UNIVERSITI PUTRA MALAYSIA

WEED DIVERSITY UNDER DIFFERENT WATER REGIMES IN IRRIGATED DIRECT-SEEDED RICE CULTIVATION

MUHAMMAD SAIFUL BIN AHMAD HAMDANI

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By

MUHAMMAD SAIFUL BIN AHMAD HAMDANI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

June 2008

Dedicated

To

My Father, My Mother and My Siblings

And Not To Forget

My Dearest Wife, son and All My Sincere Friends

For their understanding, encouragement and inspiration

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Science

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Chairman : Associate Professor Abdul Shukor Juraimi, PhD

Faculty : Agriculture

This study comprised two sets of experiment. The field trials were conducted at MARDI Bertam Rice Research Station in Seberang Perai, Penang, while the experiments on weed seed viability were done in a glass house and the Weed Biology Laboratory at Universiti Putra Malaysia. This study began in February 2004 and ended in June 2006. All field trials and weed seed viability studies were done in Off Season 2004 and Main Season 2004/2005. The objectives of the study were: a) to investigate the population and status of dominant weeds and their effect on rice yield under different water regime treatments in field condition; b) to determine the total weed seed reserve, species composition of the entire weed seed bank in the soils and their viability after being treated under different water regime treatments in the rice field.

Five water regime treatments were used namely; T1 = continuous flooded condition until maturity, T2 = early flooding until 55 DAS (day after sowing) followed by saturated condition until maturity, T3 = early flooding until 30 DAS followed by

saturated condition until maturity, T4 = continuous saturated condition until maturity, T5 = continuous field capacity condition throughout the experiment period.

Results from field trials indicated that in unweeded plots (no weed control treatment involved), T1 and T2 showed the lowest number of weed m^{-2} and weed biomass m^{-2} compared to the other water regime treatments. Plots treated with T1 and T2 significantly suppressed weed population to approximately 18 – 58% and reduced weed biomass to 14 – 57% as compared to the highest in T5 at all sampling dates (30, 60 and 90 DAS) in both Off Season 2004 and Main Season 2004/2005. For weed composition across the water regime treatments, 11 weed species were recorded in Off Season 2004 and 10 weed species in Main Season 2004/2005. Broadleaved weeds mostly *Monochoria vaginalis* and *Limnocharis flava* were the most dominant weeds in most of the water regime treatments. The SDR values of broadleaved weeds were 48.7% (T2) > 46.4% (T1) > 44.2% (T3) > 40.7% (T5) > 35.8% (T4) in Off Season 2004. In Main Season 2004/2005, the SDR values for broadleaved weeds increased to 79.5% (T2) > 68.2% (T1) > 62.4% (T3) > 62.2% (T4) > 50.57% (T5). Sedges mainly *Fimbristylis miliacea* and *Cyperus iria* were dominant in Off Season 2004 with SDR value more than 34% in all water regime treatments, but decreased to less than 23% in Main Season 2004/2005. For grasses, mostly *Echinochloa crus-galli*, *Echinochloa colona* and *Leptochloa chinensis*, SDR value more than 20% were recorded in T4 and T5 in Off Season 2004 while in Main Season 2004/2005, SDR value between 21 – 34% were observed in T1, T3 and T5.

Meanwhile rice plants treated with T1 significantly produced the highest rice grain yield, followed by T2 and T3, while T4 and T5 were the lowest in weeded plots in

both planting seasons. However, rice yield in unweeded plots were not significantly different in all water regime treatments. The rice productions in weeded plots were in the range of 22 – 60% higher in Off Season 2004 and 56 – 78% higher in Main Season 2004/2005 than in unweeded plots. Weed control treatment evidently showed stronger influence than water regime treatments. The percentages of reduction in weeded plots from the highest rice yield in T1 to lowest in T5 were 40% in Off Season 2004 and 44.4% in Main Season 2004/2005. Meanwhile the reduction of rice yield in unweeded plots compared to weeded plots was much higher, which recorded the highest of 59.1% (in T1) in Off Season 2004 and 78.3% (in T4) in Main Season 2004/2005.

The effect of different water regime treatments on viability of weed seeds in rice field was evaluated. Total weed seed reserves in soils taken from Off Season 2004 rice plots were dominated by broadleaved weeds (90625 seeds m^{-2}) mainly *Hedyotis corymbosa*, *Monochoria vaginalis* and *Ludwigia hyssopifolia*, followed by sedges (34257 seeds m^{-2}), mostly *F. miliacea* and *Cyperus iria*, while grasses (20647 seeds m^{-2}), predominantly *Leptochloa chinensis* recorded the lowest number in all water regime treatments. In soils taken from Main Season 2004/2005 rice plots, sedges (53041 seeds m^{-2}) mainly *Fimbristylis miliacea* along with broadleaved weeds (54624 seeds m^{-2}), predominantly *Monochoria vaginalis* and *Ceratopteris pteridoides* dominated in most of the water regime treatments, while grasses, mainly *Leptochloa chinensis* and *Panicum repens* again recorded the lowest number (24935 seeds m^{-2}). 10 weed species, which were not observed in the field trials, were recorded from the same soil in the weed seed bank experiment.

Differences in water regime treatments did not significantly reduce the viability of weeds seeds in the soil in Off Season 2004. However, a small reduction in seed viability (approximately 8%) was observed in Main Season 2004/2005. As for the similarity between weed seed bank composition and aboveground weed flora composition, a moderate value (62.07 - 73.33%) was observed in Off Season 2004, while in Main season 2004/2005, the value was slightly lower (51.65 – 64.29%).

Abstrak tesis dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

DIVERSITI RUMPAI DI BAWAH REGIM AIR BERBEZA DI KAWASAN SAWAH PADI TABUR TERUS

Oleh

MUHAMMAD SAIFUL BIN AHMAD HAMDANI

Jun 2008

Pengerusi: **Profesor Madya Abdul Shukor Juraimi, PhD**

Fakulti: **Pertanian**

Terdapat dua eksperimen yang terlibat dalam kajian in, di mana ujian-ujian ladang telah dilakukan di plot eksperimen padi, Stesen Kajian Padi MARDI Bertam, Sebarang Perai, Pulau Pinang manakala eksperimen kebernasan biji benih rumpai telah dijalankan di rumah kaca dan makmal Kawalan Biologi Rumpai, Universiti Putra Malaysia. Kajian bermula pada bulan Februari 2004 dan berakhir pada bulan Jun 2006. Kesemua ujian ladang dan kajian kebernasan biji benih rumpai telah dijalankan pada Luar Musim 2004 dan Musim Utama 2004/2005. Objektif kajian ini adalah; a) mengkaji status rumpai-rumpai utama dan kesannya terhadap hasil tanaman padi di bawah rawatan regim air yang berbeza di kawasan sawah; b) mengkaji jumlah keseluruhan biji benih rumpai, komposisi biji benih rumpai di dalam tanah dan juga kadar kebernasan biji benih rumpai setelah dirawat dengan regim air yang berbeza di sawah padi.

Lima rawatan regim air telah digunakan dalam kajian ini iaitu; T1 = keadaan banjir berterusan sehingga buah padi masak, T2 = keadaan banjir pada peringkat awal penanaman sehingga 55 HLT (hari lepas tanam) diikuti dengan keadaan tanah tepu air

berterusan sehingga buah padi masak, T3 = keadaan banjir pada peringkat awal penanaman sehingga 30 HLT diikuti dengan keadaan tanah tepu air berterusan sehingga buah padi masak, T4 = keadaan tanah tepu air berterusan sehingga buah padi masak, T5 = keadaan tanah pada takat kapasiti air ladang berterusan sepanjang tempoh eksperimen dijalankan.

Keputusan ujian ladang menunjukkan untuk plot-plot tanpa merumpai (tiada kawalan rumpai), T1 dan T2 menunjukkan nilai terendah bagi bilangan rumpai m^{-2} dan biomas rumpai m^{-2} berbanding regim rawatan air lain. Plot-plot yang dirawat dengan T1 dan T2 didapati mengurangkan populasi rumpai kepada kira-kira 18 – 58% dan mengurangkan biomas rumpai sebanyak 14 – 57% dengan perbezaan bererti berbanding nilai tertinggi dalam T5 pada kesemua tarikh persampelan (30, 60 dan 90 HLT) pada kedua-dua Luar Musim 2004 dan Musim Utama 2004/2005. Untuk komposisi rumpai pula, 11 spesies telah direkodkan pada Luar Musim 2004 dan 10 spesies pada Musim Utama 2004/2005. Rumpai berdaun lebar, terutamanya *Monochoria vaginalis* dan *Limnocharis flava* mendominasi dalam hampir keseluruhan rawatan regim air. Nilai SDR untuk rumpai berdaun lebar ialah 48.7% (T2) > 46.4% (T1) > 44.2% (T3) > 40.7% (T5) > 35.8% (T4) pada Luar Musim 2004. Pada Musim Utama 2004/2005, nilai SDR tersebut telah meningkat kepada .5% (T2) > 68.2% (T1) > 62.4% (T3) > 62.2% (T4) > 50.57% (T5). Rusiga, terutamanya *Fimbristylis miliacea* dan *Cyperus iria* mendominasi pada Musim Kedua 2004 dengan nilai SDR melebihi 34% dalam semua rawatan regim air, tetapi menurun kepada kurang daripada 23% pada Musim Utama 2004/2005. Untuk rumpai berdaun tirus pula, kebanyakannya *Echinochloa crus-galli*, *Echinochola colona* dan *Leptochloa chinensis*, nilai SDR melebihi 20% telah direkodkan dalam T4 dan T5

pada Luar Musim 2004 sementara pada Musim Utama 2004/2005 pula, nilai SDR sebanyak 21 – 34% didapati dalam T1, T3 dan T5.

Sementara itu di dalam plot-plot yang dirumpai (rumpai dikawal) pokok padi yang dirawat dengan T1 menunjukkan hasil padi paling tinggi, diikuti dengan T2 dan T3, sementara hasil terendah didapati dalam T4 dan T5 pada kedua-dua musim penanaman. Di dalam plot-plot tanpa merumpai pula, tiada perbezaan bererti didapati pada hasil padi di antara rawatan regim air berbeza. Produksi padi dalam plot-plot dirumpai secara puratanya 22 – 60% lebih tinggi pada Luar Musim 2004 dan 56 – 78% lebih tinggi pada Musim Utama 2004/2005 daripada produksi padi di dalam plot-plot tanpa merumpai. Pengaruh rawatan kawalan rumpai menunjukkan kesan yang lebih ketara daripada pengaruh rawatan regim air. Peratus kehilangan hasil padi dalam plot-plot dirumpai daripada hasil tertinggi dalam T1 berbanding hasil terendah dalam T5 ialah 40% pada Luar Musim 2004 dan 44.44% pada Musim Utama 2004/2005. Sementara itu peratus pengurangan hasil padi dalam plot-plot tanpa merumpai berbanding plot-plot dirumpai adalah lebih tinggi, dengan rekod paling tinggi sebanyak 59.05% (dalam T1) pada Luar Musim 2004 dan 78.34% (dalam T4) pada Musim Utama 2004/2005.

Kesan rawatan regim air berbeza terhadap kebernasan biji benih rumpai di kawasan sawah padi telah dikaji. Pada Luar Musim 2004, jumlah biji benih rumpai yang tersimpan di dalam kesemua rawatan regim air didominasi oleh rumpai berdaun lebar (90625 m^{-2} biji benih), terutamanya *Hedyotis corymbosa*, *Monochoria vaginalis* dan *Ludwigia hyssopifolia* diikuti oleh rusiga (34257 m^{-2} biji benih), terutamanya *Fimbristylis miliacea* dan *Cyperus iria*, sementara rekod paling rendah didapati pada

rumpai berdaun tirus (20647 m^{-2} biji benih), kebanyakannya *Leptochloa chinensis*. Pada Musim Utama 2004/2005, rusiga terutamanya *Fimbristylis miliacea* (53041 m^{-2} biji benih) bersama-sama rumpai berdaun lebar (54624 biji benih m^{-2}), terutamanya *Monochoria vaginalis* dan *Ceratopteris pteridoides* mendominasi kebanyakan rawatan regim air sementara rumpai berdaun tirus (24935 biji benih m^{-2}), kebanyakannya *Leptochloa chinensis* dan *Panicum repens* sekali lagi merekodkan bilangan terendah. 10 spesies rumpai yang tidak didapati dalam ujian ladang telah direkodkan dalam kajian bank biji benih rumpai.

Perbezaan dalam rawatan regim air didapati tidak mempengaruhi kadar kebernasan biji benih rumpai di dalam tanah secara bererti pada Luar Musim 2004. Walau bagaimanapun, sedikit penurunan dalam kebernasan biji benih rumpai (kira-kira 8%) telah didapati pada Musim Utama 2004/2005 dalam semua rawatan regim air. Untuk persamaan di antara komposisi biji benih rumpai di dalam tanah dengan komposisi pokok rumpai yang tumbuh di sawah padi, nilai sederhana (62.07 – 73.33%) telah drekodkan pada Luar Musim 2004, sementara pada Musim Utama 2004/2005 pula, nilai tersebut didapati telah menurun sedikit (51.65 – 64.29%).

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I would like to express my humble apology to those persons, who helped me but may not find their names in my narration here.

I certify that an Examination Committee has met on 16 June 2008 to conduct the final examination of Muhammad Saiful bin Ahmad Hamdani on his Master of Science thesis entitled "Weed Diversity under Different Water Regimes in Irrigated Direct Seeded Rice Cultivation" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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Date:

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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Date: 11 September 2008

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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MUHAMMAD SAIFUL AHMAD HAMDANI

Date: 22 July 2008

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Rice (*Oryza sativa* L.), is one of the most important cereal crops in the world (Wangda et al., 2003). It feeds well in excess of more than 2 billion people in Asia and many in Latin America, providing on average 32% of total calorie uptake (Mclean et al., 2002). However, yield stagnation or even decline has been observed in some rice growing areas of Asia since in the early 1980s (Flinn and De Datta, 1984; Cassman and Pingali, 1994). One of the major factors is a crisis of fresh water. Per capita availability of water resources has declined by 40 – 60% in many Asian countries between 1955 and 1990 (Gleick, 1993). Agriculture's share of water will decline at an even faster rate because of increasing competition from urban and industrial sectors (Tuong and Bhuiyan, 1994).

Report from United Nation's World Food Programme (WFP) shows the biggest threat to Asia in the future will be the shortage of clean water, as Asia accounts for 60% of the world's population but has only 36% of the global freshwater (Sariam, 2004). According to FAO (2000), Malaysia is categorized in Zone 3 in terms of water scarcity in the 20th Century with a need to increase water management between 25 – 100 % to meet the 2005 water requirement and rice cultivation will be badly affected by this phenomenon.

Observations have been made and most of the results showed that weeds are one of the major constraints on yield and quality of rice (Tsuru, 1991). The total annual worldwide

loss of rice due to weed infestation was found to be 15% with 5 – 72% ranging in Malaysia solely (Kuan et al., 1990). A change in crop establishment method from transplanting to wet seeding brings about changes in the weed community (Bhagat et al., 1999). Weed type and degree of infestation in rice fields are often determined by the type of rice culture (irrigated, rainfed lowland, deepwater or tidal wetlands), stand establishment method (transplanted, direct seeded), moisture regime (irrigated, rainfed), land preparation (lowland, upland) and cultural practices (Baltazar and De Datta, 1992). Under reduced water condition, weed management is most critical especially in direct-seeded rice cultivation. Rice yield is drastically reduced because of increase in weed infestations due to limited water supply (Cooper, 1982).

Weed species respond differently to changing water regimes (Bhagat et al., 1999), and soil moisture status following planting is the major factor influencing weed flora composition (Drost and Moody, 1982). In rice culture, water and weeds are often considered to be closely interlinked. Weed species respond differently to changing water regimes (Bhagat et al., 1999). For example, the dominance of grasses are favored by saturated and below saturated conditions, whereas broadleaves (aquatics) and sedges growth rapidly when soil is submerged with water (Bhagat et al., 1999). In Malaysian rice farms in the Muda irrigation project, rapid changes in water management practices have caused major shifts in weed populations from annuals to perennials, from shallow emerging to deep emerging weeds and from less competitive to more competitive weeds (Noda, 1973; Bhagat et al., 1999).

Most weeds propagate from seeds; only a few propagate vegetatively. Agricultural soils generally contain a large reservoir of weed seeds (Zimdahl et al., 1988). The number and type of weed seeds present in the soil reservoir are largely determined by the water holding capacity and pH of the soil, past weed control practices and land preparation practices. The amount of water also influences the periodicity in the germination of weeds (Diop and Moody, 1984). Variation in soil moisture conditions can also affect weed seed emergence and viability differently (Mercado, 1979).

Unfortunately, little information is available on the effects of different water regimes on weed diversity and rice growth and yield in Malaysian condition. Thus, proper amount and period of water maintained in the field must be given emphasis, which besides enhancing rice production; appropriate water management can also provide valuable indications for future weed problems and perhaps, are indispensable for evolving suitable weed control strategies.

The objectives of the research were:

1. To investigate the population and status of dominant weeds and their effects on rice yield under different water regime treatments in Bertam rice field.
2. To determine the total weed seed reserve, species composition of the entire weed seed bank in the soil and their viability after being treated under different water regime treatments in Bertam rice field.