UNIVERSITI PUTRA MALAYSIA

YIELD AND NUTRITIVE QUALITY OF FIVE SWEET POTATO VARIETIES IN RESPONSE TO FOUR LEVELS OF NITROGEN FERTILIZER

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By

RATU PENAIA VOSAWAI

Thesis submitted to the School of Graduate Studies,
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Requirements for the Degree of Master of Science

December 2013

DEDICATION

Specially dedicated to my family back home in Fiji for their support especially to my parents in particular my beloved **FATHER** who passed away two years ago.

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

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Faculty : Agriculture

Sweet potato *(Ipomoea batatas* (L.) Lam) is an important food in developing countries that is rich in beta-carotene and vitamins. A field experiment was conducted in UPM to evaluate the response of yield and yield components and nutritive quality of five sweet potato varieties planted on two different sites with four levels of nitrogen fertilizer applied. The experiment used a split plot design with nitrogen as main plot in three replications and variety as the subplots. The nitrogen fertilizer levels used were 0, 17, 34 and 68 kg N/ha and the varieties were from UPM germplasm collection of sweet potato obtained from various parts of Malaysia. The varieties were labelled A, B, C, D and E.

The results showed that nitrogen fertilizer rates affected yield components, including fresh tuber yield, vine length, and leaf number and stomatal conductance. The response curves obtained indicated an optimum fertilizer rate of 50 kg N/ha is recommended in Field 2 and 40 kg N/ha in Field 10. The highest fresh tuber yield was 14 t/ha in Field 2 and 3 t/ha in Field 10. The differences were attributed to better soil texture and fertility in Field 2 compared to Field 10.

Application of nitrogen fertilizer to sweet potato also affects its nutritive quality. Application of 50 kg N/ha in Field 2 and 40 kg N/ha in Field 10 favors the nutritive

quality in sweet potato tuber in terms of total sugar, beta-carotene, vitamin C, protein and fat

.Abstrak tesis yang dikemulalan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains Pertanian

HASIL DAN KUALITI NUTRIEN LIMA VARIETI KELEDEK DALAM RESPON KEPADA EMPAT KADAR BAJA NITROGEN

Oleh

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Keledek atau *lpomoea batatas (L.) Lam* merupakan tanaman yang kaya dengan beta karotena dan vitamin. Tanaman ini dianggap sebagai sumber makanan ruji yang penting di negara-negara membangun. Satu eksperimen lapangan dijalankan di Universiti Putra Malaysia (UPM) untuk menilai tindak balas antara hasil, komponen hasil dan kualiti nutrien lima varieti keledek dengan kadar pembajaan nitrogen. Kelima-lima varieti keledek ditanam di dua tapak tanaman yang berbeza iaitu Ladang 2 dan Ladang 10. Kedua-dua tapak tanaman dibajai empat kadar pembajaan nitrogen. Eksperimen ini memilih reka bentuk belahan plot (*split plot design)* dengan nitrogen sebagai plot utama dalam tiga replikasi dan varieti keledek sebagai subplot. Kadar pembajaan nitrogen yang digunakan ialah 0, 17, 34, dan 68 kg N/ha. Varieti keledek yang digunakan pula diperoleh daripada koleksi germplasma keledek UPM. Varieti keledek dilabel sebagai A, B, C, D dan E.

Keputusan kajian menunjukkan bahawa kadar pembajaan nitrogen mempengaruhi komponen hasil, termasuklah hasil segar (ubi keledek), berat kering tangkai, berat kering petiol, indeks keluasan daun dan konduksi stomata. Keluk tindakbalas yang diperolehi menunjukkan kadar optimum baja yang disyorkan di Ladang 2 ialah 50 kg N/ha manakala di Ladang 10 kadar optimum ialah 40 kg N/ha. Hasil ubi segar tertinggi di Ladang 2 ialah 14 t/ha dan di Ladang 10 3 t/ha. Perbezaan ini disebabkan oleh kesuburan dan tekstur tanah yang lebih baik di Ladang 2 berbanding di Ladang 10. Keledek dari varieti D mengeluarkan hasil tertinggi di kedua-dua petak dan diikuti oleh keledek varieti E.

Pembajaan nitrogen turut mempengaruhi kualiti nutrien keledek. Kadar pembajaan 34 kg N/ha menghasilkan keledek yang kaya dengan kandungan gula, beta karotena, vitamin C, protein dan lemak.

Melalui eksperimen ini, disyorkan bahawa keledek varieti D dan E yang dibajai nitrogen dengan kadar pembajaan 34 kg N/ha sangat sesuai untuk tanaman di tapak 2 dan petak 10 bagi tujuan penghasilan ubi keledek yang segar dan bernutrien tinggi.

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To all who enable me to carry out my project in spite of the difficulties thanks for helping make this thesis a success.

I certify that a Thesis Examination Committee has met on 6 December 2013 conduct the final examination of Ratu Penaia Vosawai on her thesis entitled "Yi and Nutritive Quality of Five Sweet Potato Varieties in Response to Four Levels Nitrogen Fertilizer" in accordance with the Universities and University Colleges 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 Ma 1998. The Committee recommends that the student be awarded the Master Science.

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LIST OF ABBREVIATION

Anova	Analysis of Variance
AOAC	Association of Official Analytical Chemistry
CO_2	Carbon dioxide
cm	Centimeter
˚C	Degrees celcius
g	Gram
ha	Hectare
HPLC	High Pressure Liquid Chromatography Method
hr	Hour
HCl	Hydrochloric acid
kg	Kilogram
LAI	Leaf Area Index
m	Meter
m^2	Meter square
mg/g	Milligram.gram
µmol	Micromol
ml	Milliliter
min	Minute
nm	Nanometer
N	Nitrogen
%	Percentage
NaOH	Sodium hydroxide
t	ton

CHAPTER 1

INTRODUCTION

1.1 Background of study

Sweet potato (*Ipomoea batatas* (L) Lam) is one of the most economically important crop in the world (Bovell – Benjamin, 2007). High productivity in the form of starch and beta carotene richness underlies its potential. Low sugar types generally predominate. The tubers of sweet potatoes are widely used both as food and as a material for the production of beverages, pasta, alcohol drink and natural colorants (Winarno, 1982; Yen, 1982; Collins, 1984; Yoshimoto et al., 2002; Steed and Truong, 2008). It is also served as a staple food vegetable (flesh roots and tender leaves) snack food, weaning food, animal feed as well as raw material for industrial starch and alcohol. It is processed into diverse products (Bouwkamp, 1985; Lin et al., 1985; Udensi, 2000). Sweet potato is high in nutritive value, outranking most carbohydrate foods in vitamins, minerals, protein and energy content (Watt & Merill, 1975; Onuh et al., 2004). The extensive acreage dedicated to sweet potato is due to a number of environmental and economic factors.

In world crop statistics, the sweet potato is ranked seventh, just after cassava, with an annual production around 9Mt and a cultivated area of 110 Mha (FAO, 2009). The International Potato Centre (CIP) holds the largest sweet potato gene bank in the world with more than 6,500 wild, traditional and improved varieties (Food and Culture Encyclopedia, 2003). China is the biggest sweet potato producer country in the world (Ishida et al., 2000).

Fertilizers are extremely important factors in determining crop yield, quality and nutritional content (Martinez-Ballestra et al., 2008). The availability of N in the soil has been identified as a major limitation to crop productivity in many regions of the tropics (Weeraratna, 1989; Vitousek and Howarth 1991; Aber 1992; Harris 1992).

Nitrogen (N) is among the most important element required in agricultural systems to produce food and to supply protein for the increasing world population. It is commonly a deficient nutrient and is often the controlling factor in plant growth (Raymond and Gardiner, 1998). Without N, crop cannot produce sufficient protein, amino acid and enzyme to support life. Nitrogen deficiency suppressed plant growth and dry matter accumulation. When plants are N deficient, they have fewer chloroplast components to invest towards photosynthesis. Their growth habits are poorer, their tissues become chlorotic and they will often have an unthrifty spindly appearance. Radin and Boyer

(1982) found that leaves with low nitrogen had lower turgor and slower leaf enlargement than leaves with high nitrogen. With increasing leaf area index, more solar radiation is intercepted by plants and used for photosynthesis (Carlyle, 1998; Lawlor et al., 2001). Plants therefore grow better (Carlyle, 1998). Nitrogen plays an important role in protein formation and is a major component of chlorophyll (Stangel, 1984). It is a major part of all amino acids, which are the building blocks of all proteins including the enzymes which control virtually all biological processes. N is also essential for carbohydrate use within plants and a good supply stimulates root growth and development as well as uptake of other nutrients (Brady and Well, 2008). The amount of N required increases directly in response to the requirement for protein in the diets of growing population numbers. Growing human population, export potential and market demand (Webster and Wilson, 1980) are the driving force that requires increased production of dietary protein and more N inputs into crop production systems. There is an increase N loss into surface and groundwater resources, emissions of N compounds into the atmosphere, and livestock and human excretory into the environment. Excess fertilizer N and P are widely considered the main cause of eutrophication in fresh and salt water supplies throughout the world (Burt et al., 2009**;** Erhart et al., 2007). Eutrophication is where nutrient enrichment in lakes, ponds and other such waters that stimulates the growth of acquatic organisms, which leads to a deficiency of oxygen in the water.

A wide range of tuber crops are grown worldwide, only five species account for the majority of the total production; potato (*Solanum tuberasum*), cassava (*manihot esculenta*), sweet potato (*Ipomoea batatas*), yams (*Dioscorea spp*) and taro (*Colocassia, Cytosperma, Xanthosoma spp*.) (O'Hair and Maynard, 2003; Maynard and O'Hair, 2003). Sweet potato cultivars show different growth and yield performance in different environments. The significant genotype x environment interaction between cultivars and locations was reported by Caliskan et al., (2007). The world average for storage root yield in sweet potato is about 15t/ha (FAO, 2006). The highest mean storage root yield obtained from 15 sweet potato cultivars in Georgia, USA was about 60t/ha (Bhagsari & Ashley, 1990). Studies on varieties of cassava, sweet potato and yam shows difference in nutrient content within species (Hidayat et al., 2000). For sweet potato nutrient content vary greatly depending on cultivar, climate(Rodriguez-Amaya et al., 2008), geography and geochemistry (Nordbotten et al., 2000; Nikkarinen and Mertanen , 2004; Wall, 2006) agricultural practices such as fertilizer use (Mercadante and Rodriguez-Amaya, 1991).

The objectives of this study were:

1. To evaluate the yield response of five sweet potato cultivar to different nitrogen fertilizer levels in two different sites,
2. To assess the physiological responses of the five sweet potato with varying rates of N fertilizer, and
3. To determine the relationship between nitrogen fertilizer rates and nutritional characteristics of the sweet potato cultivars.

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LIST OF PUBLICATIONS

Vosawa P., R.A. Halim[1], and A.R. Shukor. 2015. Yield and Nutritive Quality of five Sweet Potato Varieties in Response to Nitrogen Levels. Submitted for publication in Advances in Plants & Agricultural Research (Ref. No. APAR -15-RA-162).

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