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THE EFFECTS OF ORGANIC AND CHEMICAL FERTILIZERS ON THE GROWTH OF KDML 105 RICE IN LOWLAND PADDY FIELD CONDITIONS

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ABSTRACT

This experiment was conducted to study the effects of organic fertilizers on 'Khao Dawk Mali 105' rice (*Oryza sativa, '*KDML 105' variety) as regards growth and production. The experiments were conducted on a model paddy field located at the farms of Mahasarakham University, Thailand during 2014–2016 using a randomized complete block design (RCBD) that consisted of seven treatments and four replications. The continuous use of organic fertilizer for three years caused increases in nitrogen, phosphorus, potassium, and organic matter in soil, as well as an increase in the cation exchange capacity of the soil. The planting of 'KDML 105' was completed by using organic fertilizers composed of cattle manure and other organic matter in the ratio of 9,375 kg ha^{-1} for three consecutive years (2014–2016). This caused increases in the numbers of tillers per hill of KDML 105, as well as increases in the leaf area index (LAI) values, and the dry weight above ground (g/hill). The composition of the rice itself was also affected; increasing the numbers of panicle per hill, filled grain per panicle, and 1,000 seed weights, resulting in productivity as high as 2,659 kg ha^{-1} .

Key words: compost fertilizer, cattle manure, organic fertilizer, yield component

INTRODUCTION

Rice is Thailand's most commercially valued crop. In 2015, the estimated rice farming area in Thailand was roughly 9,348,243 ha, collectively, with the Northeast portion of the country being the biggest rice-farming region by area. This region is also known to produce the nation's largest amount and best quality of 'KDML 105' rice, with a crop productivity of 12,854,229 tons from its collective 5,831,030 ha of farming area. However, the productivity per hectare was the lowest at 2,293.75 kg ha^{-1} (Office of Agricultural Economics, 2017). This phenomenon was caused by an unpredictable rain pattern each year during the wet season in this region, combined with the sandy soil, which is notorious for its lack of water retention and fertility. When rain was lacking during the wet season, the productivity of 'KDML 105' rice became decreased, which led to a disappointing amount of crop turnover per hectare at the end of the season. To increase productivity, farmers should start with improving the physical and chemical conditions, as well as the mineral composition of the soil by adopting the use of organic fertilizers. However, interfering with soil composition may cause effects on the quality of 'KDML 105' crops (Boribron 1997). Due to this, farmers should be mindful of keeping up with the physical and chemical standards, so as to not drop below the intended productivity rate.

Today, managing soil and minerals to be compatible with soil conditions for different types of crops in each specific area is something farmers should be well educated on and be continuously eager to learn more. They can utilize the newfound knowledge to further maximize their productivity potential and establish sustainable businesses in Thailand's agriculture. Most of the farmers are still using large amounts of chemical fertilizers and other chemical substances, with higher dosages than ever before. This causes damaging effects on the environment, especially to the fertility of the soils. Resulting in decreased pH, the soil hardens and causing soil deterioration. As time progresses, this will cause effects on the living conditions of organisms under and above the ground (Veerapattananirund 2011); therefore, it is vital that proper management and appropriate fertilizers are used. The continuous use of artificial fertilizers could cause negative effects towards naturally occurring organic matter as well as the physical and chemical composition of the soils (Saha et al. 2013). Both governmental and private sectors are putting a lot of effort into bringing in organic fertilizers to re-enrich the soils and improving their quality. This process is called sustainable ecosystem development (Sriwichan et al. 2015). These methods used to manage soil are based on the principle that the top priority is to keep quality and fertility intact via using only organic fertilizers or using organic fertilizers in conjunction with chemical fertilizers (at suggested dosages). Combining organic fertilizers and chemical fertilizers is one of many ways to maximize the effects of fertilizers and reduce losses of nutrients and minerals from soils, as organic fertilizers absorb discharged ions released by chemical fertilizers, and then slowly re-release ions and nutrients to the rice again (Osotsapha et al. 2008). As previously stated, using organic fertilizers or other organic matter on the ground can change the soil's natural composition and promote nutrient absorption by rice. It can also boost the root system of rice, which has direct effects towards rice productivity (Yamazaki and Harada 1982).

Not only do organic fertilizers provide the soils with organic matter, but these also provide macronutrients; both primary and secondary macronutrients, all of which are vital to rice growth. These primary and secondary macronutrients help repair the bioorganic composition of the soils. The soils that have been treated with organic fertilizers for enough time will transform their conditions into a plot of land more suitable for vegetation. Organic fertilizers also help improve the soil percolation, water retention, and ventilation. These are responsible in improving the integrity of soil particles, which lessens the chance of erosion. Therefore, the purpose of this research study is to investigate the results of using organic fertilizers on the growth and production of 'KDML 105' rice. Organic fertilizers are an option to increase productivity while decreasing the use of chemical fertilizers. Furthermore, this could help farmers maximize their benefits while remaining sustainable.

MATERIALS AND METHODS

Soil preparation. The soil in the experimental field at the Department of Agricultural Technology, Faculty of Technology, Mahasarakham University was Roi-Et soil series. Each model plot was plowed, and each subplot was surrounded with ridges. Each of the 28 subplots was 5 × 5 meters. All seven treatments were then randomly assigned to the subplots, following the randomized complete block design (RCBD) for all four replicates.

Planting and Harvest. Rice was planted in 25 × 25 cm patterns throughout the whole plot, and five plants per hill under harvested area of 2 × 4 meters were collected.

Fertilizer application and water management. The plots had fertilizer applied as a combination of organic fertilizers and a suggested dosage of chemical fertilizers as recommended by the Rice Department in the ratios and times for each treatment. The experiment was conducted using naturally occurring rain during the wet seasons only. After all of the rice flowered for 20 days, all the water was drained out, so all the rice could be harvested at the same time. The experimental research covered three cropping years (2014-2016) in the wet season, the same treatment were repeated in all three cropping year.

The randomized complete block design (RCBD); consisted of the following seven treatments repeated four separate times.

Treatment 1 subplots were given no fertilizer (control).

Treatment 2 subplots were given a chemical fertilizers nutrient content of 16-16-8 ($N-P_2O_5-K_2O$) , as recommended by the Rice Department, in the ratio of 125 kg ha^{-1} (fertilized 1 day prior to planting) combined with 46-0-0 ($N-P_2O_5-K_2O$) at 31.25 kg ha^{-1} (during reproduction phase).

Treatment 3 subplots were given organic fertilizers (cattle manure) at 9,375 kg ha^{-1} (fertilized 15 days prior to planting).

Treatment 4 subplots were given organic fertilizers (pig manure) at 3,125 kg ha^{-1} (fertilized 15 days prior to planting).

Treatment 5 subplots were given organic fertilizers (pig manure) at 6,250 kg ha^{-1} (fertilized 15 days prior to planting).

Treatment 6 subplots were given organic fertilizers (chicken manure) at 1,562.50 kg ha^{-1} (fertilized 15 days prior to planting).

Treatment 7 subplots were given organic fertilizers (chicken manure) at 3,125 kg ha^{-1} (fertilized 15 days prior to planting).

Data Collection

Soil data prior to planting. Soil samples were randomly collected from different depths of soil (0–20 cm). Those samples were taken before planting to create a composite sample for analysis of pH, organic matter (OM), and cation exchange capacity (CEC), as well as nitrogen (N) by the Kjeldahl method, phosphorus (P) by the Bray II method, and potassium (K) by the Cobaltrinitrite method. Soil samples were collected randomly from different depths of soil (0–20 cm) again, and each soil sample from each treatment was separated by replicate (28 samples total). These samples were analyzed for pH, organic matter (OM), cation exchange capacity (CEC), nitrogen (N), phosphorus (P), and potassium (K) levels.

Growth data

Number of shoots per hill. Ten tussocks of rice were randomly picked from each subplot during the reproduction phase.

Leaf area index. Leaves from four tussocks that were fully spread were randomly picked from each subplot during the reproduction phase.

Dry weight (above the ground). During the harvest phase, four tussocks of rice were randomly picked from each subplot by cutting at ground level, oven-dried at 70 °C for 72 hours, and then the dry weight was measured.

Yield component data

Number of panicle per hill: Panicles from 10 hills were randomly counted from each subplot.

Number of filled grain per panicle: Grains were randomly counted from 10 panicles from each subplot.

1,000-grain weight (of s): 1000 grains were randomly weight from filled grain per panicle (grams).

Yield. Rice samples were collected from the perimeter of the 2 × 4 square meter area from each subplot. After flowering for 30 days, the rice was threshed, winnowed, cleaned, and weighed.

All findings were tested for ANOVA and differences in arithmetic means via Statistix9 program.

RESULTS AND DISCUSSION

Nutrient volume and total nitrogen in soil. After the initial application of fertilizer at different rates in the first year, there were no effects on total nitrogen in the soil. There were also no differences in term of statistics in the second year. However, during the third year of the experiment, there was a significant difference in soil nutrient changes. During the second year, Treatment 3 (fertilizing cattle manure at 9,375 kg ha^{-1}) caused the total nitrogen in the soil to increase and peak at 0.105%; however, that finding had no significant difference from Treatment 7 (applying chicken manure at 500 kg ha^{-1}). Whereas during the third year of this experiment, Treatment 3 increased total N by 0.1250%, while Treatment 1was the least capable of increasing the amount of Total N (Table 1).

Continuous utilization of composted fertilizer in the rice field for 3 years changed the volume of available phosphorus in soil to a statistically significant extent (Table 1). With the third treatment, available phosphorus volume increased and reached peaks of 31.723, 31.905, and 32.823 mg kg^{-1} in each year, respectively. This was followed by Treatment 5 (applying pig manure at 6,250 kg ha^{-1}), which contributed increases of available phosphorus in the soil by 23.880, 24.073 and 24.285 mg kg^{-1}, subsequently, while the lowest increase of available phosphorus was Treatment 1 (control).

Due to the potassium volume, the study found that continually using the composted fertilizer over 3 years affected soil nutrients. Table 1 shows that applying treatment 3 was able to mostly produce potassium volumes in the soil as follows: 201.75, 202.46 and 204.89 mg kg^{-1}, followed by treatment 5 which resulted in potassium concentrations in the soil of 160.05, 160.73 and 162.98 mg kg^{-1}, respectively. At the same time, treatment 1 was the least effective in increasing potassium in the soil. From overall 3-year experiments, applying the different ratios of composted fertilizer and chemical fertilizer into the soil resulted in increased soil nutrient volumes including nitrogen, phosphorus, and potassium, which had interactions among the treatments and experimental years. However, every treatment was able to significantly increase potassium volume in the soil.

Regarding soil organic matter, the study found that continually using fertilizer for 3 years affected organic matter. As can be seen in Table 2, organic matter was highest when applying treatment 3, with values of 1.4025, 1.1175, and 1.4650%, respectively, followed by treatment 7, which contained 1.3775, 1.3900 and 1.4100% organic matter, respectively. However, treatment 1 (control) had the least increases of organic matter of 1.0775, 1.0925 and 1.1025%, respectively. From the overall 3-year experiments, applying the different ratios of composted fertilizer and chemical fertilizer into the soil resulted in soil nutrient volume including nitrogen, phosphorus, and potassium, which interactions among the treatments and experimental years. Cation exchange capacity (CEC), after applying organic fertilizer in the rice fields over 3 years, had interactions among the treatments and years of experiments in which every treatment was significantly different (Table 2) Soil pH did not change, and every treatment was not significantly different (Table 2).

The study of effects of organic fertilizers and chemical fertilizers on the growth of KDML 105 rice according to soil samples collected prior to planting (Table 1) revealed that the levels of nitrogen in the soil (0.0675%), as well as phosphorus (8.5175 mg kg-1) were extremely low. Potassium averaged at 71.7700 mg kg-1. The average organic matter was low at 0.9400% as well as the cation exchange capacity level (9.890 meq per 100 g soil). The pH level was acidic at 5.54 (Table 2). Samples collected after all experiments showed that Treatment 3 was the best soil conditioner, raising the levels of nitrogen, phosphorus, potassium, and organic matter (0.1250%, 32.823 mg kg-1, 204.89 mg kg-1, 1.4650%, and 12.205 meq/100 g soil, respectively), these results were compatible with a study concerning effects of applying both organic fertilizers and chemical fertilizers to rice productivity and soil conditioning of Xu et al. (2008). The aforementioned study over the course of 5 years discovered that organic fertilizers could increase the level of organic matter in soil at a rate of 34.0 g kg-1of soil, while chemical fertilizers (NPK) had the least organic matter increase at 26.4 kg kg-1 of soil. Such applications can recondition soil and increase productivity (Reganold 1995; Conacher and Conacher 1998), as well as keep the environment sustainable compared to the sole use of chemical fertilizers over a long period (Chuworawetch 2005).

In addition, organic fertilizers are capable of improving the physical, biochemical, and chemical compositions of soil, as well as increasing productivity (Fulhage 2000). These continually release nutrients, converting organic compounds and inorganic compounds and resulting in higher productivity during each season (Miller et al. 2002). In which the organic matter must undergone at least some decomposition before nitrogen can be utilized. The activity of soil microbes will gradually decompose organic matter, resulting in organic N being changed into inorganic N which is called "mineralization", as well as decelerate the decrease of organic matter that occurs as agriculture-induced soil degradation (Tancho 2006). These are vital factors towards growth and productivity. Organic fertilizer application could improve overall soil composition and integrity (Yang at al. 2014). However, even though chemical fertilizers have been proven to have superior results, these are expensive, and continuous use can decrease the pH level, causing the soil to harden (Onthong and Pongpiachan 2018). Therefore, to sustain the environment and still maintain the preferred level of quality and productivity, the addition of organic matter is highly recommended**.**

Plant growth. Organic fertilizer application affects growth as indicated by the significant difference in the number of tiller per hill. The highest average number of tillers per hill were 16.62, 19.47, and 19.65, respectively; however, these numbers were significantly higher than that produced by treatment 7. Treatment 1 had the lowest average number of tillers per hill (Table 3). The leaf area index (LAI) during reproduction phase indicated that applying different kinds of organic fertilizers significantly affected the growth of rice. Treatment 3 had the greatest leaf area index. As for the dry weight above ground, in 2014, all seven treatments had no statistically significant differences. Meanwhile, in 2015 and 2016, each treatment had statistically significant differences; Treatment 3 (9,375 kg of fertilizer per ha) produced the highest dry weights for both seasons, while Treatment 1 produced the lowest dry weights (Table 3).

Treatment 3 produced the highest number of panicles, leaf area index, and dry weight (above the ground) throughout all 3 seasons. Not only did organic fertilizers increase the level of organic matter, but these also increased the primary and secondary macronutrients necessary for rice growth, as well as fixing soil composition and reconditioning it suitable for agriculture. Well-conditioned soil possesses good drainage and ventilation and heightens soil integrity, creating a life cycle suitable for microorganisms, which play an important role in promoting growth and productivity.

These results are consistent with the findings of Polthanee (2012), where the effects of organic matter manipulation on rice growth were studied by planting green beans in soil plowed with organic fertilizers prior to planting. There was a correlation between green bean remnants that increased the number of tillers. During the ripening phase, application of organic fertilizers at a rate of 9,375 kg ha^{-1} combined with NPK fertilizers (50-50-50 kg ha^{-1}) result in the greatest dry weights (Jiarakhonman 1998).

Table 1. Total N, available P and extractable K

Treatment	**Total N (%)**			**Available P** (mg kg^{-1})			**Extractable K** (mg kg^{-1})		
Before Planting	**0.0675**			**8.5175**			**71.7700**		
After Planting	**2014**	**2015**	**2016**	**2014**	**2015**	**2016**	**2014**	**2015**	**2016**
1	0.0675^{b}	0.0725^{ab} D	0.0775^{a} D	7.063^{b} E	7.080^{b} E	8.528^{a} D	76.70^{b} F	77.11^{b} F	77.92^{a} F
2	0.0800^{b}	0.085^{b} BCD	0.0975^{a} BC	10.635^{b} CD	11.057^{b} D	11.860^{a} C	114.00^{b} C	114.16^{b} C	115.37^{a} C
3	0.0875^{c}	0.105^{b} A	0.1250^{a} A	31.723^{b} A	31.905^{b} A	32.823^{a} A	201.75^{b} A	202.46^{b} A	204.89^{a} A
4	0.0725^{b}	0.0775^{ab} CD	0.0850^{a} CD	11.100^{b} C	11.875^{ab} CD	12.438^{a} C	96.30^{b} D	96.88^{b} D	99.55^{a} D
5	0.0775^{b}	0.0875^{a} BC	0.0950^{a} BCD	23.880^{a} B	24.073^{a} B	24.285^{a} B	160.05^{b} B	160.73^{b} B	162.98^{a} B
6	0.0750^{b}	0.0825^{b} BCD	0.0950^{a} BCD	9.932^{c} D	10.890^{b} D	11.893^{a} C	93.06^{b} E	93.63^{b} E	95.99^{a} E
7	0.0800^{c}	0.0925^{b} AB	0.105^{a} B	11.483^{c} C	12.292^{b} C	13.060^{a} C	95.93^{c} D	96.76^{b} D	100.33^{a} D
F-test	ns	**	**	**	**	**	**	**	**
LSD ($p \leq 0.05$)	-	0.0149	0.0175	0.861	1.0394	1.2254	1.0432	1.0631	1.7831
CV. (%)	12.22	11.69	12.15	3.83	4.49	5.03	0.59	0.60	0.98

Letters used in vertical comparison are capitalized. LSD $_{(p \leq 0.05)}$ The same letters are statistically similar. ** ($p \leq 0.01$), ns = no difference in statistics.

Letters used in horizontal comparison are in lowercase. LSD $_{(p \leq 0.05)}$= 0.0086 for comparing total N (%).The same letters are statistically similar. F-test, ** ($p \leq 0.01$) ; CV. (%) = 25.76

Letters used in horizontal comparison are in lowercase. LSD $_{(p \leq 0.05)}$= 0.5799 for comparing available P (mg kg^{-1}). The same letters are statistically similar. F-test, ** ($p \leq 0.01$) ; CV. (%) = 6.21

Letters used in horizontal comparison are in lowercase. LSD $_{(p \leq 0.05)}$= 0.7390 for comparing extractable K (mg kg^{-1}). The same letters are statistically similar. F-test, ** ($p \leq 0.01$) ; CV. (%) = 2.33

Table 2. Organic matter, cation exchange capacity, and pH levels

Treatment	Organic Matter: OM (%)			Cation Exchange Capacity: CEC (meq/100 g Soil)			pH		
Before Planting	**0.9400**			**9.8900**			**5.5400**		
After Planting	**2014**	**2015**	**2016**	**2014**	**2015**	**2016**	**2014**	**2015**	**2016**
1	1.0775^{b} D	1.0925^{ab} C	1.1025^{a} F	9.978^{b} B	10.100^{b} C	10.273^{a} E	5.53	6.15	6.51
2	1.0525^{b} D	1.1175^{ab} C	1.1325^{a} E	10.718^{b} A	10.903^{b} B	11.272^{a} D	5.68	6.39	6.43
3	1.4025^{c} A	1.4450^{b} A	1.4650^{a} A	10.798^{c} A	11.350^{b} AB	12.205^{a} A	5.79	6.32	6.69
4	1.3250^{c} C	1.3475^{b} B	1.3700^{a} D	10.790^{b} A	10.958^{b} B	11.560^{a} CD	5.84	6.47	6.59
5	1.3575^{b} B	1.3750^{b} B	1.3975^{a} BC	10.890^{c} A	11.262^{b} AB	11.873^{a} ABC	6.02	6.59	6.70
6	1.3550^{b} B	1.3650^{ab} B	1.3825^{a} CD	10.840^{c} A	11.217^{b} AB	11.613^{a} BCD	5.66	6.48	6.58
7	1.3775^{b} AB	1.3900^{b} B	1.4100^{a} B	11.048^{c} A	11.450^{b} A	12.068^{a} AB	5.81	6.69	6.83
F-test	**	**	**	**	**	**	ns	ns	ns
LSD ($p \leq 0.05$)	0.0278	0.0457	0.0259	0.4807	0.4629	0.4996	-	-	-
CV (%)	1.46	2.36	1.32	3.02	2.82	2.91	5.68	4.12	5.44

Letters used in vertical comparison are capitalized. LSD $_{(p \leq 0.05)}$ The same letters are statistically similar. ** ($p \leq 0.01$), ns = no difference in statistics.
Letters used in horizontal comparison are in lowercase. LSD $_{(p \leq 0.05)}$= 0.0189 for comparing Organic Matter (%)The same letters are statistically similar. F-test, ** ($p \leq 0.01$) ; CV. (%) = 4.61
Letters used in horizontal comparison are in lowercase. LSD $_{(p \leq 0.05)}$= 0.2652 for comparing CEC (meq/100 g Soil) The same letters are statistically similar. F-test, ** ($p \leq 0.01$) ; CV. (%) = 12.08

Table 3. The effect of organic and chemical fertilizers on growth in number of panicles, LAI, and dry weight above ground.

Treatment	**Tillers per Hill PI Stage**			**Leaf Area Index (LAI) PI stage**			**Dry Weight Above Ground (g/hill) Harvest Stage**		
	2014	**2015**	**2016**	**2014**	**2015**	**2016**	**2014**	**2015**	**2016**
T1	12.57 D	14.55 D	14.52 E	257.35 D	409.30 C	346.21 C	30.01	67.18 C	42.90 E
T2	14.27 BCD	15.62 CD	15.80 CDE	292.57 C	477.45 B	398.84 B	36.20	78.17 BC	48.62 DE
T3	16.62 A	19.47 A	19.65 A	369.89 A	564.77 A	482.58 A	41.32	93.08 A	70.52 A
T4	13.70 CD	16.07 BCD	16.15 CD	313.57 BC	479.29 B	414.85 B	35.47	77.34 BC	55.81 BCD
T5	14.95 ABC	17.02 BC	17.22 BC	331.31 B	483.95 B	423.67 B	38.60	89.14 AB	64.47 AB
T6	15.55 ABC	15.27 CD	15.57 DE	323.21 BC	495.69 B	405.75 B	34.14	81.74 AB	52.25 CD
T7	16.20 AB	17.67 B	17.85 B	342.27 AB	515.47 AB	429.49 B	37.90	87.26 AB	59.05 BC
F-test	*	**	**	**	**	**	ns	**	**
LSD ($p \leq 0.05$)	2.2694	1.7786	1.5737	32.7390	61.7840	50.1850	-	11.8610	9.2770
CV. (%)	10.29	7.24	6.35	6.92	8.50	8.15	15.19	9.74	11.10

Letters used in vertical comparison are capitalized. LSD $_{(p \leq 0.05)}$ The same letters are statistically similar. * ($p \leq 0.05$), ** ($p \leq 0.01$), ns = no difference in statistics.

Yield components. Different amounts of organic and chemical fertilizer applications caused different effects towards the number of panicles (no. per hill) in a highly statistically significant manner. Organic fertilizers (cattle manure) used in Treatment 3 produced the highest panicles for three harvest seasons at 11.02, 16.02, and 17.22, respectively (Table 4). However, in 2014, there was no significant difference between Treatments 2 and 7, while Treatment 1 (control) produced the lowest numbers of panicles (8.85, 9.95, and 11.90, respectively). In regards of number of grains (no. per panicle), each treatment produced results with no significant differences in 2014. However very significant differences occurred in both 2015 and 2016. Treatment 3 produced the highest numbers of grains (no. per panicle), at 150.97 and 158.90 per panicle, respectively. This was in contrast of Treatment 1, which produced the lowest numbers of good grains per ear. The 1,000-grain weights (g) were also significantly affected, with Treatment 3 producing the highest numbers at 27.82, 28.58, and 29.06 grams, respectively. After three experiments, it was found that differences among organic fertilizers and chemical fertilizers for yield components interacted between the type of treatment and the timing of the experiment. All treatments produced significantly higher yields in regards to the number of panicles, grains, and 1,000-grain weights (Table 4).

Yield. Different amounts of organic and chemical fertilizer applications caused significantly different rice production. In the first season, Treatment 2 (chemical fertilizers applied as suggested by the Rice Department) produced greatest productivity at 2,187.50 kg ha^{-1} but was no significant improvement over the results of Treatment 3, Treatment 5, and Treatment 7. However, in the second season, Treatment 3 had the greatest productivity at 9,375 kg ha^{-1}, but still posed no significant improvement over Treatment 2 and Treatment 7. In the third season, Treatment 3 had the greatest productivity at 2,659.37 kg ha^{-1} while Treatment 1 had the lowest productivities for all 3 seasons (1,962.50, 2,265.62 and 2,303.12 kg ha^{-1}, respectively). From all experiments, different amounts of organic and chemical fertilizer applications had significant interactions among treatments and time of experiment by increasing rice productivity year by year (Table 5).

In terms of yield components and the overall productivity of 'KDML 105', Treatment 3 produced the highest number of tillers, grains, 1,000-grain weights, and productivity. This was due to the continuous application of organic fertilizers (cattle manure) in the ratio of 9,375 kg ha^{-1} throughout the three seasons, which caused changes in soil composition and its macronutrient content. The levels of total nitrogen, available phosphorus, extractable potassium, and organic matter increased. Rice plants were better able to uptake water and minerals due to greater drainage and ventilation, resulting in greater tiller stages, leaf area index, and dry weight above ground, all of which increased yield components and productivity. These findings are consistent with Polthanee (2012), which demonstrated that organic fertilizer application at the rate of 9,375 kg ha^{-1} resulted in higher numbers of panicles and grains, as well as greater productivity (2,919.87 kg ha^{-1}). Results would be consistent with Siavoshi et al. (2011) which determined that organic fertilizer contains nitrogen that can be absorbed more effectively than chemical fertilizer. This is because organic fertilizer contains various plant nutrients which consist of main elements, secondary elements and micronutrients, while chemical fertilizers contain only the main elements according to the fertilizer formula. Therefore, when plants receive all necessary nutrients it can give better plant growth than chemical fertilizer (Osotsapha et al. 2011). The application of organic fertilizers (cattle manure) in the rate of 10,000 kg ha^{-1} increased the number of grains per cluster, and the productivity of 136 grains per panicle, with an average productivity of 5,190 kg ha^{-1} (Islam et al. 2013). Moreover, the reconditioning effects that organic fertilizers have on soil increased productivity significantly ($p \leq 0.05$) (Sang et al. 2014). The growth and productivity of 'BRRI dhan39' rice can increase to 138.89 grains per panicle and 19.53 of 1,000-grain weight through the application of organic fertilizers (chicken manure) at the rate of 15,000 kg ha^{-1} (Rahman et al. 2009). Furthermore, cow manure and granulated organic fertilizer with and without bee product had a positive impact on growth, grain quality and unmilled grain yield of KDML 105 rice in Roi Et soil series (Sukkasem and Anusontpornperm 2020).

Table 4. The effect organic and chemical fertilizers on yield components of KML 105 rice

Treatment	Panicles (no. per hill)			Grains (no. per panicle)			1,000-Grain Weight (g)		
	2014	**2015**	**2016**	**2014**	**2015**	**2016**	**2014**	**2015**	**2016**
T1	8.85^{c} D	9.95^{b} D	11.90^{a} E	119.30^{b}	125.47^{ab} C	129.67^{a} C	24.21^{b} D	25.08^{a} D	25.54^{a} D
T2	10.15^{c} AB	13.40^{b} BC	14.95^{a} BCD	126.75^{b}	134.53^{ab} BC	137.80^{a} BC	26.52^{b} B	26.97^{b} B	27.87^{a} B
T3	11.02^{c} A	16.02^{b} A	17.22^{a} A	140.32^{b}	150.97^{a} A	158.90^{a} A	27.82^{c} A	28.58^{b} A	29.06^{a} A
T4	9.87^{c} BCD	12.80^{b} C	14.70^{a} CD	123.85^{b}	133.8^{a} BC	138.65^{a} BC	25.21^{b} C	25.55^{b} CD	26.32^{a} CD
T5	9.95^{c} BC	14.05^{b} BC	15.82^{a} ABC	132.60^{b}	140.27^{ab} AB	146.83^{a} AB	25.64^{b} BC	25.94^{b} C	26.85^{a} C
T6	9.07^{b} CD	13.42^{a} BC	14.12^{a} D	121.60^{c}	132.35^{b} BC	141.52^{a} BC	25.64^{b} BC	25.89^{b} C	26.69^{a} C
T7	10.20^{c} AB	14.37^{b} B	16.17^{a} AB	129.65^{b}	137.83^{a} ABC	143.92^{a} B	26.49^{c} B	27.07^{b} B	28.04^{a} B
F-test	**	**	**	ns	*	*	**	**	**
LSD ($p \leq 0.05$)	1.0564	1.4073	1.45	-	13.412	14.118	0.9803	0.6192	0.3376
CV. (%)	7.2	7.05	6.51	8.29	6.62	6.67	2.54	1.58	2.34

Letters used in vertical comparison are capitalized. LSD $_{(p \leq 0.05)}$ The same letters are statistically similar.* ($p \leq 0.05$), ** ($p \leq 0.01$), ns = no difference in statistics.
Letters used in horizontal comparison are in lowercase. LSD $_{(p \leq 0.05)}$= 0.7253 for comparing panicles (no. per hill). The same letters are statistically similar. F-test, ** ($p \leq 0.01$); CV. (%) = 12.17
Letters used in horizontal comparison are in lowercase. LSD $_{(p \leq 0.05)}$= 7.9616 for comparing grains (no. per panicle). The same letters are statistically similar. F-test, ** ($p \leq 0.01$; CV. (%) = 9.39
Letters used in horizontal comparison are in lowercase. LSD $_{(p \leq 0.05)}$= 0.4760 for comparing 1,000-grain weight (g). The same letters are statistically similar. F-test, ** ($p \leq 0.01$); CV. (%) = 2.55

Table 5. The effect of organic and chemical fertilizers on 'KML 105' yield.

Treatment	Yield (kg ha^{-1})		
	2014	**2015**	**2016**
T1	1,962.50^{b} D	2,265.62^{a} D	2,303.12^{a} C
T2	2,187.50^{b} A	2,496.87^{a} ABC	2,515.62^{a} B
T3	2,178.12^{b} AB	2,609.37^{a} A	2,659.37^{a} A
T4	2,059.37^{c} CD	2,381.25^{b} CD	2,459.37^{a} B
T5	2,115.62^{c} ABC	2,431.25^{b} BC	2,503.12^{a} B
T6	2,078.12^{b} BC	2,403.12^{a} BC	2,450.00^{a} B
T7	2,118.75^{b} ABC	2,515.62^{a} AB	2,531.25^{a} B
F-test	**	**	**
LSD ($p \leq 0.05$)	17.329	20.733	14.255
CV. (%)	3.47	3.57	2.41

Letters used in vertical comparison are capitalized. LSD ($p \leq 0.05$) The same letters are statistically similar.. F-test, ** ($p \leq 0.01$)

Letters used in horizontal comparison are in lowercase. LSD ($p \leq 0.05$)= 9.6889 for comparing yield (kg ha^{-1}). The same letters are statistically similar. F-test, ** ($p \leq 0.01$) ; CV. (%) = 4.09

CONCLUSIONS

The continuous application of organic and chemical fertilizers for 3 years caused nutrients in soils, such as the total N, available P, extractable K, organic matter, and CEC to increase. The planting of 'KML 105' rice with the application of organic and chemical fertilizers at the rate of 9,375 kg ha^{-1} for three continuous years (2014–2016) resulted in significant difference in 'KML105' productivity by increasing the number of tillers per hill, LAI, and dry weight above ground, as well as greater yield components, productivity, grains per panicle, 1,000-grain weights and overall crop turnover per hectare.

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