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RESEARCH ARTICLE

SOIL MANAGEMENT TO INCREASE YIELD AND INCOME OF RICE PARTICIPATORY FARMER TO SUSTAINABLE

***Whadcharee Saetung and Putchanee Koaya**

Agricultural Research, Academic Group for Land Development, Land Development Department Office 5

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***Corresponding author:**
Whadcharee Saetung and Putchanee Koaya

ABSTRACT

Soil Management to Increase yield and Income of Rice Participatory Farmer to Sustainable start to 2021-2023 in Thung Ma Hue, Tan Sum District, Ubon Ratchathani Province. The objective of this study is to compare soil management suitable for growing Jasmine Rice 105 and Khorkor 43 variety, including the economic returns of each method or farmers to accept and implement them. The experiment consisted of 3 methods: 1) soil management by farmers. 2) soil management by chemical fertilizers with manure (cow manure) and 3) soil management by chemical fertilizers according to soil analysis with compost, bio-fermented liquid and green manure. The method used with Jasmine rice 105 and Khorkor 43 variety, and this experiment using Split Plot in RCBD for 3 replicates. The results that the chemical fertilizers according to soil analysis with compost, bio- fermented liquid and green manure will be rice height, tillering, number of seeds/ears, weight of 100 seeds, and rice yield higher than all methods, both in the Jasmine rice 105 and Khorkor 43 variety. The analyzing statistical, found that the response of rice height and the number of seeds/ears will be influenced only the variety factor. As for rice tillering and rice yield, found that were influenced only by factors related to different varieties and soil management methods. And found that the weight of 100 grains of rice was influenced only factor of soil management methods. For soil chemical properties, the soil pH and organic matter to be increase all methods. This may be due to organic matter from compost or green manure has resulted increase resistance to pH changes in soil to balancing, causing to have a higher soil pH. In addition, the exchangeable potassium in soil to be increased, probably due to many of residual fertilizer remaining in soil, together with the plants to absorb only a small exchangeable potassium, resulting increased potassium accumulation in the soil. more etc. As for electrical conductivity and the available phosphorus, it was found that there was a tendency to decrease. This may be due to the soil pH before experiment was very acidic, affect the available phosphorus, moreover the very acidic will be many aluminum ions (Al3+) to dissolve and extent that it is toxic to plants, which mostly in soil with a pH lower than 4.7. The aluminum ion will react with available phosphorus in form a complex compound that is difficult to dissolve and to fixed in soil, resulting that have available phosphorus decreased or low. In terms of economic returns, it will be that in both of jasmine rice 105 and Khorkor 43, the using compost with bio- ferment liquid, green manure and chemical fertilizer according to soil analysis (T3) will give economic returns over all methods, for 11,324.10 baht/rai (Jasmine rice 105) and 4,787.25 baht/rai (Khorkor 43), respectively.

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INTRODUCTION

"Thung Ma Hue" is a flat area, covers some areas of Ubon Ratchathani and Amnat Charoen Province and it is in the Lam Sebok River Basin. This area is mostly sandy, has low fertility and is very acidic, the soil pH is in the range 4 . 5 - 5 . 0 (Numano, 2015) . Flooding occurs in the rainy season and dehydrated in dry season. Upland areas have problems with soil erosion and soil does not hold water, causing the yield to be low. The researcher saw that the technology of Land Development Department should be used for testing demonstrate and compare with methods currently practiced by farmers. By allowing farmers to participate in all process in order to accept the best technology/methods and implement their own rice cultivation. In this experiment, 2 varieties of rice were tested: Khao Dok Mali 105, which is a rice promoted for export and is a variety farmers like to grow for consumption, and Khorkor 43, a new rice varieties has low sugar and suitable for those who want to take care of their health especially patients with diabetes. Therefore, in order for farmers to accept technology is suitable for increasing productivity and sustainable land use. The researcher therefore conducted a research study to test and demonstrate appropriate methods in the area for farmers to actually use to increase production. Reduce production costs for consumers and safe the environment until it leads to more efficient use of soil resources.

MATERIALS AND METHODS

Materials

- Green Manure Seeds (Jack Bean)
- Khao Dok Mali 105 and KhoKor 43 Seed
- Soil Sampling Equipment
- Manure, Compost, Biological Fermentation
    - Chemical Fertilizer 46-0-0, 18-46-0, 0-0-60
- Measuring, Scale and Dryer
- Plastic Bags, Mesh Bags
- Research Project Sign

Method

- Select the research project area in Thung Ma Hue field, near a water source and about area 1 rai with the record geographic location coordinates.
- Explain details the research project to farmers in this area regarding the duration of the research project and various work methods to farmers After that, soil samples were collected before the experiment.
- Prepare materials and equipment for research projects such as rice seeds, chemical fertilizers, manure, compost, green manure seeds, bio-ferment liquid and research plot signs, etc.
- Prepare the soil by plowing in the stubble to remove weeds and plowing to level the area ready to prepare small plots and make dyke to be durable and plow the soil thoroughly.
- Plan the experiment Split Plot Design in RCBD by setting the Main Plot to be rice varieties, including: Khokor 43 and Khao Dok Mali 105, and the Sub Plot to be the experimental method, including: 1) Farmer method 2) Manure with Chemical Fertilizer method and 3) Chemical fertilizer to soil analysis with compost, bio-ferment, green manure.
- Sowing the green manure seed to cover field with tilling and spray the bio-fermented liquid into research plots of 2 rice varieties (Khokor 43 and Dok Mali 105)
- Plowing the green manure crop during the flowering period and spraying bio-ferment liquid to accelerate the rate of decomposition of manure crop and tilling into the soil.
- Input manure, compost and chemical fertilizers in to the experimental plan and plowing in the field.
- Sowing rice seedlings, separate rice seedlings and rice planting.
- Maintain the rice research plot by eliminating snails and weeds within the plot.
- Collected growth data and rice yield composition data.
- Harvest rice products, including threshing and winnowing rice, then collect soil samples after the experiment and record economic returns including production costs (baht/rai), economic returns (baht/rai), etc.
- Analyze data using the statistical analysis, Split Plot in RCBD and writing a complete research report.

RESULTS

The Height of Rice: It was found that the Khao Dok Mali 105 rice variety gave higher height than Kho Khor 43 rice variety in all methods (Figure 1). An analyzing statistical data using the Linear Model of Split Plot Design in RCBD, it was found that the variety factors had a significantly different at 99%. ($P<0.01$). In terms of soil management all 3 methods: are farmers' methods, chemical fertilizer combined with manure and chemical fertilizer to soil analysis with compost, bio-ferment, green manure. It was found that there would be no effect on the height of the two rice varieties as there was no statistically significant difference ($P>0.05$). This indicates that the height response of rice is influenced only by cultivar factors. As for the combined influence between the factors of varieties and soil management methods, there will be no effect on rice height either as there is no statistical significant difference ($P>0.05$) (Table 1).

Tillering of rice

It was found that the Khokor 43 rice variety gave more tillering than the Khao Dok Mali 105 rice variety in all methods (Picture 2). An analyzing statistical data using the Linear Model of Split Plot Design in RCBD, it was found that varietal factors had a statistically significant difference in effect on rice tillering at 95% confidence level ($P<0.05$). The part of 3 soil management methods, it was found that simillary effect on tillering of both rice varieties because there is a statistically significant difference at 95% confidence level ($P<0.05$). This indicates that the tillering response of rice is influenced only factors of different varieties and soil management methods. As for the combined influence between factors of different varieties and soil management methods, there will be no effect on rice tillering as there is no significant difference ($P>0.05$) (Table 2).

Number of seeds per ear

It was found that the variety Khao Dok Mali 105 had a higher number of seeds per ear than the Khokor 43 rice variety in all methods (Figure 3). An analyzing statistical data using the Linear Model of Split Plot Design in RCBD, it was found that the variety factors had a significantly different effect on the number of seeds per ear of rice at 99% confidence level ($P<0.01$). As for the 3 soil management methods, it was found that there was no effect on the number of seeds per ear of two rice varieties as there was no statistically significant difference ($P>0.05$). This indicates that the number of seeds per ear of rice is influenced only by cultivar factors. As for combined influence between different varieties and soil management methods, will be no effect on number of seeds per ear of rice because there is no statistically significant difference ($P>0.05$) (Table 3).

Weight 100 grain of rice

It was found that the Khao Dok Mali 105 variety had a weight of 100 grains more than the Khorkor 43 rice variety in all methods (Figure 4). The analyzing statistical data using the Linear Model of Split Plot Design in RCBD, it was found that the variety factors had no effect on weight of 100 grains of rice because there was non-significantly difference ($P >0. 05$) . As for soil management methods, it was found that there would be effect on weight of 100 grains of both rice varieties because the results of the statistical analysis were significantly different at 99% confidence level ($P<0.01$) This indicates that the weight of 100 grains influenced only soil management factors and the combined influence between factors of different varieties and soil management methods, will be no effect on the weight of 100 grains because there is non - significantly difference ($P>0.05$) (Table 4).

Rice straw dry weight

It was found that the Khao Dok Mali 105 variety had a higher rice straw dry weight than the Khorkor 43 rice variety in all methods (Figure 5). The analyzing statistical data using the Linear Model of Split Plot Design in RCBD, it was found that the variety factors will have effect on rice straw dry weight because the results of data analysis are significantly different at 99% confidence level ($P<0.01$). But regarding the three soil management methods, it was found that there would be no effect on rice straw dry weight of 2 rice varieties because the results of data analysis were not significantly different ($P>0.05$). However, it was found that the combined influence between the factors of variety and soil management methods will have effect on rice straw dry weight because the results data analysis will be

Table 1. Analysis of height growth of rice

Replication 217.907.701.50; Main plot

Rice varieties	14438.7	0.0070 **	25043.2	0.0015 **	19378.20	0.0019 **
Error Sub plot	102.30		36.40		37.40	
Method	114.80	0.1585 NS	372.1(	0.1002 NS	212.20	0.1077 NS
Rice varieties * Method	0.10	0.9987 NS	41.30	0.7183 NS	10.90	0.8600 NS
Error	49.10		119.7(		71.10	
Total						

* Significant 95 %, ** Significant 99 %, **NS** Non – significant

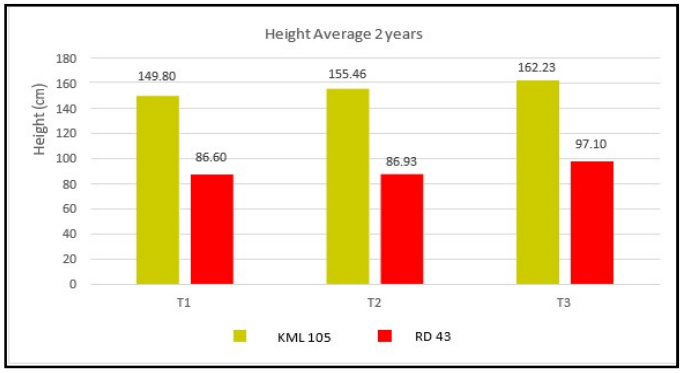

Figure 1. Height of rice varieties Khao Dok Mali 105 and Khokor 43 averaged 2 years

Table 2. Analysis of tillering of rice

Replication	2	1.0556		0.1356		0.1117	
Main plot							
Rice varieties	1	38.1356	0.0903 NS	15.3089	0.0096 **	25.4422	0.0268 *
Error	2	3.9756		0.1489		0.7106	
Sub plot							
Method	2	1.1089	0.6310 NS	5.0156	0.0090 **	2.6600	0.0324 *
Rice varieties * Method	2	2.8422	0.3368 NS	0.3622	0.5484 NS	0.2956	0.5703 NS
Error	8	2.2722		0.5589		0.4903	

Total 17

* Significant 95 %, ** Significant 99 %, NS Non - significant

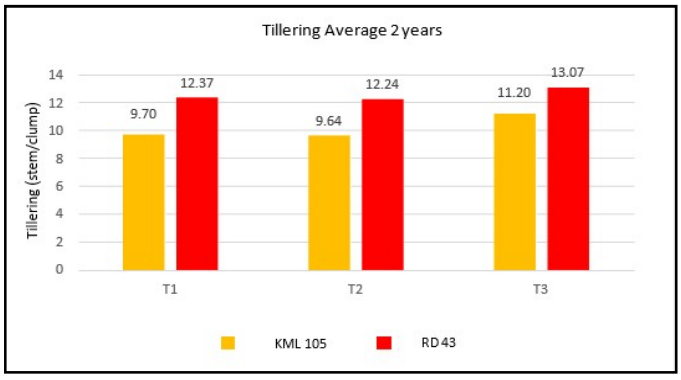

Figure 2. Tillering of rice varieties Khao Dok Mali 105 and Khokor 43

significantly different at 99% confidence level (P<0.05). This indicates that the rice straw dry weight is influenced by rice variety factors and the combined influence between rice variety soil management methods. As for soil management methods only, there will be no effect on the dry weight of rice straw, etc. (Table 5).

Yield of rice

It was found the Khao Dok Mali 105 variety had a higher rice yield than Khorkor 43 rice variety in all methods (Figure 6). The analyzing statistical data using the Linear Model of Split Plot Design in RCBD, it was found that, variety factors will have effect on rice yield because

Table 3. Analysis of number of seeds per ear of rice

Replication	2	576.35		51.00		1.50	
Main plot							
Rice varieties	1	9893.56	0.0156 *	20330.00	0.0001 **	19378.20	0.0019 **
Error Sub plot	2	158.03		2.20		37.40	
Method	2	529.84	0.3128 NS	458.30	0.0625 NS	212.20	0.1077 NS
Rice varieties * Method	2	162.10	0.6752 NS	999.20	0.0114 *	10.90	0.8600 NS
Error	8	392.84		121.40		71.10	
Total	17						

* Significant 95 %, ** Significant 99 %, NS Non – significant

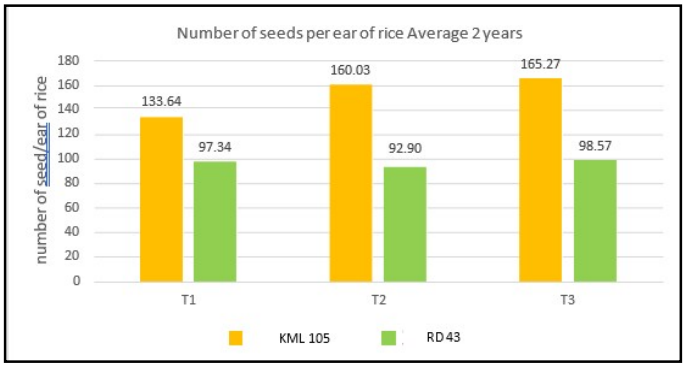

Figure 3. Number of seeds per ear of rice varieties Khao Dok Mali 105 and Khokor 43 averaged 2 years

Table 4. Analysis of weight 100 grains of rice

Replication	2	0.00001		0.00349		0.00087	
Main plot							
Rice varieties	1	0.00142	0.7651 NS	0.18201	0.0152 *	0.03736	0.1461 NS
Error Sub plot	2	0.01217		0.00282		0.00694	
Method	2	0.04377	0.0022 **	0.11209	0.0004 **	0.07267	0.0001 **
Rice varieties * Method	2	0.01594	0.0342 *	0.00042	0.9149 NS	0.00311	0.2471 NS
Error	8	0.00301		0.00470		0.00186	
Total	17						

* Significant 95 %, ** Significant 99 %, NS Non - significant

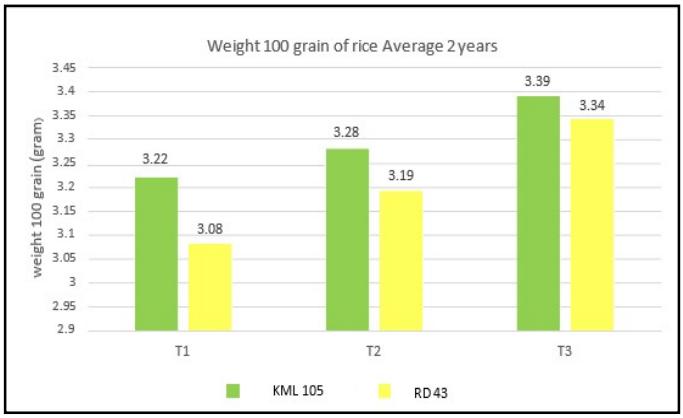

Figure 4. Weight 100 grain of rice varieties Khao Dok Mali 105 and Khokor 43 averaged 2 years

the results of the data analysis will be significantly different at 99% confidence level (P<0.05). As for the three soil management methods, it was found that they would have the same effect on yield of both rice varieties. This is because the results of the data analysis will be significantly different at 99% confidence level (P<0.05). However, it will be found that the combined influence between cultivar factors and soil management methods will not have an effect on rice yield

Table 5. Analysis of rice straw dry weight of rice

Replication	2	33733		10986		20806	
Main plot							
Rice varieties	1	201994	0.0019 **	252893	0.0334 *	226727	0.0091 **
Error Sub plot	2	395		8878		2098	
Method	2	25650	0.3722 NS	1098	0.9214 NS	9061	0.5786 NS
Rice varieties * Method	2	34717	0.2763 NS	117016	0.0095 **	69786	0.0487 *
Error	8	22879		13272		15455	
Total	17						

* Significant 95%, ** Significant 99%, NS Non–significant

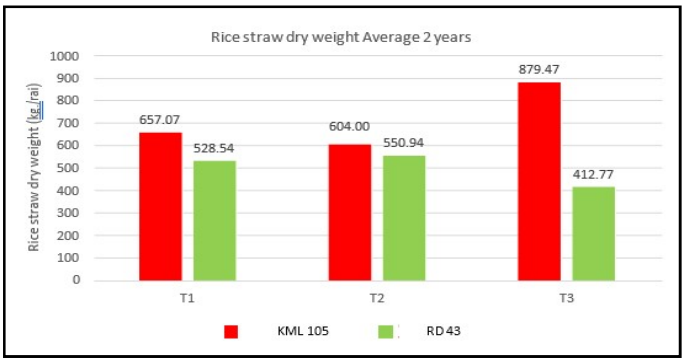

Figure 5. Rice straw dry weight of rice varieties Khao Dok Mali 105 and Khokor 43 averaged 2 years

Table 6. Analysis of yield of rice

Replication	2	34616.70		1470		12050	
Main plot							
Rice varieties	1	95338.90	0.1104 NS	892074	0.0048 **	206939	0.0111 *
Error Sub plot	2	12572.20		4322		2339	
Method	2	80616.70	0.0097 **	30717	0.1408 NS	86850	0.0110 *
Rice varieties * Method	2	8438.90	0.4380 NS	110545	0.0087 **	206	0.9805 NS
Error	8	9202.80		12143		10403	
Total	17						

* Significant 95%, ** Significant 99%, NS Non-significant

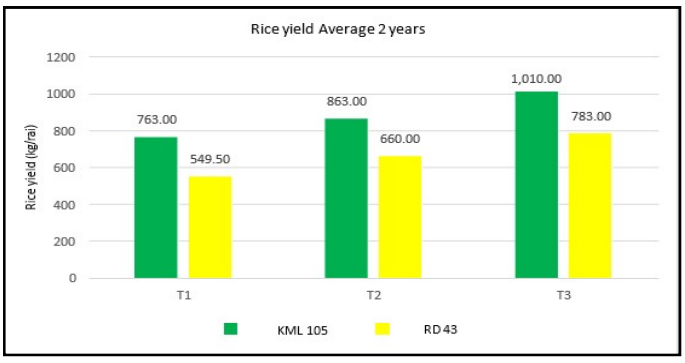

Figure 6. Yield of rice varieties Khao Dok Mali 105 and Khokor 43 averaged 2 years

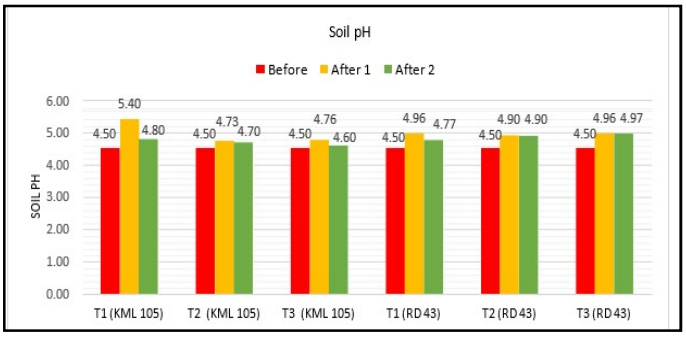

Figure 7. Soil pH before and after the experiment in soil management for rice cultivation

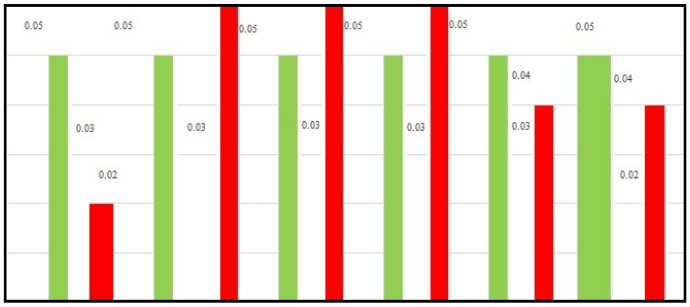

Figure 8. Electrical conductivity before and after the experiment in soil management for rice cultivation

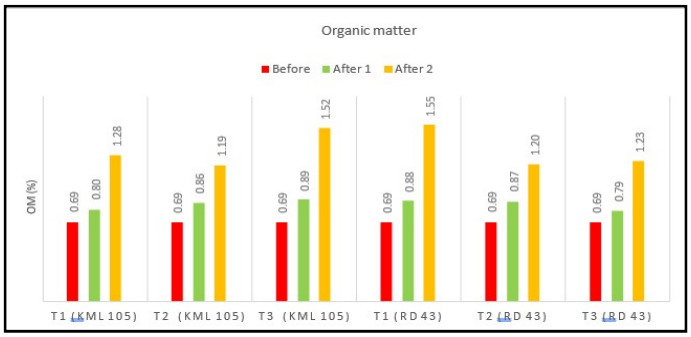

Figure 9. Organic matter before and after the experiment in soil management for rice cultivation

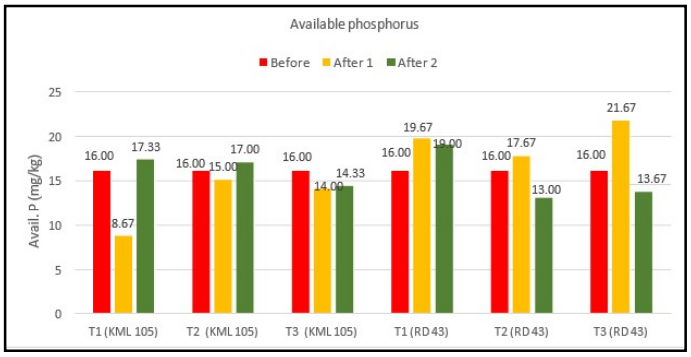

Figure 10. Available phosphorus before and after the experiment in soil management for rice cultivation

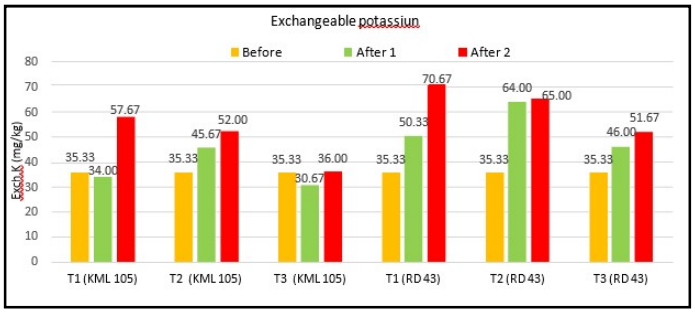

Figure 11. Exchangeable potassium before and after the experiment in soil management for rice cultivation

because the results of data analysis will not be significantly different (P>0 . 05) . This indicates that rice yield is influenced only factors of different varieties and soil management methods. But in the combined influence between factors of variety and soil management methods, there will be no effect on rice yield, etc. (Table 6)

Soil chemical properties: Soil pH before the experiment compared to after the experiment was found to have an increased trend in all methods. Before the experiment, the soil pH was equal to 4 . 50 , but after the experiment It was found that the value was higher in range of 4.68-5.10 (Figure 7). As for the electrical conductivity of soil, it was found that there was a tendency to decrease in all methods. Before the experiment, the electrical conductivity of soil was equal to 0.05 dS/m.

But after the experiment, it was found that the value decreased in range 0.02-0.04 dS/m (Figure 8).

Table 7. Average economic returns 2 years with different soil management methods

Method / Yield Product	(Kg/Rai) Value		Economic Return	Production Cost	Production Cost
		(Bath/Rai)	(Bath/Rai)	(Bath/Rai)	(Bath/Kg)
1)T1(KML 105)	763.00	11,605.23	6,605.23	5,000.00	6.55
2)T2(KML 105)	863.00	13,126.23	8,616.23	4,510.00	5.22
3)T3(KML 105)	1,010.00	15,362.10	11,324.10	4,038.00	3.99
4) T1 (RD 43)	549.50	6,456.62	1,081.62	5,375.00	9.78
5) T2 (RD 43)	660.00	7,755.00	2,870.00	4,885.00	7.40
6) T3 (RD 43)	783.00	9,200.25	4,787.25	4,413.00	5.63
Average	771.41	10,584.24	5,880.74	4,703.50	6.43

Note: T1; Farmer T2; Chemical fertilizer 18-12-6 recommended rate + manure (cow manure) rate 2 tons/rai T3; Chemical fertilizers according to soil analysis values with compost, bio-ferment liquid and green manure

In the part of organic matter, it was found that before the experiment, the organic matter in soil was 0.69 percent. At the end of the experiment, soil organic matter was a tendency to increase in all method. It will increase in the range of 1.01-1.21 percent (Figure 9). For the available phosphorus in soil, it was found that before the experiment compared to after the experiment, there was a tendency to decrease with almost every method. Before the experiment, available phosphorus in soil was 16.00 mg/kg. But after the experiment, it was found that the value was in range of 13.00-16.00 mg/kg (Figure 10). In the part of exchangeable potassium was found that before the experiment was equal to 35 . 33 mg/kg. At the end of the experiment, there was a tendency to increase with almost every experimental method, with values in the range of 33 . 33 - 64 . 50 mg/kg. (Figure 11)

Economic returns: The results of analysis economic return, found that growing the Khao Dok Mali 105 by using chemical fertilizers according to soil analysis values with compost, bio-ferment liquid and green manure (T3) will give higher economic returns than all methods. The calculation is 11,324.10 baht/rai and the method of farmers (T1) would give the lowest economic return of 6,605.23 baht/rai. For planting the Khorkor 43 rice variety, the soil management method chemical fertilizers according to soil analysis values with compost, bio-ferment liquid and green manure (T3) will give higher economic returns than all methods. The calculation is 4 ,7 87 . 25 baht/rai and the soil management method of farmers (T1) would give the lowest economic return of 1 ,0 81 . 62 baht/rai. As for the production costs of growing Khao Dok Mali 105 , it will be found that the method of using chemical fertilizers according to soil analysis values with compost, bio-ferment liquid and green manure (T3) will have the lowest production costs, has an average cost of 4,038.00 baht/rai, while the farmer method (T1) has the highest average production cost of 5,375.00 baht/rai, etc. (Table 7).

CONCLUSION AND DISCUSSION

- It was found that the method of chemical fertilizers according to soil analysis values with compost, bio-ferment liquid and green manure will give rice height, tillering, number of seeds/ears, weight of 100 grain, and rice yield higher than all methods, both in Khao Dok Mali 105 rice variety and Khorkor 43 rice variety. The analyzing the statistical data, found that the response of rice height and the number of seeds/ears of rice will be influenced only by the variety factor alone. The rice tillering and rice yield are influenced only by factors related to different varieties and soil management methods. And found that the weight of 100 grain was influenced only by factors related to soil management methods.
- Changes in soil chemical properties, it was found that the soil pH and organic matter in soil tended to increase in all methods. This may be due to the increased amount organic matter. (from fertilizer compost or green manure) has resulted increasing pH buffer by balancing the pH of soil, causing the soil pH to hiher.

In addition, it was found that exchangeable potassium in soil increased as well. This may be due to the fertilizers is a lot of residue remaining in the soil, especially in the farmers' method (T1) and the method of chemical fertilizers at recommended rates and manure (T2). Such methods may use more chemical fertilizer than necessary compared to the methods of chemical fertilizers according to soil analysis values with compost, bio-ferment liquid and green manure (T3). In addition, the plant has only a small exchangeable potassium absorbed, which will be found in method 3 in the Khorkor 43 rice variety, causing this method to have a lot of potassium remaining in the soil when compared to the Khao Dok Mali 105 rice variety, etc. As for the electrical conductivity and available phosphorus in the soil, it was found that a tendency to decrease. This may be due to the acidity of soil and dissolution of Fe, Al, and other positively ions in the soil causes a large of aluminum ions (Al3+) to dissolve that it's toxic to plants, which are found mostly in soil with a pH lower than 4.7. (Mengel and Kirkby, 1987) Aluminum ions react with available phosphorus in the soil to form complex compounds are difficult to dissolve in water or condition available phosphorus is fixed, resulting in the soil having a reduced or low amount available phosphorus. This is consistent with Sanguansuppayakorn (2004) who said that the soil reaction is strongly acidic to very acidic at levels lower than 6. This will cause very little phosphorus to dissolve in the soil because it will be fixed by iron, aluminum and manganese, etc.

- For economic returns, it was found that the chemical fertilizers according to soil analysis values with compost, bio-ferment liquid and green manure (T3) in growing Khao Dok Mali 105 and Khao Khor 43 will give higher economic returns than all methods. It is calculated as 11,324.10 baht/rai and 4,787.25 baht/rai, respectively. As for production costs, it can be found that the chemical fertilizers according to soil analysis values with compost, bio-ferment liquid and green manure (T3) will have lowest production costs of 4,038.00 baht/rai and 4,413.00 baht/rai, respectively.

Suggestion

- Farmers should consider using green manure crop, bio-ferment liquid and home-produced compost in conjunction with chemical fertilizer application methods according to soil analysis values in order to save costs and to gain worthwhile economic returns than the methods that were previously practiced regularly.
- Farmers do not respond well to the Khorkor 43 rice variety because it is a rice variety with a short harvesting period. The crops are not harvested at the same time, causing birds to destroy neighboring rice fields earlier than usual. But farmers can find appropriate management methods by making their own scarecrows to chase birds out of the area. In addition, farmers can adjust the time period for planting Khorkor 43 rice to be earlier than usual in order for the rice to be harvest the produce together. However, Khorkor 43 rice variety is a very beneficial for diabetics because it has low sugar and therefore suitable planting for household consumption, etc.

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