EFFECT OF HIGH APPLICATION RATES OF NPK AND CHICKEN MANURE ON GROWTH AND YIELD OF TR-9 RICE VARIETY IN SILABUKAN SOIL

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DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF AGRICULTRE SCIENCE WITH HONOURS

CROP PRODUCTION PROGRAMME
FACULTY OF SUSTAINABLE AGRICULTURE
UNIVERSITI MALAYSIA SABAH
2015

UNIVERSITI MALAYSIA SABAH

BORANG PENGESAHAN TESIS

JUDUL: Effect of High Application Rates of NPK and Chicken Manure on Growth and Yield of TR-9 Rice Variety in Silabukan Soil

IJAZAH: The Degree of Bachelor of Agriculture Science with Honours

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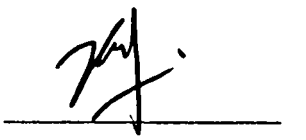

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ACKNOWLEDGEMENT

I would like to grab this chance to express my sincere thanks to my supervisor, Prof. Madya Hj. Mohd. Dandan@ Ame Hj. Alidin and my co-supervisor, Dr. Mohamadu Boyie Jalloh. They are the ones who provided me the chance to gain valuable experience and knowledge in conducting my final year project. I am very grateful to my supervisor for his patience, exemplary guidance, immense knowledge, monitoring and constant encouragement throughout the whole project. Besides, I would also like to thank Dr. Jalloh for advising me in my SPSS analysis.

Moreover, I would like to thank my family for supporting me to complete this project. Mental support from my family really encouraged me to continue completing my final year project. They frequently consoled me when I failed in transplanting my seedlings at the early stages of my project.

Furthermore, I would like to take this opportunity to thank the staff of Faculty of Sustainable Agriculture for helping me to complete my project. In the field, Mr. Eric had taught me a lot of hands-on knowledge such as how to mix cement, how to prepare the nursery pot and many more. In the laboratory, thank you to the staff who were willing to work overtime for me to complete my soil analysis. They also provide me the apparatus and chemicals that I need while running the soil test.

Last but not least, I would like to express my thanks to my friends, Peong Kim Sheng, Ng Ja Ming, Loh Chai Yuen, Tan Chiw Ling, Lee Hong Yin, Wong Ann Nee and Liew Xi Yun. They helped me to collect my soil samples in plot-17 and folding the newspaper for keeping the harvested yield. A special thanks to Ng Ja Ming who always accompanied me to the net house for data collection. She also helped me to take care of my planst when I was away for field trip to Kota Kinabalu for Cereal Crop course. Thank you to my juniors who were willing to help me during difficulties in completing this project.

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ABSTRACT

A field experiment was conducted in the net house of Faculty of Sustainable Agriculture, Universiti Malaysia Sabah, Sandakan from 12 April 2014 to 12 September 2014 to study the effect of high application rate of NPK incorporated with high rate of chicken manure on TR-9 rice variety growth and yield in Silabukan soil and to evaluate Silabukan soil nutrients (NPK, CEC, pH and organic matter) after application of NPK and chicken manure. The experimental design was completely randomized design (CRD) with three replications. Three rate of NPK (T1=60:30:30, T2=90:60:60 and T3=120:90:90 kg ha^{-1}) and three rates of chicken manure (C1=20, C2=40 and C3=60 ton ha^{-1}) were tested. Results revealed that interaction of NPK and chicken manure on TR-9 rice variety growth and yield was not significant. In term of NPK, treatment T3 had the highest plant height (135.16 cm), percentage of productive tillers (85.72 %), number of panicles (44.89), percentage of filled grains (86.50 %) and extrapolated yield (12.71 ton ha^{-1}). In term of chicken manure, treatment C3 was the highest in number of tillers (53.06), percentage of productive tillers (87.96%), percentage of dry matter (53.38 %), number of panicle (48.61) and extrapolated yield (13.08 ton ha^{-1}). For soil analysis, both treatment T3 and C3 had the highest soil pH (5.30; 5.29), total nitrogen (1.39 %; 1.35 %), available phosphorus (1639.53 ppm; 2809.54 ppm), potassium content (39.87 ppm, 49.29 ppm), and CEC (28.18 $cmol_c$ kg^{-1}; 27.19 $cmol_c$ kg^{-1}). Results suggested that the application of NPK at the rate of 60:30:30 kg ha^{-1} and chicken manure 60 ton ha^{-1} gave the highest mean tiller number (55.5), panicle number (50.17) and extrapolated yield (13.66 ton ha^{-1}), followed by 120:90:90 kg ha^{-1} NPK and 60 ton ha^{-1} chicken manure.

Kesan Campuran Kadar Tinggi Baja NPK dengan Kadar Tinggi Baja Organik Tahi Ayam ke atas Pertumbuhan dan Hasil Padi Varieti TR-9 di Tanah Silabukan

ABSTRAK

Kajian ini dijalankan dalam rumah lindungan kalis serangga Fakulti Pertanian Lestari, Universiti Malaysia Sabah selama lima bulan untuk menilai kesan campuran kadar tinggi baja NPK yang disebatikan dengan kadar tinggi baja organik tahi ayam ke atas pertumbuhan dan hasil padi varieti TR-9 di tanah Silabukan dan mengkaji kandungan nutrisi tanah Silabukan (kandungan NPK, CEC, organik dan pH) selepas aplikasi NPK dengan tahi ayam. Reka bentuk kajian ini adalah rekabentuk rawak lengkap dengan tiga replikasi. Tiga kadar NPK (60:30:30, 90:60:60 and 120:90:90 kg ha^{-1}) dan tiga kadar tahi ayam (20, 40 and 60 ton ha^{-1}) telah diguna. Keputusan menunjukkan interaksi antara NPK dan tahi ayam terhadap pertumbuhan dan hasil padi varieti TR-9 tidak signifikan. Dari segi NPK, rawatan T3 memberi min ketinggian pokok padi (135.16 cm), peratusan anak padi produktif (85.72 %), bilangan tangkai (44.98), peratusan butiran padi penuh (86.50 %) dan unjuran hasil (12.71 tan ha^{-1}). Dari segi tahi ayam, rawatan C3 memberi min anak padi (53.06), peratusan anak padi produktif (87.96 %), peratusan bahan kering (53.38 %), bilangan tangkai (48.61) dan ujuran hasil (13.08 tan ha^{-1}). Bagi analisis tanah, kedua-dua rawatan T3 and C3 mempunyai nilai pH (5.30; 5.29), kandungan nitrogen (1.39 %; 1.35 %), fosforus (1639.53 ppm; 2809.54 ppm), potassium (39.87 ppm, 49.29 ppm), and CEC (28.18 $cmol_c$ kg^{-1}; 27.19 $cmol_c$ kg^{-1}) yang tertinggi. 60:30:30 kg NPK ha^{-1} dan 60 tan tahi ayam ha^{-1} boleh dicadangkan kepada para petani kerana memberi min bilangan anak padi (55.5), bilangan tangkai (50.17) dan unjuran hasil (13.66 tan ha^{-1}) yang tertinggi. Cadangan kedua ialah 120:90:90 kg NPK ha^{-1} and 60 tan tahi ayam ha^{-1} dimana campuran ini memberi ujuran hasil (13.08 tan ha^{-1}) yang kedua tertinggi dan peratusan anak padi produktif (93.24 %) yang tertinggi.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of variance
CEC	Cation Exchange Capacity
CM	Chicken Manure
CRD	Completely Randomized Design
FSA	Faculty of Sustainable Agriculture
MOP	Muriate of Potash
SOM	Soil Organic Matter
TSP	Triple Super Phosphate
UMS	Universiti Malaysia Sabah

LIST OF FORMULA

$$\text{Percentage of productive tillers} = \frac{\text{Number of panicles produced}}{\text{Highest number of tillers produced}} \times 100$$

CHAPTER 1

INTRODUCTION

1.1 Introduction

In Malaysia, rice is the third most planted crop right after oil palm and rubber plantation. Department of Agriculture in Peninsular Malaysia (2014) reported that in 2012, Malaysia had successfully produced 2,750,404 metric ton of rice, but in 2013, Malaysia rice production had decreased to 2,626,881 metric ton. This amount of rice is not sufficient to meet the domestic demand. According to Lembaga Kemajuan Pertanian Kemubu (2011), infertile soils and poor irrigation system are the factors that contribute to low yield in rice production.

According to FAO (2004), about 72 percent of Malaysian soils are Ultisols and Oxisols. These soils are considered as problematic soil in agriculture due to its difficultly in management. Silabukan soils found in Sabah is belongs to Ultisols soil orders which can be found in old land surface with highly weathered region such as wet monsoon and warm temperate climate. Silabukan soils are also easily found in hilly topography. This is because the parent material of Silabukan soil is alluvium which is derived from low mudstone and sandstone hills. This type of soil consists of high percentage of clay and silt but low percentage of sand. Shamshuddin *et al.* (2011) suggested that this soil is an acidic soil with pH ranges four to five. He also stated that the total nitrogen and cation exchange capacity (CEC) are low while the available phosphorus is moderate in this soil. As a results, plants planted on this soil used to suffer from poor roots growth, diminished rate of nitrification and high level of phosphate fixation and hence reduce the soil fertility.

It is undeniable that soil fertility can be improved by applying inorganic fertilizer and organic fertilizer. Inorganic fertilizers are fertilizers which consist of chemical compound that usually being applied in three splits within a growing season in order to

provide sufficient nitrogen (N), phosphorus (P) and potassium (K) to the crop. Our local paddy farmers usually apply NPK fertilizers in term of Urea, Tri Super Phosphate (TSP) and Muriate of Potash (MOP) to their crops. These inorganic fertilizers are designed readily dissolved in water so that they can be easily absorbed by the plant as well as provide essential nutrients for plant growth in short period. High rate of NPK fertilizers help farmers to increase paddy yield but once overdose is applied, negative effect may occur.

Organic fertilizer such as animal manures is an alternative way to maintain long-term soil fertility and sustainability in problematic soils. Animal manures are dried under sun before use to avoid disease and plant injury due to toxicity. Among the animal manures, chicken manure provide excellent source of nutrients such as higher percentage of nitrogen, phosphorus, potassium and other essential nutrients to the crops. Besides, it also can be incorporated into most fertilizer programs. Thus, through applying organic fertilizer soil condition in rice field can be improved in term of water holding capacity and the soil ability to hold nutrients. In fact, organic fertilizer has complex formation resulting it requires longer period to decompose into usable form by crops. As a result, farmers usually practiced to apply inorganic fertilizers instead of organic fertilizers in planting paddy.

High application rate of NPK incorporated with high rate of chicken manure is believed to improve Silabukan soil fertility. This fertilizer combination can perform better than sole application of inorganic fertilizer or organic manure to sustain soil fertility and paddy productivity. Philippine Rice Research Institute (2012) also proved that continuous application of organic manure and inorganic fertilizers on paddy results in better soil productivity and functionality than using either of them solely.

In short, high rate of NPK incorporated with high rate of chicken manure help to boost up the paddy yield as NPK provide nutrient for plant to grow in a short period while chicken manure help to sustain the soil health for long term.

1.2 Justification

1.2.1 Justification of the Study

Rice is the main diet in our country but most of the land used to plant rice those days is now being used for housing, business, industrial purposes or even being replaced by industrial crops. This phenomenon cause government spends a lot of money in importing rice from neighbor country in order to fulfill our demand. Statistic showed that there is a negative trend of land usage for rice production. According to Pio Lopez (2007), Malaysia rice production is going to end due to several reasons like continuous decline in rice cultivated area, negligible grains in productivity, continuous increase in cost of production and decreasing profitability.

Rice is cultivated in almost all types of soils ranging from heavy to sandy loam soils with vary productivity. Study proved that rice yield from high clay with organic matter field is much higher than sandy field (Aminuddin *et al.* 2003). Although Silabukan soil is formed from intensely weathered soils of high temperature and high rainfall climates throughout the year, it contains high content of clay which suit to plant rice. Clay helps to increase the soil's cation exchange capacity, reduces nutrient loss through leaching and enhanced the water-holding capacity of the soil. In Malaysia, clay soil is more suitable to plant rice as most of the farmers practice irrigated planting system in which the rice is submerged in water. Therefore, Silabukan soil needs to be improved so that farmers can utilize the soil for planting rice.

Research done by Shamshuddin *et al.* (1991) showed that Silabukan soil was also being used to plant field crops but the yields were limited for low pH, high aluminum and calcium and magnesium deficiencies. It is believed that with proper management such as adding lime and organic matter into Silabukan soil can helps to increase soil pH, modify soil structure, and improve soil nutrients such as total nitrogen, available phosphorus as well as soil organic matter (Shamshuddin *et al.*, 1991). Besides, inorganic fertilizer that is fast acting and has high dissolve rate can also be added for soil amendment. When rice show signs of nutrient deficiency, inorganic fertilizer is the best choice instead of organic fertilizer. Therefore, inorganic fertilizer's fast delivery of essential elements and minerals to the rice helps to overcome nutrient deficiency within short period.

Chicken manure is a concentrated plant nutrient that consist of two to three times as much nitrogen, three to five times as much phosphorus, and about the same amount of potassium as other farm manures. It is a soil amendment that improves soil organic matter to increase water holding and nutrient holding capacity of the soil, lowers soil bulk density, beneficial biota in soil and improve soil structure in which resulting positive respond on rice production (Muneer and Hadie, 2011). On the other hand, NPK is the primary nutrient required by rice for growth and development. Nitrogen increase vegetative growth of paddy; phosphorus help in root development especially during early stage and potassium help to strengthen rice plant cells.

In a study carried out by Stephen *et al.* (2014), combining organic and inorganic fertilizer generally increased all growth parameters of *Amaranthus* species. Thus, chicken manure is incorporated with NPK to plant rice in Silabukan soils with hope that this combination could increase the rice yields.

1.2.2 Significance of the Study

The study is to improve the soil fertility in Silabukan soil so that it can be utilized in planting agricultural crops. Although Silabukan soil is a marginal soil that is poor in soil nutrient and also the soil structure, it can be used to plant a wide range of agricultural crops including oil palm with the condition that the soil fertility is modified and maintained. Therefore, through soil amendments by adding organic or inorganic fertilizer, green manure or even planting cover crops can increase the soil nutrients and soil condition.

1.3 Objectives

The objectives of this study are:

1. To determine the optimum rate of NPK and chicken manure on the growth and yield of TR-9 rice variety.
2. To evaluate the Silabukan soil nutrients status before and after the experiment.

CHAPTER 2

LITERATURE REVIEW

2.1 Rice

Rice belongs to *Poaceae* family, subfamily *Oryzoideae*, tribe *Oryzeae* and genus *Oryza*. Out of 24 species of *Oryza* genus, 22 are wild and only two are cultivated, namely *Oryza sativa* and *Oryza glaberrima*. Normally, *Oryza sativa* species is cultivated in Asia, parts of Europe and America while *Oryza glaberrima* species is only cultivated in Africa. *Oryza sativa* is further divided into three sub-species which are *indica*, *javanica* and *japonica*. This classification is based on the morphological and physiological characteristic of the rice. In short, rice grown in Malaysia belongs to *indica* sub-species.

2.1.1 Morphology of Rice

Rice is an annual plant consists of round, hollow, jointed culms as well as flat leaves and a terminal panicle. The culm is made up of a series of nodes and internodes that are in alternative orders. The leaves are attached to the node and panicles are a group of spikelets borne on the uppermost node of the culm. The uppermost leaf below the panicle is flag leaf and leaves number on the culm keep reducing from main culm to tertiary tillers. Tillers are side shoots produced from the basal node on the main culm known as primary tillers, which give rise to secondary tillers and secondary tillers turn branch into tertiary tillers. Rice plant also consists of fibrous roots which made up of rootlets and root hairs. During germination, the seedlings will produce embryonic roots which live only for a short period after germination. Then the temporary roots are replaced by the secondary adventitious roots which are produced from the underground nodes of the young culms.

1.4 Hypothesis

H_0: High application rate of NPK and chicken manure do not affect growth and yield of TR-9 rice variety and Silabukan soil nutrient.

H_1: High application rate of NPK and chicken manure affect growth and yield of TR-9 rice variety and Silabukan soil nutrient.

2.1.2 Growth and Development Phase in Rice

Rice usually takes three to six months to complete its life cycle from germinating to maturity. However, the growth and development period is depends on the variety and environment under which it grown. Physiologically, life history of rice can be categorized into three growth phases: vegetative, reproductive, and ripening (A1, Appendix A). According to Panda (2010), a 120 days rice variety that cultivated in tropic environment usually spending about 60 days in vegetative phase, 30 days in reproductive phase, and 30 days in ripening phase.

a) Vegetative Phase

Vegetative phase is a period of time where the seedling starts to germinate until the initiation of panicle primordial. Active tillering, gradual increase in plant height, and leaf emergence at regular intervals are the scene to determine the vegetative stage. This phase basically consist of four stages namely seedling stage, transplanting stage tillering stage and vegetative lag phase. Seedling stage is where the seed sprouts into young seedling with seminal and lateral roots as well as green leaves. Transplanting stage is a stage starting from uprooting, seedling transplanting until full recovery from transplanting. Normally secondary adventitious roots start to develop within 4 to 10 days after transplanting for the purpose of absorbing nutrient from the soil. Tillering stage is when the seedling undergoes active tillering. Active tillering is a stage when the increase in tiller number per unit time is high. Plant will stop producing tillers when it reached maximum tillering stage. Maximum tillering is the tiller number per plant is the highest before reaching the initiation of panicle primordial. Vegetative lag phase is where the tiller development becomes slow.

b) Reproductive Phase

This phase starts from panicle initiation to heading. This phase consist of four stages namely panicle initiation stage, booting stage, heading stage and flowering stage. Panicle initiation stage is the time when the panicle primordia initiate the panicle production in the uppermost node of the culm. At this stage, panicle is still not visible by naked eye. Booting stage is the internodes experienced elongation due to increased auxin activity. Heading stage takes place after booting stage where a portion of a panicle is observed and flowering stage usually occur about 20 to 25 days after booting. At this stage all the spikelet in the panicle bloom.

c) Ripening Phase

Ripening phase is starting from heading to maturity. Basically, this phase includes milky stage, dough stage and maturity stage. Milky stage is when the grain begins to turn milky after anthesis between seven to twelve days. Dough stage is when the milky grains become soft dough and then into hard dough stage in fourteen to twenty-one days. Maturity stage is when the grains are all free from greenish tint and become hard.

2.1.3 TR-9 Rice Variety

TR-9 rice variety which also known as *Seri Sabah* is produced by Department of Agriculture Sabah through cross breed of BG 90-21 and IR 19661-131-1-2 and IR 4215-301-2-2-6. This rice variety reaches the maturation period in the range of 123 to 133 days with 13 to 15 number of tillers and 64.2 to 82.1 cm of height. The 1000 grains weight of this rice variety is 23.5 to 25.5 g and the yield is in the range of 5 to 7.2 ton per hectare (A2, Appendix A).

2.1.4 Fertilization and Manuring of Rice

Rice require adequate and balance supply of nutrition for well growth and development so that high yields can be obtained. Major nutrients needs by rice are nitrogen, phosphorus and potassium. Fageria *et al.* (2011) found that among these three macro nutrients, nitrogen is the most limiting nutrient in producing rice yield in all rice -growing soils of the world. This is because ammonium nitrate is subjected to denitrification in the soil especially flooded soil.

Generally, rice require large amount of nitrogen at the early and mid-tillering stages in order to maximize tillers number. Besides these two stages, nitrogen is also required in the ripening stage. Wes *et al.* (2008) stated managing nitrogen in rice field is not easy as either too little or too much nitrogen application can reduce rice yield. Moreover, excessive nitrogen can lead to lodging, high levels of sterility and disease. A3 in Appendix A shows the application rate of nitrogen, phosphorus and potassium according to the growing stage of rice.

For transplanted rice, Panda (2010) suggested that apply all potassium and phosphorus as well as 25% nitrogen at planting. About 15 to 20 days after planting, 50%

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