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Effect of Green Manure on Nutrient Contents in Soil for Organic Rice Production

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Abstract

These paper was studying the effect of green manure to nutrient contents in soil for organic rice production at Ban Thi Lamphun. The rice variety was used Riceberry. The soil samples were collected from the experimental plots. The type of green manure for this were Crotalaria juncea, Sesbania rostrata and control treatment. The soil samples were collected at 5 stages. The first stage was before planting green manure. The second stage was before plow the green manure after growing 45 days. The third stage was after plowed 15 days or before rice transplanting. The fourth stage was 60 days after rice transplanting. The final stage was before harvesting or 120 days after rice transplanting. All soil samples each stage were recorded the total nitrogen, available phosphorus and exchangeable potassium, with 3 replication. The results indicated that the green manures can increase the total nitrogen, available phosphorus and exchangeable potassium more than control treatment. The sesbania can increase the total nitrogen and available phosphorus content more than crolataria 49.94 and 3.60 mg kg^{-1}, respectively. In the other hand the crolataria can increase the exchangeable potassium content more than sesbania 17.07 mg kg^{-1}.

Keywords: Green manure, Organic Rice production, Nutrient Contents

1 Introduction

The organic agriculture is one of most dynamic and rapidly-growing sectors of the global food industry, Ellis et al. (2006). Furthermore, organic farming is one of several approaches to sustainable agriculture, FAO (1999b), because of its commercial viability, and it may provide solutions to the current problems in conventional agriculture, Scialabba (2000) and Wheele (2008). The organic rice is produced from organic agriculture management that standard for organic agriculture varies from country to country. But the definition of organic agriculture is mostly similar. According to the FAO/WHO Codex Alimentarius Commission, organic agriculture is a holistic production management system which promotes and enhances agroecosystem health, including biological cycles, and soil biological activity, Pang et al (2010).

There are many way to produce organic rice. Each approach must focus on preserving the environment and the economic returns. One of many way is using green manure in order to improve the soil structure and increase the amount of minerals to the soil. Crotalaria juncea and Sesbania rostrata are green manure that are grown in order to provide soil cover and to improve the physical, chemical, and biological characteristics of soil which are incorporated into soil while still green or at maturity. Norsuwan (2011) report that Crotalaria juncea grown for 45 days after planting was 497 – 605 kg dry weight / rai, the amount total nitrogen content, phosphorus content and exchangeable potassium content was 2.70% 0.22% and 2.40%, respectively, Sesbania rostrata grown for 45 days after planting was 606 – 839 kg dry weight / rai, the amount of total nitrogen content, phosphorus content and exchangeable potassium content was 2.90 - 3.50% 0.31% and 1.29%, respectively,

Many auther have investigated in the type of plant suitable for use as a fertilizer for various crops, yield of green manure at wet weight per unit area, main content nutrient, the suitable age of green manure after planting for plowing, and the response of some economic crops that planted in the field after planting green manure Sombuttun (2005). But a few study have investigated in mineral releasing from each of green manure duing land preparation and rice growing especially organic riceberry rice at northern Thailand that it is necessary to study to provide advice to farmer.

In this study, we performed a field experiment to investigate the effect of green manure application on total nitrogen content, phosphorus content and exchangeable potassium content on soil with different time of organic rice production in order to advice the farmer to analyze and select the highest efficiency green manure for organinc rice production.

2 Materials and Methods

2.1 *Preparation of experimental plots*

The study was conducted from July 2017 to January 2018 on the long-term agricultureal field trial at Banthi district, Lamphun province, Thailand. Each field was divided into three equal parts where Crotalaria juncea, Sesbania rostrata and Control treatments were established. The size of each experimental plot was 25 m2 (5 m x 5 m) with 3 plots in each treatment and separated each others by bunds.

2.2 *Preparation of green manure*

To investigate the effect of green manure application on total nitrogen content, available phosphorus content and exchangeable potassium content on soil with different time of organic rice, the experiment plots were divided into 3 parts, one part was the plot without green manure as a control and the others were green manure (Crotalaria juncea and Sesbania rostrata). The green manures 31.25 kg ha-1 were transplanted by seedling in each plot then plow the green manures 60 days after seedling.

2.3 *Rice planting*

The green manure was plowed and incorporated into the soil then left for 3 days. Flood the field and harrow to break the soil clods into smaller mass and incorporate plant residue for 10 days. Let the water drain naturally to allow volunteer seeds and weed seeds to germinate. Flood and level the field before rice planting. Rice seedlings aged 25 days was transplanted to each experimental plot on a 25 cm x 25 cm spacing. Use continuous flooding (3-5 cm) until 10 days before harvesting, then the water was release from plots.

2.4 *Soil sampling*

The soil samples were collected at 5 stages. The first stage was before planting green manure. The second stage was before plow the green manure after growing 45 days. The third stage was after plowed 15 days or before rice transplanting. The fourth stage was 60 days after rice transplanting. The final stage was before harvesting or 120 days after rice transplanting. All soil samples each stage with 3 replication were recorded the total nitrogen, available phosphorus and exchangeable potassium with Distillation and Spectrophotometer method. All the experiment data will be carried out in completely randomized design. Each reported value was the mean ± standard deviation of three analyses from three replications in CRD design. The experimental data was subjected to analysis of variance (ANOVA) at the level of $P \leq 0.05$.

3 Result and discussion

3.1 *Total Nitrogen content*

Total nitrogen contents in soil samples at each green manure type (*Sesbania rostrata* and *Crotalaria juncea*) applied to soil and during the experimental period are shown in Fig. 1. Total nitrogen content increased for each type of green manure plot with the increasing soil sampling period from state 1 to 2, because of nitrogenfixation by leguminous plant. The results revealed that there was increase in total nitrogen content in soil, which was similar to that of *S.rostrata* plots increased nearby nitrogen content in *C.juncea* plots. This may be due to the *S.rostrata's* ability to fix N_2 with stem nodules was similar to that of *C.juncea*'s. At state 2 to 3, the green manure was decomposed and released total nitrogen into soil during land preparation and before transplanting period. The results shown that there was an increase in total nitrogen content in the soil of *S.rostrata* plots higher than that of the *C.juncea* plots, due to its ability to decompose more easily than *S.rostrata*, so it could release nitrogen faster than that of *S.rostrata*. At state 3 to 5, Rice was growing which required necessary nutrient. The results revealed that the trend of decreasing nitrogen content in the control plots and *C.juncea* plots, in the experimental plot where *S. rostrata* was planted, there was increased in total nitrogen content in the soil, because *S. rostrata* gradually decomposed and released nitrogen to the soil in a higher amount than the rice used to grow throughout the growing season. While the experimental plot where *C.juncea* was planted, the nitrogen content decreased continuously, because *C.juncea* has decomposed and released much of it before. For this stage, the nitrogen release was less than the amount of rice needed to grow throughout the season.

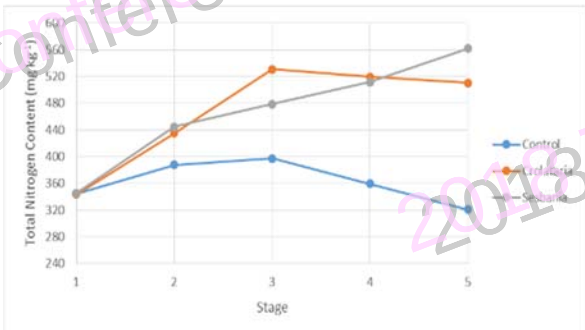

Figure 1 Stages and Total nitrogen content

S. rostrata can increase the total nitrogen content more than *C. juncea* and control treatment 49.94 and 240.98 mg kg^{-1}, respectively. According to Meelu et al. (1988), Kalidurai et al. (2003) and Domyos (2013)

C.juncea and S. *rostrata* can nitrogenfixation 143 Kg N ha^{-1} and 199 Kg N ha^{-1} at 60 days ages.

3.2 Available Phosphorus content

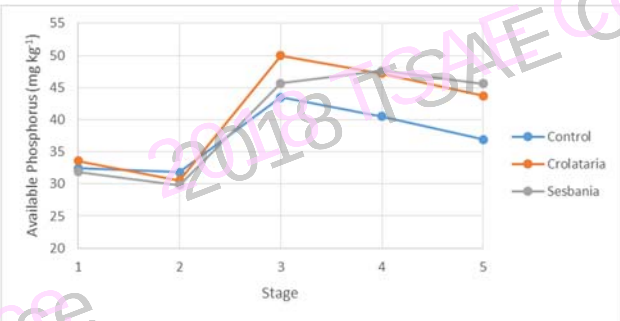

Figure 2 Stages and Available Phosphorus content

Available phosphorus contents in soil samples at each green manure type (*Sesbania rostrata* and *Crotalaria juncea*) applied to soil *and* during the experimental period are shown in Fig. 2. Available phosphorus contents for each type of green manure plot decreased with the increasing soil sampling period from state 1 to 2, because green manure and weeds absorbed nutrients to grow. The result revealed that the experimental plot where planted green manures and control plots had similarly available phosphorus contents. For state 2 to 3, the green manure was decomposed during land preparation and before transplanting period. The results shown that there was an increase in available phosphorus content in the soil of *C.juncea* plots higher than that of the *S.rostrata* plots, due to its ability to decompose more easily than *S.rostrata*, so it could release Available phosphorus content faster than that of *S.rostrata.* At the control plots, the amount of Available phosphorus increased because weeds was decomposed as well. For state 3 to 5, rice was growing which required necessary nutrient. The results revealed that trend of decreasing available phosphorus contents in the control plots and *C.juncea* plots, in the experimental plot where *S. rostrata* was planted, there was increased in available phosphorus content in the soil, because *S. rostrata* gradually decomposed and released available phosphorus to the soil in a higher amount than the rice used to grow throughout the growing season. While the experimental plot where *C.juncea* was planted, the available phosphorus content decreased continuously, due to *C.juncea* has decomposed and released much of it before. At this stage, the available phosphorus release was less than the amount of rice needed to grow throughout the season.

S. rostrata can increase the available phosphorus content more than *C.juncea* and control treatment 3.60 and 9.27 mg kg-1, respectively.

3.3 Exchangeable Potassium content

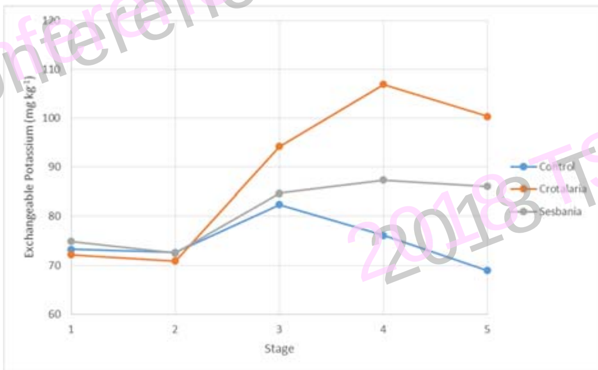

Figure 3 Stages and Exchangeable Potassium content

Exchangeable potassium contents in soil samples at each green manure type (*Sesbania rostrata* and *Crotalaria juncea*) applied to soil *and* during the experimental period are shown in Fig. 3. Exchangeable potassium contents for each type of green manure plot decreased with the increasing soil sampling period from state 1 to 2, because green manure and weeds absorbed nutrients to grow. For this reason, the experimental plot where planted green manures and control plots had similarly exchangeable potassium contents. At state 2 to 3, the green manure was decomposed during land preparation and before transplanting period. The results shown that there was an increase in exchangeable potassium content in the soil of *C.juncea* plots higher than that of the *S.rostrata* plots, due to its ability to decompose more easily than *S.rostrata*, so it could release exchangeable phosphorus content faster than that of *S.rostrata.* At the control plots, the amount of exchangeable potassium increased, because weeds was decomposed as well. At state 3 to 5, rice was growing which required necessary nutrient. The results revealed that trend of decreasing exchangeable potassium contents in the control plots and *C.juncea* plots, in the experimental plot where green manure planted, there was increased in exchangeable potassium content in the soil, because *S. rostrata* gradually decomposed and released exchangeable potassium to the soil in a higher amount than the rice used to grow throughout the growing season. While the experimental plot where *C.juncea* was planted, the exchangeable potassium content decreased continuously, due to the stem of *C.juncea* could more accumulate exchangeable potassium than that of *S. rostrata*.

C.juncea can increase the exchangeable potassium content more than *S. rostrata* and control treatment 17.07 and 32.52 mg kg-1, respectively.

4 Conclusions

The green manures can increase the total nitrogen, available phosphorus and exchangeable potassium more than control treatment. The sesbania can increase the total nitrogen and available phosphorus content more than crolataria 49.94 and 3.60 mg kg^{-1}, respectively. In the other hand the crolataria can increase the exchangeable potassium content more than sesbania 17.07 mg kg^{-1}.

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