UNIVERSITI PUTRA MALAYSIA

GROWTH RATE AND YIELD OF WATER SPINACH (*Ipomoea reptans*) UNDER THREE WATERING SYSTEMS

MOHD SYARBANI ISNAR

FP 2015 120

GROWTH RATE AND YIELD OF WATER SPINACH (*Ipomoea reptans*) UNDER THREE WATERING SYSTEMS

MOHD SYARBANI BIN ISNAR

FACULTY OF AGRICULTURE

UNIVERSITY PUTRA MALAYSIA

SERDANG SELANGOR

2014/2015

GROWTH RATE AND YIELD OF WATER SPINACH (*Ipomoea reptans*) UNDER THREE WATERING SYSTEMS

BY

MOHD SYARBANI BIN ISNAR

162370

This project report is submitted in partial fulfillment of the requirements for the degree of Bachelor of Agriculture (Science of Agriculture)

DEPARTMENT OF LAND MANAGEMENT

FACULTY OF AGRICULTURE

UNIVERSITY PUTRA MALAYSIA

SERDANG SELANGOR

2014/2015

CERTIFICATION FORM

This project report entitle Growth Rate and Yield of Water Spinach (*Ipomoea reptans*) under Three Irrigation Systems is prepared by Mohd Syarbani Bin Isnar and submitted to Faculty of Agriculture in fulfilment of the requirement of PRT 4999 (Final Year Project) for the award of the degree of Bachelor of Agriculture Science.

Student's name: Student's signature:

MOHD SYARBANI BIN ISNAR ....

Certified by:

…………………………

Dr. Christopher Teh Boon Sung

Department of Land Management

Faculty of Agriculture

Universiti Putra Malaysia.

Date: ………………………..

ACKNOWLEDGEMENTS

First and foremost, I am humbly thankful to Allah S.W.T. for the wisdom, love, grace, and beauty I have been blessed with in life.

I am grateful and would like to express my heartfelt to my supervisor Dr. Christopher Teh Boon Sung for his countless hour of refining my writing, reviewing experimental protocols, helping to develop my scientific methodology, unwavering support, guidance and valuable advice throughout the course of my study. This research would not be possible without the support of my supervisor.

I am eternally grateful to Akmal Hafiz Bin Jaafar, my partnership on this project who struggled prepared and run the experiment and exchanged the data for mutual purpose. Besides that, I would like to thank to all lab assistance for the grateful guidance throughout my research execution especially to Encik Abdul Aziz Bin Abdullah, Puan Fouziah Bt Sulaiman, Puan Nor Fariz Bt Sulaiman, and Encik Azali Bin Md Sab.

Last but certainly not the least, I am indebted to my dear family for their love, constant encouragement and support. I am blessed by having them beside me. My family's encouragement and conviction will always inspire me. I dedicated my work to them.

ABSTRACT

The irrigation system (overhead sprinkler, drip irrigation, and a capillary wick system) determines the water supply to water spinach (*Ipomoea reptans*) where water is an adequate element for their growth rate. The main problem for the irrigation system is water loss/wastage. Overhead sprinkler will have the most amount of water loss. The drip irrigation system has irregular water pressure. A capillary wick system does not have much water loss, where it is lost by evaporation process in the PVC pipe. The seeds are directly sown in the Rb900 tube, replacing the polybag. Rb900 tube is made of plastic one alternative way because the tube is lighter and uses less media. The tube system however has not been tested scientifically. The media use was BX-1, but the problem with the media is its nutrient content are not known.

The objective of this project was to compare three irrigation systems (overhead sprinkler, drip irrigation, and a capillary wick system) in term of their effects on: i) Water spinach leaf nutrient contents (N, P, K, Ca, and Mg), ii) Growth rate of water spinach under three different watering system, and iii) BX-1 media analysis. The field experiment was located at Field No. 15, University Putra Malaysia under a rain shelter. There were three replications per treatment. Consequently, the design comprises nine experimental units or plot. The experiment layout was the RCB (Randomized Complete Block) design. Each experiment plot consisted of a single tray or tube stand that accommodated 10 water spinach (*Ipomoea reptans*) seedlings, where each seedling planted in a RB900 rubber tube and with BX-1 as the growth media. The total number of water spinach was required at least 10 plants per plot x 9 plots or 90 plants. Irrigation was carried out daily. For all treatments except the capillary wick system, a daily total of 45 ml of water was supplied to each tube. Plant growth rate was measured once every 7 days until 28 days. A seedling

from every plot was destructively measured. Growth parameter measured were the dry weight of the various plant part (leaves, stem, and roots), total leaf area, and plant height were increased proportional to the time. The leaf tissue samples were oven dried at 105˚C for 2 h and then analysed, following Jones (2001), for its nutrient status of the wet ashing method. These three treatments had significant effects on growth rate and yield of water spinach where capillary wick system, T3 show the highest growth rate and yield of water spinach due to less leached of water. The nutrients status decreased over times because of volatilizations of nutrients to the air and denitrification occurred.

Keywords: Overhead sprinkler, drip irrigation, capillary wick system, BX-1 media, Rb900 tube, water spinach (*Ipomoea reptans)*, growth rate, yield, wet ashing, Kjeldahl method, denitrification.

ABSTRAK

Sistem pengairan (overhead sprinkler, drip irrigat, dan sistem sumbu kapilari) menentukan bekalan air untuk kangkung *(Ipomoea reptans)* yang mana air merupakan elemen penting untuk kadar pertumbuhan pokok. Masalah utama untuk sistem pengairan adalah kehilangan air atau pembaziran. Overhed sprinkler mempunyai jumlah kehilangan air yang paling banyak. Sistem drip irrigation membekalkan tekanan air yang tidak teratur untuk setiap pokok. Sistem kapilari sumbu tidak mempunyai kehilangan banyak air namun air hilang melalui proses penyejatan dalam paip PVC. Benih disemai secara langsung dalam tiub Rb900. Tiub Rb900 diperbuat daripada plastik satu cara alternatif untuk menggantikan polibeg kerana tiub ini lebih ringan dan penggunaan media yang kurang. Walaubagaimanapun, sistem tiub ini belum diuji secara saintifik. Media pertumbuhan yang digunakan adalah BX-1, tetapi kandungan nutrien media ini tidak diketahui.

Objektif projek ini adalah untuk membandingkan tiga sistem pengairan (overhead sprinkler, drip irrigation, dan sistem kapilari sumbu) dari segi kesannya terhadap: i) kandungan nutrient dalam kangkung (N, P, K, Ca, dan Mg), ii) Kadar pertumbuhan kangkung di bawah tiga sistem pengairan yang berbeza, dan iii) analisis BX-1 media. Projek ini dijalankan di Ladang No. 15, Universiti Putra Malaysia di bawah tempat perlindungan hujan. Terdapat tiga replikasi bagi setiap rawatan. Oleh itu, reka bentuk terdiri daripada sembilan unit uji kaji atau plot. Susun atur eksperimen adalah RCB (Blok Rawak Lengkap) reka bentuk. Setiap plot eksperimen terdiri daripada dulang atau pemegang tiub tunggal yang memuatkan sepuluh benih pokok kankung *(Ipomoea reptans)*, setiap anak benih ditanam di dalam tiub Rb900 dan BX-1 sebagai media pertumbuhan. Jumlah kangkung diperlukan sekurang-kurangnya 10 pokok bagi setiap plot plot x 9 atau 90 jumlah pokok. Air dibekalkan setiap hari sebanyak 45 ml air setiap tiub untuk semua

rawatan kecuali sistem kapilari sumbu. Kadar pertumbuhan tumbuhan diukur sekali setiap 7 hari hingga 28 hari. Setiap anak benih dari setiap plot telah diukur secara musnah. Parameter yang diukur adalah berat kering tumbuhan (daun, batang, dan akar), jumlah luas daun, dan ketinggian pokok yang meningkat berkadar terus dengan masa. Sampel tisu daun telah keringkan pada 105˚C selama 2 jam dan kemudian dianalisis, Jones (2001), kaedah pengabuan basah digunakan untuk menentukan status nutrien. Ketiga-tiga rawatan telah memberi kesan ke atas kadar pertumbuhan dan hasil kangkung yang mana sistem kapilari sumbu menunjukkan kesan yang tertinggi ke atas pertumbuhan kangkung kerana sistem ini kurang mempunyai kadar larut lesap ke bawah media. Nutrien status menurun berkadar terus dengan masa kerana pemeruapan nutrien ke udara dan proses denitrifikasi berlaku.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS / SYMBOLS

Kg	Kilogram
g	Gram
cm	Centimeter
mm	Millimeter
ha	Hectare
mL	Milliliter
℃	Centigrade
ψ	Water potential
MPa	Mega Pascal
kPa	Kilopascal
dS cm^{-1}	deciSiemens per centimeter
%	Percentage
D_B / ρ_B	Bulk density
pF	Water retention
CEC	Cation exchange capacity
EC	Electrical conductivity
AA	Auto-analyzer
$cmol^+$ kg^{-1}	Centimole charge per kilogram
AAS	Atomic absorption spectrophotometry
NH_4OAc	Ammonium acetate
K_2SO_4	Potassium sulphate
H_2SO_4	Sulfuric acid
H_2O_2	Hydrogen peroxide
TFW	Total fresh weight
TDW	Total dry weight
WC	Water content
DWL	Dry weight of leaves
DWR	Dry weight of root
DWS	Dry weight of stem
TLA	Total leaf area
H	Height of plants
S:R	Shoot to root ratio (dry weight)
N	Nitrogen
P	Phosphorus
K	Potassium
Ca	Calcium
Mg	Magnesium
SNK-test	Student-Newman-Keuls test
RCBD	Randomized Complete Block Design

CHAPTER 1

INTRODUCTION

1.1 Irrigation System and water spinach.

Water is an essential element for plant growth system. Each crop requires an optimum amount of water for good growth and uneven. In arid regions, irrigation provides the only source of water for agricultural production, while in most semi-arid regions, where most of the agriculture depends on unreliable rainfall. Depending on rainfall alone is not sufficient to provide the optimum amount of water to crops. Rainfall for every planting season of uncertainty, one of the factors of irrigation systems is required. In fact, the irrigation may the only way to maintain high and sustainable agriculture productivity. Farmers have adopted this system for centuries. Irrigation infrastructure may vary from simple hand-watering of plants at the lower end of the scale, to huge irrigation machines, a complex network of canals and water controlling structures, the institutions and organizations that develop and manage the irrigation water supplies and the excess water often associated with irrigation, the irrigation industry, and the service personnel who keep the systems operating, at the upper end of the scale (Jensen, 1991). The principle purpose is simple; to maximize the constant yield of crop production by consuming the water at optimum need by the crops without wasting the water. Besides, to secure the plant from frost damage. The irrigation comprises the management of available water resources by controlling the distribution water to the crops and withdrawal excess water by well drainage.

The full impact of irrigation not only can save time and money consume, it is also influencing the entire growth phase of seedbed preparation, germination, root growth, nutrient utilization, plant growth and re-growth, yield and quality. The key to maximizing irrigation effort is uniformity.

There is a various type of irrigation system that has been applied by the farmers. It is differ in how the water obtained from surface is distributed within field. The goal is to supply the entire filed with water uniformly so that each plant has the amount of water needed.

Water spinach or *Ipomoea reptans* is an herbaceous aquatic or semi-aquatic perennial of plant of the trophic and subtrophics. Water spinach (*Ipomea reptans)* is of East Indian origin and a member of the *Convolvulaceae* (morning glory) family. It has long, jointed and hollow stems, which allow the vines to float on water or creep across muddy ground. Adventitious roots are formed at nodes, which are in contact with water or moist soil. They exude a milky juice, and are white or green, depending on variety. Water spinach has no relationship with common spinach, but it is closely related to sweet potato (*Ipomea batatas*) (Fernando and Dimsey, 2010).

Water spinach has different names according to language and dialect. Water convolvulus, Kang cong and Swamp cabbage are some alternative names in English. For Mandarin, it is known in as Kong xin cai (empty heart/stem vegetable); ong tsoi and weng cai (pitcher vegetable) in Cantonese, Filipino and Malaysian called as kang kong and Japanese called as Asagaona (morning glory leaf vegetable).

1.2 Problem statements

All different irrigation will have a different amount of water loss but the amount of water supply is same except for a capillary wick system. The overhead sprinkler has the most amount of water loss. The amount of waterfall outside the tube is greater than in the tube. For drip irrigation, it has a water pressure problem where different within the plots would be different pressure. For a wick capillary system does not much water loss but the water loss by evaporation process in the PVC pipe under hot condition.

Rb900 tube has not tested scientifically and BX-1 media even does not have basic nutrition (N, P, K, Ca and Mg) information. Insufficient information about the chemical and physical analysis of the media would be the major problem when applying the fertilizer. The toxicity will occur when the fertilizer miscalculate and likewise the deficiency of nutrient. It is important to know the BX1 analysis before planting any crop.

1.3 Objective

1. To analyze the chemical and physical characteristics of the BX-1 media.
2. To analyze the growth rate and yield of water spinach (*Ipomoea reptans*) under three watering systems.
3. To analyze the nutrients content of water spinach leaf (N, P, K, Ca, and Mg) under three watering systems.

1.4 Hypothesis

1. Ho: There is no different of yield and growth rate between the treatments.
2. H_A: There is a different of yield and growth rate between the treatments.

REFERENCES

Andriesse, J. (1988). *Nature and management of tropical peat soils*: Food & Agriculture Org.

Baligar, V. C., Fageria, N. K., & He, Z. L. (2001). Nutrient use efficiency in plants. *Communications in Soil Science and Plant Analysis*, *32*(7-8), 921-950.

Bainbridge, D. A., Almoril, R., & Javier, J. of the presentation: More efficient irrigation systems for desert and dryland restoration. *Restoration and Management Notes*, *8*(1), 1-14.

Beeson, R. C., & Knox, G. W. (1991). Analysis of efficiency of overhead irrigation in container production. *HortScience*, *26*(7), 848-850.

Boelter, D. H. (1969). Physical Properties of Peats as Related to Degree of Decomposition1. *Soil Sci. Soc. Am. J.*, *33*(4), 606-609.

Breckle, S. W., Yair, A., & Veste, M. (2008). *Arid dune ecosystems: the Nizzana Sands in the Negev Desert* (Vol. 200). Springer.

Breda, N. J. (2003). Ground-based measurements of leaf area index: a review of methods, instruments and current controversies. *Journal of experimental botany*, *54*(392), 2403-2417.

Cooper, A. J., Forouhi, N. G., Ye, Z., Buijsse, B., Arriola, L., Balkau, B., ... & Wareham, N. J. (2012). Fruit and vegetable intake and type 2 diabetes: EPIC-InterAct prospective study and meta-analysis. *European journal of clinical nutrition*, *66*(10), 1082-1092.

Chason, D. B., & Siegel, D. I. (1986). Hydraulic conductivity and related physical properties of peat, Lost River Peatland, northern Minnesota. *Soil Science*, *142*(2), 91-99.

Ehlers, W., & Goss, M. J. (2003). *Water dynamics in plant production*. CABI.

Feyen, J., & Mwendera, E. J. (1992). Future irrigation training and research: Needs, strategies and means. *Irrigation and Drainage Systems*, *6*(3), 201-221.

Ginwal, H., Rawat, P., Sharma, S., Bhandari, A., Krishnan, C., & Shukla, P. (2001). Standardization of Proper Volume/size and Type of Root Trainer for Raising *Dalbergia sissoo Seedlings: Nursery Evaluation and Field Trial. Indian Forester, 127(5), 580-590. Retrieved from http://www.i-scholar.in/index.php/indianforester/article/view/2860*

Gnatowski, T., Szatyłowicz, J., Brandyk, T., & Kechavarzi, C. (2010). Hydraulic properties of fen peat soils in Poland. *Geoderma*, *154*(3), 188-195.

Holder, M., Brown, K. W., Thomas, J. C., Zabcik, D., & Murray, H. E. (1991). Capillary-wick unsaturated zone soil pore water sampler. *Soil Science Society of America Journal*, *55*(5), 1195-1202.

Jensen, M. (2007). Beyond irrigation efficiency. *Irrigation Science*, *25*(3), 233-245.

Kechavarzi, C., Dawson, Q., & Leeds-Harrison, P. B. (2010). Physical properties of low-lying agricultural peat soils in England. *Geoderma*, *154*(3), 196-202.

Susila, A. D., Prasetyo, T., & Palada, M. C. (2012). Drip Irrigation: Will It Increase Yield in Traditional Vegetable Production System?

Tran Hoang Chat, Ngo Tien Dung, Dinh Van Binh and Preston T R 2005: Water spinach *(Ipomoea aquatica)* as replacement for guinea grass for growing and lactating rabbits. *Livestock Research for Rural Development. Volume 17, Article #109.* Retrieved October 23, 2014, from http://www.lrrd.org/lrrd17/10/chat17109.htm

Umar, K. J., Hassan, L. G., Dangoggo, S. M., & Ladan, M. J. (2007). Nutritional composition of water spinach (Ipomoea aquatica Forsk.) leaves.*Journal of Applied Sciences*, *7*, 803-809.

Yuan, B. Z., Nishiyama, S., & Kang, Y. (2003). Effects of different irrigation regimes on the growth and yield of drip-irrigated potato. *Agricultural Water Management*, *63*(3), 153-167.