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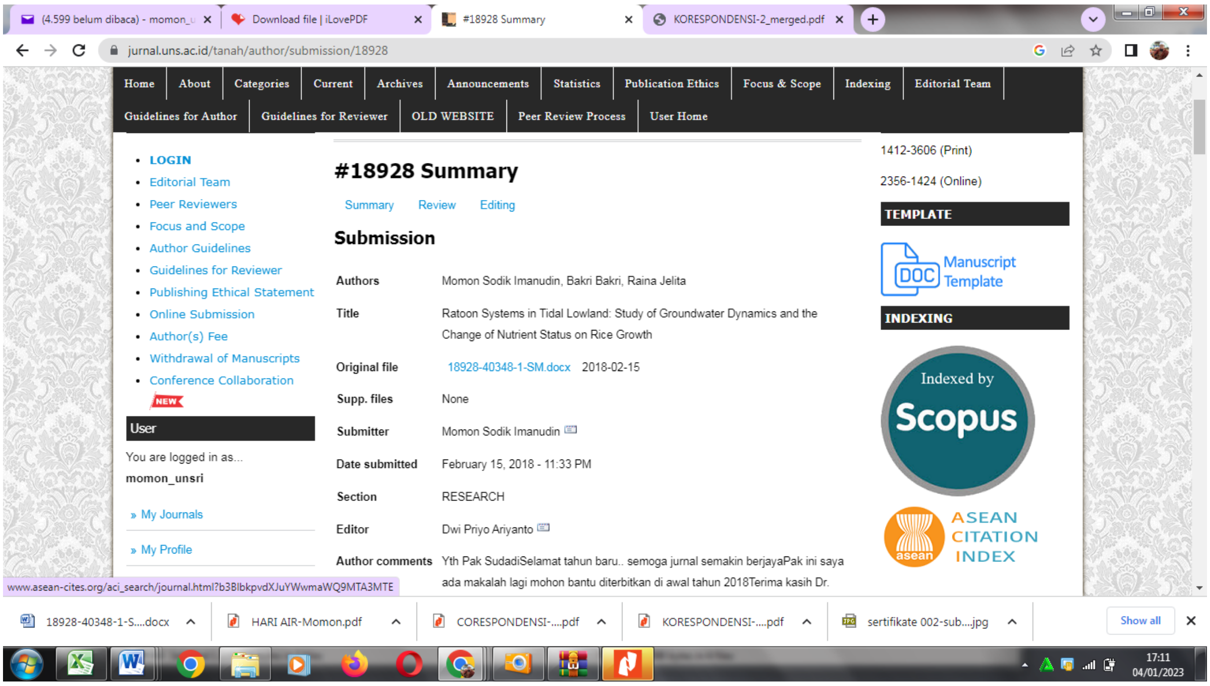

STUDY OF GROUND WATER DYNAMICS AND CHANGE OF LAND NUTRIENT STATUS ON THE GROWTH OF RATOON PADDY IN TIDAL LOWLAND AGRICULTURE

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ABSTRACT

Plant Cultivation in Tidal Lowland at MT 2 (March-April) had not been maximally conducted by farmers. This research aimed to study the dynamics of ground water and nutrient status condition in order to support plant cultivation at MT2. The research was conducted in Banyu Urip Village Tanjung Lago Telang II Banyuasin. The plant used in this activity was paddy with ratoon cultivation system. Ratoon system is paddy cultivation by using first paddy planting season shoots. Urea treatment was given with dose 0 kg/ha (control) and dose 150 kg/ha. The analysis result of soil showed that there was an increasing of nutrient status than its early soil condition. However, it did not significantly different. Therefore, fertilizing was not effective for ratoon cultivation system. The study of ground water dynamics showed that at the early phase, ground water level dropped above 30 cm (critical) but it increased by the rain and water retention in the canal. The average of ground water level was at the depth of 5-30 cm so it was suitable for plant growth. Plant growth at B treatment was better and its production was 2.8 ton/ha. This 2.8 ton/ha plant production was classified as high category for paddy with ratoon cultivation system.

Keywords: tidal lowland; rice ratoon; water table; gate operation

I. INTRODUCTION

Tidal lowland in South Sumatera Province has been reclaimed since 1970 to be developed as an agriculture area with total wide 301.780 hectares (Sudana, 2005). However, as time passes, there were several obstacles in the use of tidal lowland such as low productivity due to several physical problems (Dariah and Agus, 2007), chemical problems (Setyorini et al., 2007) and biological problems (Saraswati *et al*., 2007), as well as other social, institutional, organization, infrastructures problems, and low profit. Therefore, some area that used for agricultural land cannot be optimally used by the local people so some of them were used for other purposes such as palm oil and rubber plantation (Wahyunto, 2009).

Agricultural land transfer from paddy cultivation area into palm oil and rubber plantation area is very influential on annual rice production. Therefore, several strategies are required to return the quantity of production per year, such as: 1) increasing the wide area of production by opening new rice fields, 2) increasing of land productivity, and 3) expanding the harvest area through IP (harvest index) increasing (Erdiman, 2012).

One of the effort to increase paddy production is using intensification method such as ratoon system. There are several point that affect the growth of rice crops in ratoon cultivation system, such as: 1) the height of stems cutting from the harvest remaining, 2) variety, 3) ground water condition after harvesting, and 4) harvesting (Erdiman, 2012).

The potency of ratoon cultivation system is very good and it has been tested in several area in the tropics. The benefits are earlier growing time and safe workforce about 50-60%. The affecting factor is soil moisture. However, it has not been developed in tidal lowland. The fluctuation of ground water level highly influence the plant growth. Paddy plants usually need – 20 cm to – 30 cm water level from ground surface. It is related with the plant roots in penetrating the soil to absorb the water for plant (Faruq *et al*., 2014). So far, this ratoon paddy cultivation techniques has not been developed in the tidal lowland area. The farmers just leave it without any management. Whereas it has very good potency if it is developed just like in an irrigated land. Lampung BPTP (Center for Assessment of Agricultural Technology) reported that paddy production with ratoon method was 0.7 – 5 ton/ha (Ernawati *et al*., 2014). Mareza et al., 2016, reported that paddy production with ratoon method in Indonesia was 1.5-2. 5 ton/ha. In China, it has reached 3.8 ton/ha. This production diversity is influenced by land condition and rice variety. One of the decisive factor is water availability. Related to this point, a study about the influence of ground water level to the growth of paddy in ratoon method is required.

II. METHODOLOGY

Field practice was conducted in Banyu Urip Village (P17 6S Tc7) Tanjung Lago Sub District Banyuasin Regency South Sumatera Province in February – April 2013. Field practice was conducted by evaluating the influence of ground water level to the growth of paddy with ratoon method. There were two land plots that used for observation area of paddy with ratoon method: 1) land A with no fertilizer which located at Tc7 land number 5, 2) land B with fertilizer as many as 150 kg per ha which located at Tc7 land number 6. There were several observed parameters during this field practice, such as: 1) the depth of ground water level, 2) rain fall, 3) the height of water level in the canal, 4) plant height. Some secondary data were also used for supporting data. The analysis of soil fertility was conducted at the Physical Chemical Laboratory, Soil Department.

III. RESULT AND DISCUSSION

3.1. General Condition of Study Area

South Sumatera, there are several lowland area that can be used for agricultural area. Ngudiantoro (2010) stated in his report that Indonesia has 33 million hectares lowland area both in tidal lowland area and non-tidal lowland area. As many as 20 million hectares of tidal lowland area in Indonesia can be found in big islands such as Sumatera, Kalimantan, Sulawesi and Papua. Meanwhile, there are about 1.5 million hectares of tidal lowland that had been developed by the government. This tidal lowland development project better known as tidal lowland reclamation. In South Sumatera itself, tidal lowland reclamation has been conducted since 1969, and Telang II Delta is one of the reclamated delta.

Telang II Delta is located in Banyuasin Regency. Its wide area is ± 13.800 ha. It was first opened in 1979/1980 with transmigration placement in 1990. Geographically, Telang II Delta area is separated by Telang River flanked by Musi River in the east, Banyuasin River in the west, Sebalik River and Gasing River in the south.

Banyu Urip Village is one of the villages which located in Telang II Delta where this research was conducted. Administratively, Banyu Urip Village is under Tanjung Lago Sub District and the boundary areas are; Karang Batu Village in the north, Suka Damai Village in the south, Mulia Sari Village in the east, and Bangun Sari Village in the west.

In Banyu Urip Village, plant cultivation pattern that commonly conducted by the farmers is paddy – corn – fallow land. In the first planting season (MT I), the land is planted with monoculture system. It is started with pre – planting period (land cultivation) in October, planting period in November, and harvesting season in March. Meanwhile, the second planting period (MT II) is conducted in May – September and it is planted with corn. The interval time between the first and second planting period, in the late of February to the middle of April, is used by the farmers to take care of the remaining rice crops harvest and then it will produce more rice for the second harvest or better known as ratoon.

The characteristic of land that used for food crop cultivation is dominated by clay fraction. Therefore, the soil permeability is relatively slow with index as many as 1.08 cm per hour (Santoso, 2012). In her report, Koriyanti (2013) stated that agricultural land in Banyu Urip Village is a wet area with dominated by swamp area with very high water inundation fluctuation. In the rain season, the waters will inundates the land as high as +12 cm, while in the dry season, the height of ground water level will be -112 cm.

In the natural condition, soils in the tidal lowland area are saturated by the water or shallow inundated, along the year or in a long time, several months, or in a year (Subagyo, 2006). In the Soil Taxonomy classification (Soil Survey Staff, 1999), swampy area is classified as wet soils. It is characterized by aquatic condition, which currently experiencing water saturation and continuously or periodically reduction.

3.2. The Effect of Ground Water Table

The level of ground water table in Banyu Urip Village Telang II Delta is influenced by sea water tidal. However, water in the land or river does not contain salt or saline. In the other words, it is a fresh water. It is related with the position of Telang II Delta which located in the zone II. This region is located in the downstream area but more closely located to the upstream where the direct influence of sea water or salinity is no longer going but the energy of tidal is still received in the form of up and down (rising and falling) river flows follow the cycle of tidal movement. Based on the type of water overflow, water in Telang II Delta has C water overflow type where land cannot be flooded by the tide even though it is in high tide. However, ground water level is still influenced by the fluctuation of tidal.

Djakfar (2002), wrote the description of type C overflow that tidal lowland never been flooded by the highest tide of river water tidal. However, high tide still influence the elevation of ground water level so the depth of ground water level never been deeper than 50 cm below ground surface. The average height of ground water level never been higher than 50 cm above ground water elevation (the highest).

The height of ground water level is highly influenced by rain fall. It is similar with the field result. The height of ground water level was measured by using wells. The result showed that the highest ground water level was identified in March. The ground water level reached -5cm from the ground level (shown in the graph in Figure 1). It is related with the high intensity of rain fall in March as presented in Figure 3, that the highest average rain fall was identified in March.

This rain impact to the ground water level that it becomes relatively shallow about 20 cm underground surface. In this condition, soil humidity is maintained to supply water needs for paddy plants.

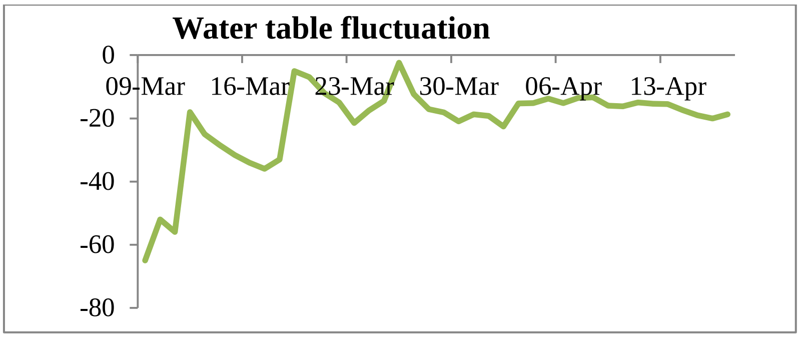

Figure 1. Daily ground water level fluctuation, measurement was conducted by using wells

In the daily rain graph (Figure 2), the calculation was conducted together with ground water level observation. It showed a direct proportional that in March, rain happens almost every single day.

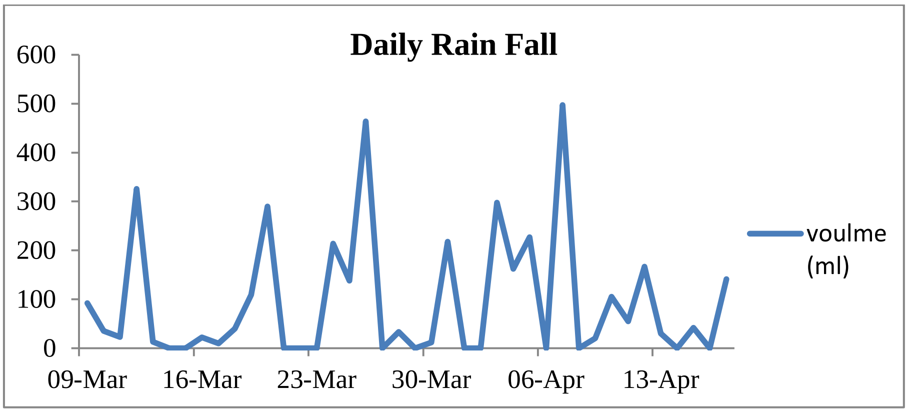

Figure 2. Daily rain fall on 23 February – 3 April 2013

As a comparation data, rainfall observation was also conducted at Kenten Climatology Station. The last 10 years monthly rainfall data in 2002 – 2012 was collected. The graph of annual rain fall (Figure 3) showed that March is a wet month with average rain fall volume reaches ≥ 400 ml per year. Therefore, it can be interpreted that ground water level was determined by the volume of rain fall. However, water condition in the land is also influenced by

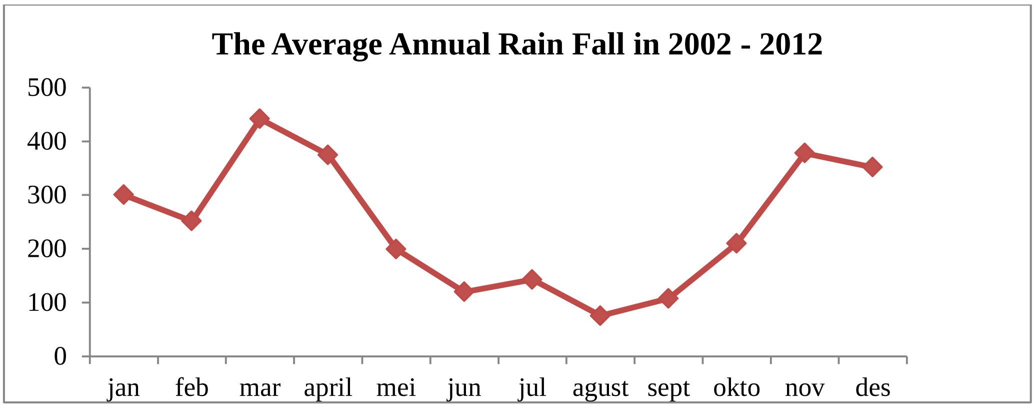

Figure 3. Graph of annual rain fall in 2002 – 2012

Ground water is a water that moves in the soil especially in the spaces between the soil pores and rock cracks (Takaeda, 2006). Meanwhile, ground water level is the difference or gap of water input from the precipitation, rain that infiltrate the soil, added with condensation by the plants and soil as well as adsorption by soil, reduced by water that lost through evapotranspiration process, ground surface flow, percolation, and lateral seepage. In its mechanism, the change of ground water level involves three main mechanism, namely: 1) retention and water movement in the soil, 2) absorption (uptake) and water translocation in plant, 3) evapotranspiration. Therefore, it can be interpreted that the periodical ground water level fluctuation depends on the balance of water input and loss.

Based on the above graph, it can be seen than ground water condition in the land showed ground water depth level with balanced rain fall condition. Even though ground water level condition in the land has dropped to -65 cm from the ground surface, but its ground water condition lifted to -18 cm from the ground surface so plants were not died due to lack of water. In this ground water condition from -5 to -36 cm from the ground surface so paddy plants water requirement can be fulfilled.

3.3. Ratoon Paddy Cultivation System

Paddy cultivation activity in Banyu Urip Village P17-6S used early age paddy variety namely IR-64. This paddy variety age is > 105 to 124 days. First Planting Period I is conducted by farmer in October to March, while the Second Planting Period II is conducted by farmer in May to September. In the MT I and MT II interval in March – May, farmers plant fallow crops or continue to take care the harvested paddy plant or grow it again to be harvested better known as ratoon paddy system. Ratoon paddy has a short life cycle only about 40 days.

In the ratoon paddy cultivation system, the top part of harvested paddy will be cut and its plant stump will be left about 20 – 30 cm from the ground surface. However, according to Ichi (1983), ratoon cut can be conducted about 5 cm and 20 cm from the ground surface. The water depth level is maintained about 5 cm. This condition is difficult if it is planted in the tidal lowland area with typology B. Research by Setiawan et al., (2014) showed that there was no interaction between the thickness of irrigation and the height of stem cutting to the plant growth. Ratoon plant production can reach 3.12 ton/ha in the continuous flooding treatment.

In order to get maximum production, fertilizer is required because ratoon cultivation system has low production potency. In the observation in Banyu Urip Village, there were two observed agricultural lands. Land A with no fertilizer and Land B with fertilizer namely urea as many as 150 kg per hectares. It was given one time after paddy stem cutting.

Ratoon paddy cultivation will be continued if shoot grown from the paddy stalks grow more than 70% (Islam et al., 2008). Paddy plants in vegetative phase require different amount of water in accordance with the requirement. Vegetative phase of paddy plant is divided into three phases, namely: a) recovery stages and roots growth (0-10 days after planting), b) maximum growth phase of tiller (10-50 days after planting) and, c) effective shooting and ineffective shooting (35-45 days after planting).

The growth and quantity of tillers is highly influence by cutting technique. Farmers have problem with this cutting. Harvesting process in Telang is conducted by using high cutting technique. To cut it back, farmers are constrained by time and energy. Cutting height very affect ratoon paddy cultivation system especially in its vegetative phase. The higher cutting, the fewer tiller will be but its growth will be very fast with less tiller quantity (Wasis, 2014).

In ratoon paddy system, recovery phase and maximum tiller growth will not be experienced because paddy will not be transplanted and ratoon paddy will not have intensive tiller growth like newly planted paddy. Ratoon paddy has an effective shooting phase if previously cut stems will grow new shoots and produce new leaves. The following process is the increasing of plant height shown by the lengthening of leaves.

Furthermore, paddy plants turn into generative phase. In this phase, it covers the early development of panicles (40-50 days after planting), fulfilling phase (50-60 days after planting), and flowering (60-80 days after planting). Research by Faruq et al., 2014 showed that ratoon paddy can be harvested in 90 days and 96 days according to the research result by Setiawan et al (2014). This situation is characterized by panicles formation and growing. However, in the generative phase, ratoon paddy do not need a long time so in 20 days paddy plant has showed its panicle existence.

In the generative phase, paddy plants require a lot of water. Drought in this period will influence the formation of panicles, flower, and fertilization so it increases the sterility of plant and decrease plant production. Based on the ground water observation at the field, ground water level was at -5 to -36 cm from the ground surface. It showed that paddy’s water requirement was quite sufficient because paddy’s roots able to absorb water in the depth of 20-30 cm below ground surface.

3.4. The Effect of Fertilazation on the growth of paddy ratoon

In addition of ground water level that able to influence the growth and production of paddy, fertilization also influence it. As previously written that Land A was given with no fertilizer and Land B with fertilizer as many as 150 kg per ha. It showed that it had different result in plant height and production. Ratoon production at Land A was 0.8 ton per hectare and ratoon paddy production at Land B was 2.8 ton per hectare. Table 1 showed the height of plant in different treatment of land.

Table 1. Average weekly paddy height

Week	Land A (cm)	Land B (cm)
1	74.61	79.64
2	81.60	95.20
3	87.20	102.00
4	100.30	109.90

Based on the above table about average weekly paddy height, it showed that there was a difference in the plant height at Land A and Land B. In the first week, its difference was 5 cm. In the second week, its difference was 13 cm. In the third week, its difference was 14 cm. And in the last week, its difference was 9.6 cm. At Land A with no fertilizer, showed that plants height were shorter than plants in Land B. However, the plants were cut in the similar height about 25 cm from the ground surface. The water height in each land was also similar. The difference of these plants can be interpreted that plants growth with no fertilizer were slower than plants with fertilizer. The difference of plants height and plants production was not depend on the ground water level because ground water level in land able to be reached by roots. However, it was caused by different soil fertility.

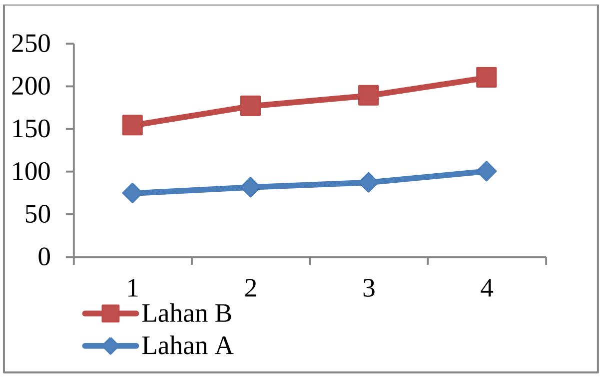

Figure 4. Graph of average weekly paddy height

This above graph showed the significant difference of ratoon paddy at Land A with no fertilizer and Land B with fertilizer. As reported by Hanafiah (2005) in her book, that NH_4^+ in the urea fertilizer plays a role in composing all proteins (acids – amino acids – enzyme) and chlorophyll, coenzyme and nucleic acids as well as growth hormones such as cytokines and auxins.

Table 2. The result of initial and final soil analysis in the study area

Type of Analysis	Initial Soil Analysis	Final Soil Analysis	
		Land A	Land B
pH H_2O	4.28	4.62	4.50
Ph KCl	3.85	3.93	3.89
C-organic	0.46	4.74	5.31
N- Total (%)	0.04	0.42	0.39
P-Bray I (ppm)	29.25	25.20	21.45
K-dd (me per 100 g)	0.26	0.38	0.32
Na (me per 100 g)	0.87	0.54	0.76
Ca (me per 100 g)	1.88	2.05	2.28
Mg (me per 100 g)	1.20	0.68	0.55
KTK (me per 100 g)	17.40	30.45	43.50
Al-dd (me per 100 g)	1.36	1.50	0.76
H-dd (me per 100 g)	0.38	0.72	0.64
Texture			
Sand (%)	22.06	32.64	30.35
Dust (%)	31.61	44.88	42.84
Clay (%)	46.33	22.48	26.81

Fertilization can increase the growth but in certain level it cannot increase the production quantity. A research by Bonn and Bollich (2006) showed that nitrogen application as many as 90-120 kg/ha was no longer able to increase paddy production. This condition was in line with the research result Islam et al., (2008), that the highest paddy production with ratoon method was achieved in urea dose as many as 120 kg/ha. A research in showed that an application of urea as many as 60 kg N/ha able to increase paddy production with ratoon method as many as 1.9 ton/ha on 30 cm stem cutting (Huossainzade et al., 2011). The growth and production of plant is influenced by fertility level and also environmental condition especially temperature and sun radiation (Oad et al., 2002).

Based on the analysis result at the laboratory (Table 2), analysis was conducted for initial land sample before ratoon technique and after ratoon technique. Initial soil sample analysis showed that C-organic content in the soil was low as many as 0.46% while in the analyzed soil sample after ratoon technique, C-organic content increased up to more than 5%. At Land A with no fertilizer, the content of C-organic in the soil was 4.74% while at Land B with fertilizer treatment, C-organic content was 5.31%. The difference of C-organic content at these two soil treatments was 0.57%.

As showed by the analysis result, before ratoon treatment the content of N-total was 0.04%, while the content of N-total at the land with ratoon technique increased into 0.42 % at Land A and 0.39 at Land B. Cation Exchange Capacity (CEC) of land also increased from 17.40 me per 100 g into 30.45 me per 100 g at Land A and 43.50 me per 100 g at Land B.

The increasing of C-organic content and Cation Exchange Capacity (CEC) content at these two lands were different. The increasing of C-organic content and Cation Exchange Capacity (CEC) index were possibly caused by urea fertilizer treatment. However, N-total at Land A was higher than Land B. It was related with Al-dd at Land A which higher 0.74 per 100 g than Land B.

The increasing of chemical content in the soil was not only caused by fertilizer treatment but also triggered by the additional of litter component in the plant. If it was seen from the height of plants, fertilizer treatment to the plant height was directly proportional. However, fertilizer treatment was inefficient because the production cost was not balanced with the production result. The production result of paddy with ratoon method was only one-third of normal production.

IV. CONCLUSION AND RECOMENDATION

Based on the above description, it can be concluded that:

a. Ground water level in a particular land is highly determined by rainfall in this area. However, water existence in a canal able to inhibit the decrease of groundwater level.
b. The condition of ground water level at the rice fields in Banyu Urip Village was high because during rainy season it able to reach -5 cm from the ground surface,

c. Paddy roots able to reach waters in the depth of 20 cm from the ground surface and ground water level condition was -5 cm to -36 cm from the ground surface. It showed that water requirement could be fulfilled,

d. The production of paddy field with ratoon method was influenced by urea fertilizer treatment. It was showed by the production difference of Land A, as many as 0.8 ton per ha, and Land B as many as 2.8 ton per ha,

e. Fertilizer treatment for paddy plant with ratoon method was ineffective because if it was compared with land with no fertilizer, it only increased C-organic content as many as 0.5% and Cation Exchange Capacity (CEC) content as many as 13.00 me per 100 g.

It is suggested that in plant cultivation with ratoon method, it should be conducted in wet month such as March. It is intended to maintain the height level of ground water so plant water requirement can be fulfilled. A balanced fertilizer treatment should be conducted in paddy cultivation with ratoon method in order to get a balanced production with fertilizer cost. A further research about a balanced fertilizer dose is required in order to increase paddy production with ratoon method.

References

Ali H, Ebrahim Azarpour, Hamid Z.D, Maral, M and Hamid R.B. 2011. Management of Cutting Height and Nitrogen Fertilizer Rates on Grain Yield and Several Attributes of Ratoon Rice (Oryza sativa L.) In Iran. World Applied Sciences Journal 15 (8): 1089-1094, 2011.

Bond, J.A., Bollich, P.K. 2006. Ratoon Rice Response to Nitrogen Fertilizer. Plant Health Progress 5(1). DOI 10.1094/CM-2006-0523-02-RS.

Dariah A., dan F.Agus. 2007. Management onf soil physics on rice field. Agriculture Research Center. Bogor.

Djafar, Z.R. 2002. Development and management of Lowland to suppot sustainable of food security. Paper presented in workshop of Lowland Management and Development Palembang.

Ernawati, Bambang W., Edwin H., Gohan O.M. 2014. The Technology of Rice Pady Ratoon system. Applied Agriculture Research Technolory of Lampung. Ministry of Agriculture.

Erdiman. 2005. Salibu Technology to increase land productivity of rice (3 – 6 ton ha^{-1} th) and increase farmer income (Rp. 15 – 25 juta th). Applied Agriculture Research Technolory, West Sumatra.

Golam F, Rosna M.T and Zakaria H. P. 2014. Rice Ratoon Crop: A Sustainable Rice Production System for Tropical Hill Agriculture. Sustainability 2014, 6, 5785-5800; doi: 10.3390/su6095785

Islam, S.M., Hasanuzzaman, M., and Rokonuzzaman. 2008. Ratoon Rice Response to Different Fertilizer Doses in Irrigated Condition. Agriculturae Conspectus Scientifi cus | Vol. 73 (2008) No. 4 (197-202).

Mareza, E., Zainal R. D, Rujito, A.S., Andi W. 2016. Growth and production of paddy ratoon in some variety of rice in tidal lowland areas. Proceding of National Seminar Suboptimal Land. Palembang, 20-21 October 2016

Masahiko ICHII 1983. The Effect of Water Management on Ratoon Ability of Rice Plants. Tech Bull Fac Agr Kagawa Univ Vol 34, No 2, 123- 128, 1983

Hanafiah, K. A. 2005. Fundamental of Soil Science. Jakarta; Raja Grafindo Persada.

Koriyanti. 2013. Prospectives of Water Table Management on Reclaimed Tidal Lowlands with Subsurface Drainage Systems. (Case Study of Banyu Urip of Banyuasin, South Sumatera Province. Indonesia). Seminar Internasional ISABE. Yogyakarta.

Ngudiantoro. 2010. Developing of water table prediction model in Tidal Lowland of C/D land thypology. Case study in South Sumatera. Research Science Journal (13) 3.13303.

Oad, F.C. Pompe, Sta, Cruz, N., Memon, N.L, Ood, 2002. Rice Ratooning Management. Journal of Applied Sciences 2 (1):29-35.

Setiawan, A. Setyono Y.D, Nugroho. A. 2014. Intermitent Irigation and Cutting Height on Growth and Yield Ratoo Rice. (Oryza sativa L.). Journal of Agriculture Science 36(1).

Santoso, A.B., N.K. Fageria, A.S. Prabhu. 2003. Rice ratooning management practices for higher yields. Commun. Soil Sci. Plant Anal. 34:881-918.

Saraswati dan Edi H. 2007. The Photencial of Organic Fertilizer on the Rice Field. Agricultural Research Center Agency. Bogor. 151-174 p.

Setyorini, D., Didi Ardi S., dan Nurjaya. 2007. The Recommendation of Fertilizer Application on Paddy in New Rice Field Areas. Agricultural Research Center Agency. 77-106.

Soil Survey Staff. Keys to Soil Taxonomy. 11th ed. *USDA*-National Resources Conservation Service, 2010.

Sudana, Wayan. 2005. Potencial and prospect of lowland for developing agricultural product. Agricultural Analysis and Polcy (3)2, Juni 2005: 141-151.

Subagyo, H. 2006. The Classification and Distribution of Lowland Areas. In Lowland Handbook of 1-23p. Agricultural Research Center Agency. Bogor.

Takaeda, K. 2006. Hydrology for Irrigation n. Jakarta: PT. Pradnya Paramita.

Wahyunto. 2009. Lowland Rice in Indonesia to Support National Food Security. Agricultural Information (18) 2, 2009.

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RESEARCH ARTICLE

RATOON SYSTEMS IN TIDAL LOWLAND: STUDY OF GROUND-WATER DYNAMICS AND THE CHANGE OF NUTRIENT STATUS ON RICE GROWTH IN

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ABSTRACT

It has been widely known that crop cultivation in tidal lowland areas in the second crop (March-April) is not conducted by farmers in a maximum way. Thus, this research aims at investigating the dynamics of ground water and its nutrient status condition for the purpose of supporting plant cultivation in the second crop after rice planting. The study was conducted in Banyu Urip Village, Tanjung Lago Telang II, Banyuasin. The plant used in this activity was paddy, with the treatment of a ratoon cultivation system. The ratoon system is paddy cultivation by using the first paddy planting season shoots. A urea treatment was given with a dose of 0 kg/ha (control) and a dose of 150 kg/ha. The results of soil analysis showed that, although not significant, there was an increase inof the nutrient status of the soil condition. Therefore, it can be concluded that fertilizing was considered ineffective for the system of ratoon cultivation. The study of ground-water dynamics showed that at the early phase, a ground-water table was dropped above 30 cm (critical) but it could increase by the rain and water retention in the canal. The average of the ground-water table during the ratoon period was at the depth of 5-30 cm below the soil surface, allowing it to be suitable for plant growth. The plant growth at B treatment was better and its production was 2.8 ton/ha. This 2.8 ton/ha plant production was classified as a high category for paddy with the ratoon cultivation system. There is no effect of the fertilizer treatment on the nutrient status in the soil. Moreover, the application of fertilizer did not give a significant result on the production of rice.

Keywords: tidal lowland; rice ratoon; water table; gate operation

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INTRODUCTION

The tidal lowland in South Sumatera Province has been reclaimed since 1970 to be developed as an agriculture area with the total wide of 301.780 hectares (Sudana, 2005). However, as time passes, there were several obstacles toin the use of tidal lowland such as a low productivity due to several physical problems (Dariah & Agus, 2007), chemical problems (setyorini, Suriadikarta, & Nurjaya, 2007) and biological problems (Saraswati & Husen, 2007), as well as other social, institutional, organizational, infrastructural problems, and financial problem low profits. Therefore, some area used for agricultural land cannot be optimally used by the local people so that some of them were used for the other purposes such as palm oil and rubber plantation (Wahyunto, 2009).

The agricultural land transfer from paddy cultivation area into palm oil and rubber plantation area is very affected by n the annual rice production. Therefore, there is a need to implement several strategies to increase the quantity of production per year, such as: 1) increasing the wide area of production by opening new rice fields, 2) increasing land productivity, and 3) expanding the harvest area through increasing the IP (harvest index) (Erdiman, 2012).

One of the efforts to increase the production of paddy is employing the ratoon system as a method of intensification. There are several points that affect the growth of rice crops in the ratoon cultivation system, such as: 1) the height of stems cutting from the harvest remaining, 2) variety, 3) the ground-water condition after harvesting, and 4) harvesting (Erdiman, 2012).

The potency of ratoon cultivation system is very good and it has been tested in several areas in the tropics. The benefits are earlier growing time and reducing the workforce is about 50-60%. The other affecting factor is soil moisture. However, it has not been developed in the tidal lowland. The fluctuation of the ground-water level highly influences the plant growth. Paddy plants usually need -20 cm to -30 cm water level from the ground surface. It is related with the plant roots in penetrating the soil to uptake –water for the plant (Faruq, Taha, & Prodhan, 2014). So far, this ratoon paddy cultivation technique has not been developed in the tidal lowland area. Although it has a very good potency if it is developed like in an irrigated land, the farmers just leave it without any management. Lampung BPTP (Center for Assessment of Agricultural Technology) reported that paddy production with the ratoon method reaches up to 0.7 – 5 ton/ha (Ernawati, Bambang W, Edwin H, & Gohan O M, 2014). Mareza, Djafar, Suwignyo, & Wijaya (2016), reported that paddy production with the ratoon method in Indonesia was 1.5-2.5 ton/ha, whereas, in China, it is able to achieve 3.8 ton/ha. This production diversity is influenced by the land condition and rice variety. One of the decisive factors is water availability. Concerning this point, a study about the effect of ground-water level to on the growth of paddy in the ratoon method is required.

METHODOLOGY

This study was conducted at Primary canal 17 in Banyu Urip Village of Tanjung Lago sub-district, Banyuasin Regency, in February – April 2013. The field practice was conducted by evaluating the influence of ground-water level on the growth of rice with the ratoon system. Ciherang and IR64 rice variety wereas used in this study. There were two land plots used for the observation area of paddy: 1) Land A with no fertilizer, located at Tertiary block number 7 (Tc7) land number 5, 2) Land B with fertilizer as many as 150 kg per ha, located at Tc7 land number 6. There were several observed parameters during this field practice, such as: 1) the depth of ground-water level, 2) rainfall, 3) the height of water level in the canal, 4) plant height. Some secondary data were also used as the supporting data. The analysis of soil fertility was conducted at the Physical Chemical Laboratory, the Soil Department of Sriwijaya University. The parameters of soil chemical and physical properties were pH, C-Organic, N-Total, P-Bray, K-dd, Na, Ca, Mg, CEC, Al-dd, and soil texture.

RESULT AND DISCUSSION

Characteristic of Farming System Technology

Banyu Urip Village is one of the villages located in Telang II Delta. Administratively, Banyu Urip Village is located in Tanjung Lago Subdistrict and it has a border with the Karang Batu Village in the north, Suka Damai Village in the south, Mulia Sari Village in the east, and Bangun Sari Village in the west. In Banyu Urip Village, a plant cultivation pattern commonly conducted by the farmers is paddy–

corn–fallow land. In the first planting season (PS I), the land is planted with a monoculture system. It is started with the pre-–planting period (land cultivation) in October, planting period in November, and harvesting season in March. Meanwhile, the second planting season (PS II) is conducted in May–September and it is planted with corn. The interval time between the first and second planting period, in the late of February to the middle of April, is used by the farmers to take care of the remaining rice crops harvest and then it will produce more rice for the second harvest or better known as ratoon.

The characteristic of land used for food crop cultivation is dominated by clay fraction. Therefore, the soil permeability is relatively slow with the index as many as 1.08 cm per hour (Santos, Fageria, & Prabhu, 2003). Koriyanti (2013) stated that the agricultural land in Banyu Urip Village is a wet area dominated by swamp area with very high fluctuations of water inundation. In the rain season, the waters will inundate the land as high as +12 cm, while in the dry season, the height of the ground-water depth will be -112 cm (below the soil surface).

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In the natural condition, soils in the tidal lowland area are saturated by the water or shallow inundated, along the year or in a long time, several months, or in a year (Subagyo, 2006). In the Soil Taxonomy classification (Soil Survey Staff, 2010), the swampy area is classified as wet soils. It is characterized by aquatic conditions, which currently experiencing water saturation and continuously or periodically reduction. Nurfaijah, Setiawan, Arif, & Widodo (2015) reported that the growth and yield of rice at ground-water depth less than 10 cm showed the best result and is not significantly different with the 5-7 cm inundation treatment. Reinforced by Setiawan, Tyasmoro, & Nugroho (2014), the critical value of the plant is at a water depth of -15 cm. In this condition, the ground water must be immediately increased. Susilawati & Purwoko (2014) reported that rice cultivation by the ratoon system will show maximum results when the cutting of stems is as high as 2-5 cm and followed by waterlogging as high as 2-5 cm.

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Groundw-Water Table Dynamic

Fluctuations in groundwater levels in the study area are influenced by a high tide and rainfall conditions. The tide can be used as the irrigation water supply because it contains no salt, unless long dry season will occur salt-water intrusion to the primary and secondary canal. Based on the type of hydro-topography class, Telang II Delta belongs to type C where the tide cannot enter the land, just up the secondary -channel. However, the groundwater depth is still influenced by tidal fluctuations, so tidal retention can maintain the depth of the groundwater table.

Djakfar (2002) wrote the description of type C overflow that tidal lowland has never been flooded by the highest tide of river water tidal. However, a high tide still influences the elevation of the ground-water level so that the depth of the ground-water level has never been deeper than 50 cm below the ground surface. The average height of ground-water level has never been higher than 50 cm above the ground-water elevation (the highest).

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The height of ground-water level is highly influenced by rainfall. It is similar towith the field result. The height of the ground-water level was measured by using wells. The result showed that the highest ground-water level was identified in March. The ground-water level reached -5cm from the ground level (shown in the graph in Figure 1). It is related with the high intensity of rainfall in March as presented in Figure 3, showing that the highest average rainfall was identified in March.

This rain impacts on the ground-water level so that it becomes relatively shallow about 20 cm underground surfaces. In this condition, soil humidity is maintained to supply water needs for paddy plants.

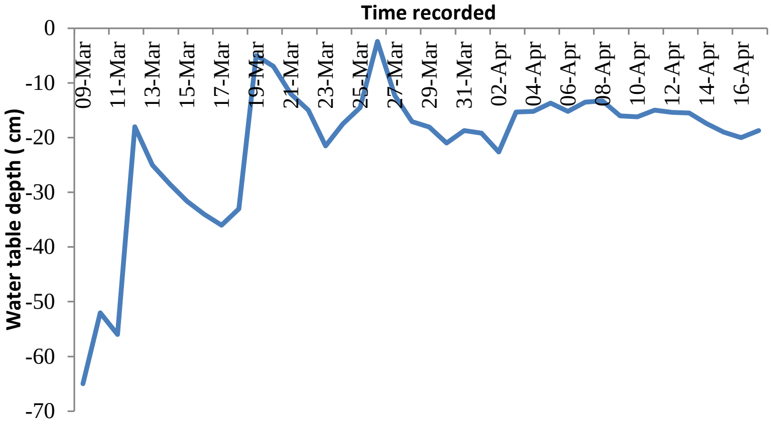

Figure 1. Daily ground-water level fluctuation, measurement was conducted by using wells

In the daily rain graph (Figure 2), the calculation was conducted together with the ground water level observation. In a direct observation~~proportional~~, it is showed that, in March, rain happens almost every five days. The rainfall distribution during the second crop period (March-April) was sufficient to support the crop water requirement of rice.

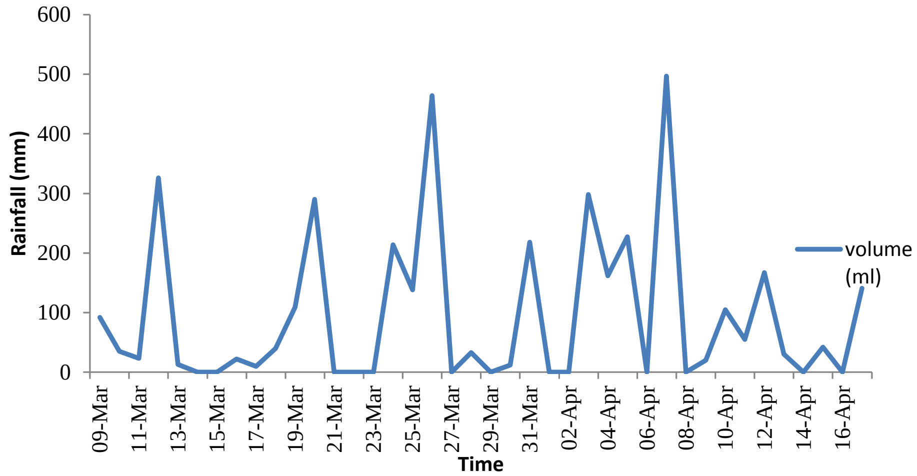

Figure 2. Daily rainfall on 23 February – 3 April 2013

As a comparison data, rainfall observation was also conducted at Kenten Climatology Station. The last 10 years monthly rainfall data in 2002 – 2012 was collected. The graph of annual ~~rain fall~~ rainfall (Figure 3) showed that March is a wet month with average rainfall volume reaches ≥ 400 ml per year. Therefore, it can be interpreted that the ground-water level was determined by the volume of rainfall. However, the water condition in the land is also influenced by the tide-water.

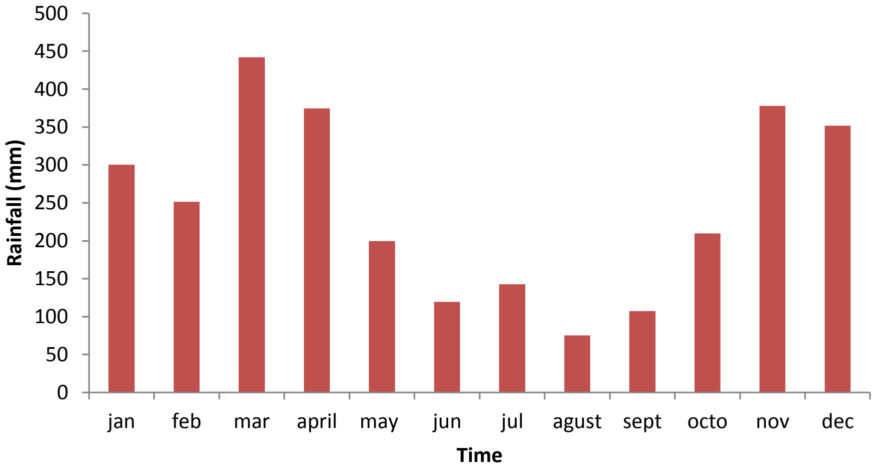

Figure 3. Graph of annual rainfall in 2002 – 2012

Ground-water is water that moves in the soil especially in the spaces between the soil pores and rock cracks (Sosrodarsono & Takeda, 2006). Meanwhile, a ground-water level is the difference or balancing water ~~water~~ input from the precipitation, rain that infiltrates the soil, added with condensation by the plants and soil as well as adsorption by soil, reduced by water that lost through evapotranspiration process, ground surface flow, percolation, and lateral seepage. In its mechanism, the change of ground-water level involves three main mechanisms, namely: 1) retention and water movement in the soil, 2) absorption (uptake) and water translocation in the plant, 3) evapotranspiration. Therefore, it can be interpreted that the periodical ground-water level fluctuation depends on the balance of water input and loss.

Based on Figure 1, it can be seen that the ground-water condition in the land showed ground water depth level was strongly influenced by rainfall condition. Even though the ground-water level condition in the land has dropped to -65 cm from the ground surface, its ground-water condition lifted to -18 cm from the ground surface so that plants were not died due to the lack of water. With this ground-water condition from -5 to -36 cm from the ground surface, the water requirement of rice plants can be fulfilled (Nurfaijah et al., 2015).

Ratoon Paddy Cultivation System

The paddy cultivation activity in Banyu Urip Village P17-6S used early age paddy variety namely IR-64. This paddy variety age is > 105 to 124 days. The first Planting Period I is conducted the~~by~~ farmer from~~in~~ October to March, while the second Planting Period II is conducted by farmers from~~in~~ May until September. In the Planting Period (PP I) and PP II interval from~~in~~ March-~~–~~May, farmers plant fallow crops or continue to take care of the harvested paddy plant or grow it again to be harvested. It is better known as the ratoon paddy system. Ratoon paddy has a short life cycle. It only needs about 40 days for the rice to be harvested.

In the ratoon paddy cultivation system, the top part of harvested paddy will be cut and its plant stump will be left about 20-30 cm from the ground surface. However, according to Ichii (1983), ratoon cut can be conducted at about 5 cm and 20 cm from the ground surface. The water depth level is maintained at about 5 cm. This condition is difficult if it is planted in the tidal lowland area with typology B. A research by Setiawan et al. (2014) showed that there was no interaction between the thickness of irrigation and the height of stem cutting to the plant growth. The ratoon plant production can reach up to 3.12 ton~~/~~ ha^{-1} in the continuous flooding treatment.

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In order to get the maximum production, a fertilizer is required because the ratoon cultivation system has low production potency. In the observation in Banyu Urip Village, there were two observed agricultural lands. Land A is without fertilizer whereas Land B is treated with urea fertilizer as many as 150 kg per hectares. It was only given one time after paddy stem cutting.

Ratoon paddy cultivation will be continued if the shoots grown from the paddy stalks grow more than 70% (Islam, Hasanuzzaman, & Rokonuzzaman, 2008). Paddy plants in vegetative phase require a different amount of water in accordance with the requirement. The ~~V~~vegetative phase of paddy plant is divided into three phases, namely: a) recovery stages and roots growth (0-10 days after planting), b) maximum growth phase of tiller (10-50 days after planting), and c) effective shooting and ineffective shooting (35-45 days after planting).

The growth and quantity of tillers ~~is~~ are highly influenced by the cutting technique. The harvesting process in Telang is conducted using a high cutting technique. It seems that farmers have the problem with this cutting. To cut it back, farmers are constrained by time and energy. Cutting height very strong affects the ratoon paddy cultivation system, especially in its vegetative phase. The higher cutting, the fewer tillers will be but its growth will be very fast with less tiller quantity (Wasis, 2014).

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In the ratoon paddy system, the recovery phase and maximum tiller growth will not be experienced because paddy will not be transplanted and ratoon paddy will not have intensive tiller growth like newly planted paddy. Ratoon paddy has an effective shooting phase if the previous cut stems will grow new shoots and produce new leaves. The following process is the increase of the plant height shown by the lengthening of leaves.

Furthermore, paddy plants turn into generative phase. In this phase, it covers the early development of panicles (40-50 days after planting), fulfilling the phase (50-60 days after planting), and flowering (60-80 days after planting). A research by Faruq et al. (2014) showed that ratoon paddy can be harvested in 90 days, while the study conducted by Setiawan et al. (2014) revealed that it can be harvested in 96 days. This situation is characterized by the formation and growing of panicles. However, in the generative phase, ratoon paddy do not need a long time so that in 20 days paddy plants have shown~~ed~~ panicle existence.

In the generative phase, paddy plants require a lot of water. Drought in this period will influence the formation of panicles, flower, and fertilization. In this case, it increases the sterility of plant and decreases plant production. Based on the ground~~-~~water observation in~~at~~ the field, the ground~~-~~water level was at -5 to -36 cm from the ground surface. It is showed that paddy's water requirement was quite sufficient because paddy's roots are able to absorb water in the depth of 20-30 cm below the ground surface.

The Effect of Fertili~~a~~zation on the Growth of Paddy Ratoon

In addition to~~of~~ the ground~~-~~water level, fertilization also plays a role in that able to influence influencing the growth and production of paddy. As previously written, Land A was treated with no fertilizer and Land B is with fertilizer as many as 150 kg per ha. The result showed that there is a difference in~~on~~ plant height and production between those two lands. The production of ratoon paddy at Land A was 0.8 ton per hectare. Meanwhile, at Land B, the ratoon paddy production was 2.8 ton per hectare. Table 1 showed the height of the plants in the different treatment of the land.

Table 1. Mean weekly paddy height

Week	Land A (cm)	Land B (cm)
1	74.61	79.64
2	81.60	95.20
3	87.20	102.00
4	100.30	109.90

Based on the above table about the average weekly paddy height, it is seen that there was a difference in the plant height at Land A and Land B. In the first week, its difference was 5 cm. In the second week, its difference was 13 cm. In the third week, its difference was 14 cm. And in the last week, its difference was 9.6 cm. At Land A with no fertilizer, it is showed that the height of the plants was shorter than those in Land B. However, the plants were cut in the similar height about 25 cm from the ground surface. The water height in each land was also similar. Having a closer look at the difference of these plants, it can be interpreted that the plants with no fertilizer were grown slower than those with fertilizer. The difference in~~of~~ plant height and plant production did not depend on the ground~~-~~water level because the ground~~-~~water level in the land is able to be reached by roots. However, it was caused by the difference in~~of~~ soil fertility.

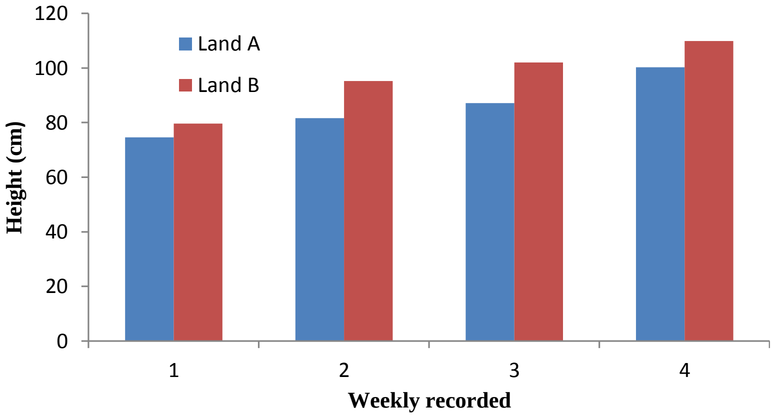

Figure 4. Graph of average weekly paddy height

This above graph showed the significant difference of ratoon paddy at Land A with no fertilizer and Land B with fertilizer. As reported by Hanafiah (2005), NH_4^+ in the urea fertilizer plays a role in composing all proteins (acids–amino acids–enzyme) and chlorophyll, coenzyme, and nucleic acids as well as growth hormones such as cytokines and auxins

Mareza, Djafar, Suwignyo, & Wijaya (2016b) reported that the application of urea fertilization with the dose of 150 kg/ha enhances the performance of rice growth. It produced 15-16 gr grain weight/clump. The application of fertilizer especially Nitrogen, followed by waterlogging after harvesting the main plant, increases the plant height and the productivity of tillers and rats. The growth of ratoon rice was very dependent on the dose of fertilizer given, and the ratoon response was varying with to the dose of different fertilizers (McCauley et al., 2006).

The application of urea fertilizer half of the first dose of the main crop could improve the quality of the yield. The result is that the height of ratoon reaches up to 2.25-3.61 m. Thus, the utilization of ratoon plant system and management of rice farming with ratoon system in the tidal lowland is believed to be increasing the harvesting indexes per planting season. Therefore, the rice harvest that has been done once per planting season increases to two times per season. Thus, the additional yield per planting season will be obtained.

The production of ratoon rice is very seasonally dependent; this is related to the status of groundwater. However, the resulting production can make optimal land use with low production costs. The results and income of farmers per planting season are also increased since farming with the ratoon system is saving input production, cost, and time (Susilawati & Purwoko, 2014).

Table 2. The result of initial and final soil analysis in the study area

Type of Analysis	Initial Soil Analysis	Final Soil Analysis	
		Land A	Land B
pH H_2O	4.28	4.62	4.50
pHKCl	3.85	3.93	3.89
C-organic	0.46	4.74	5.31
N- Total (%)	0.04	0.42	0.39
P-Bray I (ppm)	29.25	25.20	21.45
K-dd (me per 100 g)	0.26	0.38	0.32
Na (me per 100 g)	0.87	0.54	0.76
Ca (me per 100 g)	1.88	2.05	2.28
Mg (me per 100 g)	1.20	0.68	0.55
CEC (me per 100 g)	17.40	30.45	43.50
Al-dd (me per 100 g)	1.36	1.50	0.76
H-dd (me per 100 g)	0.38	0.72	0.64
Texture			
Sand (%)	22.06	32.64	30.35
Silt (%)	31.61	44.88	42.84
Clay (%)	46.33	22.48	26.81

Fertilization can increase the growth but atin a certain level, it cannot increase the production quantity. A research by (Bond & Bollich, 2006) showed that the nitrogen application as many as 90-120 kg/ ha^{-1} was no longer able to increase paddy production. This condition was in line with the research result of Islam et al. (2008), stated that the highest paddy production with ratoon method was achieved in urea dose as many as 120 kg/ ha^{-1}. The application of urea as many as 60 kg N/ ha^{-1} is able to increase paddy production with ratoon method as many as 1.9 ton/ ha^{-1} on 30 cm stem cutting (Huossainzade et al., 2011). The growth and production of the plant areis influenced by the

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Comment [Dr.6]: Not found in reference fertility level and also environmental condition especially temperature and sun radiation (Oad, Cruz, Memon, Oad, & Hassan, 2002).

Based on the analysis result at the laboratory (Table 2), shows the main problem of soil fertility is the low acidity level. Soil analysis was conducted for the initial land sample before and after the ratoon technique. The initial soil sample analysis showed that C-organic content in the soil was low as many as 0.46% while in the analyzed soil sample after ratoon technique, C-organic content increased up to more than 5%. At Land A with no fertilizer, the content of C-organic in the soil was 4.74% while at Land B with the fertilizer treatment, C-organic content was 5.31%. The difference of C-organic content inat these two soil treatments was 0.57%.

As showed by the analysis result, before ratoon treatment the content of N-total was 0.04%, while the content of N-total at the land with ratoon technique increased up to 0.42 % at Land A and 0.39 at Land B. Cation Exchange Capacity (CEC) of land also increased from 17.40 me per 100 g to 30.45 me per 100 g at Land A and 43.50 me per 100 g at Land B.

The increasing of C-organic content and Cation Exchange Capacity (CEC) content at these two lands were different. The increasing of C-organic content and Cation Exchange Capacity (CEC) index were possibly caused by urea fertilizer treatment. However, N-total at Land A was higher than Land B. It was because Al-dd at Land A is 0.74 per 100 g higher than at Land B. The increasing of chemical content in the soil was not only caused by the fertilizer treatment but also triggered by the additional of litter component in the plant. If it was only seen from the height of plants, the fertilizer treatment to the plant height was directly proportional. However, the fertilizer treatment was inefficient because the production cost was not balanced with the production result. The production result of paddy with ratoon method was only one-third of normal production.

CONCLUSION AND RECOMMENDATION

Based on the above description, it can be concluded that:

1. The fluctuation of ground-water table in tertiary block (on the farm) is highly determined by the rainfall in this area. However, the water availability in a canal is able to keep the groundwater table near the root zone to fulfill crop water requirement.
2. The condition of the ground-water table in the rice fields in Banyu Urip Village was near the soil surface because during the rainy season it is able to reach -5 cm from the ground surface.
3. Paddy roots are able to reach waters in the depth of 20 cm from the ground surface and ground water table under 5 to 36 cm from the ground surface. It showned that the water requirement could be fulfilled.
4. The production of paddy field with ratoon method was influenced by the urea fertilizer treatment. It was showed by the production difference of Land A (0.8 ton per ha) and Land B (2.8 ton per ha).
5. The fertilizer treatment for paddy plants with ratoon method was ineffective because if it was compared to the land with no fertilizer, it only increased C-organic content as many as 0.5% and Cation Exchange Capacity (CEC) contents as many as 13.00 me per 100 g.

It is suggested that plant cultivation with ratoon method should be conducted in wet season such as March. It is intended to maintain the height level of the ground-water table so plant water requirement can be fulfilled. A balanced fertilizer treatment should be conducted in paddy cultivation with ratoon method in order to get a balanced production with fertilizer cost. A further research about fertilizer application dose is required in order to increase the production of paddy with ratoon system.

REFERENCES

Bond, J. A., & Bollich, P. K. (2006). Ratoon Rice Response to Nitrogen Fertilizer. *Plant Health Progress*, *5*(1). http://doi.org/10.1094/CM-2006-0523-02-RS

Dariah, A., & Agus, F. (2007). Pengelolaan Sifat Fisik Tanah Sawah Bukaan Baru. In *Prosiding Tanah Sawah Bukaan Baru* (pp. 107–130). Bogor: Balai Besar Litbang Sumberdaya Lahan Pertanian. BBLSLP.

Erdiman. (2012). *Teknologi Salibu Meningkatkan Produktivitas Lahan (3-6 Ton/Ha/Tahun) dan Pendapatan Petani (Rp.15-25 Juta/Tahun)*. *TEKNOLOGI SALIBU MENINGKATKAN PRODUKTIVITAS LAHAN (3 DAN PENDAPATAN PETANI (Rp - 16 5) . T 2ON5 - /HA/TT JU A/ AH AH T U UN N)*. Padang, Sumatera Barat.

Ernawati, P. :, Bambang W, Edwin H, & Gohan O M. (2014). *Teknologi Budidaya Pada Sawah Sistem Ratun*. Lampung. Retrieved from http://lampung.litbang.pertanian.go.id/ind/images/stories/leaflet2015/ratunpadi.pdf

Faruq, G., Taha, R. M., & Prodhan, Z. H. (2014). Rice ratoon crop: A sustainable rice production system for tropical hill agriculture. *Sustainability*, *6*, 5785–5800. http://doi.org/10.3390/su6095785

Hanafiah, K. A. (2005). *Dasar-dasar ilmu tanah*. PT RajaGrafindo Persada. Retrieved from https://books.google.co.id/books/about/Dasar_dasar_ilmu_tanah.html?id=AkbRnQAACAAJ&redir_esc=y

Ichii, M. (1983). The Effect of Water Management On Ratoon Ability of Rice Plants. *Tech Bull Fac Agr*, *34*(2), 123–128.

Islam, M. S., Hasanuzzaman, M., & Rokonuzzaman, M. (2008). Ratoon Rice Response to Different Fertilizer Doses in Irrigated Condition. *Agriculturae Conspectus Scientificus*, *73*(4), 197–202. Retrieved from https://acs.agr.hr/acs/index.php/acs/article/view/23

Mareza, E., Djafar, Z. R., Suwignyo, R. A., & Wijaya, A. (2016a). Pertumbuhan dan Produksi Ratun berbagai Varietas Padi Potensial Pasang Surut dengan Potensi Ratun yang Berbeda (The Growth and Production of Various Tidal Rice Varieties with Different Potential Ratoon). In *Prosiding Seminar Nasional Lahan Suboptimal 2016* (Vol. 1, pp. 979–587). Palembang: Pusat Unggulan Riset dan Pengembangan Lahan Suboptimal, Universitas Sriwijaya.

Mareza, E., Djafar, Z. R., Suwignyo, R. A., & Wijaya, D. A. (2016b). Morfofisiologi Ratun Padi Sistem Tanam Benih Langsung di Lahan Pasang Surut. *Jurnal Agronomi Indonesia (Indonesian Journal of Agronomy)*, *44*(3), 228–234. http://doi.org/10.24831/jai.v44i3.12908

Nurfaijah, Setiawan, B. I., Arif, C., & Widodo, S. (2015). Sistem Kontrol Tinggi Muka Air Untuk Budidaya Padi. *Jurnal Irigasi*, *10*(2), 97–110. http://doi.org/10.31028/ji.v10.i2.97-110

Oad, F. C., Cruz, P. S., Memon, N., Oad, N. L., & Hassan, Z. U. (2002). Rice Ratooning Management. *Journal of Applied Sciences*, *2*, 29–35. http://doi.org/10.3923/jas.2002.29.35

Santos, A. B., Fageria, N. K., & Prabhu, A. S. (2003). Rice Ratooning Management Practices for Higher Yields. *Communications in Soil Science and Plant Analysis*, *34*(5–6), 881–918. http://doi.org/10.1081/CSS-120018981

Saraswati, R., & Husen, E. (2007). Prospek Penggunaan Pupuk Hayati pada Sawah Bukaan Baru. In *Lahan Sawah Bukaan Baru* (pp. 151–173). Bogor: Balai Penelitian Tanah,Kementerian Pertanian. Retrieved from http://balittanah.litbang.pertanian.go.id/document.php?folder=ind/dokumentasi/buku/buku lahan sawah bukaan baru&filename=08pupukhayati_rasti&ext=pdf

Setiawan, A., Tyasmoro, S. Y., & Nugroho, A. (2014). INTERMITTENT IRRIGATION AND CUTTING HEIGHT ON RATOON RICE (Oryza sativa L.). *AGRIVITA, Journal of Agricultural Science*, *36*(1), 72–80. http://doi.org/10.17503/AGRIVITA.V36I1.331

setyorini, D., Suriadikarta, D. A., & Nurjaya. (2007). Rekomendari Pemupukan Padi di Lahan Sawah

Bukaan Baru. In *ahan Sawah Bukaan Baru* (pp. 77–106). Bogor: Balai Penelitian Tanah,Kementerian Pertanian. Retrieved from http://balittanah.litbang.pertanian.go.id/ind/dokumentasi/buku/buku lahan sawah bukaan baru/05pemupukan_diah.pdf?secure=true

Soil Survey Staff. (2010). *Keys to Soil Taxonomy* (11th ed.). Washington: United States Department of Agriculture, Natural Resources Conservation Service. Retrieved from https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_050915.pdf

Sosrodarsono, S., & Takeda, K. (2006). *Hidrologi untuk pengairan*. Jakarta: Pradnya Paramita. Retrieved from http://www.nlb.gov.sg/biblio/4194217

Sudana, W. (2005). Potensi dan Prospek Lahan Rawa sebagai Sumber Produksi Pertanian. *Analisis Kebijakan Pertanian*, *3*(2), 141–151. http://doi.org/10.21082/AKP.V3N2.2005.141-151

Susilawati, & Purwoko, B. S. (2014). PENGUJIAN VARIETAS DAN DOSIS PUPUK UNTUK MENINGKATKAN PERTUMBUHAN DAN HASIL RATUN-PADI DI SAWAH PASANG SURUT. *Jurnal Pengkajian Dan Pengembangan Teknologi Pertanian*, *15*(1), 47–54. http://doi.org/10.21082/JPPTP.V15N1.2012.P%P

Wahyunto. (2009). Lahan Sawah di Indonesia Sebagai Pendukung Ketahanan Pangan Nasional (Paddy fields in Indonesia as a back stopped for national food security). *Informatika Pertanian*, *18*(2), 133–152. Retrieved from http://perpustakaan.pertanian.go.id/simpertan_litbang/katalog/majalah/all/informatika-pertanian/18/2/2009/lahan-sawah-di-indonesia-sebagai-pendukung-ketahanan-pangan-nasional

Ali H, Ebrahim Azarpour, Hamid Z.D, Maral, M and Hamid R.B. 2011. Management of Cutting Height and Nitrogen Fertilizer Rates on Grain Yield and Several Attributes of Ratoon Rice (Oryza sativa L.) In Iran. World Applied Sciences Journal 15 (8): 1089-1094, 2011.

Djafar, Z.R. 2002. Development and management of Lowland to supportt sustainable of food security. Paper presented in workshop of Lowland Management and Development Palembang.

Koriyanti. 2013. Prospectives of Water Table Management on Reclaimed Tidal Lowlands with Subsurface Drainage Systems. (Case Study of Banyu Urip of Banyuasin, South Sumatera Province. Indonesia). Seminar Internasional ISABE. Yogyakarta.

McCauley, N., F.T.,Turner, M.O. Way, and L.J.Vawter. 2006. Hybrid Ratoon Management. RiceTech

Ngudiantoro. 2010. Developing of water table prediction model in Tidal Lowland of C/D land thypology. Case study in South Sumatera. Research Science Journal (13) 3.13303.

Subagyo, H. 2006. The Classification and Distribution of Lowland Areas. In Lowland Handbook of 1-23p. Agricultural Research Center Agency. Bogor.

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STUDY OF GROUND WATER DYNAMICS AND CHANGE OF ~~LAND~~SOIL NUTRIENT STATUS ON ~~THE~~ RICE GROWTH ~~OFRATOON PADDY~~IN RATOON SYSTEM IN TIDAL LOWLAND~~AGRICULTURE~~

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ABSTRACT

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Plant Cultivation in Tidal Lowland at MT 2 (March-April) had not been maximally conducted by farmers. This research aimed tostudy the dynamics of ground water and nutrient status condition in order to support plant cultivation at MT2. The research was conducted inBanyu Urip VillageTanjungLagoTelang II Banyuasin. The plant used in this activity was paddy with ratoon cultivation system.Ratoon system is paddy cultivation by using first paddy planting season shoots. Urea treatment was given with dose 0 kg/ha (control) and dose 150 kg/ha. The analysis result of soil showed that there was an increasing of nutrient status than its early soil condition. However, it did not significantly different. Therefore, fertilizing was not effective for ratoon cultivation system. The study of ground water dynamics showed that at the early phase, ground water level dropped above 30 cm (critical) but it increased by the rain and water retention in the canal. The average of ground water level was at the depth of 5-30 cm so it was suitable for plant growth. Plant growth at B treatment was better and its production was 2.8 ton/ha.This 2.8 ton/ha plant production was classified as high category for paddy with ratoon cultivation system.

Keywords: tidal lowland; rice ratoon; water table; gate operation

I. INTRODUCTION

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Tidal lowland in South Sumatera Provincehas been reclaimed since 1970 to be developed as an agriculture area with total wide 301.780 hectares (Sudana, 2005). However, as time passes, there were several obstacles in the use of tidal lowlandsuch as low productivity due to several physical problems (DariahandAgus, 2007), chemical problems(Setyoriniet al., 2007) and biological problems (Saraswati*et al*., 2007), as well as other social, institutional, organization, infrastructures problems, and low profit. Therefore, some area that used for agricultural land cannot be optimally used by the local people so some of them were used for other purposes such as palm oil and rubber plantation (Wahyunto, 2009).

Agricultural land transfer from paddy cultivation area into palm oil and rubber plantation area is very influential on annual rice production. Therefore, several strategies are required to return the quantity of production per year, such as: 1) increasing the wide area of production by opening new rice fields, 2) increasing of land productivity, and 3) expanding the harvest area through IP (harvest index) increasing (Erdiman, 2012).

One of the effort to increase paddy production is using intensification method such as ratoon system. There are several point that affect the growth of rice crops in ratoon cultivation system, such as: 1) the height of stems cutting from the harvest remaining, 2) variety, 3) ground water condition after harvesting, and 4) harvesting (Erdiman, 2012).

The potency of ratoon cultivation system is very good and it has been tested in several area in the tropics. The benefits are earlier growing time and safe workforce about 50-60%.The affecting factor is soil moisture. However, it has not been developed in tidal lowland. The fluctuation of ground water level highly influence the plant growth. Paddy plants usually need – 20 cm to– 30 cm water level from ground surface. It is related with the plant roots in penetrating the soil to absorb the water for plant (Faruq*et al*., 2014).So far, this ratoon paddy cultivation techniques has not been developed in the tidal lowland area. The farmers just leave it without any management. Whereas it has very good potency if it is developed just like in an irrigated land. Lampung BPTP (Center for Assessment of Agricultural Technology) reported that paddy production with ratoon method was 0.7 – 5 ton/ha (Ernawati*et al*., 2014).Mareza et al., 2016, reported that paddy production with ratoon methodin Indonesia was 1.5-2. 5 ton/ha.In China, it has reached 3.8 ton/ha. This production diversity is influenced by land condition and rice variety. One of the decisive factor is water availability. Related to this point, a study about the influence of ground water level to the growth of paddy in ratoon method is required.

II. METHODOLOGY

~~Field practice~~Study was conducted inBanyu Urip Village (P17 6S Tc7) TanjungLago Sub DistrictBanyuasin RegencySouth Sumatera Province in February – April 2013. Field practice was conducted by evaluating the influence of ground water level to the growth of paddy with

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ratoon method. There were two land plotsthat used for observation area of paddy with ratoon method:1)land A with no fertilizer which located atTc7 land number 5, 2)land B with fertilizer as many as 150 kg per ha which located at Tc7 land number 6. There were several observed parameters during this field practice, such as: 1)the depth of ground water level, 2) rain fall, 3) the height of water level in the canal, 4) plant height. Some secondary data were also used for supporting data. The analysis of soil fertility was conducted at the Physical Chemical Laboratory, Soil Department.

III. RESULT AND DISCUSSION

3.1. General Condition of Study Area

South Sumatera, there are several lowland area that can be used for agricultural area.Ngudiantoro (2010) stated in his report that Indonesia has 33 million hectares lowland area both in tidal lowland area and non-tidal lowland area. As many as 20 million hectares of tidal lowland area in Indonesia can be found in big islands such as Sumatera, Kalimantan, Sulawesi and Papua. Meanwhile, there are about 1.5 million hectares of tidal lowland that had been developed by the government.This tidal lowlanddevelopment project better known as tidal lowland reclamation. In South Sumatera itself, tidal lowland reclamationhas been conducted since 1969, and Telang II Delta is one of the reclamateddelta.

Telang II Delta is located inBanyuasin Regency. Its wide area is ±13.800 ha. It was first openedin 1979/1980 with transmigration placement in 1990. Geographically, Telang II Delta area is separated by Telang River flanked by Musi River in the east, Banyuasin River in the west, Sebalik River and Gasing River in the south.

Banyu Urip Villageis one of the villages which located in Telang II Delta where this research was conducted. Administratively,Banyu Urip Villageis under TanjungLago Sub Districtand the

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Comment [DAF7]: This section should be deleted, it does not correlate with your title and objective of this study boundary areas are; KarangBatu Village in the north, SukaDamai Village in the south, Mulia Sari Village in the east, and Bangun Sari Village in the west.

In Banyu Urip Village,plant cultivation pattern that commonly conducted by the farmers is paddy – corn –fallow land. In the first planting season (MT I), the land is planted with monoculture system. It is started with pre – planting period (land cultivation) in October, planting period in November, and harvesting season inMarch. Meanwhile, the second planting period (MT II) is conducted in May – September and it is planted with corn. The interval time between the first and second planting period, in the late of Februaryto the middle of April, is used by the farmers to take care of the remaining rice crops harvest and then it will produce more rice for the second harvest or better known as ratoon.

The characteristic of land that used for food crop cultivation is dominated by clay fraction. Therefore, the soil permeability is relatively slow withindex as many as 1.08 cm per hour (Santoso, 2012). In her report,Koriyanti (2013) stated that agricultural land in Banyu Urip Villageis a wet area with dominated by swamp area with very high water inundation fluctuation. In the rain season, the waters will inundates the land as high as +12 cm, while in the dry season, the height of ground water level will be -112 cm.

In the natural condition, soils in the tidal lowland area are saturated by the water or shallow inundated, along the year or in a long time, several months, or in a year (Subagyo, 2006). In the Soil Taxonomy classification (Soil Survey Staff, 1999), swampy area is classified as wet soils. It is characterized by aquatic condition, which currently experiencing water saturation and continuously or periodically reduction.

3.2. ~~The Effect of~~Ground Water Table Dynamic

The level of ground water table in Banyu Urip VillageTelang II Delta is influenced by sea water tidal. However, water in the land or riverdoes not contain salt or saline. In the other words, it is a fresh water. It is related with the position ofTelang II Delta which located in the zone II. This region is locatedin the downstream areabut more closely located to the upstreamwhere the direct influence of sea water or salinity is no longer going but the energy of tidal is still receivedin the form of up and down (rising and falling)river flows follow the cycleof tidal movement. Based on the type of water overflow, water in Telang II Deltahas C water overflowtype where land cannot be flooded by the tide even though it is in high tide. However, ground water level is still influenced by the fluctuation of tidal.

Djakfar (2002), wrote the description of type C overflowthat tidal lowlandnever been flooded by the highest tide of river water tidal. However, high tide still influence the elevation ofground water level so the depth of ground water level never been deeper than 50 cm below ground surface.The average height of ground water level never been higher than 50 cm above ground water elevation (the highest).

The height of ground water level is highly influenced by rain fall. It is similar with the field result. The height of ground water level was measured by using wells. The result showed that the highest ground water level was identified in March. The ground water level reached -5cm from the ground level (~~shown in the graph in~~Figure1). It is related with the high intensity of rain fall in March as presented in Figure 3, that the highest average rain fall was identified inMarch.

This rain impact to the ground water level that it becomes relatively shallow about 20 cm undergroundsurface. In this condition, soil humidity is maintained to supply water needs for paddy plants.

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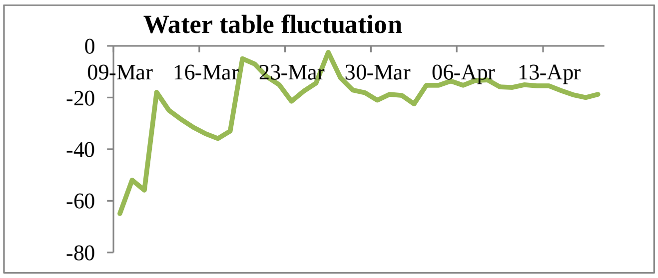

Figure 1.Daily ground water level fluctuation, measurement was conducted by using wells

In the daily rain graph (Figure 2), the calculation was conducted together with ground water level observation. It showed a direct proportional that in March, rain happens almost every single day.

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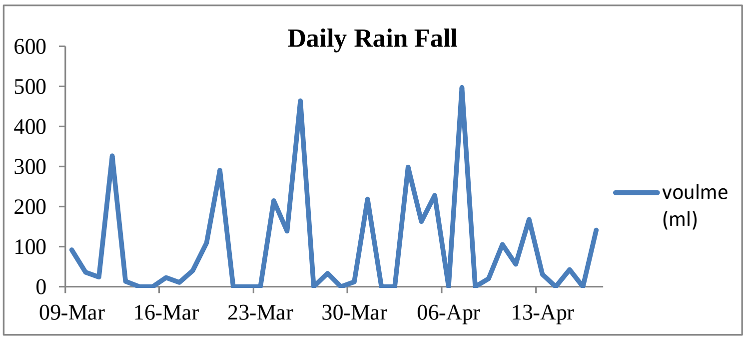

Figure 2.Daily rain fall on 23 February – 3 April 2013

As a comparation data, rainfall observation was also conducted atKenten Climatology Station. The last 10 years monthly rainfall data in 2002 – 2012was collected. The graph of annual rain fall (Figure 3) showed that March is a wet month with average rain fall volume reaches≥400 ml peryear. Therefore, it can be interpreted that ground water level was determined by the volume of rain fall. However, water condition in the land is alsoinfluenced by ....???????

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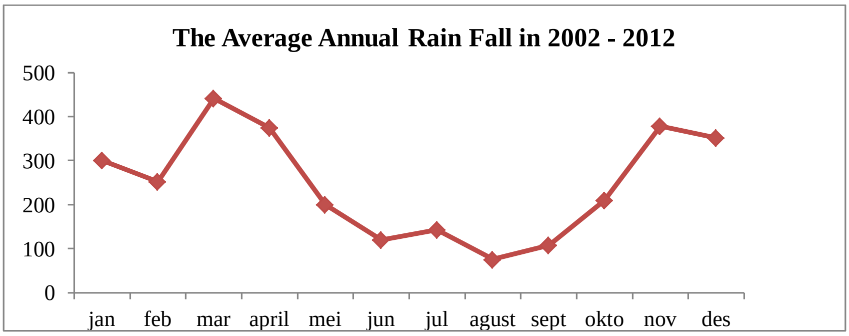

Figure 3.Graph of annual rain fall in 2002 – 2012

Ground water is a water that moves in the soil especially in the spaces between the soil poresand rock cracks (Takaeda, 2006). Meanwhile, ground water level is the difference or gap of water input from the precipitation, rain that infiltrate the soil, added with condensation by the plants and soil as well as adsorption by soil, reduced by water that lost through evapotranspiration process, ground surface flow, percolation, and lateral seepage. In its mechanism, the change of ground water level involves three main mechanism, namely: 1) retention and water movement in the soil, 2) absorption (uptake) and water translocation in plant, 3) evapotranspiration. Therefore, it can be interpreted that the periodical ground water level fluctuation depends on the balance of water input and loss.

Based on ~~the above graph~~figure ???, it can be seen than~~ground water condition in the land showed~~ ground water ~~depth~~level with balanced rain fall condition. Even though ground water level conditionin the landhas dropped to -65 cm from the ground surface, but its ground water condition lifted to -18 cm from the ground surface so plants were not died due to lack of water. In this ground water condition from -5 to -36 cm from the ground surfaceso paddy plants water requirement can be fulfilled.

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3.3. Ratoon Paddy Cultivation System

Paddy cultivation activity in Banyu Urip Village P17-6S used early age paddy variety namely IR-64. This paddy variety age is >105to 124 days. First Planting Period~~I~~ is conducted by farmer in October to March, while the Second Planting Period ~~II~~is conducted by farmer in May to September. In the MT I and MT II interval inMarch – May, farmers plant fallow crops or continue to take care the harvested paddy plantor grow it again to be harvested better known as ratoon paddy system. Ratoon paddy has a short life cycle only about 40 days.

In the ratoon~~paddy cultivation sy~~stem, the top part of ~~harvested~~paddy will be cut and ~~its plant stump will be~~ left about 20 – 30 cm from the ground surface. However, according to Ichi (1983), ratoon cut can be conducted about 5 cm and 20 cm from the ground surface. The water depth level is maintained about 5 cm. This condition is difficult if it is planted in the tidal lowlandarea with typology B.Research by Setiawan et al.,(2014)showed that there was no interaction between the thickness of irrigation and the height of stem cutting to the plant growth. Ratoon plant production can reach 3.12 ton/ha in the continuous flooding treatment.

In order to get maximum production, fertilizer is required because ratoon cultivation system has low production potency. In the observation in Banyu Urip Village, there were two observed agricultural lands. Land A with no fertilizer and Land B with fertilizer namelyurea as many as 150 kg per hectares. It was given one time after paddy stem cutting.

Ratoon paddy cultivation will be continued if shoot grown from the paddy stalks grow more than 70% (Islam et al., 2008). Paddy plants in vegetative phase require different amount of water in accordance with the requirement. Vegetative phase of paddy plant is divided into three phases, namely: a) recovery stages and roots growth (0-10 days after planting), b) maximum growth phase of tiller (10-50 days after planting) and, c) effective shooting and ineffective shooting (35-45 days after planting).

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The growth and quantity of tillers is highly influence by cutting technique. Farmers have problem with this cutting. Harvesting process in Telang is conducted by using high cutting technique. To cut it back, farmers are constrained by time and energy. Cutting height very affectratoon paddy cultivation system especially in its vegetative phase. The higher cutting, the fewer tiller will be but its growth will be very fast with less tiller quantity(Wasis, 2014).

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In ratoon paddy system, recovery phase and maximum tiller growth will not be experienced because paddy will not be transplanted and ratoon paddy will not have intensive tiller growth like newly planted paddy.Ratoon paddy has an effective shooting phase if previously cut stems will grow new shoots and produce new leaves. The following process is the increasing of plant height shown by the lengthening of leaves.

Furthermore, paddy plants turn into generative phase. In this phase, it covers the early development of panicles (40-50 days after planting), fulfilling phase (50-60 days after planting), and flowering (60-80 days after planting).Research by Faruq et al., 2014 showed that ratoon paddy can be harvested in 90 days and96 days according to the research result by Setiawan et al (2014).This situation is characterized by panicles formation and growing. However, in the generative phase, ratoon paddy do not need a long time so in 20 days paddy plant has showed its panicle existence.

In the generative phase, paddy plants require a lot of water. Drought in this period will influence the formation of panicles, flower, and fertilization so it increases the sterility of plant and decrease plant production. Based on the ground water observation at the field, ground water level was at -5 to -36 cm from the ground surface. It showed that paddy's water requirement was quite sufficient because paddy's roots able to absorb water in the depth of 20-30 cm below ground surface.

3.4. The Effect of Fertilazation on the growth of paddy ratoon

In addition of ground water level that able to influence the growth and production of paddy, fertilization also influence it. As previously written that Land A was given with no fertilizer and Land B with fertilizer as many as 150 kg per ha. It showed that it had different result in plant height and production. Ratoon production at Land A was 0.8 ton per hectare and ratoon paddy production at Land B was 2.8 ton per hectare. Table 1 showed the height of plant in different treatment of land.

Table 1.Average weekly paddy height

Week	LandA (cm)	LandB (cm)
1	74.61	79.64
2	81.60	95.20
3	87.20	102.00
4	100.30	109.90

Based on ~~the above~~ table 1 ~~about average weekly paddy height, it showed that~~there was a difference in the plant height at Land A and Land B. In the first week, its difference was 5 cm. In the second week, its difference was 13 cm. In the third week, its difference was 14 cm. And in the last week, its difference was 9.6 cm. ~~At Land A with no fertilizer, showed that plants height were shorter than plants inLand B.~~ However, the plants were cut in the similar height about 25 cm from the ground surface. The water height in each land was also similar. The difference~~ of these plants can be interpreted thatplants growth with no fertilizer were slower than plants with fertilizer~~.may be ralated with fertilizer treatment. The difference of plants height and plants production was not depend on the ground water level because ground water level in land able to be reached by roots. However, it was caused by different soil fertility.

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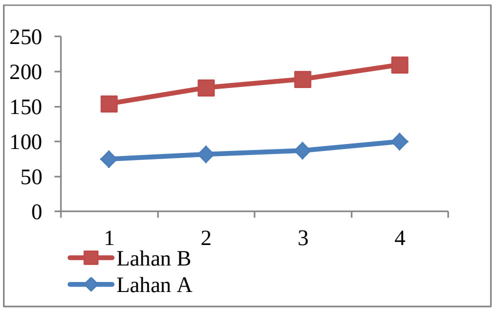

Figure 4. Graph of average weekly paddy height

This above graph showed the significant difference of ratoon paddy at Land A with no fertilizer and Land B with fertilizer. ~~As reported by~~Hanafiah (2005)~~in her book~~, reportedthat NH_4^+ in the urea fertilizer plays a role in composing all proteins (acids – amino acids – enzyme) and chlorophyll, coenzyme and nucleic acidsas well as growth hormones such as cytokines and auxins.

Comment [DAF36]: Did you do variance analysis (ANOVA)?

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Table 2. The result of initial and final soil analysis in the study area

Comment [DAF38]: use the common term

Type of Analysis	Initial Soil Analysis	Final Soil Analysis	
		Land A	Land B
pH H_2O	4.28	4.62	4.50
Ph KCl	3.85	3.93	3.89
C-organic	0.46	4.74	5.31
N- Total (%)	0.04	0.42	0.39
P-Bray I (ppm)	29.25	25.20	21.45
K-dd (me per 100 g)	0.26	0.38	0.32
Na (me per 100 g)	0.87	0.54	0.76
Ca (me per 100 g)	1.88	2.05	2.28
Mg (me per 100 g)	1.20	0.68	0.55
KTK (me per 100 g)	17.40	30.45	43.50
Al-dd (me per 100 g)	1.36	1.50	0.76
H-dd (me per 100 g)	0.38	0.72	0.64
Texture			
Sand(%)	22.06	32.64	30.35
Dust(%)	31.61	44.88	42.84
Clay (%)	46.33	22.48	26.81

Fertilization can increase the growth but in certain level it cannot increase the production quantity. A research by Bonn and Bollich (2006) showed that nitrogen application as many as 90-120 kg/ha was no longer able to increase paddy production. This condition was in line with the research result Islam et al., (2008), that the highest paddy production with ratoon method was achieved in urea dose as many as 120 kg/ha. A research in showed that an application ofurea as many as 60 kg N/ha able to increasepaddy production with ratoon method as many as 1.9 ton/ha on 30 cm stem cutting (Huossainzade et al., 2011). The growth and production of plant is influenced by fertility level and also environmental condition especially temperature and sun radiation (Oad et al., 2002).

Based on the analysis result at the laboratory(Table 2), analysis was conducted for initial land sample before ratoon technique and after ratoon technique. Initial soil sample analysis showed that C-organic content in the soil was low as many as 0.46% while in the analyzed soil sample after ratoon technique, C-organic content increased up tomore than 5%. At Land A with no fertilizer, the content of C-organic in the soil was 4.74% while at Land B with fertilizer treatment, C-organic content was 5.31%. The difference of C-organic content at these two soil treatments was 0.57%.

Comment [DAF39]: Explain this fact !!! why ???

As showed by the analysis result, before ratoon treatment the content of N-total was 0.04%, while the content of N-total at the land with ratoon technique increased into 0.42 % at Land A and 0.39 at Land B.Cation Exchange Capacity (CEC) of land also increased from 17.40 me per 100g into 30.45 me per 100g at Land A and 43.50 me per 100g at Land B.

Comment [DAF40]: Explain this fact !!! why ???

The increasing of C-organic content and Cation Exchange Capacity (CEC) content at these two lands were different. The increasing of C-organic content and Cation Exchange Capacity (CEC) index were possiblycaused by urea fertilizer treatment. However, N-total at Land A was higher than Land B. It was related with Al-ddat Land A which higher 0.74 per 100 g than Land B.

Comment [DAF41]: Fertilizer application did not increase C-organik and CEC. C-org and CEC may increase if you applying organic matter !!!!

The increasing of chemical content in the soil was not only caused by fertilizer treatment but also triggered by the additional of litter component in the plant. If it was seen from the height of plants,fertilizer treatment to the plant height was directly proportional. However, fertilizer treatment was inefficient because the production cost was notbalanced with the production result. The production result of paddy with ratoon method was only one-third of normal production.

Comment [DAF42]: What do you mean ????

IV. CONCLUSION AND RECOMENDATION

Comment [DAF43]: Please make a conclusion based on your own objective of your research !!!

Based on the above description, it can be concluded that:

a. Ground water level in a particular land is highly determined by rainfall in this area. However, water existence in a canal able to inhibit the decrease of groundwater level.

b. The condition of ground water level at the rice fields in Banyu Urip Villagewas high because during rainy season it able to reach-5cm from the ground surface,

c. Paddy roots able to reach waters in the depth of 20 cm from the ground surface and ground water level condition was -5cmto -36 cmfrom the ground surface. It showed that water requirement could be fulfilled,

d. The production of paddy field with ratoon method was influenced by urea fertilizer treatment. It was showed by the production difference of Land A,as many as 0.8 ton per ha, and Land B as many as 2.8 ton per ha,

e. Fertilizer treatment for paddy plant with ratoon method was ineffective because if it was compared with land with no fertilizer, it only increased C-organic content as many as 0.5% and Cation Exchange Capacity (CEC) content as many as 13.00 me per 100g.

It is suggested that in plant cultivation with ratoon method, it should be conducted in wet month such as March. It is intended to maintain the height level of ground water so plant water requirement can be fulfilled.A balanced fertilizer treatment should be conducted in paddy cultivation with ratoon method in order to get a balanced production with fertilizer cost.A further research about a balanced fertilizer doseis required in order to increase paddy productionwith ratoon method.

References

Comment [DAF44]: See journal's standard

Ali H, EbrahimAzarpour, Hamid Z.D, Maral, M and Hamid R.B. 2011.Management of Cutting Height and Nitrogen Fertilizer Rates on Grain Yield and Several Attributes of Ratoon Rice (Oryza sativa L.)In Iran. World Applied Sciences Journal 15 (8): 1089-1094, 2011.

Bond, J.A., and Bollich, P.K. 2006.Ratoon Rice Response to Nitrogen Fertilizer. Plant Health Progress 5(1).DOI 10.1094/CM-2006-0523-02-RS.

Dariah A., d~~an~~ and F.Agus. 2007. Management onf soil physics on rice field. Agriculture Research Center. Bogor.

Djafar, Z.R. 2002.Development and management of Lowland to suppot sustainable of food security.Paper presented in workshop of Lowland Management and Development Palembang.

Ernawati, Bambang W., Edwin H., Gohan O.M. 2014.The Technology of Rice PadyRatoon system.Applied Agriculture Research Technology of Lampung.Ministry of Agriculture.

Erdiman. 2005. SalibuTechnology to increase land productivity of rice (3 – 6 ton ha^{-1} th) and increasefarmerincome (Rp. 15 – 25 juta th). Applied Agriculture Research Technology, West Sumatra.

Golam F, Rosna M.T and Zakaria H. P. 2014. Rice Ratoon Crop: A Sustainable Rice Production System for Tropical Hill Agriculture. Sustainability 2014, 6, 5785-5800; doi:10.3390/su6095785

Islam, S.M., Hasanuzzaman, M., and Rokonuzzaman. 2008. Ratoon Rice Response to Different Fertilizer Doses in Irrigated Condition**.** Agriculturae Conspectus Scientificus | Vol. 73 (2008) No. 4 (197-202).

Mareza, E., Zainal R. D, Rujito, A.S., Andi W. 2016.Growth and production of paddy ratoon in some variety of rice in tidal lowland areas. Procedingof National Seminar Suboptimal Land. Palembang, 20-21 October 2016

Masahiko ICHII 1983. The Effect of Water Management on Ratoon Ability of Rice Plants. Tech Bull FacAgr Kagawa UnivVol 34, No 2, 123- 128, 1983

Hanafiah, K. A. 2005. Fundamental of Soil Science.Jakarta; RajaGrafindoPersada.

Koriyanti. 2013. Prospectivesof Water Table Management onReclaimedTidal Lowlandswith Subsurface Drainage Systems. (Case Studyof Banyu Urip of Banyuasin, South Sumatera Province. Indonesia). Seminar Internasional ISABE. Yogyakarta.

Ngudiantoro. 2010. Developing of water table prediction model in Tidal Lowland of C/D land thypology. Case study in South Sumatera.Research Science Journal (13) 3.13303.

Oad, F.C. Pompe, Sta, Cruz, N., Memon, N.L, Ood, 2002. Rice Ratooning Management.Journal of Applied Sciences 2 (1):29-35.

Setiawan, A. Setyono and Y.D,Nugroho. A. 2014. IntermitentIrigation and Cutting Height on Growth *and Yield Ratoo Rice*.(Oryza sativa L.).Journal of Agriculture Science 36(1).

Santoso, A.B., N.K. Fageria, and A.S. Prabhu. 2003. Rice ratooning management practices for higher yields. Commun. Soil Sci. Plant Anal. 34:881-918.

Saraswatidan Edi H. 2007. The Photencial of Organic Fertilizer on the Rice Field.Agricultural Research Center Agency. Bogor.151-174 p.

Setyorini, D., DidiArdi S., ~~dan~~Nurjaya. 2007. The Recommendation of Fertilizer Application on Paddy in New Rice Field Areas. Agricultural Research Center Agency.77-106.

Soil Survey Staff.Keys to Soil Taxonomy.11th ed. *USDA*-National Resources Conservation Service, 2010.

Sudana, Wayan. 2005. Potencial and prospect of lowland for developing agricultural product. Agricultural Analysis and Polcy (3)2, Juni 2005: 141-151.

Subagyo, H. 2006. The Classification and Distribution of Lowland Areas.In Lowland Handbookof 1-23p.Agricultural Research Center Agency. Bogor.
Takaeda, K. 2006. Hydrology for Irrigation n. Jakarta: PT. PradnyaParamita.
Wahyunto. 2009. Lowland Rice in Indonesia to Support National Food Security. Agricultural Information (18) 2, 2009.

STUDY OF GROUND WATER DYNAMICS AND CHANGE OF LAND NUTRIENT STATUS ON THE GROWTH OF RATOON PADDY IN TIDAL LOWLAND AGRICULTURE

ABSTRACT

Plant Cultivation in Tidal Lowland at MT 2 (March-April) had not been maximally conducted by farmers. This research aimed to study the dynamics of ground water and nutrient status condition in order to support plant cultivation at MT2. The research was conducted in Banyu Urip Village Tanjung Lago Telang II Banyuasin. The plant used in this activity was paddy with ratoon cultivation system. Ratoon system is paddy cultivation by using first paddy planting season shoots. Urea treatment was given with dose 0 kg/ha (control) and dose 150 kg/ha. The analysis result of soil showed that there was an increasing of nutrient status than its early soil condition. However, it did not significantly different. Therefore, fertilizing was not effective for ratoon cultivation system. The study of ground water dynamics showed that at the early phase, ground water level dropped above 30 cm (critical) but it increased by the rain and water retention in the canal. The average of ground water level was at the depth of 5-30 cm so it was suitable for plant growth. Plant growth at B treatment was better and its production was 2.8 ton/ha. This 2.8 ton/ha plant production was classified as high category for paddy with ratoon cultivation system.

Keywords: tidal lowland; rice ratoon; water table; gate operation

I. INTRODUCTION

Tidal lowland in South Sumatera Province has been reclaimed since 1970 to be developed as an agriculture area with total wide 301.780 hectares (Sudana, 2005). However, as time passes, there were several obstacles in the use of tidal lowland such as low productivity due to several physical problems (Dariah and Agus, 2007), chemical problems (Setyorini et al., 2007) and biological problems (Saraswati *et al*., 2007), as well as other social, institutional, organization, infrastructures problems, and low profit. Therefore, some area that used for agricultural land cannot be optimally used by the local people so some of them were used for other purposes such as palm oil and rubber plantation (Wahyunto, 2009).

Agricultural land transfer from paddy cultivation area into palm oil and rubber plantation area is very influential on annual rice production. Therefore, several strategies are required to return the quantity of production per year, such as: 1) increasing the wide area of production by opening new rice fields, 2) increasing of land productivity, and 3) expanding the harvest area through IP (harvest index) increasing (Erdiman, 2012).

One of the effort to increase paddy production is using intensification method such as ratoon system. There are several point that affect the growth of rice crops in ratoon cultivation system, such as: 1) the height of stems cutting from the harvest remaining, 2) variety, 3) ground water condition after harvesting, and 4) harvesting (Erdiman, 2012).

The potency of ratoon cultivation system is very good and it has been tested in several area in the tropics. The benefits are earlier growing time and safe workforce about 50-60%. The affecting factor is soil moisture. However, it has not been developed in tidal lowland. The fluctuation of ground water level highly influence the plant growth. Paddy plants usually need – 20 cm to – 30 cm water level from ground surface. It is related with the plant roots in penetrating the soil to absorb the water for plant (Faruq *et al*., 2014). So far, this ratoon paddy cultivation techniques has not been developed in the tidal lowland area. The farmers just leave it without any management. Whereas it has very good potency if it is developed just like in an irrigated land. Lampung BPTP (Center for Assessment of Agricultural Technology) reported that paddy production with ratoon method was 0.7 – 5 ton/ha (Ernawati *et al*., 2014). Mareza et al., 2016, reported that paddy production with ratoon method in Indonesia was 1.5-2. 5 ton/ha. In China, it has reached 3.8 ton/ha. This production diversity is influenced by land condition and rice variety. One of the decisive factor is water availability. Related to this point, a study about the influence of ground water level to the growth of paddy in ratoon method is required.

II. METHODOLOGY

Field practice was conducted in Banyu Urip Village (P17 6S Tc7) Tanjung Lago Sub District Banyuasin Regency South Sumatera Province in February – April 2013. Field practice was conducted by evaluating the influence of ground water level to the growth of paddy with ratoon

Comment [H1]: Is it block number? Is it better important than geographic location? I think is better showed in a map. It is important to describe the distance of sea method. There were two land plots that used for observation area of paddy with ratoon method: 1) land A with no fertilizer which located at Tc7 land number 5, 2) land B with fertilizer as many as 150 kg per ha which located at Tc7 land number 6. There were several observed parameters during this field practice, such as: 1) the depth of ground water level, 2) rain fall, 3) the height of water level in the canal, 4) plant height. Some secondary data were also used for supporting data. The analysis of soil fertility was conducted at the Physical Chemical Laboratory, Soil Department.

III. RESULT AND DISCUSSION

3.1. General Condition of Study Area

South Sumatera, there are several lowland area that can be used for agricultural area. Ngudiantoro (2010) stated in his report that Indonesia has 33 million hectares lowland area both in tidal lowland area and non-tidal lowland area. As many as 20 million hectares of tidal lowland area in Indonesia can be found in big islands such as Sumatera, Kalimantan, Sulawesi and Papua. Meanwhile, there are about 1.5 million hectares of tidal lowland that had been developed by the government. This tidal lowland development project better known as tidal lowland reclamation. In South Sumatera itself, tidal lowland reclamation has been conducted since 1969, and Telang II Delta is one of the reclamated delta.

Telang II Delta is located in Banyuasin Regency. Its wide area is ± 13.800 ha. It was first opened in 1979/1980 with transmigration placement in 1990. Geographically, Telang II Delta area is separated by Telang River flanked by Musi River in the east, Banyuasin River in the west, Sebalik River and Gasing River in the south.

Banyu Urip Village is one of the villages which located in Telang II Delta where this research was conducted. Administratively, Banyu Urip Village is under Tanjung Lago Sub

District and the boundary areas are; Karang Batu Village in the north, Suka Damai Village in the south, Mulia Sari Village in the east, and Bangun Sari Village in the west.

In Banyu Urip Village, plant cultivation pattern that commonly conducted by the farmers is paddy – corn – fallow land. In the first planting season (MT I), the land is planted with monoculture system. It is started with pre – planting period (land cultivation) in October, planting period in November, and harvesting season in March. Meanwhile, the second planting period (MT II) is conducted in May – September and it is planted with corn. The interval time between the first and second planting period, in the late of February to the middle of April, is used by the farmers to take care of the remaining rice crops harvest and then it will produce more rice for the second harvest or better known as ratoon.

The characteristic of land that used for food crop cultivation is dominated by clay fraction. Therefore, the soil permeability is relatively slow with index as many as 1.08 cm per hour (Santoso, 2012). ~~In her report,~~ Koriyanti (2013) stated that agricultural land in Banyu Urip Village is a wet area with dominated by swamp area with very high water inundation fluctuation. In the rain season, the waters will inundates the land as high as +12 cm, while in the dry season, the height of ground water level will be -112 cm.

Comment [H2]: Do not use active sentence or subject

In the natural condition, soils in the tidal lowland area are saturated by the water or shallow inundated, along the year or in a long time, several months, or in a year (Subagyo, 2006). In the Soil Taxonomy classification (Soil Survey Staff, 1999), swampy area is classified as wet soils. It is characterized by aquatic condition, which currently experiencing water saturation and continuously or periodically reduction.

3.2. The Effect of Ground Water Table

The level of ground water table in Banyu Urip Village Telang II Delta is influenced by sea water tidal. However, water in the land or river does not contain salt or saline. In the other words, it is a fresh water. It is related with the position of Telang II Delta which located in the zone II. This region is located in the downstream area but more closely located to the upstream where the direct influence of sea water or salinity is no longer going but the energy of tidal is still received in the form of up and down (rising and falling) river flows follow the cycle of tidal movement. Based on the type of water overflow, water in Telang II Delta has C water overflow type where land cannot be flooded by the tide even though it is in high tide. However, ground water level is still influenced by the fluctuation of tidal.

Comment [H3]: How is far from the sea?

Djakfar (2002), wrote the description of type C overflow that tidal lowland never been flooded by the highest tide of river water tidal. However, high tide still influence the elevation of ground water level so the depth of ground water level never been deeper than 50 cm below ground surface. The average height of ground water level never been higher than 50 cm above ground water elevation (the highest).

The height of ground water level is highly influenced by rain fall. It is similar with the field result. The height of ground water level was measured by using wells. The result showed that the highest ground water level was identified in March. The ground water level reached -5cm from the ground level (shown in the graph in Figure 1). It is related with the high intensity of rain fall in March as presented in Figure 3, that the highest average rain fall was identified in March.

This rain impact to the ground water level that it becomes relatively shallow about 20 cm underground surface. In this condition, soil humidity is maintained to supply water needs for paddy plants.

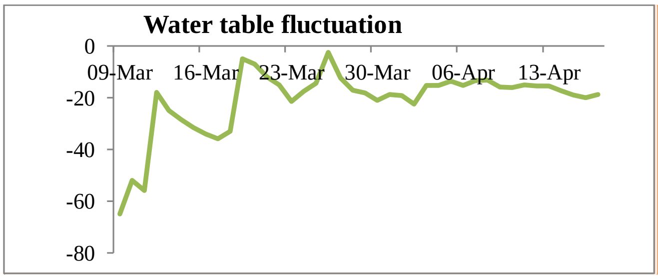

Figure 1. Daily ground water level fluctuation, measurement was conducted by using wells

In the daily rain graph (Figure 2), the calculation was conducted together with ground water level observation. It showed a direct proportional that in March, rain happens almost every single day.

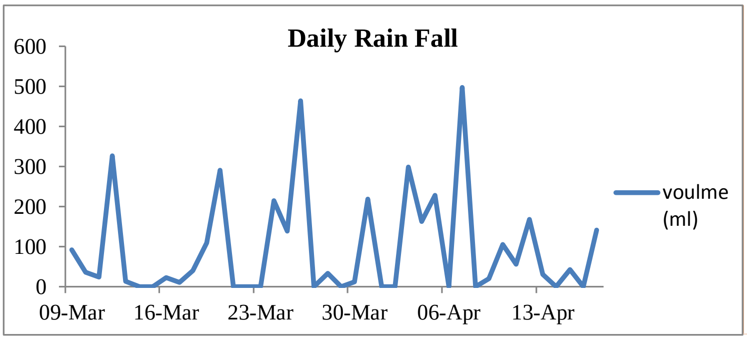

Figure 2. Daily rain fall on 23 February – 3 April 2013

As a comparation data, rainfall observation was also conducted at Kenten Climatology Station. The last 10 years monthly rainfall data in 2002 – 2012 was collected. The graph of annual rain fall (Figure 3) showed that March is a wet month with average rain fall volume reaches ≥ 400 ml per year. Therefore, it can be interpreted that ground water level was determined by the volume of rain fall. However, water condition in the land is also influenced by

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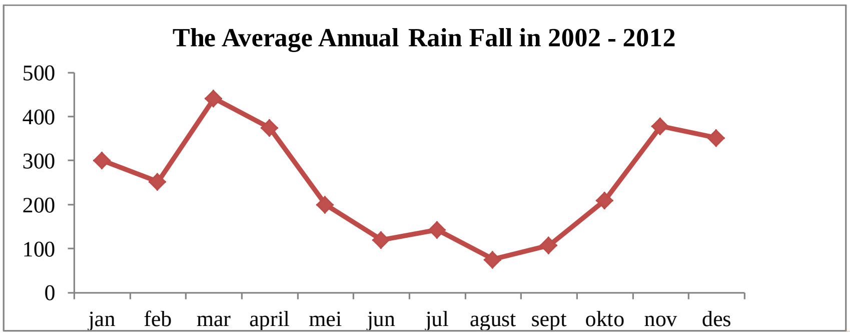

Figure 3. Graph of annual rain fall in 2002 – 2012

Ground water is a water that moves in the soil especially in the spaces between the soil pores and rock cracks (Takaeda, 2006). Meanwhile, ground water level is the difference or gap of water input from the precipitation, rain that infiltrate the soil, added with condensation by the plants and soil as well as adsorption by soil, reduced by water that lost through evapotranspiration process, ground surface flow, percolation, and lateral seepage. In its mechanism, the change of ground water level involves three main mechanism, namely: 1) retention and water movement in the soil, 2) absorption (uptake) and water translocation in plant, 3) evapotranspiration. Therefore, it can be interpreted that the periodical ground water level fluctuation depends on the balance of water input and loss.

Based on the above graph, it can be seen than ground water condition in the land showed ground water depth level with balanced rain fall condition. Even though ground water level condition in the land has dropped to -65 cm from the ground surface, but its ground water condition lifted to -18 cm from the ground surface so plants were not died due to lack of water. In this ground water condition from -5 to -36 cm from the ground surface so paddy plants water requirement can be fulfilled.

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3.3. Ratoon Paddy Cultivation System

Paddy cultivation activity in Banyu Urip Village P17-6S used early age paddy variety namely IR-64. This paddy variety age is > 105 to 124 days. First Planting Period I is conducted by farmer in October to March, while the Second Planting Period II is conducted by farmer in May to September. In the MT I and MT II interval in March – May, farmers plant fallow crops or continue to take care the harvested paddy plant or grow it again to be harvested better known as ratoon paddy system. Ratoon paddy has a short life cycle only about 40 days.

Comment [H9]: What is means with senteces before?

In the ratoon paddy cultivation system, the top part of harvested paddy will be cut and its plant stump will be left about 20 – 30 cm from the ground surface. However, according to Ichi (1983), ratoon cut can be conducted about 5 cm and 20 cm from the ground surface. The water depth level is maintained about 5 cm. This condition is difficult if it is planted in the tidal lowland area with typology B. Research by Setiawan et al., (2014) showed that there was no interaction between the thickness of irrigation and the height of stem cutting to the plant growth. Ratoon plant production can reach 3.12 ton/ha in the continuous flooding treatment.

In order to get maximum production, fertilizer is required because ratoon cultivation system has low production potency. In the observation in Banyu Urip Village, there were two observed agricultural lands. Land A with no fertilizer and Land B with fertilizer namely urea as many as 150 kg per hectares. It was given one time after paddy stem cutting.

Ratoon paddy cultivation will be continued if shoot grown from the paddy stalks grow more than 70% (Islam et al., 2008). Paddy plants in vegetative phase require different amount of water in accordance with the requirement. Vegetative phase of paddy plant is divided into three phases, namely: a) recovery stages and roots growth (0-10 days after planting), b) maximum growth phase of tiller (10-50 days after planting) and, c) effective shooting and ineffective shooting (35-45 days after planting).

The growth and quantity of tillers is highly influence by cutting technique. Farmers have problem with this cutting. Harvesting process in Telang is conducted by using high cutting technique. To cut it back, farmers are constrained by time and energy. Cutting height very affect ratoon paddy cultivation system especially in its vegetative phase. The higher cutting, the fewer tiller will be but its growth will be very fast with less tiller quantity (Wasis, 2014).

In ratoon paddy system, recovery phase and maximum tiller growth will not be experienced because paddy will not be transplanted and ratoon paddy will not have intensive tiller growth like newly planted paddy. Ratoon paddy has an effective shooting phase if previously cut stems will grow new shoots and produce new leaves. The following process is the increasing of plant height shown by the lengthening of leaves.

Furthermore, paddy plants turn into generative phase. In this phase, it covers the early development of panicles (40-50 days after planting), fulfilling phase (50-60 days after planting), and flowering (60-80 days after planting). Research by Faruq et al., 2014 showed that ratoon paddy can be harvested in 90 days and 96 days according to the research result by Setiawan et al (2014). This situation is characterized by panicles formation and growing. However, in the generative phase, ratoon paddy do not need a long time so in 20 days paddy plant has showed its panicle existence.

In the generative phase, paddy plants require a lot of water. Drought in this period will influence the formation of panicles, flower, and fertilization so it increases the sterility of plant and decrease plant production. Based on the ground water observation at the field, ground water level was at -5 to -36 cm from the ground surface. It showed that paddy’s water requirement was quite sufficient because paddy’s roots able to absorb water in the depth of 20-30 cm below ground surface.

3.4. The Effect of Fertilazation on the growth of paddy ratoon

In addition of ground water level that able to influence the growth and production of paddy, fertilization also influence it. As previously written that Land A was given with no fertilizer and Land B with fertilizer as many as 150 kg per ha. It showed that it had different result in plant height and production. Ratoon production at Land A was 0.8 ton per hectare and ratoon paddy production at Land B was 2.8 ton per hectare. Table 1 showed the height of plant in different treatment of land.

Table 1. Average weekly paddy height

Week	Land A (cm)	Land B (cm)
1	74.61	79.64
2	81.60	95.20
3	87.20	102.00
4	100.30	109.90

Based on the above table about average weekly paddy height, it showed that there was a difference in the plant height at Land A and Land B. In the first week, its difference was 5 cm. In the second week, its difference was 13 cm. In the third week, its difference was 14 cm. And in the last week, its difference was 9.6 cm. At Land A with no fertilizer, showed that plants height were shorter than plants in Land B. However, the plants were cut in the similar height about 25 cm from the ground surface. The water height in each land was also similar. The difference of these plants can be interpreted that plants growth with no fertilizer were slower than plants with fertilizer. The difference of plants height and plants production was not depend on the ground water level because ground water level in land able to be reached by roots. However, it was caused by different soil fertility.

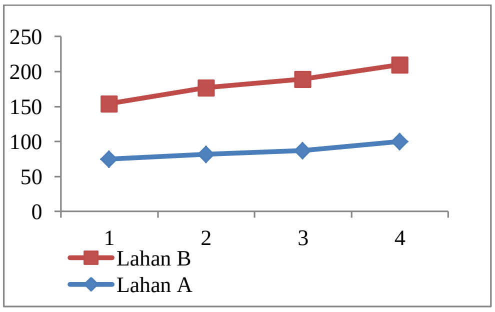

Figure 4. Graph of average weekly paddy height

This above graph showed the significant difference of ratoon paddy at Land A with no fertilizer and Land B with fertilizer. As reported by Hanafiah (2005) in her book, that NH_4^+ in the urea fertilizer plays a role in composing all proteins (acids – amino acids – enzyme) and chlorophyll, coenzyme and nucleic acids as well as growth hormones such as cytokines and auxins.

Comment [H10]: Please explain more

Table 2. The result of initial and final soil analysis in the study area

Type of Analysis	**Initial Soil Analysis**	**Final Soil Analysis**	
		Land A	**Land B**
pH H_2O	4.28	4.62	4.50
Ph KCl	3.85	3.93	3.89
C-organic	0.46	4.74	5.31
N- Total (%)	0.04	0.42	0.39
P-Bray I (ppm)	29.25	25.20	21.45
K-dd (me per 100 g)	0.26	0.38	0.32
Na (me per 100 g)	0.87	0.54	0.76
Ca (me per 100 g)	1.88	2.05	2.28
Mg (me per 100 g)	1.20	0.68	0.55
KTK (me per 100 g)	17.40	30.45	43.50
Al-dd (me per 100 g)	1.36	1.50	0.76
H-dd (me per 100 g)	0.38	0.72	0.64
Texture			
Sand (%)	22.06	32.64	30.35
Dust (%)	31.61	44.88	42.84
Clay (%)	46.33	22.48	26.81

Comment [H11]: Do you mean CEC?

Comment [H12]: silt

Comment [H13]: please use english

Fertilization can increase the growth but in certain level it cannot increase the production quantity. A research by Bonn and Bollich (2006) showed that nitrogen application as many as 90-120 kg/ha was no longer able to increase paddy production. This condition was in line with the research result Islam et al., (2008), that the highest paddy production with ratoon method was achieved in urea dose as many as 120 kg/ha. A research in showed that an application of urea as many as 60 kg N/ha able to increase paddy production with ratoon method as many as 1.9 ton/ha on 30 cm stem cutting (Huossainzade et al., 2011). The growth and production of plant is influenced by fertility level and also environmental condition especially temperature and sun radiation (Oad et al., 2002).

Based on the analysis result at the laboratory (Table 2), analysis was conducted for initial land sample before ratoon technique and after ratoon technique. Initial soil sample analysis showed that C-organic content in the soil was low as many as 0.46% while in the analyzed soil sample after ratoon technique, C-organic content increased up to more than 5%. At Land A with no fertilizer, the content of C-organic in the soil was 4.74% while at Land B with fertilizer treatment, C-organic content was 5.31%. The difference of C-organic content at these two soil treatments was 0.57%.

As showed by the analysis result, before ratoon treatment the content of N-total was 0.04%, while the content of N-total at the land with ratoon technique increased into 0.42 % at Land A and 0.39 at Land B. Cation Exchange Capacity (CEC) of land also increased from 17.40 me per 100 g into 30.45 me per 100 g at Land A and 43.50 me per 100 g at Land B.

The increasing of C-organic content and Cation Exchange Capacity (CEC) content at these two lands were different. The increasing of C-organic content and Cation Exchange Capacity (CEC) index were possibly caused by urea fertilizer treatment. However, N-total at Land A was higher than Land B. It was related with Al-dd at Land A which higher 0.74 per 100 g than Land B.

The increasing of chemical content in the soil was not only caused by fertilizer treatment but also triggered by the additional of litter component in the plant. If it was seen from the height of plants, fertilizer treatment to the plant height was directly proportional. However, fertilizer treatment was inefficient because the production cost was not balanced with the production result. The production result of paddy with ratoon method was only one-third of normal production.

Comment [H14]: What is mean?

IV. CONCLUSION AND RECOMENDATION

Comment [H15]: This sections is not enough answer the objection

Based on the above description, it can be concluded that:

a. Ground water level in a particular land is highly determined by rainfall in this area. However, water existence in a canal able to inhibit the decrease of groundwater level.
b. The condition of ground water level at the rice fields in Banyu Urip Village was high because during rainy season it able to reach -5 cm from the ground surface,
c. Paddy roots able to reach waters in the depth of 20 cm from the ground surface and ground water level condition was -5 cm to -36 cm from the ground surface. It showed that water requirement could be fulfilled,
d. The production of paddy field with ratoon method was influenced by urea fertilizer treatment. It was showed by the production difference of Land A, as many as 0.8 ton per ha, and Land B as many as 2.8 ton per ha,
e. Fertilizer treatment for paddy plant with ratoon method was ineffective because if it was compared with land with no fertilizer, it only increased C-organic content as many as 0.5% and Cation Exchange Capacity (CEC) content as many as 13.00 me per 100 g.

It is suggested that in plant cultivation with ratoon method, it should be conducted in wet month such as March. It is intended to maintain the height level of ground water so plant water requirement can be fulfilled. A balanced fertilizer treatment should be conducted in paddy cultivation with ratoon method in order to get a balanced production with fertilizer cost. A further research about a balanced fertilizer dose is required in order to increase paddy production with ratoon method.

References

Ali H, Ebrahim Azarpour, Hamid Z.D, Maral, M and Hamid R.B. 2011. Management of Cutting Height and Nitrogen Fertilizer Rates on Grain Yield and Several Attributes of Ratoon Rice (Oryza sativa L.) In Iran. World Applied Sciences Journal 15 (8): 1089-1094, 2011.

Bond, J.A., Bollich, P.K. 2006. Ratoon Rice Response to Nitrogen Fertilizer. Plant Health Progress 5(1). DOI 10.1094/CM-2006-0523-02-RS.

Dariah A., dan F.Agus. 2007. Management onf soil physics on rice field. Agriculture Research Center. Bogor.

Djafar, Z.R. 2002. Development and management of Lowland to suppot sustainable of food security. Paper presented in workshop of Lowland Management and Development Palembang.

Ernawati, Bambang W., Edwin H., Gohan O.M. 2014. The Technology of Rice Pady Ratoon system. Applied Agriculture Research Technolory of Lampung. Ministry of Agriculture.

Erdiman. 2005. Salibu Technology to increase land productivity of rice (3 – 6 ton ha^{-1} th) and increase farmer income (Rp. 15 – 25 juta th). Applied Agriculture Research Technolory, West Sumatra.

Golam F, Rosna M.T and Zakaria H. P. 2014. Rice Ratoon Crop: A Sustainable Rice Production System for Tropical Hill Agriculture. Sustainability 2014, 6, 5785-5800; doi: 10.3390/su6095785

Islam, S.M., Hasanuzzaman, M., and Rokonuzzaman. 2008. Ratoon Rice Response to Different Fertilizer Doses in Irrigated Condition**.** Agriculturae Conspectus Scientifi cus | Vol. 73 (2008) No. 4 (197-202).

Mareza, E., Zainal R. D, Rujito, A.S., Andi W. 2016. Growth and production of paddy ratoon in some variety of rice in tidal lowland areas. Proceding of National Seminar Suboptimal Land. Palembang, 20-21 October 2016

Masahiko ICHII 1983. The Effect of Water Management on Ratoon Ability of Rice Plants. Tech Bull Fac Agr Kagawa Univ Vol 34, No 2, 123- 128, 1983

Hanafiah, K. A. 2005. Fundamental of Soil Science. Jakarta; Raja Grafindo Persada.

Koriyanti. 2013. Prospectives of Water Table Management on Reclaimed Tidal Lowlands with Subsurface Drainage Systems. (Case Study of Banyu Urip of Banyuasin, South Sumatera Province. Indonesia). Seminar Internasional ISABE. Yogyakarta.

Ngudiantoro. 2010. Developing of water table prediction model in Tidal Lowland of C/D land thypology. Case study in South Sumatera. Research Science Journal (13) 3.13303.

Oad, F.C. Pompe, Sta, Cruz, N., Memon, N.L, Ood, 2002. Rice Ratooning Management. Journal of Applied Sciences 2 (1):29-35.

Setiawan, A. Setyono Y.D, Nugroho. A. 2014. Intermitent Irigation and Cutting Height on Growth *and Yield Ratoo Rice.* (Oryza sativa L.). Journal of Agriculture Science 36(1).

Santoso, A.B., N.K. Fageria, A.S. Prabhu. 2003. Rice ratooning management practices for higher yields. Commun. Soil Sci. Plant Anal. 34:881-918.

Saraswati dan Edi H. 2007. The Photencial of Organic Fertilizer on the Rice Field. Agricultural Research Center Agency. Bogor. 151-174 p.

Setyorini, D., Didi Ardi S., dan Nurjaya. 2007. The Recommendation of Fertilizer Application on Paddy in New Rice Field Areas. Agricultural Research Center Agency. 77-106.

Soil Survey Staff. Keys to Soil Taxonomy. 11th ed. *USDA*-National Resources Conservation Service, 2010.
Sudana, Wayan. 2005. Potencial and prospect of lowland for developing agricultural product. Agricultural Analysis and Polcy (3)2, Juni 2005: 141-151.
Subagyo, H. 2006. The Classification and Distribution of Lowland Areas. In Lowland Handbook of 1-23p. Agricultural Research Center Agency. Bogor.
Takaeda, K. 2006. Hydrology for Irrigation n. Jakarta: PT. Pradnya Paramita.
Wahyunto. 2009. Lowland Rice in Indonesia to Support National Food Security. Agricultural Information (18) 2, 2009.

Ratoon systems in tidal lowland: Study of ground water dynamics and the change of nutrient status on rice growth in

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ABSTRACT

It has been widely known that crop cultivation in tidal lowland areas in the second crop (March-April) is not conducted by farmers in a maximum way. Thus, this research aims at investigating the dynamics of ground water and its nutrient status condition for the purpose of supporting plant cultivation in the second crop after rice planting. The study was conducted in Banyu Urip Village, Tanjung Lago Telang II, Banyuasin. The plant used in this activity was paddy, with the treatment of a ratoon cultivation system. The ratoon system is paddy cultivation by using the first paddy planting season shoots. A urea treatment was given with a dose of 0 kg/ha (control) and a dose of 150 kg/ha. The results of soil analysis showed that, although not significant, there was an increase of the nutrient status of the soil condition. Therefore, it can be concluded that fertilizing was considered ineffective for the system of ratoon cultivation. The study of ground water dynamics showed that at the early phase, a ground water table was dropped above 30 cm (critical) but it could increase by the rain and water retention in the canal. The average of ground water table during the ratoon period was at the depth of 5-30 cm below the soil surface, allowing it to be suitable for plant growth. The plant growth at B treatment was better and its production was 2.8 ton/ha. This 2.8 ton/ha plant production was classified as a high category for paddy with the ratoon cultivation system. There is no effect of the fertilizer treatment on the nutrient status in the soil. Moreover, the application of fertilizer did not give a significant result on the production of rice.
Keywords: tidal lowland; rice ratoon; water table; gate operation

1. Introduction

The tidal lowland in South Sumatera Province has been reclaimed since 1970 to be developed as an agriculture area with the total wide of 301.780 hectares (Sudana, 2005). However, as time passes, there were several obstacles in the use of tidal lowland such as a low productivity due to several physical problems (Dariah and Agus, 2007), chemical problems (Setyorini et al., 2007) and biological problems (Saraswati *et al*., 2007), as well as other social, institutional, organizational, infrastructural problems, and financial problem low profits. Therefore, some area used for agricultural land cannot be optimally used by the local people so that some of them were used for the other purposes such as palm oil and rubber plantation (Wahyunto, 2009).

The agricultural land transfer from paddy cultivation area into palm oil and rubber plantation area is very affected by n the annual rice production. Therefore, there is a need to implement several strategies to increase the quantity of production per year, such as: 1) increasing the wide area of production by opening new rice fields, 2) increasing land productivity, and 3) expanding the harvest area through increasing the IP (harvest index) (Erdiman, 2012).

One of the efforts to increase the production of paddy is employing the ratoon system as a method of intensification. There are several points that affect the growth of rice crops in the ratoon cultivation system, such as: 1) the height of stems cutting from the harvest remaining, 2) variety, 3) the ground water condition after harvesting, and 4) harvesting (Erdiman, 2012).

The potency of ratoon cultivation system is very good and it has been tested in several areas in the tropics. The benefits are earlier growing time and reducing the workforce about 50-60%. The other affecting factor is soil moisture. However, it has not been developed in the tidal lowland. The fluctuation of the ground water level highly influences the plant growth. Paddy plants usually need -20 cm to -30 cm water level from the ground surface. It is related with the plant roots in penetrating the soil to uptake water for plant (Faruq *et al*., 2014). So far, this ratoon paddy cultivation technique has not been developed in the tidal lowland area. Although it has a very good potency if it is developed like in an irrigated land, the farmers just leave it without any management. Lampung BPTP (Center for Assessment of Agricultural Technology) reported that paddy production with the ratoon method reaches up to 0.7 – 5 ton/ha (Ernawati *et al*., 2014). Mareza et al., 2016, reported that paddy production with the ratoon method in Indonesia was 1.5-2.5 ton/ha, whereas in China, it is able to achieve 3.8 ton/ha. This production diversity is influenced by the land condition and rice variety. One of the decisive factors is water availability. Concerning this point, a study about the effect of ground water level to the growth of paddy in the ratoon method is required.

2. Methodology

This study was conducted at Primary canal 17 in Banyu Urip Village of Tanjung Lago sub district, Banyuasin Regency, in February – April 2013. The field practice was conducted by evaluating the influence of ground water level on the growth of rice with the ratoon system. Ciherang and IR64 rice variety was used in this study. There were two land plots used for the observation area of paddy: 1) Land A with no fertilizer, located at Tertiary block number 7 (Tc7) land number 5, 2) Land B with fertilizer as many as 150 kg per ha, located at Tc7 land number 6. There were several observed parameters during this field practice, such as: 1) the depth of ground water level, 2) rainfall, 3) the height of water level in the canal, 4) plant height. Some secondary data were also used as the supporting data. The analysis of soil fertility was conducted at the Physical Chemical Laboratory, the Soil Department of Sriwijaya University. The parameters of soil chemical and physical properties were pH, C-Organic, N-Total, P-Bray, K-dd, Na, Ca, Mg, CEC, Al-dd, and soil texture.

3. Result and Discussion

3.1 Characteristic of Farming System Technology

Banyu Urip Village is one of the villages located in Telang II Delta. Administratively, Banyu Urip Village is located in Tanjung Lago Subdistrict and it has a border with the Karang Batu Village in the north, Suka Damai Village in the south, Mulia Sari Village in the east, and Bangun Sari Village in the west. In Banyu Urip Village, a plant cultivation pattern commonly conducted by the farmers is paddy–corn–fallow land. In the first planting season (PS I), the land is planted with monoculture system. It is started with pre–planting period (land cultivation) in October, planting period in November, and harvesting season in March. Meanwhile, the second planting season (PS II) is conducted in May–September and it is planted with corn. The interval time between the first and second planting period, in the late of February to the middle of April, is used by the farmers to take care of the remaining rice crops harvest and then it will produce more rice for the second harvest or better known as ratoon.

The characteristic of land used for food crop cultivation is dominated by clay fraction. Therefore, the soil permeability is relatively slow with index as many as 1.08 cm per hour (Santoso, 2012). Koriyanti (2013) stated that the agricultural land in Banyu Urip Village is a wet area dominated by swamp area with very high fluctuations of water inundation. In the rain season, the waters will inundate the land as high as +12 cm, while in the dry season, the height of the ground water depth will be -112 cm (below the soil surface).

In the natural condition, soils in the tidal lowland area are saturated by the water or shallow inundated, along the year or in a long time, several months, or in a year (Subagyo, 2006). In the Soil Taxonomy classification (Soil Survey Staff, 1999), swampy area is classified as wet soils. It is characterized by aquatic conditions, which currently experiencing water saturation and continuously or periodically reduction.

Nurfaizah et al., (2015) reported that the growth and yield of rice at ground water depth less than 10 cm showed the best result and is not significantly different with the 5-7 cm inundation treatment. Reinforced by Setiawan et al., (2014), the critical value of the plant is at a water depth of -15 cm. In this condition, the ground water must be immediately increased. Susilawati (2012) reported that rice cultivation by the ratoon system will show maximum results when the cutting of stems is as high as 2-5 cm and followed by waterlogging as high as 2-5 cm.

3.2 Ground Water Table Dynamic

Fluctuations in groundwater levels in the study area are influenced by a high tide and rainfall conditions. The tide can be used as the irrigation water supply because it contains no salt, unless long dry season will occur salt water intrusion to the primary and secondary canal. Based on the type of hydro-topography class, Telang II Delta belongs to type C where the tide cannot enter the land, just up the secondary channel. However, the groundwater depth is still influenced by tidal fluctuations, so tidal retention can maintain the depth of groundwater table.

Djakfar (2002) wrote the description of type C overflow that tidal lowland has never been flooded by the highest tide of river water tidal. However, a high tide still influences the elevation of ground water level so that the depth of ground water level has never been deeper than 50 cm below the ground surface. The average height of ground water level has never been higher than 50 cm above the ground water elevation (the highest).

The height of ground water level is highly influenced by rainfall. It is similar with the field result. The height of ground water level was measured by using wells. The result showed that the highest ground water level was identified in March. The ground water level reached -5cm from the ground level (shown in the graph in Figure 1). It is related with the high intensity of rainfall in March as presented in Figure 3, showing that the highest average rainfall was identified in March.

This rain impacts on the ground water level so that it becomes relatively shallow about 20 cm underground surfaces. In this condition, soil humidity is maintained to supply water needs for paddy plants.

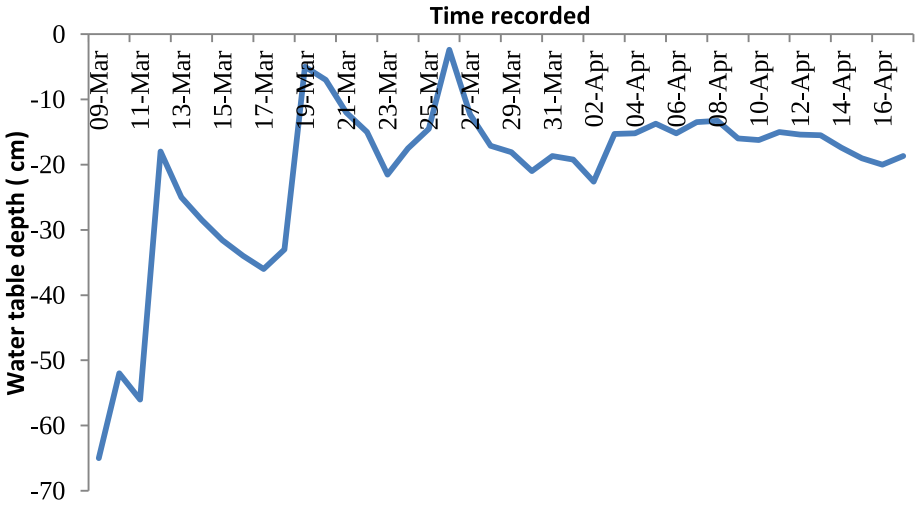

Figure 1. Daily ground water level fluctuation, measurement was conducted by using wells

In the daily rain graph (Figure 2), the calculation was conducted together with the ground water level observation. In a direct proportional, it is showed that, in March, rain happens almost every five day. The rainfall distribution during the second crop period (March-April) was sufficient to support the crop water requirement of rice.

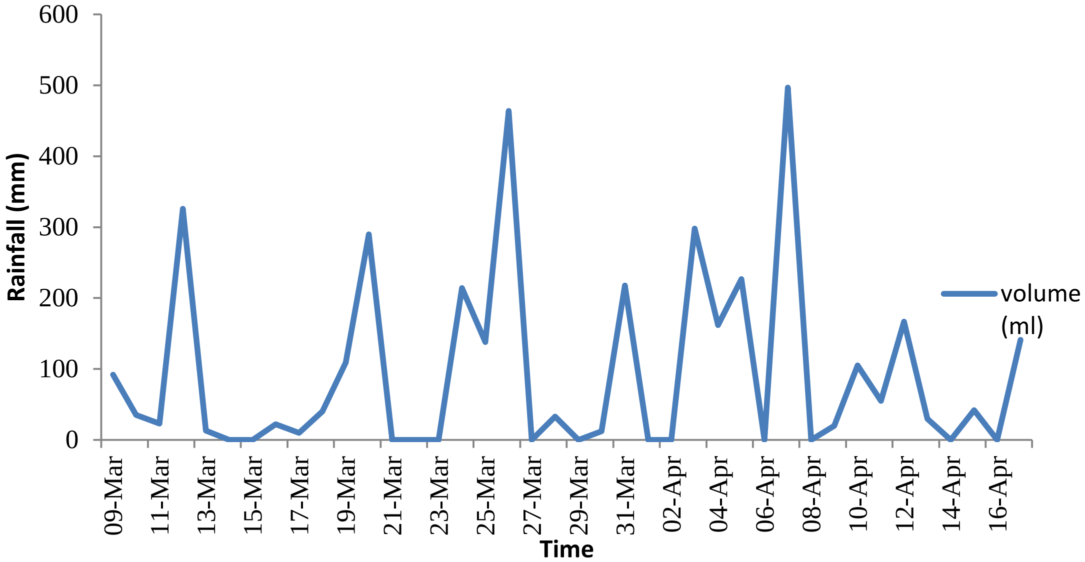

Figure 2. Daily rainfall on 23 February – 3 April 2013

As a comparison data, rainfall observation was also conducted at Kenten Climatology Station. The last 10 years monthly rainfall data in 2002 – 2012 was collected. The graph of annual rain fall rainfall (Figure 3) showed that March is a wet month with average rainfall volume reaches $\geq$ 400 ml per year. Therefore, it can be interpreted that the ground water level was determined by the volume of rainfall. However, the water condition in the land is also influenced by the tide water.

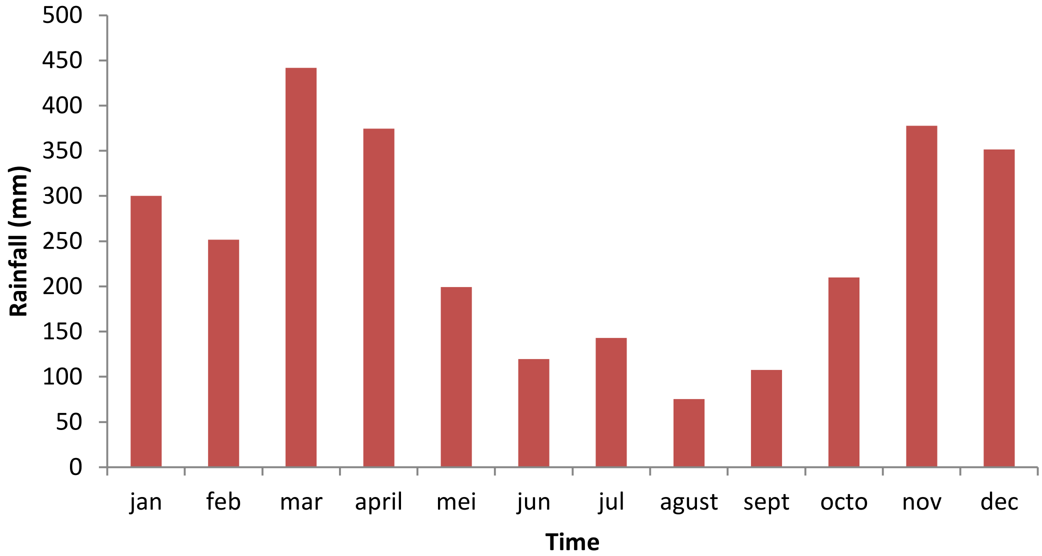

Figure 3. Graph of annual rainfall in 2002 – 2012

Ground water is water that moves in the soil especially in the spaces between the soil pores and rock cracks (Takaeda, 2006). Meanwhile, a ground water level is the difference or balancing water water input from the precipitation, rain that infiltrate the soil, added with condensation by the plants and soil as well as adsorption by soil, reduced by water that lost through evapotranspiration process, ground surface flow, percolation, and lateral seepage. In its mechanism, the change of ground water level involves three main mechanisms, namely: 1) retention and water movement in the soil, 2) absorption (uptake) and water translocation in plant, 3) evapotranspiration. Therefore, it can be interpreted that the periodical ground water level fluctuation depends on the balance of water input and loss.

Based on Figure 1, it can be seen that the ground water condition in the land showed ground water depth level was strongly influenced by rainfall condition. Even though the ground water level condition in the land has dropped to -65 cm from the ground surface, its ground water condition lifted to -18 cm from the ground surface so that plants were not died due to the lack of water. With this ground water condition from -5 to -36 cm from the ground surface, the water requirement of rice plants can be fulfilled (Nurfaizah et al., 2015).

3.3 Ratoon Paddy Cultivation System

The paddy cultivation activity in Banyu Urip Village P17-6S used early age paddy variety namely IR-64. This paddy variety age is > 105 to 124 days. The first Planting Period I is conducted by farmer in October to March, while the second Planting Period II is conducted by farmers in May until September. In the Planting Period (PP I) and PP II interval in March – May, farmers plant fallow crops or continue to take care the harvested paddy plant or grow it again to be harvested. It is better known as the ratoon paddy system. Ratoon paddy has a short life cycle. It only needs about 40 days for the rice to be harvested.

In the ratoon paddy cultivation system, the top part of harvested paddy will be cut and its plant stump will be left about 20-30 cm from the ground surface. However, according to Ichi (1983), ratoon cut can be conducted about 5 cm and 20 cm from the ground surface. The water depth level is maintained about 5 cm. This condition is difficult if it is planted in the tidal lowland area with typology B. A research by Setiawan et al. (2014) showed that there was no interaction between the thickness of irrigation and the height of stem cutting to the plant growth. The ratoon plant production can reach up to 3.12 ton/ha in the continuous flooding treatment.

In order to get the maximum production, a fertilizer is required because the ratoon cultivation system has low production potency. In the observation in Banyu Urip Village, there were two observed agricultural lands. Land A is without fertilizer whereas Land B is treated with urea fertilizer as many as 150 kg per hectares. It was only given one time after paddy stem cutting.

Ratoon paddy cultivation will be continued if the shoots grown from the paddy stalks grow more than 70% (Islam et al., 2008). Paddy plants in vegetative phase require different amount of water in accordance with the requirement. Vegetative phase of paddy plant is divided into three phases, namely: a) recovery stages and roots growth (0-10 days after planting), b) maximum growth phase of tiller (10-50 days after planting), and c) effective shooting and ineffective shooting (35-45 days after planting).

The growth and quantity of tillers is highly influenced by the cutting technique. The harvesting process in Telang is conducted using a high cutting technique. It seems that farmers have problem with this cutting. To cut it back, farmers are constrained by time and energy. Cutting height very strong affects the ratoon paddy cultivation system especially in its vegetative phase. The higher cutting, the fewer tillers will be but its growth will be very fast with less tiller quantity (Wasis, 2014).

In the ratoon paddy system, the recovery phase and maximum tiller growth will not be experienced because paddy will not be transplanted and ratoon paddy will not have intensive tiller growth like newly planted paddy. Ratoon paddy has an effective shooting phase if the previous cut stems will grow new shoots and produce new leaves. The following process is the increase of the plant height shown by the lengthening of leaves.

Furthermore, paddy plants turn into generative phase. In this phase, it covers the early development of panicles (40-50 days after planting), fulfilling the phase (50-60 days after planting), and flowering (60-80 days after planting). A research by Faruq et al. (2014) showed that ratoon paddy can be harvested in 90 days, while the study conducted by Setiawan et al. (2014) revealed that it can be harvested in 96 days. This situation is characterized by the formation and growing of panicles. However, in the generative phase, ratoon paddy do not need a long time so that in 20 days paddy plants have showed panicle existence.

In the generative phase, paddy plants require a lot of water. Drought in this period will influence the formation of panicles, flower, and fertilization. In this case, it increases the sterility of plant and decrease plant production. Based on the ground water observation at the field, the ground water level was at -5 to -36 cm from the ground surface. It is showed that paddy's water requirement was quite sufficient because paddy's roots are able to absorb water in the depth of 20-30 cm below the ground surface.

3.4The Effect of Fertilazation on the Growth of Paddy Ratoon

In addition of the ground water level, fertilization also plays a role in that able to influence influencing the growth and production of paddy. As previously written, Land A was treated with no fertilizer and Land B is with fertilizer as many as 150 kg per ha. The result showed that there is a difference on plant height and production between those two lands. The production of ratoon paddy at Land A was 0.8 ton per hectare. Meanwhile, at Land B, the ratoon paddy production was 2.8 ton per hectare. Table 1 showed the height of the plants in the different treatment of land.

Table 1. Mean weekly paddy height

Week	Land A (cm)	Land B (cm)
1	74.61	79.64
2	81.60	95.20
3	87.20	102.00
4	100.30	109.90

Based on the above table about the average weekly paddy height, it is seen that there was a difference in the plant height at Land A and Land B. In the first week, its difference was 5 cm. In the second week, its difference was 13 cm. In the third week, its difference was 14 cm. And in the last week, its difference was 9.6 cm. At Land A with no fertilizer, it is showed that the height of the plants was shorter than those in Land B. However, the plants were cut in the similar height about 25 cm from the ground surface. The water height in each land was also similar. Having a closer look at the difference of these plants, it can be interpreted that the plants with no fertilizer were grown slower than those with fertilizer. The difference of plant height and plant production did not depend on the ground water level because the ground water level in land is able to be reached by roots. However, it was caused by the difference of soil fertility.

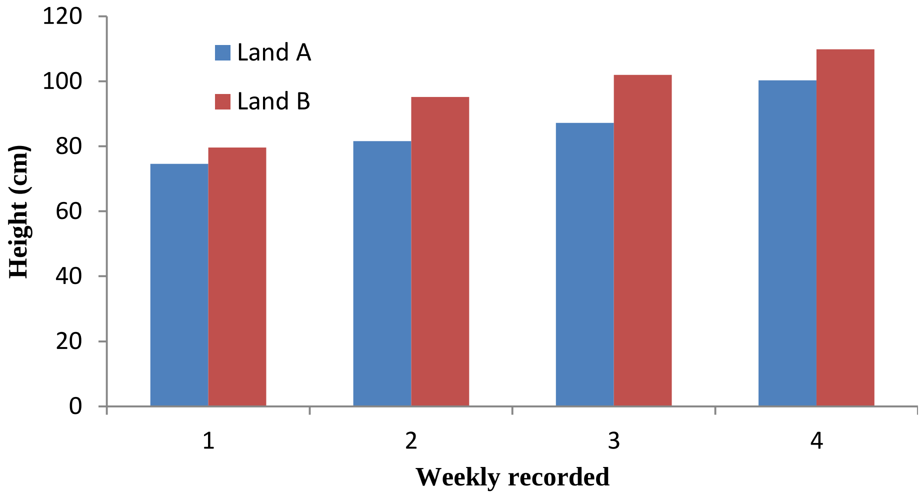

Figure 4. Graph of average weekly paddy height

This above graph showed the significant difference of ratoon paddy at Land A with no fertilizer and Land B with fertilizer. As reported by Hanafiah (2005), NH_4^+ in the urea fertilizer plays a role in composing all proteins (acids–amino acids–enzyme) and chlorophyll, coenzyme, and nucleic acids as well as growth hormones such as cytokines and auxins

Mareza et al. (2016) reported that the application of urea fertilization with the dose of 150 kg/ha enhances the performance of rice growth. It produced 15-16 gr grain weight/clump. The application of fertilizer especially Nitrogen, followed by waterlogging after harvesting the main plant, increases the plant height and the productivity of tillers and rats. The growth of ratoon rice was very dependent on the dose of fertilizer given, and the ratoon response was varying with to the dose of different fertilizers (McCauley et al., 2006).

The application of urea fertilizer half of the first dose of the main crop could improve the quality of the yield. The result is that the height of ratoon reaches up to 2.25-3.61 m. Thus, the utilization of ratoon plant system and management of rice farming with ratoon system in the tidal lowland is believed to be increasing the harvesting indexes per planting season. Therefore, the rice harvest that has been done once per planting season increases to two times per season. Thus, the additional yield per planting season will be obtained.

The production of raton rice is very seasonally dependent; this is related to the status of groundwater. However, the resulting production can make optimal land use with low production costs.The results and income of farmers per planting season are also increased since farming with the ratoon system is saving input production, cost, and time (Susilawati et al., 2012).

Table 2. The result of initial and final soil analysis in the study area

Type of Analysis	Initial Soil Analysis	Final Soil Analysis	
		Land A	Land B
pH H_2O	4.28	4.62	4.50
pHKCl	3.85	3.93	3.89
C-organic	0.46	4.74	5.31
N- Total (%)	0.04	0.42	0.39
P-Bray I (ppm)	29.25	25.20	21.45
K-dd (me per 100 g)	0.26	0.38	0.32
Na (me per 100 g)	0.87	0.54	0.76
Ca (me per 100 g)	1.88	2.05	2.28

Mg (me per 100 g)	1.20	0.68	0.55
CEC (me per 100 g)	17.40	30.45	43.50
Al-dd (me per 100 g)	1.36	1.50	0.76
H-dd (me per 100 g)	0.38	0.72	0.64
Texture			
Sand (%)	22.06	32.64	30.35
Silt (%)	31.61	44.88	42.84
Clay (%)	46.33	22.48	26.81

Fertilization can increase the growth but in certain level it cannot increase the production quantity. A research by Bonn and Bollich (2006) showed that the nitrogen application as many as 90-120 kg/ha was no longer able to increase paddy production. This condition was in line with the research result of Islam et al. (2008), stated that the highest paddy production with ratoon method was achieved in urea dose as many as 120 kg/ha. The application of urea as many as 60 kg N/ha is able to increase paddy production with ratoon method as many as 1.9 ton/ha on 30 cm stem cutting (Huossainzade et al., 2011). The growth and production of plant is influenced by the fertility level and also environmental condition especially temperature and sun radiation (Oad et al., 2002).

Based on the analysis result at the laboratory (Table 2), shows the main problem of soil fertility is the low acidity level. Soil analysis was conducted for initial land sample before and after the ratoon technique. The initial soil sample analysis showed that C-organic content in the soil was low as many as 0.46% while in the analyzed soil sample after ratoon technique, C-organic content increased up to more than 5%. At Land A with no fertilizer, the content of C-organic in the soil was 4.74% while at Land B with the fertilizer treatment, C-organic content was 5.31%. The difference of C-organic content at these two soil treatments was 0.57%.

As showed by the analysis result, before ratoon treatment the content of N-total was 0.04%, while the content of N-total at the land with ratoon technique increased up to 0.42 % at Land A and 0.39 at Land B. Cation Exchange Capacity (CEC) of land also increased from 17.40 me per 100 g to30.45 me per 100 g at Land A and 43.50 me per 100 g at Land B.

The increasing of C-organic content and Cation Exchange Capacity (CEC) content at these two lands were different. The increasing of C-organic content and Cation Exchange Capacity (CEC) index were possibly caused by urea fertilizer treatment. However, N-total at Land A was higher than Land B. It was because Al-dd at Land A is 0.74 per 100 g higher than at Land B.

The increasing of chemical content in the soil was not only caused by the fertilizer treatment but also triggered by the additional of litter component in the plant. If it was only seen from the height of plants, the fertilizer treatment to the plant height was directly proportional. However, the fertilizer treatment was inefficient because the production cost was not balanced with the production result. The production result of paddy with ratoon method was only one-third of normal production.

4. Conclusion and Recommendation

Based on the above description, it can be concluded that:

a. The fluctuation of ground water table in tertiary block (on farm) is highly determined by the rainfall in this area. However, the water availability in a canal is able to keep the groundwater table near the root zone to fulfill crop water requirement.
b. The condition of ground water table in the rice fields in Banyu Urip Village was near soil surface because during rainy season it is able to reach -5 cm from the ground surface.
c. Paddy roots are able to reach waters in the depth of 20 cm from the ground surface and ground water table under 5 to 36 cm from the ground surface. It showed that the water requirement could be fulfilled.

d. The production of paddy field with ratoon method was influenced by the urea fertilizer treatment. It was showed by the production difference of Land A (0.8 ton per ha) and Land B (2.8 ton per ha).
e. The fertilizer treatment for paddy plants with ratoon method was ineffective because if it was compared to the land with no fertilizer, it only increased C-organic content as many as 0.5% and Cation Exchange Capacity (CEC) contents as many as 13.00 me per 100 g.

It is suggested that plant cultivation with ratoon method should be conducted in wet season such as March. It is intended to maintain the height level of ground water table so plant water requirement can be fulfilled. A balanced fertilizer treatment should be conducted in paddy cultivation with ratoon method in order to get a balanced production with fertilizer cost. A further research about fertilizer application dose is required in order to increase the production of paddy with ratoon system**.**

References

Ali H, Ebrahim Azarpour, Hamid Z.D, Maral, M and Hamid R.B. 2011. Management of Cutting Height and Nitrogen Fertilizer Rates on Grain Yield and Several Attributes of Ratoon Rice (Oryza sativa L.) In Iran. World Applied Sciences Journal 15 (8): 1089-1094, 2011.

Bond, J.A., Bollich, P.K. 2006. Ratoon Rice Response to Nitrogen Fertilizer. Plant Health Progress 5(1). DOI 10.1094/CM-2006-0523-02-RS.

Dariah A., dan F.Agus. 2007. Management onf soil physics on rice field. Agriculture Research Center. Bogor.

Djafar, Z.R. 2002. Development and management of Lowland to suppot sustainable of food security. Paper presented in workshop of Lowland Management and Development Palembang.

Ernawati, Bambang W., Edwin H., Gohan O.M. 2014. The Technology of Rice Pady Ratoon system. Applied Agriculture Research Technolory of Lampung. Ministry of Agriculture.

Erdiman. 2005. Salibu Technology to increase land productivity of rice (3 – 6 ton ha^{-1} th) and increase farmer income (Rp. 15 – 25 juta th). Applied Agriculture Research Technolory, West Sumatra.

Golam F, Rosna M.T and Zakaria H. P. 2014. Rice Ratoon Crop: A Sustainable Rice Production System for Tropical Hill Agriculture. Sustainability 2014, 6, 5785-5800; doi: 10.3390/su6095785

Islam, S.M., Hasanuzzaman, M., and Rokonuzzaman. 2008. Ratoon Rice Response to Different Fertilizer Doses in Irrigated Condition**.** Agriculturae Conspectus Scientifi cus | Vol. 73 (2008) No. 4 (197-202).

Mareza, E., Zainal R. D, Rujito, A.S., Andi W. 2016. Growth and production of paddy ratoon in some variety of rice in tidal lowland areas. Proceding of National Seminar Suboptimal Land. Palembang, 20-21 October 2016

Masahiko ICHII 1983. The Effect of Water Management on Ratoon Ability of Rice Plants. Tech Bull Fac Agr Kagawa Univ Vol 34, No 2, 123- 128, 1983

Nurfaizah, Budi I. S., Chusnul, A, Slamet W. 2015. Control Water Level System for Paddy Field Cultivation. Irrigation Jurnal :10(2): 97-110 .

Hanafiah, K. A. 2005. Fundamental of Soil Science. Jakarta; Raja Grafindo Persada.

Koriyanti. 2013. Prospectives of Water Table Management on Reclaimed Tidal Lowlands with Subsurface Drainage Systems. (Case Study of Banyu Urip of Banyuasin, South Sumatera Province. Indonesia). Seminar Internasional ISABE. Yogyakarta.

Mareza, E. Zainal, R. D. Rujito, A.S. and Andi. W. 2016. Morphophysiological Characters of Rice Ratoon from Direct Seeding in Tidal Swamp Land. Agronomic Indonesian Journal 44(3): 228-234.

McCauley, N., F.T.,Turner, M.O. Way, and L.J.Vawter. 2006. Hybrid Ratoon Management. RiceTech

Ngudiantoro. 2010. Developing of water table prediction model in Tidal Lowland of C/D land thypology. Case study in South Sumatera. Research Science Journal (13) 3.13303.

Oad, F.C. Pompe, Sta, Cruz, N., Memon, N.L, Ood, 2002. Rice Ratooning Management. Journal of Applied Sciences 2 (1):29-35.

Setiawan, A. Setyono Y.D, Nugroho. A. 2014. Intermitent irigation and cutting height on growth *and yield ratoo rice.* (Oryza sativa L.). Journal of Agriculture Science 36(1).

Susilawati dan Bambang S.P. 2012. Testing of rice varieties and fertilizer dose to increase growth and rice products in the tidal lowland. Journal of Agricultural Technology Assessment and Development 15(1): 47-54

Santoso, A.B., N.K. Fageria, A.S. Prabhu. 2003. Rice ratooning management practices for higher yields. Commun. Soil Sci. Plant Anal. 34:881-918.

Saraswati dan Edi H. 2007. The Photencial of Organic Fertilizer on the Rice Field. Agricultural Research Center Agency. Bogor. 151-174 p.

Setyorini, D., Didi Ardi S., dan Nurjaya. 2007. The Recommendation of Fertilizer Application on Paddy in New Rice Field Areas. Agricultural Research Center Agency. 77-106.

Soil Survey Staff. Keys to Soil Taxonomy. 11^{th} ed. *USDA*-National Resources Conservation Service, 2010.

Sudana, Wayan. 2005. Potencial and prospect of lowland for developing agricultural product. Agricultural Analysis and Polcy (3)2, Juni 2005: 141-151.

Subagyo, H. 2006. The Classification and Distribution of Lowland Areas. In Lowland Handbook of 1-23p. Agricultural Research Center Agency. Bogor.

Takaeda, K. 2006. Hydrology for Irrigation n. Jakarta: PT. Pradnya Paramita.

Wahyunto. 2009. Lowland Rice in Indonesia to Support National Food Security. Agricultural Information (18) 2, 2009.

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RESEARCH ARTICLE

RATOON SYSTEMS IN TIDAL LOWLAND: STUDY OF GROUNDWATER DYNAMICS AND THE CHANGE OF NUTRIENT STATUS ON RICE GROWTH

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ABSTRACT

It has been widely known that crop cultivation in tidal lowland areas in the second crop (March-April) is not conducted by farmers in a maximum way. Thus, this research aims at investigating the dynamics of groundwater and its nutrient status condition for the purpose of supporting plant cultivation in the second crop after rice planting. The study was conducted in Banyu Urip Village, Tanjung Lago Telang II, Banyuasin. The plant used in this activity was paddy, with the treatment of a ratoon cultivation system. The ratoon system is paddy cultivation by using the first paddy planting season shoots. A urea treatment was given with a dose of 0 kg/ha (control) and a dose of 150 kg/ha. The results of soil analysis showed that, although not significant, there was an increase in the nutrient status of the soil condition. Therefore, it can be concluded that fertilizing was considered ineffective for the system of ratoon cultivation. The study of groundwater dynamics showed that at the early phase, a groundwater table was dropped above 30 cm (critical) but it could increase by the rain and water retention in the canal. The average of the groundwater table during the ratoon period was at the depth of 5-30 cm below the soil surface, allowing it to be suitable for plant growth. The plant growth at B treatment was better and its production was 2.8 ton/ha. This 2.8 ton/ha plant production was classified as a high category for paddy with the ratoon cultivation system. There is no effect of the fertilizer treatment on the nutrient status in the soil. Moreover, the application of fertilizer did not give a significant result on the production of rice.

Keywords: tidal lowland; rice ratoon; water table; gate operation

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INTRODUCTION

The tidal lowland in South Sumatera Province has been reclaimed since 1970 to be developed as an agriculture area with the total wide of 301.780 hectares (Sudana, 2005). However, as time passes, there were several obstacles to the use of tidal lowlands such as chemical problems (Setyorini, Suriadikarta, & Nurjaya, 2007) and biological problems (Saraswati & Husen, 2007), as well as other social, institutional, organizational, infrastructural problems, and financial problem low profits. Therefore, some area used for agricultural land cannot be optimally used by the local people so that some of them were used for

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the other purposes such as palm oil and rubber plantation (Wahyunto, 2009).

The agricultural land transfer from paddy cultivation area into palm oil and rubber plantation area is very affected by n the annual rice production. Therefore, there is a need to implement several strategies to increase the quantity of production per year, such as 1) increasing the wide area of production by opening new rice fields, 2) increasing land productivity, and 3) expanding the harvest area through increasing the IP (harvest index) (Erdiman, 2012).

One of the efforts to increase the production of paddy is employing the ratoon system as a method of intensification. There are several points that affect the growth of rice crops in the ratoon cultivation system, such as 1) the height of stems cutting from the harvest remaining, 2) variety, 3) the groundwater condition after harvesting, and 4) harvesting (Erdiman, 2012).

The potency of ratoon cultivation system is very good and it has been tested in several areas in the tropics. The benefits are earlier growing time and reducing the workforce is about 50-60%. The other affecting factor is soil moisture. However, it has not been developed in the tidal lowland. The fluctuation of the groundwater level highly influences the plant growth. Paddy plants usually need -20 cm to -30 cm water level from the ground surface. It is related to the plant roots in penetrating the soil to uptake water for the plant (Faruq, Taha, & Prodhan, 2014). So far, this ratoon paddy cultivation technique has not been developed in the tidal lowland area. Although it has a very good potency if it is developed like in an irrigated land, the farmers just leave it without any management. Lampung BPTP (Center for Assessment of Agricultural Technology) reported that paddy production with the ratoon method reaches up to 0.7 – 5 ton ha^{-1} (Ernawati, Bambang W, Edwin H, & Gohan O M, 2014). Mareza, Djafar, Suwignyo, & Wijaya (2016) reported that paddy production with the ratoon method in Indonesia was 1.5-2.5 ton ha^{-1}, whereas, in China, it is able to achieve 3.8 ton ha^{-1}. This production diversity is influenced by the land condition and rice variety. One of the decisive factors is water availability. Concerning this point, a study about the effect of groundwater level on the growth of paddy in the ratoon method is required.

MATERIALS AND METHOD

This study was conducted at Primary canal 17 in Banyu Urip Village of Tanjung Lago sub-district, Banyuasin Regency, in February – April 2013. The field practice was conducted by evaluating the influence of groundwater level on the growth of rice with the ratoon system. Ciherang and IR64 rice variety were used in this study. There were two land plots used for the observation area of paddy: 1) Land A with no fertilizer, located at Tertiary block number 7 (Tc7) land number 5, 2) Land B with fertilizer as many as 150 kg ha^{-1}, located at Tc7 land number 6. There were several observed parameters during this field practice, such as 1) the depth of groundwater level, 2) rainfall, 3) the height of water level in the canal, 4) plant height. Some secondary data were also used as the supporting data. The analysis of soil fertility was conducted at the Physical-Chemical Laboratory, the Soil Department of Sriwijaya University. The parameters of soil chemical and physical properties were pH, C-Organic, N-Total, P-Bray, K-dd, Na, Ca, Mg, CEC, Al-dd, and soil texture.

RESULT AND DISCUSSION

Characteristic of Farming System Technology

Banyu Urip Village is one of the villages located in Telang II Delta. Administratively, Banyu Urip Village is located in Tanjung Lago Subdistrict and it has a border with the Karang Batu Village in the north, Suka Damai Village in the south, Mulia Sari Village in the east, and

Bangun Sari Village in the west. In Banyu Urip Village, a plant cultivation pattern commonly conducted by the farmers is paddy–corn–fallow land. In the first planting season (PS I), the land is planted with a monoculture system. It is started with the pre-planting period (land cultivation) in October, planting period in November, and harvesting season in March. Meanwhile, the second planting season (PS II) is conducted in May–September and it is planted with corn. The interval time between the first and second planting period, in the late of February to the middle of April, is used by the farmers to take care of the remaining rice crops harvest and then it will produce more rice for the second harvest or better known as ratoon.

The characteristic of land used for food crop cultivation is dominated by clay fraction. Therefore, the soil permeability is relatively slow with the index as many as 1.08 cm hour^{-1} (Santos, Fageria, & Prabhu, 2003). Imanudin, Priatna, Wildayana, & Armanto (2017) stated that the agricultural land in Banyu Urip Village is a wet area dominated by swamp area with very high fluctuations of water inundation. In the rain season, the waters will inundate the land as high as +12 cm, while in the dry season, the height of the groundwater depth will be -112 cm (below the soil surface).

In the natural condition, soils in the tidal lowland area are saturated by the water or shallow inundated, along the year or in a long time, several months, or in a year (Imanudin, Armanto, Susanto, & Bernas, 2010). In the Soil Taxonomy classification (Soil Survey Staff, 2010), the swampy area is classified as wet soils. It is characterized by aquatic conditions, which currently experiencing water saturation and continuously or periodically reduction. Nurfaijah, Setiawan, Arif, & Widodo (2015) reported that the growth and yield of rice at groundwater depth less than 10 cm showed the best result and is not significantly different with the 5-7 cm inundation treatment. Reinforced by Setiawan, Tyasmoro, & Nugroho (2014), the critical value of the plant is at a water depth of -15 cm. In this condition, the groundwater must be immediately increased. Susilawati & Purwoko (2014) reported that rice cultivation by the ratoon system will show maximum results when the cutting of stems is as high as 2-5 cm and followed by waterlogging as high as 2-5 cm.

Groundwater Table Dynamic

Fluctuations in groundwater levels in the study area are influenced by high tide and rainfall conditions. The tide can be used as the irrigation water supply because it contains no salt unless long dry season will occur saltwater intrusion to the primary and secondary canal. Based on the type of hydro-topography class, Telang II Delta belongs to type C where the tide cannot enter the land, just up the secondary channel. However, the groundwater depth is still influenced by tidal fluctuations, so tidal retention can maintain the depth of the groundwater table.

Imanudin et al. (2010) wrote the description of type C overflow that tidal lowland has never been flooded by the highest tide of river water tidal. However, a high tide still influences the elevation of the groundwater level so that the depth of the groundwater level has never been deeper than 50 cm below the ground surface. The average height of the groundwater level has never been higher than 50 cm above the groundwater elevation (the highest).

The height of the groundwater level is highly influenced by rainfall. It is similar to the field result. The height of the groundwater level was measured by using wells. The result showed that the highest groundwater level was identified in March. The groundwater level reached -5 cm from the ground level (shown in the graph in Figure 1). It is related with the high intensity of rainfall in March as presented in Figure 3, showing that the highest average rainfall was identified in March.

This rain impacts on the groundwater level so that it becomes relatively shallow about 20 cm underground surfaces. In this condition, soil humidity is maintained to supply water needs for paddy plants.

In the daily rain graph (Figure 2), the calculation was conducted together with the groundwater level observation. In a direct observation, it is showed that, in March, rain happens almost every five days. The rainfall distribution during the second crop period (March-April) was sufficient to support the crop water requirement of rice.

As a comparison data, rainfall observation was also conducted at Kenten Climatology Station. The last 10 years monthly rainfall data in 2002 – 2012 was collected. The graph of annual rainfall (Figure 3) showed that March is a wet month with average rainfall volume reaches ≥ 400 ml per year. Therefore, it can be interpreted that the groundwater level was determined by the volume of rainfall. However, the water condition in the land is also influenced by the tidewater.

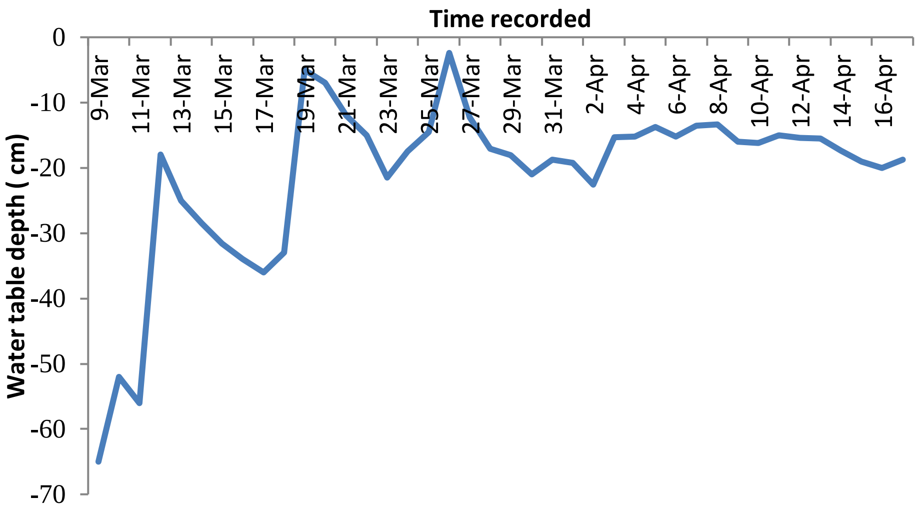

Figure 1. Daily groundwater level fluctuation, measurement was conducted by using wells

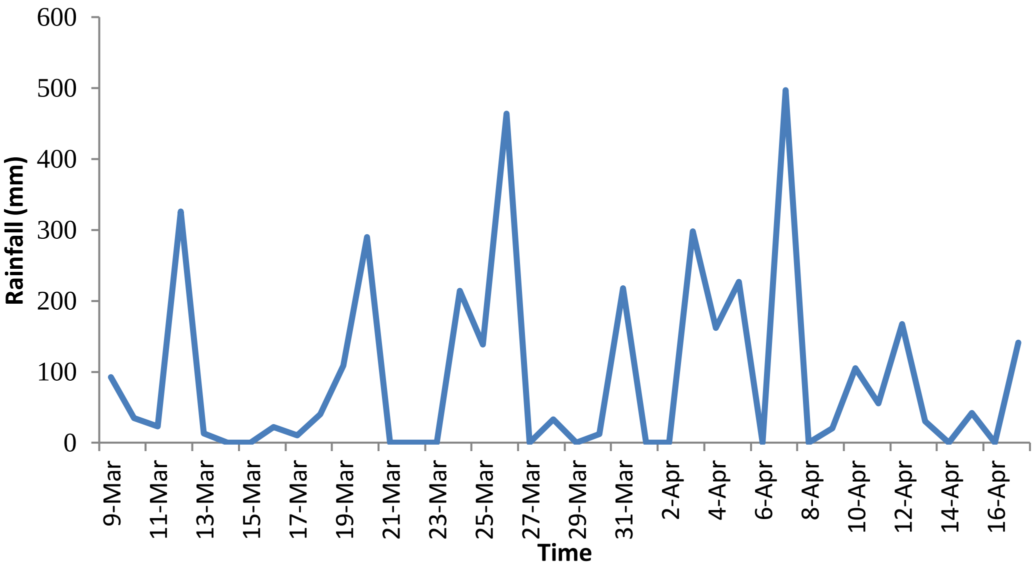

Figure 2. Daily rainfall on 23 February – 3 April 2013

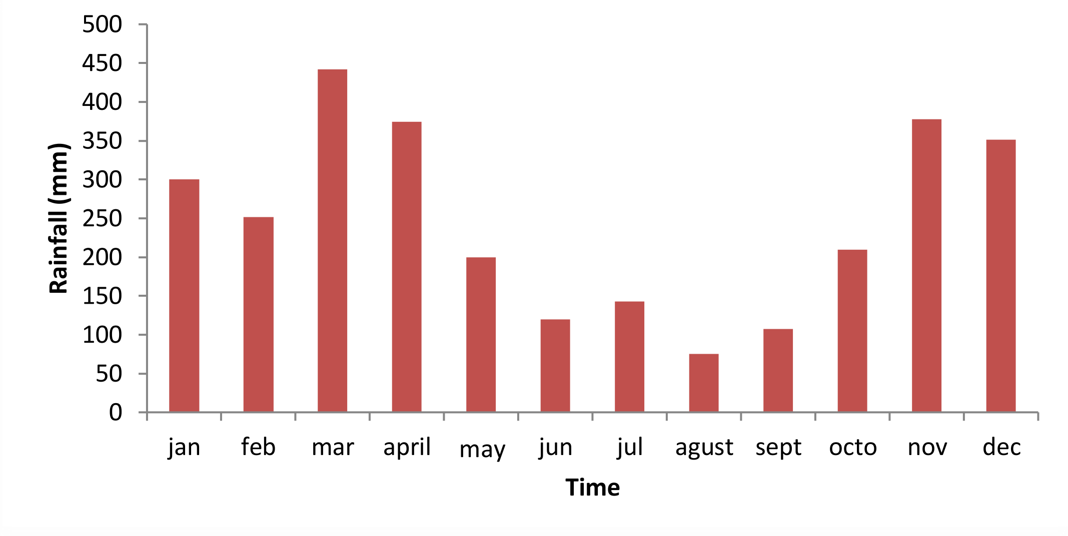

Figure 3. Annual rainfall in 2002 – 2012

Groundwater is water that moves in the soil especially in the spaces between the soil pores and rock cracks (Sosrodarsono & Takeda, 2006). Meanwhile, a groundwater level is the difference or balancing water input from the precipitation, rain that infiltrates the soil, added with condensation by the plants and soil as well as adsorption by soil, reduced by water that lost through evapotranspiration process, ground surface flow, percolation, and lateral seepage. In its mechanism, the change of groundwater level involves three main mechanisms, namely: 1) retention and water movement in the soil, 2) absorption (uptake) and water translocation in the plant, 3) evapotranspiration. Therefore, it can be interpreted that the periodical groundwater level fluctuation depends on the balance of water input and loss.

Based on Figure 1, it can be seen that the groundwater condition in the land showed groundwater depth level was strongly influenced by rainfall condition. Even though the groundwater level condition in the land has dropped to -65 cm from the ground surface, its groundwater condition lifted to -18 cm from the ground surface so that plants were not died due to the lack of water. With this groundwater condition from -5 to -36 cm from the ground surface, the water requirement of rice plants can be fulfilled (Nurfaijah et al., 2015).

Ratoon Paddy Cultivation System

The paddy cultivation activity in Banyu Urip Village P17-6S used early age paddy variety namely IR-64. This paddy variety age is > 105 to 124 days. The first Planting Period I is conducted the farmer from October to March, while the second Planting Period II is conducted by farmers from May until September. In the Planting Period (PP I) and PP II interval from March-May, farmers plant fallow crops or continue to take care of the harvested paddy plant or grow it again to be harvested. It is better known as the ratoon paddy system. Ratoon paddy has a short life cycle. It only needs about 40 days for the rice to be harvested.

In the ratoon paddy cultivation system, the top part of harvested paddy will be cut and its plant stump will be left about 20-30 cm from the ground surface. However, according to Ichii (1983), ratoon cut can be conducted at about 5 cm and 20 cm from the ground surface. The water depth level is maintained at about 5 cm. This condition is difficult if it is planted in the tidal lowland area with typology B. A research by Setiawan et al. (2014) showed that there was no interaction between the thickness of irrigation and the height of stem cutting to the plant growth. The ratoon plant production can reach up to 3.12 ton ha^{-1} in the continuous flooding treatment.

In order to get the maximum production, a fertilizer is required because the ratoon cultivation system has low production potency. In the observation in Banyu Urip Village, there were two observed agricultural lands. Land A is without fertilizer whereas Land B is treated with urea fertilizer as many as 150 kg ha^{-1}. It was only given one time after paddy stem cutting.

Ratoon paddy cultivation will be continued if the shoots grown from the paddy stalks grow more than 70% (Islam, Hasanuzzaman, & Rokonuzzaman, 2008). Paddy plants in vegetative phase require a different amount of water in accordance with the requirement. The vegetative phase of paddy plant is divided into three phases, namely: a) recovery stages and roots growth (0-10 days after planting), b) maximum growth phase of tiller (10-50 days after planting), and c) effective shooting and ineffective shooting (35-45 days after planting).

The growth and quantity of tillers are highly influenced by the cutting technique. The harvesting process in Telang is conducted using a high cutting technique. It seems that farmers have the problem with this cutting. To cut it back, farmers are constrained by time and energy. Cutting height very strong affects the ratoon paddy cultivation system, especially in its vegetative phase. The higher cutting, the fewer tillers will be but its growth will be very fast with less tiller quantity (Wasis Nyoto, 2014).

In the ratoon paddy system, the recovery phase and maximum tiller growth will not be experienced because paddy will not be transplanted and ratoon paddy will not have intensive tiller growth like newly planted paddy. Ratoon paddy has an effective shooting phase if the previous cut stems will grow new shoots and produce new leaves. The following process is the increase of the plant height shown by the lengthening of leaves.

Furthermore, paddy plants turn into generative phase. In this phase, it covers the early development of panicles (40-50 days after planting), fulfilling the phase (50-60 days after planting), and flowering (60-80 days after planting). A research by Faruq et al. (2014) showed that ratoon paddy can be harvested in 90 days, while the study conducted by Setiawan et al. (2014) revealed that it can be harvested in 96 days. This situation is characterized by the formation and growing of panicles. However, in the generative phase, ratoon paddy does not need a long time so that in 20 days paddy plants have shown panicle existence.

In the generative phase, paddy plants require a lot of water. Drought in this period will influence the formation of panicles, flower, and fertilization. In this case, it increases the sterility of plant and decreases plant production. Based on the groundwater observation in the field, the groundwater level was at -5 to -36 cm from the ground surface. It is showed that paddy's water requirement was quite sufficient because paddy's roots are able to absorb water in the depth of 20-30 cm below the ground surface.

The Effect of Fertilization on the Growth of Paddy Ratoon

In addition to the groundwater level, fertilization also plays a role in that able to influence influencing the growth and production of paddy. As previously written, Land A was treated with no fertilizer and Land B is with fertilizer as many as 150 kg ha^{-1}. The result showed that there is a difference in plant height and production between those two lands. The production of ratoon paddy at Land A was 0.8 ton ha^{-1}. Meanwhile, at Land B, the ratoon paddy production was 2.8 ton ha^{-1}. Table 1 showed the height of the plants in the different treatment of the land.

Table 1. Mean weekly paddy height

Week	Land A (cm)	Land B (cm)
1	74.61	79.64
2	81.60	95.20
3	87.20	102.00
4	100.30	109.90

Based on Table 1 about the average weekly paddy height, it is seen that there was a difference in the plant height at Land A and Land B. In the first week, its difference was 5 cm. In the second week, its difference was 13 cm. In the third week, its difference was 14 cm. And in the last week, its difference was 9.6 cm. At Land A with no fertilizer, it is showed that the height of the plants was shorter than those in Land B. However, the plants were cut in the similar height about 25 cm from the ground surface. The water height in each land was also similar. Having a closer look at the difference of these plants, it can be interpreted that the plants with no fertilizer were grown slower than those with fertilizer. The difference in plant height and plant production did not depend on the groundwater level because the groundwater level in the land is able to be reached by roots. However, it was caused by the difference in soil fertility.

Figure 4 showed the significant difference of ratoon paddy at Land A with no fertilizer and Land B with fertilizer. As reported by Hanafiah (2005), NH_4^+ in the urea fertilizer plays a role in composing all proteins (acids–amino acids–enzyme) and chlorophyll, coenzyme, and nucleic acids as well as growth hormones such as cytokines and auxins

Mareza et al. (2016b) reported that the application of urea fertilization with the dose of 150 kg ha^{-1} enhances the performance of rice growth. It produced 15-16 gr grain weight per clump. The application of fertilizer especially Nitrogen, followed by waterlogging after harvesting the main plant, increases the plant height and the productivity of tillers and rats. The growth of ratoon rice was very dependent on the dose of fertilizer given, and the ratoon response was varying with to the dose of different fertilizers. Maximum production of rice on the grain yield of ratoon crop was given by N=150, P2O5 = 85, K2O = 90, S=13, Zn = 4: in kg ha^{-1}. However, the grain yield from ratoon crop was produced to be less than the main crop. On the other hand, the crop duration was shorter. It was a good alternative to increase cropping intensity and total rice yield (Islam et al., 2008).

The application of urea fertilizer half of the first dose of the main crop could improve the quality of the yield. The result is that the height of ratoon reaches up to 2.25-3.61 m. Thus, the utilization of ratoon plant system and management of rice farming with ratoon system in the tidal lowland is believed to be increasing the harvesting indexes per planting season. Therefore, the rice harvest that has been done once per planting season increases to two times per season. Thus, the additional yield per planting season will be obtained. The production of ratoon rice is very seasonally dependent; this is related to the status of groundwater. However, the resulting product can make optimal land use with low production costs. The results and income of farmers per planting season are also increased since farming with the ratoon system is saving input production, cost, and time (Susilawati & Purwoko, 2014).

Fertilization can increase the growth but a certain level, it cannot increase the production quantity. A research by (Bond & Bollich, 2006) showed that the nitrogen application as many as 90-120 kg ha^{-1} was no longer able to increase paddy production. This condition was in line with the research result of Islam et al. (2008), stated that the highest paddy production with ratoon method was achieved in urea dose as many as 120 kg ha^{-1}.

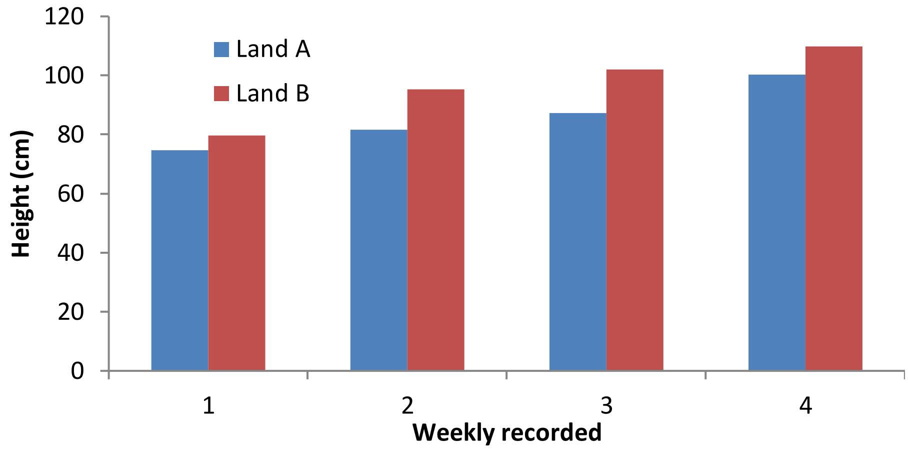

Figure 4. The weekly average height of paddy

Table 2. The result of initial and final soil analysis in the study area

Type of Analysis	Initial Soil Analysis	Final Soil Analysis	
		Land A	Land B
pH H_2O	4.28	4.62	4.50
pH KCl	3.85	3.93	3.89
C-organic	0.46	4.74	5.31
N- Total (%)	0.04	0.42	0.39
P-Bray I (ppm)	29.25	25.20	21.45
K-dd (me $100g^{-1}$)	0.26	0.38	0.32
Na (me $100g^{-1}$)	0.87	0.54	0.76
Ca (me $100g^{-1}$)	1.88	2.05	2.28
Mg (me $100g^{-1}$)	1.20	0.68	0.55
CEC (me $100g^{-1}$)	17.40	30.45	43.50
Al-dd (me $100g^{-1}$)	1.36	1.50	0.76
H-dd (me $100g^{-1}$)	0.38	0.72	0.64
Texture			
Sand (%)	22.06	32.64	30.35
Silt (%)	31.61	44.88	42.84
Clay (%)	46.33	22.48	26.81

The application of urea as many as 60 kg N ha^{-1} is able to increase paddy production with ratoon method as many as 1.9 ton ha^{-1} on 30 cm stem cutting (Huossainzade, Azarpour, Doustan, Moraditochaee, & Bozorgi, 2011). The growth and production of the plant are influenced by the fertility level and also environmental condition especially temperature and sun radiation (Oad, Cruz, Memon, Oad, & Hassan, 2002).

Based on the analysis result at the laboratory (Table 2), shows the main problem of soil fertility is the low acidity level. Soil analysis was conducted for the initial land sample before and after the ratoon technique. The initial soil sample analysis showed that C-organic content in the soil was low as many as 0.46% while in the analyzed soil sample after ratoon technique, C-organic content increased up to more than 5%.

At Land A with no fertilizer, the content of C-organic in the soil was 4.74% while at Land B with the fertilizer treatment, C-organic content was 5.31%. The difference of C-organic content in these two soil treatments was 0.57%.

As showed by the analysis result, before ratoon treatment the content of N-total was 0.04%, while the content of N-total at the land with ratoon technique increased up to 0.42 % at Land A and 0.39 at Land B. Cation Exchange Capacity (CEC) of land also increased from 17.40 me $100g^{-1}$ to 30.45 me $100g^{-1}$ at Land A and 43.50 me $100g^{-1}$ at Land B.

The increasing of C-organic content and Cation Exchange Capacity (CEC) content at these two lands were different. The increasing of C-organic content and Cation Exchange Capacity (CEC) index were possibly caused by urea fertilizer treatment. However, N-total at Land A was higher than Land B. It was because Al-dd at Land A is 0.74 $100g^{-1}$ higher than at Land B. The increasing of chemical content in the soil was not only caused by the fertilizer treatment but also triggered by the additional of litter component in the plant. If it was only seen from the height of plants, the fertilizer treatment to the plant height was directly proportional. However, the fertilizer treatment was inefficient because the production cost was not balanced with the production result. The production result of paddy with ratoon method was only one-third of normal production.

CONCLUSION AND RECOMMENDATION

The fluctuation of groundwater table in tertiary block (on the farm) is highly determined by the rainfall in this area. However, the water availability in a canal is able to keep the groundwater table near the root zone to fulfill crop water requirement.

The condition of the groundwater table in the rice fields in Banyu Urip Village was near the soil surface because during the rainy season it is able to reach -5 cm from the ground surface.

Paddy roots are able to reach waters in the depth of 20 cm from the ground surface and groundwater table under 5 to 36 cm from the ground surface. It is shown that the water requirement could be fulfilled.

The production of paddy field with ratoon method was influenced by the urea fertilizer treatment. It was shown by the production difference of Land A (0.8 ton ha^{-1}) and Land B (2.8 ton ha^{-1}).

The fertilizer treatment for paddy plants with ratoon method was ineffective because if it was compared to the land with no fertilizer, it only increased C-organic content as many as 0.5% and Cation Exchange Capacity (CEC) contents as many as 13.00 me $100g^{-1}$.

It is suggested that plant cultivation with ratoon method should be conducted in wet season such as March. It is intended to maintain the height level of the groundwater table so plant water requirement can be fulfilled. A balanced fertilizer treatment should be conducted in paddy cultivation with ratoon method in order to get a balanced production with fertilizer cost. A further research about fertilizer application dose is required in order to increase the production of paddy with ratoon system**.**

REFERENCES

Bond, J. A., & Bollich, P. K. (2006). Ratoon Rice Response to Nitrogen Fertilizer. *Plant Health Progress*, *5*(1). http://doi.org/10.1094/CM-2006-0523-02-RS

Dariah, A., & Agus, F. (2007). Pengelolaan Sifat Fisik Tanah Sawah Bukaan Baru. In *Prosiding Tanah Sawah Bukaan Baru* (pp. 107–130). Bogor: Balai Besar Litbang Sumberdaya Lahan Pertanian. BBLSLP.

Erdiman. (2012). *Teknologi Salibu Meningkatkan Produktivitas Lahan (3-6 Ton/Ha/Tahun) dan Pendapatan Petani (Rp.15-25 Juta/Tahun)*. *TEKNOLOGI SALIBU MENINGKATKAN PRODUKTIVITAS LAHAN (*

3 DAN PENDAPATAN PETANI (Rp - 16 5) . T 2ON5 - /HA/TT JU A/ AH AH T U UN N). Padang, Sumatera Barat.

Ernawati, P. :, Bambang W, Edwin H, & Gohan O M. (2014). *Teknologi Budidaya Pada Sawah Sistem Ratun*. Lampung. Retrieved from http://lampung.litbang.pertanian.go.id/ind/images/stories/leaflet2015/ratunpadi.pdf

Faruq, G., Taha, R. M., & Prodhan, Z. H. (2014). Rice ratoon crop: A sustainable rice production system for tropical hill agriculture. *Sustainability*, *6*, 5785–5800. http://doi.org/10.3390/su6095785

Hanafiah, K. A. (2005). *Dasar-dasar ilmu tanah*. PT RajaGrafindo Persada. Retrieved from https://books.google.co.id/books/about/Dasar_dasar_ilmu_tanah.html?id=AkbRnQAACAAJ&redir_esc=y

Huossainzade, A., Azarpour, E., Doustan, H. Z., Moraditochaee, M., & Bozorgi, H. R. (2011). Management of Cutting Height and Nitrogen Fertilizer Rates on Grain Yield and Several Attributes of Ratoon Rice (Oryza sativa L.) In Iran. *World Applied Sciences Journal*, *15*(8), 1089–1094. Retrieved from https://pdfs.semanticscholar.org/54a3/038c79ec02aa85d834360d8bed25866a0469.pdf

Ichii, M. (1983). The Effect of Water Management On Ratoon Ability of Rice Plants. *Tech Bull Fac Agr*, *34*(2), 123–128.

Imanudin, M. S., Armanto, M. E., Susanto, R. H., & Bernas, S. T. (2010). Water Status Evaluation on Tertiary Block for Developing Land Use Pattern and Water Management Strategies in Acid Sulfat Soil of Saleh Tidal Lowland Reclamation Areas of South Sumatera. *AGRIVITA, Journal of Agricultural Science*, *32*(3), 241–253. http://doi.org/10.17503/AGRIVITA.V32I3.16

Imanudin, M. S., Priatna, S. J., Wildayana, E., & Armanto, M. E. (2017). Variability of Ground Water Table and Some Soil Chemical Carachteristic on Tertiary Block of Tidal Lowland Agriculture South Sumatera Indonesia. *Sains Tanah*, *14*(1), 7–17.

Islam, M. S., Hasanuzzaman, M., & Rokonuzzaman, M. (2008). Ratoon Rice Response to Different Fertilizer Doses in Irrigated Condition. *Agriculturae Conspectus Scientificus*, *73*(4), 197–202. Retrieved from https://acs.agr.hr/acs/index.php/acs/article/view/23

Mareza, E., Djafar, Z. R., Suwignyo, R. A., & Wijaya, A. (2016a). Pertumbuhan dan Produksi Ratun berbagai Varietas Padi Potensial Pasang Surut dengan Potensi Ratun yang Berbeda (The Growth and Production of Various Tidal Rice Varieties with Different Potential Ratoon). In *Prosiding Seminar Nasional Lahan Suboptimal 2016* (Vol. 1, pp. 979–587). Palembang: Pusat Unggulan Riset dan Pengembangan Lahan Suboptimal, Universitas Sriwijaya.

Mareza, E., Djafar, Z. R., Suwignyo, R. A., & Wijaya, D. A. (2016b). Morfofisiologi Ratun Padi Sistem Tanam Benih Langsung di Lahan Pasang Surut. *Jurnal Agronomi Indonesia (Indonesian Journal of Agronomy)*, *44*(3), 228–234. http://doi.org/10.24831/jai.v44i3.12908

Nurfaijah, Setiawan, B. I., Arif, C., & Widodo, S. (2015). Sistem Kontrol Tinggi Muka Air Untuk Budidaya Padi. *Jurnal Irigasi*, *10*(2), 97–110. http://doi.org/10.31028/ji.v10.i2.97-110

Oad, F. C., Cruz, P. S., Memon, N., Oad, N. L., & Hassan, Z. U. (2002). Rice Ratooning Management. *Journal of Applied Sciences*, *2*, 29–35. http://doi.org/10.3923/jas.2002.29.35

Santos, A. B., Fageria, N. K., & Prabhu, A. S. (2003). Rice Ratooning Management Practices for Higher Yields. *Communications in Soil Science and Plant Analysis*, *34*(5–6), 881–918. http://doi.org/10.1081/CSS-120018981

Saraswati, R., & Husen, E. (2007). Prospek Penggunaan Pupuk Hayati pada Sawah Bukaan Baru. In *Lahan Sawah Bukaan Baru* (pp. 151–173). Bogor: Balai Penelitian Tanah,Kementerian Pertanian. Retrieved from http://balittanah.litbang.pertanian.go.id/document.php?folder=ind/dokumentasi/buku/buku lahan sawah bukaan baru&filename=08pupukhayati_rasti&ext=pdf

Setiawan, A., Tyasmoro, S. Y., & Nugroho, A. (2014). INTERMITTENT IRRIGATION AND CUTTING HEIGHT ON RATOON RICE (Oryza sativa L.). *AGRIVITA, Journal of Agricultural Science*, *36*(1), 72–80. http://doi.org/10.17503/AGRIVITA.V36I1.331

Setyorini, D., Suriadikarta, D. A., & Nurjaya. (2007). Rekomendari Pemupukan Padi di Lahan Sawah Bukaan Baru. In *ahan Sawah Bukaan Baru* (pp. 77–106). Bogor: Balai Penelitian Tanah,Kementerian Pertanian. Retrieved from http://balittanah.litbang.pertanian.go.id/ind/dokumentasi/buku/buku lahan sawah bukaan baru/05pemupukan_diah.pdf?secure=true

Soil Survey Staff. (2010). *Keys to Soil Taxonomy* (11th ed.). Washington: United States Department of Agriculture, Natural Resources Conservation Service. Retrieved from https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_050915.pdf

Sosrodarsono, S., & Takeda, K. (2006). *Hidrologi untuk pengairan*. Jakarta: Pradnya Paramita. Retrieved from http://www.nlb.gov.sg/biblio/4194217

Sudana, W. (2005). Potensi dan Prospek Lahan Rawa sebagai Sumber Produksi Pertanian. *Analisis Kebijakan Pertanian*, *3*(2), 141–151. http://doi.org/10.21082/AKP.V3N2.2005.141-151

Susilawati & Purwoko, B. S. (2014). PENGUJIAN VARIETAS DAN DOSIS PUPUK UNTUK MENINGKATKAN PERTUMBUHAN DAN HASIL RATUN-PADI DI SAWAH PASANG SURUT. *Jurnal Pengkajian Dan Pengembangan Teknologi Pertanian*, *15*(1), 47–54. http://doi.org/10.21082/JPPTP.V15N1.2012.P%P

Wahyunto. (2009). Lahan Sawah di Indonesia Sebagai Pendukung Ketahanan Pangan Nasional (Paddy fields in Indonesia as a back stopped for national food security). *Informatika Pertanian*, *18*(2), 133–152. Retrieved from http://perpustakaan.pertanian.go.id/simpertan_litbang/katalog/majalah/all/informatika-pertanian/18/2/2009/lahan-sawah-di-indonesia-sebagai-pendukung-ketahanan-pangan-nasional

Wasis Nyoto 2014. Response of the ratoon rice (Oryza sativa L.) system to the height of pruning and dosing of mycoriza in the vegetative phase. Skripsi. National Veteran University. (Not published)