UNIVERSITI PUTRA MALAYSIA

RESPONE OF DIFFERENT SWEET CORN VARIETIES TO APPLICATION OF CHEMICAL FERTILIZER, POULTRY MANURE AND Bacillus sphaericus (UPMB10)

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MOHAMAD HAFIS KAMARUDDIN

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DEDICATION

I dedicate this humble effort to the soul of my father, beloved mother, and my brothers, without their inspiration and help, this ambition could not have been achieved at Universiti Putra Malaysia.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

RESPONSE OF DIFFERENT SWEET CORN VARIETIES TO APPLICATION OF CHEMICAL FERTILIZER, POULTRY MANURE AND *Bacillus sphaericus* (UPMB10)

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Chairman : Associate Professor Halimi Mohd Saud, PhD
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The expansion of sweet corn cultivation offer an alternative option to the present pineapple cultivation on peat in Malaysia. The major sweet corn growing areas are located in Pontian, Johor (1°29'8.02" N; 103°23'16.3" E), Kuala Langat, Selangor (2°48'13.8" N; 101°29'42.3" E) and Bintulu, Sarawak (3°10'16.8" N; 113°2'30.9" E). This experiment was conducted at Integrated Peat Soil Research Station (IPRS) Pontian, Johor. The size of study plots was 1.5 m x 1.5 m and planting distance was 75 cm x 25 cm. Randomized Completely Block Design (RCBD) was used as the experimental design with four replications. All the fertilizers were applied on the first week after planting.

The objectives of the first experiment was to determine the effect of *Bacillus sphaericus* (UPMB10), poultry manure (PM) and chemical fertilizer (CF) combinations and determine the effective rate of fertilizers on yield and quality of sweet corn grown on peat soils. The combination of UPMB10, poultry manure and chemical fertilizers were to exploit the yield potential of Hybrimas sweet corn. The treatments used were T1: No Fertilizer, T2: Chemical Fertilizer (160 kg N/ha, 34 kg P_2O_5/ha, 90 kg K_2O/ha), T3: Poultry Manure (3.56 tonnes/ha), T4: *Bacillus sphaericus* (UPMB10) (50L of Solution and 10,000L of Water), T5: 50%CF + 50%PM, T6: 50%PM + 50%UPMB10, T7: 50%CF + 50%UPMB10, T8: 30%CF + 30%PM + 40%UPMB10. Treatment T6 (50% Poultry Manure + 50% UPMB10) resulted in the highest plant height at 6, 8 and 10 weeks after planting (WAP) compared to other treatments. It also gave the highest root volume of Hybrimas sweet corn (6077.5 cm^3). Root and ear lengths, fresh and dry weights of ear were obtained to be the highest at T4 (UPMB10) but these parameters were not significantly different from T6.

The objective of the second experiments was to determine the effect of fertilizer treatments on selected varieties of sweet corn on peat soils. The best fertilizer rate obtained from the first experiment was applied to second experiment at the

first week after planting. Five varieties of sweet corn were grown on peat soil were Thai Supersweet (V1), 316 (V2), Hybrimas (V3), 1001Y (V4) and 6001BC (V5). Seed germination of Hybrimas (V3) sweet corn showed the highest percentages (97%) compared other varieties. Hybrimas sweet corn showed the highest plant height at 4 WAP, 8 WAP and 10 WAP. Root volume, root length, leaf area, ear length, total chlorophyll and soluble solid content (SSC) were highest from Hybrimas (V3). Fresh and dry weights of plant were also found to be high on 316 (V2) sweet corn at 545 g and 361.5 g respectively. Sensory evaluation showed that the Hybrimas (V3) gave highest score on appearance, sweetness, flavor and overall preference compared among varieties.

A combination of 50% Poultry Manure and 50% UPMB10 (T6) was the suitable treatment for growing Hybrimas sweet corn on peat soils. Thus, Hybrimas sweet corn showed good potential for commercial production on peat soils of Peninsular Malaysia.

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

KESAN PERBEZAAN JENIS JAGUNG MANIS PADA PENGGUNAAN BAJA KIMIA, TAHI AYAM DAN *Bacillus sphaericus* (UPMB10)

Oleh

MOHAMAD HAFIS KAMARUDDIN

November 2016

Pengerusi : Profesor Madya Halimi Mohd Saud, PhD
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Tanaman jagung manis diperluaskan menjadi salah satu alternatif pilihan selain tanaman nanas di tanah gambut di Malaysia. Kawasan utama dalam penanaman jagung manis terletak di Pontian, Johor (1°29'8.02" N; 103°23'16.3" E), Kuala Langat, Selangor (2°48'13.8" N; 101°29'42.3" E) and Bintulu, Sarawak (3°10'16.8" N; 113°2'30.9" E). Eksperimen ini telah dijalankan di Stesen Penyelidikan Tanah Gambut Bersepadu (IPRS) Pontian, Johor. Saiz plot ialah 1.5 m x 1.5 m dan jarak tanaman 75 cm x 25 cm. *Randomized Completely Block Design* (RCBD) telah digunakan sebagai reka bentuk eksperimen dengan empat replikasi. Semua baja telah diberikan pada minggu pertama selepas penanaman.

Objektif ekperimen pertama ialah menentukan kesan *Bacillus sphaericus* (UPMB10), tahi ayam (PM) dan baja kimia (CF) dan menentukan kadar berkesanan baja pada hasil dan kualiti pertumbuhan jagung manis di tanah gambut. Kombinasi UPMB10, tahi ayam dan baja kimia boleh digunakan untuk mengeksploitasi potensi hasil jagung manis Hybrimas. Rawatan digunakan ialah T1: Tiada Baja, T2: Baja Kimia (160 kg N/ha, 34 kg P_2O_5/ha, 90 kg K_2O/ha), T3: Tahi Ayam (3.56 tan/ha), T4: *Bacillus sphaericus* (UPMB10) (50L of larutan and 10,000L of air), T5: 50%CF + 50%PM, T6: 50%PM + 50%UPMB10, T7: 50%CF + 50%UPMB10, T8: 30%CF + 30%PM + 40%UPMB10. Kombinasi baja antara 50% *Basillus sphaericus* (UPMB10) + 50% tahi ayam (T6) menunjukkan tinggi pokok pada minggu ke 6, 8 dan 10 selepas menanam (WAP) berbanding lain-lain rawatan. Dengan itu memberi Isipadu akar paling tinggi adalah jagung manis Hybrimas ialah (6077.5 cm^3). Panjang akar dan tongkol, berat basah dan kering tongkol menunjukkan T4 (UPMB10) adalah tinggi tetapi parameter ini tidak signifikasi berbeza daripada T6.

Objektif ekperimen kedua adalah menentukan kesan rawatan baja pada pemilihan variati jagung manis di tanah gambut. Kadar baja yang terbaik

diperoleh daripada eksperimen satu telah digunakan untuk eksperimen kedua pada minggu pertama selepas menanam. Lima variati jagung manis di atas tanah gambut adalah Thai Supersweet (V1), 316 (V2), Hybrimas (V3), 1001Y (V4) dan 6001BC (V5). Percambahan biji benih jagung manis Hybrimas (V3) menunjukkan peratusan paling tinggi iaitu 97% berbanding variati lain. Jagung manis Hybrimas (V3) menunjukkan pokok paling tinggi pada 4, 8 dan 10 minggu selepas menanam (WAP). Isipadu akar, panjang akar, keluasan daun, panjang tongkol, jumlah klorofil dan tahap kemanisan biji (SSC) menunjukkan paling tinggi diperoleh pada Hybrimas (V3). Berat basah dan kering tumbuhan juga didapati tinggi adalah jagung manis 316 (V2). Penilaian rasa menunjukkan Hybrimas (V3) menunjukkan paling tinggi skor pada penampilan, kemanisan, rasa dan keseluruhan pilihan berbanding variati lain.

Kombinasi 50% tahi ayam dan 50% UPMB10 telah menunjukkan kesesuaian baja bagi penanaman jagung manis Hybrimas di tanah gambut. Oleh itu, Hybrimas jagung manis menunjukkan potensi yang baik untuk pengeluaran komersial di atas tanah gambut terutamanya di Semenanjung Malaysia.

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This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfillment for the Master of Science. The members of the Supervisory Committee are as follows:

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ANOVA	Analysis of variance
Al	Aluminum
ºC	Celsius
Ca	Calcium
CEC	Cation exchange capacity
CF	Chemical fertilizer
Chl	Chlorophyll
cm	Centimeter
cm^3	Cubic centimeter
DOA	Department of Agriculture
FAO	Food and Agriculture Organization
g	Gram
ha	Hectare
K	Potassium
Kg	Kilogram
L	Liter
LA	Leaf area
LSD	Least significant difference
M	Molarity
m	Meter
m^2	Meter per square
Meq	Milliequivalents
Mg	Magnesium
mg	Milligrams
mg cm^{-2}	Milligrams centimeter square
mL	Milliliter
MyGAP	Malaysian Good Agriculture Practices
N	Nitrogen
P	Phosphorus
PM	Poultry manure
SSC	Solid soluble content

t	Tons
UPMB10	*Bacillus sphaericus*
µs/cm	Micro-Siemens per centimeter
WAP	Week after planting
w	Week
w/v	Weight per volume
%	Percentage

CHAPTER 1

INTRODUCTION

1.1 Introduction

The family of maize (*Zea mays L.)* is Poaceae and type of grain crop of the grass family. Agriculture is a major contributor to the national economy in Malaysia (EPU, 2013). The increase in world population growth has lead to huge impact to the agriculture system (Lokare, 2007). Maize is the largest food industrial crop and third most important crop grown after wheat and rice (Kayani and Rahman, 1987). In Malaysia, sweet corn is an important crop and grows well in large areas of the country. The major sweet corn growing areas are located in West Johor, Selangor and Sarawak. In near 2015, 11,196 hectares of land were cultivated with sweet corn and total productions were 99,640 metric tons as fresh fruits (DOA, 2015). The suitable temperature for maize growth is 30°C to 36°C and 700 mm of rain water per year. The optimum pH is 5.5 to 6.5, but peat soils have low pH between 2.8 to 4.5. Thus, the Malaysian soils need to be limed because it is acidic in nature.

There are a number of reasons for the declining yield of maize on peat soils. Possible causes of this problem include lower amounts of certain nutrient and imbalances in the soil. Peat soils has more than 90% organic matter and consists of the remains of plants that are decaying. Desirable characteristics are the main contributing feature in cereal yield. Cereal yield of maize is highly related to the kernel set which is very sensitive to environmental conditions during the process of germination and silking stages (Cirilo and Andrade, 1999b). Scientists measured the effect of different environments on cereal yield in maize at different locations and observed that grain yield severely varied from each position due to the changes in characters influencing productions (Abraha and Savage, 2006). Soil microorganisms such as fungi, bacteria and actinomycetes need an optimum temperature, energy, water, pH, nutrients and oxygen.

Fertilizers are widely used to supply essential nutrient for plant to increase yield. The crops increased linearly with the amount of fertilizer that they absorb (Loomis and Conner, 1992). The agricultural sectors are strongly depending of on fertilization with mineral nutrients. When crops are grown under modern high production conditions, substantial amounts of nutrients are removed from the soil (Taiz and Zeiger, 2002). The chemical fertilizer in the inorganic form that provides nutrient elements and organic fertilizers from plant or animal residues (Taiz and Zeiger, 2002). Fertilizers enhance the fertility of the soil or replace the loss of chemical elements that had taken from the soil by harvesting, grazing, leaching or erosion.

Organic amendments including animal manures, green manures, crop residues and animal organic wastes composted noticeably will add to the soil to improve its productivity. It is also known that such alterations can significantly raise the amount of valuable microbes in the soil that are participating in the fixation of biological nitrogen, mineralization, organic matter decay and nitrification. To increase crop production, one of the organic materials such as poultry manure (PM) are used but pure organic farming never meets the increasing demand for nutrient supply, as sufficient amounts of organic materials are not available. In addition, there is another way for supplying nutrients through biological inoculums but this technique needs large quantity of organic matter and on it is own cannot favor the plant nutrient supply to soil eco-system (Hussain *et al.,* 1999). The main principle in this system is to use a mixture of effective microbes (biological microorganisms) to enhance the quality and health of soil. On this aspect there are major theories such as supplementation of organic energy, disease and pests, inorganic nutrient solubilisation, soil microbial populations balancing, nitrogen fixation capability and photosynthesis are documented (Higa and Wididana, 1991).

Biofertilizers are substances containing living microorganisms which support growth by increasing the source of primary nutrients to the host plant (Vessey, 2003). Biofertilizer contains living cells of different types of microorganisms which have the ability to mobilize nutritionally important elements from non usable to usable form through biological process. The microorganisms that support growth of plant by controlling harmful organisms are known as bio-pesticides (Banerjee *et al.,* 2006). On the other hand, farmers can find organic manures easily and at low cost compared with other fertilizers (Berova and Karanatsidis, 2008). The chemical fertilizers are extensive used for a long time thus result in declining in productivity and also environmental quality (Rahim, 2002). The used of organic fertilizers and other microbial products is crucial in the current attempt to make the agriculture industry a viable component of a healthy and pleasant ecosystem. Sweet corn production is not sufficient to meet the national demand and Malaysia still imports it from Taiwan, Thailand and Australia. One of the programs was designed to get high yield of sweet corn by applying optimum rate of fertilizer for production sweet corn grown on peat soil.

1.2 Problem Statement

Peat soils constitute potentially the largest readily available area of uncultivated land with potential agricultural use. In years 1921, pineapple has been successfully cultivated on peat soil in Malaysia. Furthermore sweet corn are potential cultivation have been grown successfully on peat. However, major problems were encountered especially on deep peat in physical and chemical characteristics.

The nature and the characteristics of nutrient release from chemical fertilizer, organic fertilizer and biofertilizers (Microbial Inoculants) are different and each type of fertilizer has its advantages and disadvantages with regard to crop growth and soil fertility (Chen, 2008). The uses of organic amendments in nature farming systems for food and agricultural production have long been practiced in many countries. Some farmers depend only on organic manure as a source of nutrients. However, production was low due to limited sources. Chemical fertilizers are high in nutrient levels but also high in toxicity. Moreover, composts are cheaper than other fertilizers but it is limited availability in the markets. On the other hand, biofertilizers with as microbes can be low cost and have more benefits for soil, however low production and less popular among farmers. There is minimal research done on biofertilizers. More research needs to be carried out to confirm the benefits of biofertilizer on the growth, production and soil improvement as well as to compare between these fertilizers.

1.3 Research Objectives

1.3.1 To determine the effect of *Bacillus sphaericus* (UPMB10), poultry manure and chemical fertilizer combinations on growth of sweet corn on peat soils.

1.3.2 To determine the effective rate of fertilizers on yield and quality of sweet corn grown on peat soils.

1.3.3 To determine the effect of fertilizer treatments on selected varieties of sweet corn on peat soils.

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