UNIVERSITI PUTRA MALAYSIA

CRITICAL PERIOD FOR WEED CONTROL IN SATURATED AND FLOODED FIELD, AND CHEMICAL WEED CONTROL IN DIRECT SEEDED RICE UNDER SATURATED CONDITION

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By

MOHAMAD NAJIB BIN MOHD YUSOF

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

August 2009

Dedicated

To

My Parents and Siblings

And Not Forgetting

My Wife, daughter 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 requirement for the degree of Master of Science

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Chairman: **Abdul Shukor Juraimi, PhD**

Faculty: **Agriculture**

Two field experiments were conducted at MARDI station, Seberang Perai, Penang. The experiments were: 1) Critical period in saturated and flooded field (off season 2005 and main season 2005/2006); 2) Chemical weed control in saturated field (main season 2005/2006 and off season 2006). The objectives of the study were: a) to determine the critical period of weed competition under saturated and flooded field conditions; b) to determine the efficacy of herbicides in controlling weed and their subsequent effect on rice productivity under saturated field. The first study consisted of different weeding periods under saturated and flooded field conditions. Meanwhile, the second experiment evaluated ten widely used herbicides which were available in the market either individually or as mixture, and sequentially applied in direct seeded rice fields during the critical period of weed competition under saturated field condition.

Results from the first experiment indicated that Summed Dominance Ratio (SDR) of weed composition was different under saturated condition compared with flooded condition for both seasons. The dominance ranking of weed groups in off season 2005 under saturated condition was sedges followed by grasses and broadleaved weeds, while in main season 2005/2006, grassy weeds was the most dominant followed by sedges and broadleaved weeds. Under flooded condition the dominance ranking of weed groups was broadleaved followed by grasses and sedges where the trend was the same in both seasons. The numbers of tillers, along with rice grain yield were significantly affected by weed competition in both saturated and flooded condition. Yield loss due to weed competition was higher in saturated condition (54.5%) than in flooded condition (35.2%). Based on the 5% level of yield loss, the critical period in off season 2005 was at 2-71days after sowing (DAS) under saturated condition, and 15-73 DAS under flooded condition. In the main season 2005/2006, the critical periods were at 1-72 DAS in saturated condition and 2-98 DAS in flooded condition.

Results from the second study indicated that in main season 2005/2006, the hierarchical position of 4 dominant weeds out of 10 species were *Fimbristylis miliacea* > *Ludwigia hyssopifoli* > *Leptochloa chinensis* > *Echinochloa crus-galli.*, This was completely the reverse to that of off season 2006 where the dominant species were *Echinochloa crus-galli* > *Leptochloa chinensis* > *Fimbristylis miliaceae* > *Limnocharis flava.* Seven of the eighteen treatments over the two cropping seasons showed better broad spectrum weed control, increased grain yields and better yield component indicators. Due to variation of the dominant weed infestation between seasons the potential treatments were

pretilachlor followed by bentazon/MCPA (T2), cyhalofop-butyl + bensulfuron followed by bentazon/MCPA (T4), bispyribac-sodium followed by bentazon/MCPA (T6), benthiocarb/propanil followed by bentazon/MCPA (T8), penoxsulam + benthiocarb followed by bentazon/MCPA (T10), fenoxaprop-p-ethyl/safener + benthiocarb/propanil followed by bentazon/MCPA (T12) and quinclorac + benthiocarb/propanil followed by bentazon/MCPA (T14) in main season and pretilachlor followed by bentazon/MCPA (T2), bispyribac-sodium followed by bentazon/MCPA (T6) and penoxsulam + benthiocarb follow by bentazon/MCPA (T10) in off season 2006. Rice yield losses due to weed competition in unweeded treatments were 60% in main season 2005/2006 and 54% in off season 2006. This experiment also showed that sequential herbicide application would give a better result compared with a single herbicide application.

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

TEMPOH KRITIKAL BAGI KAWALAN RUMPAI PADA KEADAAN TANAH TEPU DAN BANJIR, DAN KAWALAN KIMIA RUMPAI TANAMAN PADI TABUR TERUS DALAM KEADAAN TANAH TEPU AIR

Oleh

MOHAMAD NAJIB BIN MOHD YUSOF

Ogos 2009

Pengerusi: **Abdul Shukor Juraimi, PhD**

Fakulti: **Pertanian**

Dua kajian di ladang telah dilaksanakan di stesen MARDI Seberang Perai, Pulau Pinang. Kajian tersebut adalah: 1) Kajian penentuan tempoh kritikal persaingan rumpai dalam keadaan tanah tepu dan banjir (luar musim 2005 dan musim utama 2005/2006); 2) Kajian kawalan kimia rumpai dalam keadaan tanah tepu air (musim utama 2005/2006 dan luar musim 2006). Objektif kajian adalah: a) untuk mengenalpasti tempoh kritikal bagi mengawal rumpai dalam keadaan tanah tepu air dan banjir; b) untuk menentukan keberkesanan racun herba bagi mengawal rumpai dan kesannya kepada hasil padi. Kajian pertama merangkumi tempoh kritikal tanaman perlu bebas dari rumpai, dan tempoh kritikal rumpai boleh bersaing dengan tanaman dalam keadaan tanah tepu air dan banjir. Manakala, kajian kedua merangkumi sepuluh jenis racun rumpai sawah padi yang digunakan secara meluas dan terdapat dipasaran diuji penggunaanya samada secara semburan berkala, campuran dan sekali semburan dalam tanaman padi tabur terus semasa tempoh kritikal persaingan rumpai dalam keadaan tanah tepu air.

Hasil dari kajian pertama mendapati nilai SDR menunjukkan komposisi rumpai berbeza antara keadaan tanah tepu berbanding keadaan air bertakung untuk kedua-dua musim. Di luar musim 2005, didapati kumpulan rumpai yang paling utama pada keadaan tanah tepu adalah dari jenis rusiga, diikuti dari kumpulan rumput dan rumpai daun lebar. Pada musim utama 2005/2006 pula, rumpai dari jenis rumput merupakan kumpulan rumpai utama diikuti oleh rumpai dari jenis rusiga dan daun lebar. Pada keadaan air yang bertakung, kumpulan rumpai utama mengikut hirarki pada kedua-dua musim ialah rumpai daun lebar diikuti rumpai dari jenis rumput dan rusiga. Bilangan anak pokok padi dan hasil padi dipengaruhi dengan bererti oleh tempoh saingan rumpai pada kedua-dua keadaan tanah tepu dan air bertakung. Pengurangan hasil padi disebabkan persaingan rumpai adalah lebih tinggi pada keadaan tanah tepu (54.5%) berbanding pada keadaan air bertakung (35.2%). Berdasarkan 5% pengurangan hasil padi, tempoh kritikal mengawal rumpai pada luar musim 2005 adalah 2–71 Hari Selepas Tabur (HST) pada keadaan tanah tepu, dan 15 – 73 HST pada keadaan air bertakung. Pada musim utama 2005/2006 pula, tempoh kritikal adalah 1-72 HST pada keadaan tanah tepu dan 2-98 HST bagi keadaan air bertakung.

Hasil dari kajian kedua pula mendapati pada musim utama 2005/2006, 4 spesis rumpai dari 10 spesis yang dominan mengikut hirarki adalah *Fimbristylis miliacea* > *Ludwigia hyssopifolia* > *Leptochloa chinensis* > *Echinochloa crus-galli*, namun pada luar musim 2006 hirarki ini terbalik iaitu *Echinochloa crus-galli* > *Leptochloa chinensis* >

Fimbristylis miliaceae > *Limnocharis flava.* Tujuh daripada lapan belas perlakuan yang diuji selama dua musim menunjukkan kawalan rumpai yang meluas disamping meningkatkan hasil padi dan komponen hasil. Disebabkan kepelbagaian serangan rumpai yang dominan antara musim, perlakuan yang berpotensi diguna pada musim utama adalah pretilachlor diikuti bentazon/MCPA (T2), cyhalofop-butyl + bensulfuron diikuti bentazon/MCPA (T4), bispyribac-sodium diikuti bentazon/MCPA (T6), benthiocarb/propanil diikuti bentazon/MCPA (T8), penoxsulam + benthiocarb diikuti bentazon/MCPA (T10), fenoxaprop-p-ethyl/safener + benthiocarb/propanil diikuti bentazon/MCPA (T12) dan quinclorac + benthiocarb/propanil diikuti bentazon/MCPA (T14). Manakala pada luar musim pretilachlor diikuti bentazon/MCPA (T2), bispyribac-sodium diikuti bentazon/MCPA (T6) dan penoxsulam + benthiocarb diikuti bentazon/MCPA (T10). Kerugian hasil disebabkan persaingan rumpai dalam perlakuan tanpa kawalan rumpai ialah 60% pada musim utama 2005/2006 dan 54% pada luar musim 2006. Kajian ini juga menunjukkan ulangan semburan racun pada kali kedua pada tempoh kritikal persaingan rumpai dapat memberi keputusan lebih baik berbanding sekali semburan sahaja.

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I would also like to express my humble apology to all those , who have helped me in one way or anther but may not find their names in my narration here.

I certify that an Examnation Committee has met on 27 August 2009 to conduct the final examination of Mohamad Najib bin Mohd Yusof on his Master of Science thesis entitled " Critical period for weed control in saturated and flooded condition" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Commitee recommends that candidate be awarded the relevent degree. Members of theExamination Committee are as follows:

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Date: 14 January 2010

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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MOHAMAD NAJIB BIN MOHD YUSOF

Date:

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CHAPTER 1

INTRODUCTION

Rice is a major source of carbohydrate for more than 60% of the world's population, most of whom live in Asia and about 80% of it is grown under irrigated conditions (Roger and Watanabe 1986). Food security in Asia is therefore strongly dependent on an adequate, available supply of affordable rice. Experts estimated that global rice supply would need to increase at an average of 1.7% per annum for the next 20 years, and average rice yields must roughly doubled in the next 20 years, if a global shortage is to be avoided. At the same time the need to increase total production, and unit area productivity is being felt, society is also demanding that agricultural practices be environment friendly and be part of a sustainable agricultural system (Chin 2005).

Water is becoming more valuable with increasing competition among agriculture, urbanization, and industry. Water use in agriculture is generally considered to be relatively low in value, less efficient and highly subsidized (FAO 2000). Though trading affects water supply and demand, constraints on supply will be the dominant factor determining future use.

Water-saving irrigation practices have been one of China's basic national policies. Chinese farmers use ponds to capture rainfall, store surplus water from the Zhanghe Irrigation System, and conserve water from other sources (Loeve et al. 2001). The used of ponds in China was not driven by farmers desire but rather imposed on them due to increasing water scarcity (Shahbaz et al. 2006).

There is a wrong conviction that, standing water of higher depth all throughout the life period of the plant is essential for growing a good crop of rice. It has been observed that standing water is necessary only to a depth of 5cm and only needed to a certain period of the life of the plant (Dastane 1967). It also proved that the rice yield was similar among three water regimes (saturated condition, alternate flooding and draining, and continuous flooding) when the full rate of herbicide was applied (Janiya and Johnson 2005).

Weeds are potentially the most severe and widespread biological constrain to rice production. In Malaysia, the unweeded plot of rice usually recorded 10-35% yield loss (Lo et al. 1990). Although difficult to measure, average rice yield losses specifically due to weeds has ranged beween 5 and 72%, but they vary considerably (Kuan et al. 1990). This loss depends mainly on the season of crop sowing, weed species, weed density, rice cultivar, growth rate and density of weed and rice (Rezaul Karim et al. 2004), and soil moisture status following planting is the major factor influencing weed flora composition (Drost and Moody 1982). For example, the dominance of *Echinocloa* species is favored by saturated condition, while *Leptochloa chinensis* (L.) Nees emerges best when the soil moisture is below saturation (Bhagat et al. 1999). A review done by Bhagat et al. (1996) found that moist or saturated soils favor the emergence of grasses and sedges. Once established, these weeds are difficult to control by flooding.

The critical period of weed competition (CPWC) is an important consideration in the development of alternative weed management strategies (Swanton and Weise 1991). The

critical period indicates appropriate timing for weed management and aids in understanding the impact of weed populations on the crop. This is because the duration of weed presence along with the crop and the time of weed emergence, relative to the crop, both affect weed/crop competition (Hall et al. 1992).

Evidence of the need for improved weed management practices in rice production comes from the observations that weed species shifts have occurred towards species that are more difficult to control, including weedy rice (Moody 1995; Casimero et al. 2005), the evolution of herbicide resistance in rice weeds (Gressel and Baltazar 1996), in addition to the overall requirement to reduce yield loss due to weeds.

Since, no single weed control technique is perfect and because the weed population constantly adapts to its physical environment, a multilateral approach is required for sustainability and control of weeds. There is a growing need for the development of technically sound, economically feasible and environmentally friendly weed management strategies. Therefore, this research was done to solve the weed problem in irrigated direct seeded rice fields under minimal water condition.

The general objective of this study is to determine chemical weed control during the critical period under saturated soil condition in direct seeded rice.

The specific objectives are:

1. To determine the critical period of weed competition in direct seeded rice under saturated and flooded field conditions.

2. To evaluate and determine the suitable herbicides used for weed control in direct seeded rice under saturated soil condition.