultivar is subjected to Fe beyond the toxic concentration, the cultivar tends to reduce its number of tillers, number of panicles, and increase empty grains (Sahrawat, 2004). In general, unfavourable abiotic condition in rice planting leads to decrease in productivity and increase in probability of crop failure (Helmi, 2015).

Effect of Locations

The locations resulted in a different effect on the number of tillers per hill, number of productive tillers per hill, and yield potential per hectare (Table 2). Rice plants planted on Gunung Makmur showed a better response and resulted in the number of tillers per hill, number of productive tillers per hill and potential yield per hectare, respectively 15.51 tillers, 13.73 tillers and 5.26 t ha^{-1}, and significantly different from the rice crop planted in the location of Petung, which produced tillers number, number of productive tillers and the potential yield, respectively 14.20 tillers, 12.36 tillers and 4.75 t ha^{-1} (Fig.1 and 2).

Table 1. The results of soil analysis on paddy fields of Petung and Gunung Makmur

No.	Soil Parameters	Petung		Gunung Makmur	
		Value	Criteria*)	Value	Criteria*)
1	pH	4.70	Sour	4.51	Sour
2	Total N (%)	0.21	Moderate	0.27	Moderate
3	P_2O_5 available (ppm)	14.2	High	55.1	Very High
4	K available (ppm)	33.5	Moderate	42.3	High
5	CEC (meq/100g)	18.4	Moderate	30.0	High
6	Base saturation (%)	46.0	Moderate	38.0	Low
7	Al saturation (%)	21.0	High	21.0	High
8	Fe (ppm)	87.0	Very High	120.0	Very High
9	Mn (ppm)	27.7	Very High	14.7	High

Remarks: *) Sulaeman, Suparto, & Eviati (2005)

Table 2. Analysis of variance to the number of tillers per hill, number of productive tillers per hill, number of grains per panicle, percentage of filled grain per panicle, weight of 1000 grains, and yield potential per hectare

Source of Variance	df	Probability levels for statistical significance					
		Number of tillers per hill (NTH)	Number of productive tillers per hill (NPTH)	Number of grains per panicle (NGP)	Percentage of filled grain per panicle (PFGP)	1000 grains weight (1000 GW)	Yield potential per hectare (YP)
Locations	1	**	**	ns	ns	ns	*
Cultivars (within Locations)	2	**	**	ns	**	**	**
N Fertilizers (within Cultivars)	16	**	ns	ns	*	*	ns

Remarks: * = significant at P<0.05 level; ** = significant at P<0.01 level; ns = not significant (P>0.05); df = degrees of freedom

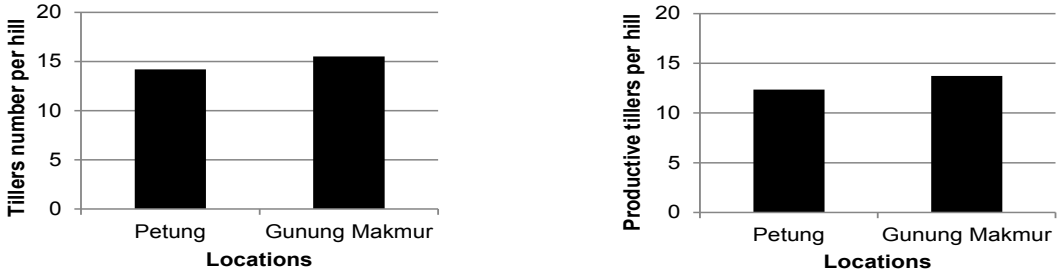


Fig 1. The number of tillers and productive tillers per hill of paddy in locations of Petung and Gunung Makmur

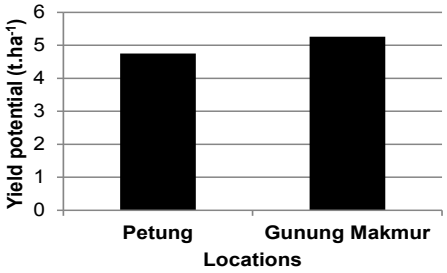


Fig. 2. The yield potential per hectare of paddy in locations of Petung and Gunung Makmur

The differences in tillers number and productive tillers number per hill and yield potential were suspected to be influenced by the differences in soil nutrient status between the two sites. The soil analysis showed that Gunung Makmur had better chemical properties than those of Petung site, especially the content of N, P and K (Table 1). Better irrigated system in Gunung Makmur paddy field in comparison to that in Petung paddy field is observed. The system can supply higher capacity of water, not only that is required by rice to grow, but also reducing acidic soil condition and Fe ions due to leaching effect. Thus, the nutrition absorption by the root of rice is optimal. The inundation and leaching of land have caused anaerobic condition of soil, therefore providing better decomposition of organic matters by microorganism and nutritional availability (Suriadikarta, 2005).

Effect of Cultivars

Nanung resulted in the number of tillers per hill, the number of productive tillers per hill, and the weight of 1000 grains higher than Pance Kuning at Gunung Makmur location. Conversely, Pance Kuning resulted in the number of tillers per hill, the number of productive tillers per hill, the percentage of filled grain per panicle, weight of 1000 grains, and higher potential yield than Nanung at Petung location (Fig. 3, 4 and 5).

The presence of significant differences is influenced by genetic factors between the two cultivars. The number of tillers produced is strongly influenced by the number of books or stem segments of each cultivar. There are differences in the number of tillers produced due to differences in the ability of each cultivar to produce tillers (Kurniawan & Widodo, 2009), while the number of grains and the number of filled grains per panicle are influenced by panicle length, the presence of a secondary branch of panicle, and grain fertility rates.

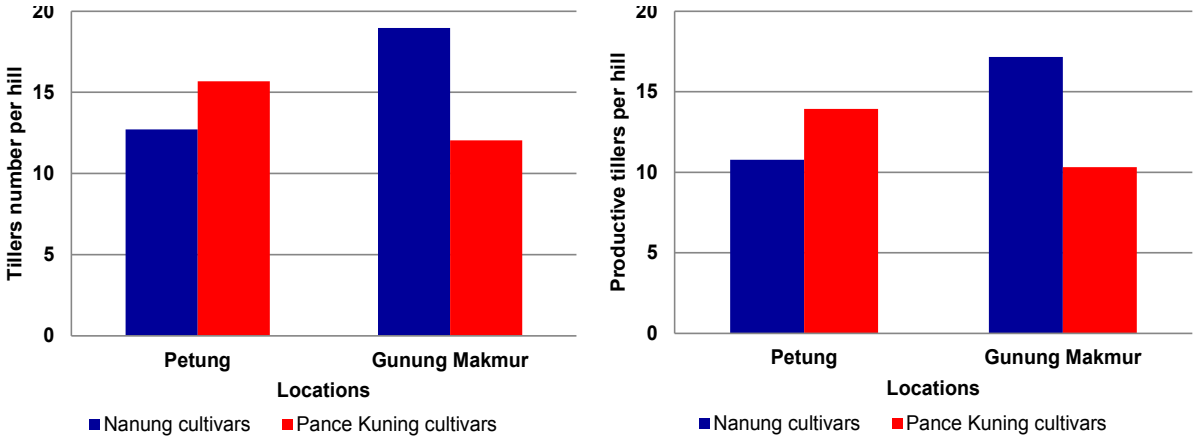


Fig. 3. Effect of cultivars on the number of tillers per hill and number of productive tillers per hill

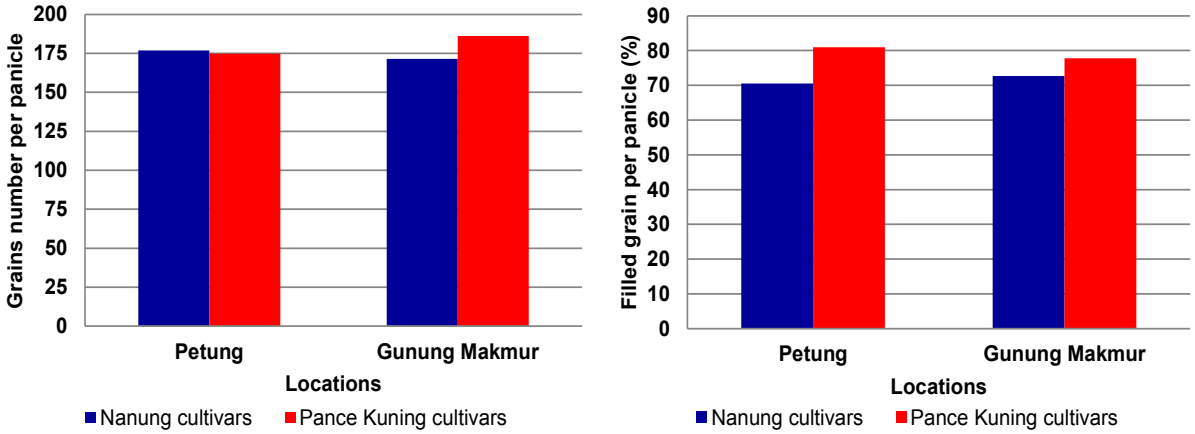


Fig. 4. Effect of cultivars on the number of grains per panicle and the percentage of filled grain per panicle

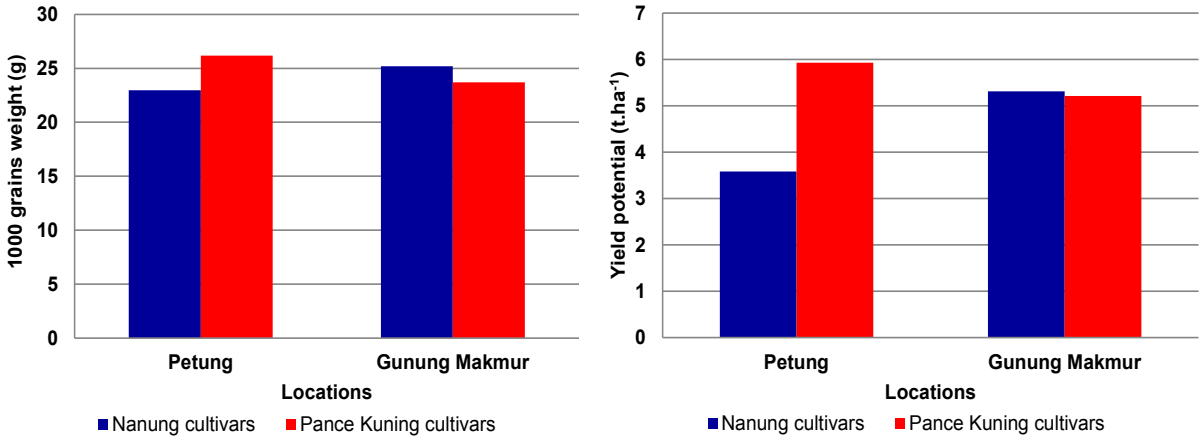


Fig. 5. Effect of cultivars on 1000 grains weight and yield potential per hectare

Besides the genetic factors, the difference is also influenced by environmental factors. The analysis showed that Nanung had a better response to the location of Gunung Makmur, while Pance Kuning had a better response to the location of Petung. In high acidic soil, the abundant amount of Fe and Mn contents is inversely correlated to nutritional absorption (Baligar & Fageria, 2005). Toxicity due to Fe ions in rice cultivars reduces productivity up to 90%, and this condition often occurs in newly

operated paddy field, more specifically in acidic soil condition (Asch, Becker, & Kpongor, 2005).

The presence of 1000 grains weight difference between the two cultivars is caused by the differences in grain size and percentage of filled grain produced. Visual observation also suggests that the grain size of cultivars Pance Kuning is greater than cultivars Nanung. The difference in the percentage of filled grain and grain size will affect the yield potential per hectare. The analysis showed that cultivars Pance Kuning were able to provide a higher yield than cultivars Nanung although the number of tillers and number of grains per panicle were less.

Effect of Nitrogen Fertilizer

The application of 75 kg N ha^{-1} to Nanung cultivars, both in Petung and Gunung Makmur, resulted in the highest number of tillers per hill. The application of 75 kg N ha^{-1} to Pance Kuning cultivars in Petung resulted in the highest number of tillers per hill, while the highest number of tillers per hill at Gunung Makmur was obtained on the application of 25 kg N ha^{-1} (Table 3; Fig.6).

The application of 75 kg N ha^{-1} to Nanung cultivars on Petung also resulted in the highest percentage of filled grain per panicle, while the highest percentage of filled grain per panicle at Gunung Makmur was obtained by the application of 50 kg N ha^{-1}. The application of 25 kg N ha^{-1} to Pance Kuning cultivars on Petung resulted in the highest percentage of filled grain per panicle, whereas the highest percentage of filled grain per panicle at Gunung Makmur was obtained on the application of 50 kg N ha^{-1} (Table 3; Fig. 7).

Nitrogen fertilization has an important role in rice cultivation, especially in poor soil nitrogen. Nitrogen is especially necessary to stimulate vegetative growth of crops by stimulating root growth, as well as the leafing, tillering and flowering phases. Nitrogen-based fertilizer increases number of tillers (Hartanto, Darjanto, & Marsandi, 2010; Tabar, 2012; Tayefe, Gerayzade, Amiri, & Zade, 2014), but inversely correlated with fertile pollen per hill, thus increasing the infertile panicle (Gunawardena, Fukai, & Blamey, 2003; Tabar, 2012; Tayefe, Gerayzade, Amiri, & Zade, 2014).

The results of previous studies of two local varieties of paddy treated nitrogen fertilizer showed that both varieties had a very high ability to uptake nutrients N (Sugiyanta, Rumawas, Chozin, Mugnisyah, & Ghulamahdi, 2008). However, other studies show that there are less local rice cultivars in response to the application of Nitrogen and Phosphorus fertilizers (Saito et al., 2006).

The application of 75 kg N ha^{-1} to cultivars Nanung and Pance Kuning in Petung resulted in the highest weight of 1000 grains. The highest weight of 1000 grains of Nanung cultivars in Gunung Makmur was caused by the application of N fertilizer 0 $kg.ha^{-1}$, whereas for cultivars Pance Kuning obtained on the application of 100 kg N ha^{-1} (Table 4; Figure 8).

The weight of 1000 grains indicates that Nanung cultivars showed a positive response to N fertilizer on Petung and negative responses on Gunung Makmur, while Pance Kuning cultivars showed a positive response to N fertilizer, both in Petung and Gunung Makmur.

Nitrogen application increases the number of tillers and number of panicles per hill but reduces the pollen fertile, thus increasing the void panicles (Gunawardena, Fukai, & Blamey, 2003). Nitrogen treatment influences the percentage of fertile pollen, the percentage of grain pithy and production (Limbongan, Purwoko, Trikoesoemaningtyas, & Aswidinnoor, 2009).

Table 3. Effect of nitrogen fertilizer (N) on number of tillers per hill and the percentage of filled grain per panicle of two cultivars in two locations

N fertiizer	Number of tillers per hill				Percentage of filled grain per panicle (%)			
	l1		l2		l1		l2	
	c1	c2	c1	c2	c1	c2	c1	c2
n0	12.64 ab	15.45 b	17.95 b	12.27 b	63.93 c	79.23 a	72.77 a	79.01 a
n1	11.72 b	15.72 b	18.36 b	13.64 a	68.89 b	81.92 a	72.80 a	74.75 b
n2	12.22 ab	14.97 b	19.70 a	11.72 bc	70.71 b	81.37 a	73.48 a	79.25 a
n3	13.78 a	17.19 a	20.92 a	11.75 bc	76.56 a	81.87 a	73.13 a	77.60 ab
n4	13.22 a	15.11 b	17.94 b	10.83 c	72.33 b	80.33 a	71.47 a	78.43 a

Remarks: l1 = Petung locations; l2 = Gunung Makmur locations; c1 = Nanung cultivars; c2 = Pance Kuning cultivars; n0 = 0 $kg.ha^{-1}$; n1 = 25 $kg.ha^{-1}$; n2 = 50 $kg.ha^{-1}$; n3 = 75 $kg.ha^{-1}$; n4 = 100 $kg.ha^{-1}$. Numbers followed by same letter in a column are not significantly different in LSD test 5%

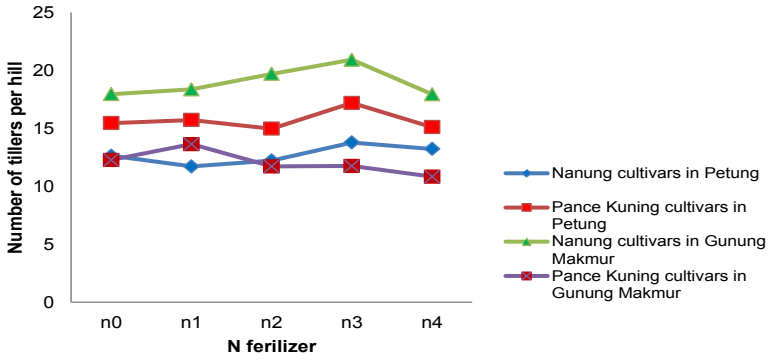
Table 4. Effect of nitrogen fertilizer (N) on weight of 1000 grains of two cultivars in two locations

N Fertilizer	1000 grains weight (g)			
	I1		I2	
	c1	c2	c1	c2
n0	22.42 b	26.49 a	26.98 a	24.39 b
n1	22.29 b	25.95 a	23.68 b	23.01 b
n2	23.06 ab	25.76 a	25.44 ab	20.80 c
n3	24.52 a	26.98 a	24.32 b	23.39 b
n4	22.55 a	25.72 a	25.49 ab	26.95 a

Remarks: I1 = Petung locations; I2 = Gunung Makmur locations; c1 = Nanung cultivars; c2 = Pance Kuning cultivars; n0 = 0 kg.ha^{-1}; n1 = 25 kg.ha^{-1}; n2 = 50 kg.ha^{-1}; n3 = 75 kg.ha^{-1}; n4 = 100 kg.ha^{-1}; Numbers followed by same letter in a column are not significantly different in LSD test 5%

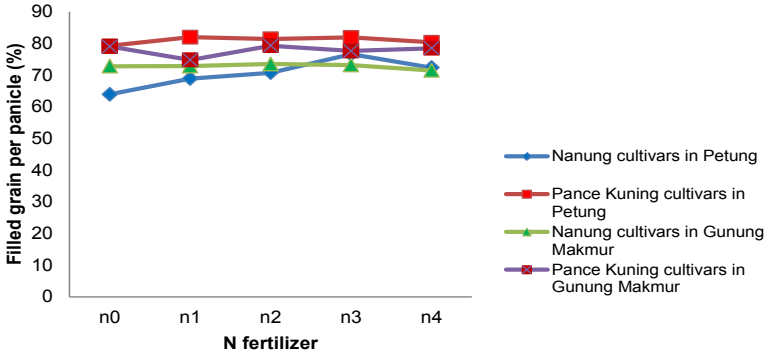
Results of the research by Tabar (2012) showed that N and P fertilization increased the number of tillers and productive tillers, grain number, 1000 grain weight, and yield. Other studies reported that N application increased panicle per hill, total grain per panicle (Haque & Haque, 2016), 1000 grain weight and yield of the grain (Tabar, 2012; Tayefe, Gerayzade, Amiri, & Zade, 2014; Haque & Haque, 2016).

The overall results showed that both cultivars, namely Nanung and Pance Kuning, showed different responses to the N fertilizer at different wetland conditions.



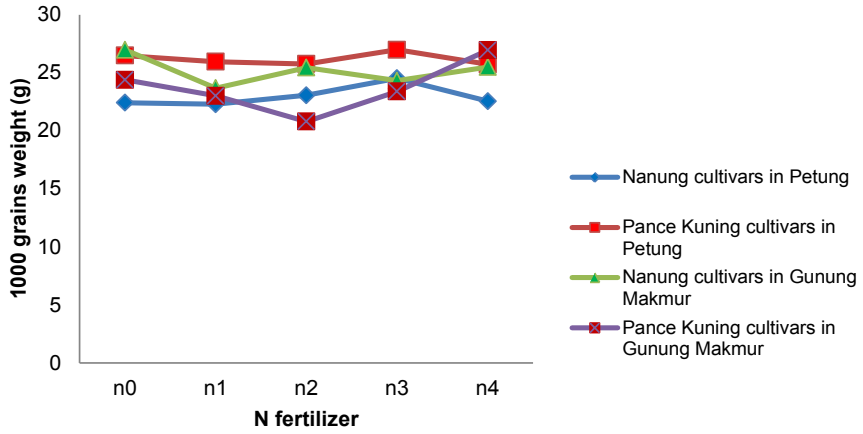
Remarks: n0 = 0 kg.ha^{-1}; n1 = 25 kg.ha^{-1}; n2 = 50 kg.ha^{-1}; n3 = 75 kg.ha^{-1}; n4 = 100 kg.ha^{-1}.

Fig. 6. Effect of N fertilizer on number of tillers per hill



Remarks: n0 = 0 kg.ha^{-1}; n1 = 25 kg.ha^{-1}; n2 = 50 kg.ha^{-1}; n3 = 75 kg.ha^{-1}; n4 = 100 kg.ha^{-1}.

Fig. 7. Effect of N fertilizer on percentage of filled grain per panicle



Remarks: n0 = 0 kg.ha^{-1}; n1 = 25 kg.ha^{-1}; n2 = 50 kg.ha^{-1}; n3 = 75 kg.ha^{-1}; n4 = 100 kg.ha^{-1}

Fig. 8. Effect of N fertilizer to 1000 grains weight

CONCLUSIONS

The locations resulted different effects on the number of tillers per hill, number of productive tillers per hill and the yield potential per hectare. Gunung Makmur paddy fields produced tiller number per hill, the number of productive tillers per hill, and the yield potential per hectare higher than those in Petung.

Cultivars Nanung produced the number of tillers per hill, number of productive tillers per hill, and the weight of 1000 grains higher than Pance Kuning cultivars in Gunung Makmur paddy fields. Moreover, Pance Kuning produced the number of tillers per hill, number of productive tillers per hill, the percentage of filled grain per panicle, weight of 1000 grains and potential yield per hectare higher than Nanung in Petung.

Nitrogen fertilizer resulted different effects on the number of tillers per hill, the percentage of filled grain per panicle and the weight of 1000 grains. Nanung and Pance Kuning showed a positive response to the application of 75 kg N ha^{-1} in Petung for the character of tiller number and weight of 1000 grains.

REFERENCES

Arsyad, D. M., Saidi, B. B., & Enrizal. (2014). Pengembangan inovasi pertanian di lahan rawa pasang surut mendukung kedaulatan pangan [Development of agricultural innovations in tidal swamp land for increasing food sovereignty]. *Pengembangan Inovasi Pertanian*, *7*(4), 169-176.

Asch, F., Becker, M., & Kpongor, D. S. (2005). A quick and efficient screen for resistance to iron toxicity in lowland rice. *Journal of Plant Nutrition and Soil Science, 168,* 764-773.

Baligar, V. C., & Fageria, N. K. (2005). Soil aluminum effects on growth and nutrition of cacao. *Soil Science and Plant Nutrition*, *51*(5), 709–713. http://doi.org/10.1111/j.1747-0765.2005.tb00097.x

Gunawardena, T. A., Fukai, S., & Blamey, F. P. C. (2003). Low temperature induced spikelet sterility in rice. I. Nitrogen fertilisation and sensitive reproductive period. *Australian Journal of Agricultural Research*, *54*(10), 937–946. http://doi.org/10.1071/AR03075

Hartanto, B., Darjanto, & Marsandi, K. (2010). Respon lima belas varietas padi sawah terhadap pemupukan nitrogen [Responses of fifteen varieties of wetland paddy to N fertilizer]. *Agronomika, 10*(1), 15-28.

Haque, M. A., & Haque, M. M. (2016). Growth, yield and nitrogen use efficiency of new rice variety under variable nitrogen rates. *American Journal of Plant Sciences, 7,* 612-622.

Helmi. (2015). Peningkatan produktivitas padi lahan rawa lebak melalui penggunaan varietas unggul padi rawa [Increase of productivity in Lebak swamp area with the use of superior variety of swampland paddy]. *Jurnal Pertanian Tropik, 2*(2), 78-92.

Ifansyah, H., & Priatmadi, B. J. (2003). Nitrogen di tanah sawah pasang surut yang ditanami padi lokal tanpa pemupukan [Tidal-land nitrogen cultivated with local rice cultivar without fertilizer application]. *Jurnal Tanah Tropika,* (16), 87-95.

Kurniawan, Y., & Widodo. (2009). Keragaan empat varietas lokal padi pada pemberian amelioran tanah ultisol, abu sekam padi dan dolomit di lahan gambut [Responses of four local varieties on amelioran of ultisol, hull ash, and dolomite applications in peat soil]. *Jurnal Akta Agrosia, 12*(1), 45-50.

Limbongan, Y. L., Purwoko, B. S., Trikoesoemaningtyas, & Aswidinnoor, H. (2009). Respon genotipe padi sawah terhadap pemupukan nitrogen di dataran tinggi [Response of rice genotypes to nitrogen fertilizer in highland]. *Jurnal Agronomi Indonesia, 37*(3), 175-182. Retrieved from http://journal.ipb.ac.id/index.php/jurnalagronomi/article/view/1232/341

Sahrawat, K. L. (2004). Iron toxicity in wetland rice and the role of other nutrient. *Journal of Plant Nutrition 27*(8), 1471-1504.

Saito, K., Linquist, B., Atlin, G. N., Phanthaboon, K., Shiraiwa, T., & Horie, T. (2006). Response of traditional and improved upland rice cultivars to N and P fertilizer in northern Laos. *Field Crops Research*, *96*(2–3), 216–223. http://doi.org/10.1016/j.fcr.2005.07.003

Steel, R. G. D., & Torrie, J. H. (1980). *Principles and procedures of statistics: A biometrical approach* (2nd ed.). Montréal, NY: McGraw-Hill Book Co.

Sugiyanta, Rumawas, F., Chozin, M. A., Mugnisyah, W. Q., & Ghulamahdi, M. (2008). Studi serapan hara N, P, K dan potensi hasil lima varietas padi sawah (*Oryza sativa* L.) pada pemupukan anorganik dan organik [Absorption of N, P and K, and yield of five lowland rice cultivars (*Oryza sativa* L.) under inorganic and organic fertilization]. *Buletin Agronomi, 36*(3), 196-203. Retrieved from http://repository.ipb.ac.id/jspui/bitstream/123456789/35791/2/Sugiyanta_abstract.pdf

Suhartini, T. (2001). Peranan plasma nuftah padi dalam meningkatkan produktivitas lahan keracunan besi [The role of rice germ plasm to increase productivity of the land with iron toxicity]. *Buletin Agronomi, 29*(2), 35-39. Retrieved from http://journal.ipb.ac.id/index.php/jurnalagronomi/article/view/1545/614

Suhartini, T. (2004). Perbaikan varietas padi untuk lahan keracunan Fe [The modification of rice variety aimed to high Fe toxicity in a rice field]. *Buletin Plasma Nutfah, 10*(1), 1-11.

Sulaeman, Suparto, & Eviati. (2005). *Petunjuk teknis: Analisis kimia tanah, tanaman, air, dan pupuk* [Technical instructions: Soil chemical analysis, plant, water and fertilizer]. Bogor, ID: Indonesian Soil Research Institute.

Suriadikarta, D. A. (2005). Pengelolaan lahan sulfat masam untuk usaha pertanian [The management of sulphuric acidic soil for agricultural productivity]. *Jurnal Litbang Pertanian, 24*(1), 36-45.

Tabar, Y. (2012). Effect of nitrogen and phosphorus fertilizer on growth and yield rice (*Oryza sativa* L.). *International journal of Agronomy and Plant Production, 3*(12), 579-584. Retrieved from https://www.academia.edu/3458540/Effect_of_Nitrogen_and_Phosphorus_Fertilizer_on_Growth_and_Yield_Rice_Oryza_Sativa_L

Tayefe, M., Gerayzade, A., Amiri, E., & Zade, A. N. (2014). Effect of nitrogen on rice yield, yield components and quality parameters. *African Journal of Biotechnilogy 13*(1), 91-105.

Wahdah. R., Langai, B. F., & Sitaresmi, T. (2012). Keragaman karakter varietas lokal padi pasang surut Kalimantan Selatan {The diversity of local rice variety in South Kalimantan tidal-land field]. *Penelitian Pertanian Tanaman Pangan, 31*(3), 158-165.