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ENHANCEMENT OF WATER SAVING CAPACITY IN RICE (*Oryza sativa*) THROUGH PLANT GROWTH-PROMOTING RHIZOBACTERIA (PGPR) STIMULATION

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BY

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A project submitted to the Faculty of Agriculture, Universiti Putra Malaysia in fulfillment of the requirement of PRT 4999 (Final Year Project) for the award of the degree of Bachelor of Agricultural Science

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CERTIFICATION FORM

This project report entitled Enhancement of Water Saving Capacity in Rice (*Oryza sativa*) Through Plant Growth-Promoting Rhizobacteria (PGPR) Stimulation is prepared by Azie Asmiati Bt Alias and submitted to the Faculty of Agriculture, Universiti Putra Malaysia in fulfillment of the requirement of PRT 4999 (Final Year Project) for the award of the degree of Bachelor of Agricultural Science.

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Research related to technologies in water saving capacities can lead to an increase in the water use efficiency in crop production. New water saving technologies potentially act as substitutes for conventional cultivation technique which has a high demand for water consumption (3000 L water/ kg grain yield) in rice cultivation. Rice is highly sensitive to water deficiency and may cause a decline in vegetative growth and crop yield. Hence, a strategic and economic water management system known as soil saturated cultivation (SSC) was applied in this experiment in the presence of plant growth-promoting rhizobacteria (PGPR). During growth development, water was maintained under saturated and flooded conditions as in conventional system. This experiment was conducted in a growth chamber for 28 days at Soil Microbiology Lab, Department of Land Management, Universiti Putra Malaysia. The objective of this experiment was to measure the effectiveness of water saving capacity on vegetative growth of rice and to measure the ability of PGPR in enhancing the stimulation of water saving capacity in rice plant. The hypotheses were: (1) PGPR inoculum has the ability to fix nitrogen (N_2), solubilize phosphate and potassium and produce Indole-3-acetic acid (IAA), (2) PGPR used is able to stimulate vegetative growth of rice in saturated soil condition, (3) PGPR used can potentially save the usage of NPK fertilizer, (4) PGPR helps the rice plant to endure and tolerate water stress. This experiment consisted of 8 treatments under different conditions (saturated and flooded): Inoculated and non-inoculated with PGPR (UPMB-10) at a fertilizer rate of 33% N, 33% P and 33%K; Inoculated and non-inoculated with PGPR (UPMB-10) at 100% NPK fertilizer rate. Based on this experiment the vegetative growth of paddy in a saturated condition with application of

UPMB-10 showed good growth, equivalent to flooded conditon treatment with and without UPMB-10. Result from each treatment with UPMB-10 inoculation under saturated condition showed significant results through observations of the following parameters: plant height, dry weight and fresh weight, root volume and area and, total nitrogen content in plant tissue. UPMB-10 have the ability and potentitally to enhance the water rice saving capacity by saving 12 % water compared to the conventional water consumption. Besides, it has an added beneficial effect in reducing 33% of the NPK fertilizer input for rice production under flooded system (conventional)

ABSTRAK

Kajian berkaitan teknologi kapasiti simpanan air mampu meningkatkan efisien produksi hasil tanaman. Teknologi simpanan air yang terkini berpotensi bertindak sebagai pengganti teknik kultivar konvensional yang memerlukan penggunaan air (3000 L air/ kg hasil bijirin) dalam kultivasi padi. Padi mempunyai tahap sensitif pada kekurangan air dan mampu menyebabkan penuruan pertumbuhan vegetatif dan hasil tanaman. Oleh itu, pengurusan strategik dan ekomomik air yang dikenali sebagai kultivasi tanah tepu (SSC) diaplikasikan dalam eksperimen ini bersama Rhizobackteria Penggalak Tumbesaran Tanaman (PGPR). Semasa perkembangan pertumbuhan, air dibekalkan secara tanah tepu dan keadaan banjir seperti sistem konvensional. Eksperimen ini dilaksanakan dalam peti tiruan pertumbuhan selama 28 hari di Makmal Mikrobiologi Tanah, Jabatan Pengurusan Tanah, Universiti Putra Malaysia. Objektif eksperimen ini untuk mengukur tahap efisien kapasiti simpanan air pada pertumbuhan vegetatif padi dan mengukur kebolehan PGPR dalam mempertingkatkan simulasi kapasiti simpanan air pada padi. Hipotesis adalah: (1) Inokulasi PGPR berkebolehan memperbaiki nitrogen (N_2), melarut fosfat dan potasium serta menghasilkan Indol-3-asetik asid (IAA), (2) PGPR mampu mengstimulasi pertumbuhan vegetatif padi dalam keadaan tanah tepu, (3) PGPR berpotensi menjimatkan baja NPK, (4) PGPR membantu padi berhadap dan bertolerasi dengan keadaan stress air. Eksperimen ini mempunyai 8 rawatan dibawah keadaan berbeza (tanah tepu dan banjir): Inokulasi dan tanpa inokulasi PGPR (UPMB-10) pada kadar baja 33% N, 33% P dan 33% K ;Inokulasi dan tanpa inokulasi PGPR (UPMB-10) pada 100% baja NPK. Berdasarkan eksperimen, pertumbuhan vegetatif padi

pada keadaan tanah tepu serta aplikasi UPMB-10 menunjukan pertumbuhan baik setara dengan rawatan pada keadaan banjir dengan ada atau tanpa UPMB-10. Keputusan setiap rawatan dengan inokulasi UPMB-10 pada keadaan tanah tepu menunjukan keputusan yang signifikan melalui pemerhatian berdasarkan parameter: tinggi pokok, berat kering pokok, berat segar pokok, isipadu akar, luas akar dan jumlah kandungan nitrogen dalam tisu . UPMB-10 mempunyai kebolehan mempertingkatkan kapasiti simpanan air melalui penjimatan 12% air berbanding konvensional. Selain itu, mempunyai kelebihan dengan pengurangan 67% kadar input baja NPK pengeluaran padi secara sistem banjir (konvensional).

CHAPTER 1

INTRODUCTION

1.1 Introduction

Malaysia is endowed with a rich and variety of natural resources that undergo continuous demographic pressures. The current Malaysian population numbers present are more than 28 million and are estimated to increase significantly annually (Anon 2014, Department of Statistics Malaysia). This increase in population means the food source requirement would also increase, which then create the most essential issue of providing enough food for the population.

In Asia, rice contributes an average of 32 % of total calorie uptake (Maclean et al., 2002). Due to the population growth the demand for rice is expected to keep increasing in the incoming decades (Pingali et al., 1997).Hence, decreasing availability of water sources threatens the productivity of the irrigated rice ecosystem and ways must be sought to save water and increase crop productivity (Guerra et al., 1998) since 75% of global rice output is produced in irrigated lowlands.

People from all over the world especially Malaysia consume rice as basic food preference in everyday diet due to the high starch content which provides carbohydrates for human energy. Rice productions require high cost management such as water cost, fertilizer, and sunlight. However, with the recent climate change which also affects rainfall intensity in Malaysia, farmers suffer

from water shortage for rice irrigation. An increase in water saving capacity of rice with the aid of PGPR inoculation and phytohormone production could be one of the reliable methods to be appllied for future rice production facing the global climate change challenge. This approach could ensure a continued rice supply to support the local and global demand.

Hence, the use of bio-fertilizer or appropriately called "microbial inoculant", defined as a prepared biological product containing live or latent cells of efficient microbial strains for nitrogen fixation, phosphate solubilization or cellulolytic decomposition in agriculture, becomes most relevant. Bio-fertilizer has the ability to increase soil fertility by increasing soil microbial population and accelerate the microbial processes to augment availability of nutrients in forms which are easily assimilated by plants. Thus the infertile soils are repaired and become more environmentally friendly while at the same time increasing its sustainabilit and economic benefits to agriculture.

The application of PGPR from the biofertilizer helps to enhance the process of fixing atmospheric nitrogen, solubilizing phosphates and producing phytohormones which improve plant growth development. One major aspect which determines growth of a rice plant is the root development that is essential for soil nutrient absorption. However, a similar effect on water uptake by rice plant roots inoculated with PGPR has not been well researched

1.2 Objective

- To measure the effectiveness of water saving capacity on vegetative growth of rice.
- To measure the ability of plant growth promoting rhizobacteria (PGPR) in enhancing the stimulation of water saving capacity in rice plants.

1.3 Hypothesis

Null hypothesis

- The enhancement of water saving capacity in rice plants through PGPR stimulation have no significant effect on growth performance compared to conventional or flooded system with the absence of PGPR.

Alternative hypothesis

- The enhancement of water saving capacity in rice plants through PGPR stimulation have significant effects on growth performance compared to conventional flooded system with the absence of PGPR

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