INVESTIGATIONS OF TWO WETLAND PADDY VARIETIES SUPPLIED WITH DIFFERENT FERTILIZER RATES PLANTED ON ULTISOL AND ENTISOL SOILS

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DECLARATION

I declare that this dissertation is of my intellectual labor except for literatures that each has been cited and acknowledged.

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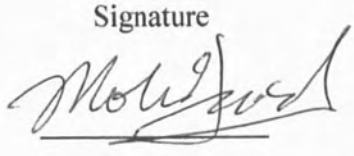
1.	**SUPERVISOR** (Dr.rer. nat Mohd Faisal bin Mohd Noor)	Signature 
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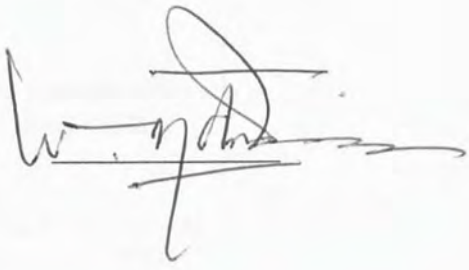
3.	**EXAMINER 1** (Prof. Dr. Wan Mohammad Wan Othman)	
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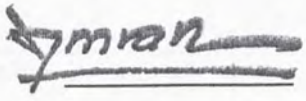
5.	**DEAN** (Associate Professor Dr. Amran Ahmed)	

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ABSTRACT

In a glasshouse pot experiment, the response of two paddy varieties were studied on Tuaran (Entisol) and Papar (Ultisol) soil at five different N fertilisation rates. The response of these two popular varieties amongst local farmer which, is currently subsidised by the government was measured in terms of N percentage in plant, RGB value and dry weight as well as the interaction of applied FR with the former variables. Two replicates per variety gave a total number of forty – eight (48) pots. Nitrogen was applied at 0, 50, 100, 150, 200 and 300 kg ha^{-1} at three split applications; before tillering, tillering and stem elongation stage. This experiment was desired to obtain optimum and maximum fertilisation rate and also to determine the suitability of a variety grown on every soil. Its' purpose is also to investigate the relationship between plant greenness (RGB) against fertilisation rate. Maximum fertilisation rate was recorded at 159.5 kg ha^{-1} for MR159PR and 220.7 kg ha^{-1} for MR159 on Tuaran soil. Optimal fertilisation rate is suggested at 124.45 kg ha^{-1} for MR159_PR and MR159_TN at 78.16 kg ha^{-1}. Result also showed that RGB increases with fertilisation rate until 200 kg ha^{-1} . Only variety MR159 responded significantly in this experiment, suggesting that it is suitable to be grown on both soil type.

ABSTRAK

Respon dua varieti padi terhadap lima (5) kadar pembajaan berbeza telah dikaji pada tanah Entisol (Tuaran) dan Ultisol (Papar) dalam suatu eksperimen rumah hijau di mana benih padi di tanam di dalam pasu. Kajian ini mengukur hubungan dan respon dua varieti padi yang popular di kalangan petani tempatan dan juga di subsidikan oleh kerajaan seperti respon peratus kandungan N, nilai RGB dan berat kering sample serta interaksi kadar pembajaan berbeza terhadap pembolehubah – pembolehubah yang dinyatakan. Nitrogen telah dibekalkan kepada 2 replikat bagi setiap varieti pada kadar 0, 50, 100, 150, 200 and 300 kg ha^{-1} dalam tiga tahap iaitu; sebelum pengeluaran ruas / perdu , semasa pengeluaran ruas dan pemanjangan batang . Objektif kajian ini adalah mendapatkan nilai pembajaan yang optimum dan maksimum serta menentukan kesesuaian varieti tertentu terhadap jenis tanah . Ia juga dijalankan bagi mengkaji hubungan kehijauan daun terhadap pembajaan. Kadar pembajaan maksimum bagi MR159_PR didapati adalah 159.5 kg ha^{-1} dan 220.7 kg ha^{-1} bagi MR159 pada tanah jenis Tuaran. Manakala, kadar pembajaan optimum pula didapati ialah 124.45 kg ha^{-1} bagi MR159_PR dan 78.16 kg ha^{-1} bagi MR159_TN . RGB didapati meningkat dengan pertambahan kadar pembajaan namun menurun selepas kadar 200 kg ha^{-1}. Dalam eksperimen ini, hanya variety MR159 sahaja yang menunjukkan respon yang signifikan di mana ia di dapati dapat tumbuh dengan sesuai di atas kedua – dua jenis tanah.

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LIST OF SYMBOLS

ha	Hectares
t/ha	Tonnes per hectare
r^2	R- square
Kg ha^{-1}	Kilogram per hectare
N	Nitrogen
°C	Degree Celcius
NH_4^+	Ammonium
RGB	Red Green Blue
nm	Nanometer
Km	Kilometer
Kg	Kilogram
g	Gram
cm	Centimeter
g/l	Gram per litre
NO_3^-	Nitrate
NH_4NO_3	Ammonium nitrate
P	Pearson correlation coefficient
FR	Fertilisation Rate
NP	Nitrogen in Plant
DW	Dry Weight
MR159	Paddy variety MR159
TR7	Paddy variety TR7
DIP	Days In Pot
LAI	Leaf Area Index

CHAPTER 1

INTRODUCTION

1.1 Project Background

Paddy or rice (*Oryza Sativa L.)* is a cereal grain that has been cultivated for over 5000 years all over the world. It is a semiaquatic annual grass and survives as a seasonal plant producing new tillers. It is known as the main agricultural crop in most tropical countries such as Thailand, India, Burma and Malaysia (Grist, 1986). Its' height varies by variety and environmental conditions ranging from 0.4 to over 5 metres (Huke, 1990).

The origin of paddy has long been the main debate over the years among scientist but there are no historical facts to where paddy first came from. However, the Kachins of Northern Myanmar (Burma) believed that their ancestors were sent forth from the center of the earth, given seeds of rice and were directed to a wondrous country where everything was perfect and rice grew well (Huke, 1990). The Chinese myth says that rice was a gift of animal rather than of gods. No matter what these ancient believes or myths

quote, rice has been known to feed people for a longer period of time than any other crop in the world.

Malaysia has a very high potential in becoming one of worlds' main rice producer, due to the excellent agro climatic condition for paddy that is present in the country. However, Malaysia is not one of the ten main producers of rice. Malaysia is still annually importing about 65% of rice from Thailand and other Asian countries such as China and Indonesia, which shows that there is a rice shortage in the country (FAO, 1999).

There has been tremendous effort being put by Malaysia Agricultural Research and Development Institute (MARDI) to increase the rice production such as facilitating research and development for efficient management practices, production systems, producing superior rice varieties with higher yield potential, increasing productivity, improving grain quality and post harvest management both at state and national level (Malaysia Paddy,2000) However, fluctuating paddy yield with an indication of a gradual decline over time and the shrinking of rice production has been reported (Rice Production in Malaysia, 2002).

One of the main known problem effecting in yield is fertilising and nutrient supply to both plant and soil (De Datta,1968). The lack of this affectc directly the yield of a given field. In Sabah, there might be more factors contributing to poor yield such as inefficient management especially among smallholders known as the 3T (Tanam, Tunggu, Tuai) attitude or "Plant, Wait, Harvest" attitude (Tating, *personal communication*). This way of planting among farmers in Sabah is where they normally just plant the paddy seeds and let it grow without any proper management system such as pest ocntrol or fertilising to ensure maximum yield.

Despite the higher need for rice in Asian countries, estimates showed that national average yields obtained in temperate zone countries are higher than those in the tropics. For instance, national average yields for Japan, Australia and United States (temperate zones) range from 4 to 6 metric tons per hectare whereas most tropical countries produces only about 1.5 tons per hectare (FAO, 1964). This deficiency has become critical lately especially for Malaysia and Sabah itself since paddy cultivation has become less popular among local farmers.

There are several reasons for this low yield but, soil related constraints such as nutrient imbalance and low Cation Exchange Capacity (CEC) also might be among the limiting factors. In Sabah, one of the reasons for the declining production level may be

due to lack of knowledge on the importance of fertiliser among farmers. Fertiliser is one of the most effective means of production inputs for rice, and among all fertiliser elements, nitrogen is universally needed in all soils (Coulter, 1998). Nitrogen is an essential substitute of amino acids, nucleic acids, nucleotides, and chlorophyll. It promotes biomass production and grain protein content (Dobermann, 2000). Thus, N affects all parameters contributing to yield.

Presently, farmers are subsidized with fertiliser and paddy seeds of variety MR 159 and TR7 from their local agriculture stations. However, the optimal fertilising level specifically for these two most popular varieties (MR159 and TR7) has yet to be reviewed (Tating, *personal communication*). It is known that the amount of nitrogen fertiliser required for maximum grain yield with a particular varietal type depends upon differences among soils, seasons and years (FAO, 1960). Hence, fertilisation rate and the most suitable fertilisation time have to be determined in order to raise maximum yield. The outcome of this project shall provide local farmers with informations on suitable fertiliser rate (optimum) for variety MR159 and TR7.

1.2 Project Objectives

1.2.1 To investigate the optimal level of N fertilizer application for maximum paddy yield.

1.2.2 To identify suitable soil type for varieties MR159 and TR7.

1.2.3 To investigate the relationships of paddy leaf green color (RGB) to N fertilisation.

CHAPTER 2

LITERATURE REVIEW

2.1 PADDY

Although rice is the main agricultural crop in most tropical countries, national average yields per hectare in the tropics traditionally have been below the average yields obtained in temperate zone countries. In Table 1.0, Japan and the Philippines have approximately the same total agriculture area under rice production which is 3mil ha. However, Japans' rice production is five times higher than that of Philippines.

Table 1.0 : Rice, area, yield and production in 3 temperate and tropical countries.(FAO, 1964)

COUNTRY	AREA (1,000 ha)	YIELD (kg/ha)	PRODUCTION (1,000 met tons)
Japan	3,272	5,240	17,157
U.S.A	717	4,440	3,187
Spain	64	6,230	399
Malaysia	380	2,290	869
Phillipines	3,129	1,220	3,223
Indonesia	6,738	1,740	11,764

Reasons leading to this large difference might have a lot to do with the implemented growing systems in each country or environmental factors. The latest statistic also shows that Malaysia has lower yield and production rate compared to other Asian countries. In year 2000, Malaysia recorded yield of only 23.53 kg / ha. Philippines, a country geographically close to Malaysia recorded 131.29 kg / ha (FAOSTAT, 2001).

At present, there are hundreds of paddy hybrids that has been produced worldwide mainly in Japan, Indonesia, USA, Korea, Mexico and Malaysia itself. Malaysia has been using Chinese CMS (cytoplasmic male sterile) as genetic tools in test crosses with 68 advanced lines and identified more than 10 competent varieties such as MR5, MR83, MR98, Y626 that gave yield up to 5.7 t/ha (IRRI, 1986). Competent varieties as such are supposedly to bring the best yield provided with the right soil, fertiliser management practices and soil types. However, a low production level is still

experienced in the country especially Sabah despite the cultivation of these superior varieties. Limiting factors should be studied to identify whether this is affected by growing systems, climate, soil or fertiliser management.

2.2 SOIL

In Sabah, paddy are normally grown on two types of soil which is sandy loam/ clay loam and alluvial soil (Tating, *personal communication*). These type of soils are in the Entisols and Ultisol order respectively. In Asia, 35% of the tropical area is covered by Ultisols which shows a good potential for rice cultivation (Coulter, 1998). The reason for the high abundance of Ultisols in the tropics is that the high rainfall which results in strong weathering.

Ultisols are the type of soil that are highly weathered and usually red or yellow in color. This color reflects the oxidation of iron and aluminium that occurs in the soil. Basically, it shares the same properties as Oxisols except for the illuvial clay layer present in Ultisols (Grunwald,1996). They are also soils with a subsurface horizon of clay accumulation (argillic horizon) and low base status, usually deep and well drained but lacking some of the more granular structure of Oxisols, and thus more liable to erosion. The pH is generally low in the range of 4.5 – 5.5, but the more acid soils have an

aluminum saturation as high as 80% making them suitable only for acid-tolerant crops such as paddy otherwise requiring lime (Coulter, 1998)

Entisols are coarser than very fine sand. Its' texture is usually loamey and clayey and it is known as transitions between the other soil orders and non – soils. Non - soils are very unstable areas either because of water erosion and wind erosions. For instance, as the soil depth increases, the organic matter decreases (Grunwald, 1996). Two suborders of Entisols, *aquents* and *fluvents* together with two suborders of Inceptisols, *aquepts* and *tropepts* include many of the alluvial soils are found in the river plains of the Indian sub – continent, Thailand, China, Indonesia and Malaysia. Entisols are soils in deep regolith or earth with no horizons except perhaps a plough layer. In the tropics, soils of recently reclaimed mangrove swamps, recent volcanic ash and young river alluvium would fall in this order (Coulter, 1998)

However, inherent soil fertility of rice growing areas in flat alluvial areas in Sabah is reported almost exhausted as a result of being continuously cropped with high yielding varieties and also land clearing method itself (Malaysia Paddy,2000). Burning after clearing is the conventional and general rule in paddy planting because it is the only practical method of clearing debris before cropping. It temporarily enriches the soil in phosphates and cations but in the longer run, it leads to a rundown in soil fertility due to

leaching and losses of nitrogen and sulphur (Soanne,1998). This is called *soil degradation* where it is defined as a decrease in soil quality as measured by changes in soil properties and processes, and a consequent decline in productivity in terms of production now and in the foreseeable future. Any use of soil will cause degradation to some extent, if only through a diminution of organic matter or export of nutrients contained in the crop. Standard practices of soil and water management will address these quality changes.(Stocking,1998)

2.3 N- FERTILISER MANAGEMENT

Fertiliser is one of the most effective ways to improve supply of nitrogen and organic matter to plants. Among the fertiliser element, nitrogen is hardly managed and it is the most common nutrient deficiency in paddy soils. Therefore, managing the N-fertiliser application in the right concentration and time can improve yield (De Datta,1969).

The most common nutrient deficiency in paddy soils is of nitrogen. There are several reasons that contribute to this. Firstly, tropical rice soils are known to be low in total nitrogen content than in the temperate areas because of its sandy character are easily

exhausted of plant nutrients (Kawaguchi,1966). The growth stages of paddy plants generally requires split application of nitrogen primarily to prevent lodging and minimize nitrogen losses through leaching. Three split application proved to be better than one or two, where an experiment conducted in nine locations in India showed that a native variety (Taichung) produced high yields five out of nine times with 50 – 25 – 25 kg ha^{-1} N application. One hundred percent of nitrogen fertiliser application at transplanting time produced high yields two times and one time at 75 – 25 kg ha^{-1} N application (IRRI, 1966).

The second reason to nitrogen deficiency is due to mineralisation of organic matter which proceeds almost as rapidly under saturated conditions as it does in aerated soils. Hence even in rice paddies which are almost always flooded, organic matter levels, and so organic nitrogen levels, are low (Greenland,1998). This is why N- fertilizing to paddy plants is vital in a big amount to provide the nutrient it needs to grow well.

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