UNIVERSITI PUTRA MALAYSIA

WATER REQUIREMENTS, WATER DISTRIBUTION PATTERN AND POTASSIUM SUBSTITUTION WITH SODIUM FROM SEAWATER FOR PINEAPPLE CULTIVATION ON BRIS SOIL

MD. NIAZUDDIN

FP 2007 8

WATER REQUIREMENTS, WATER DISTRIBUTION PATTERN AND POTASSIUM SUBSTITUTION WITH SODIUM FROM SEAWATER FOR PINEAPPLE CULTIVATION ON BRIS SOIL

By

MD. NIAZUDDIN

Thesis Submitted to the School of Graduate Studies, Univerisiti Putra Malaysia in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

May 2007

DEDICATED
TO
MY MOTHER AND FATHER
MY GRAND FATHER
AND
MY WIFE FARZANA AFROSE (ASHA)
MY SON FAHIM SHAHRIAR
DAUGHTER NILIMA FARZANA (MIHI)

Abstract of thesis presented to the Senate of Univeristi Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

WATER REQUIREMENTS, WATER DISTRIBUTION PATTERN AND POTASSIUM SUBSTITUTION WITH SODIUM FROM SEAWATER FOR PINEAPPLE CULTIVATION ON BRIS SOIL

By

MD. NIAZUDDIN

May 2007

Chairman: Professor M. M. Hanafi, PhD, *AMIC*

Faculty: Agriculture

Pineapple is one of the most traded tropical fruit in Malaysia; mostly planted on peat soil. However, Malaysia has a vast area of sandy fallow beach ridges interspersed swales (BRIS) soil. Due to lack of cultivable land, increasing populations, and urge to improve the standard of living of inhabitants of in this area, there is a need to develop a viable commercial-oriented agriculture. Therefore, the objectives of the study were to estimate the crop water requirements, water distribution patterns, and K substitution with Na from seawater for cultivation of pineapple on BRIS soil. A series of experiments including soil temperature, water distribution, and crop water requirements of the BRIS soil were determined in the glasshouse and field. Water distribution patterns were determined using water application rates of 2, 4, and 8 l/h emitters at different times of duration using a specially designed apparatus. Crop water requirements of 'N-36' of pineapple were estimated by planting of different stages of plants on the lysimeters and using the CROPWAT model. Pineapple stages were adjusted according to their length of growth on the lysimeters and in the model. The estimated crop water requirements was applied in the field at BRIS soil area, Terengganu using Na from seawater for substitution of K requirements of pineapple (based on 300 kg K ha^{-1}) at 15, 30, and 60% in comparison to the control (100% K) using fertigation techniques for 4 months with irrigation water. Pineapple growth, development, and yield were measured. With the exception in the morning, the topsoil temperature of BRIS soil was higher than the subsoil. The temperature gradually increased from 08:00 up to 14:00 hr of a day then decreased. On normal soil temperature and heated soil, the shape of water distribution of the wetted fronts was spherical or ellipsoidal. The higher discharge rate in short duration, the lateral movement was more as compared with the vertical movement. But the opposite was observed when lower discharge rate was applied in long time of duration. Wetted waterfronts were increased with increasing soil temperature in both horizontal and vertical directions. The average calculated crops reference evaporation (ET_c) at the respective stages was 0.83, 0.73, 0.68 and 0.61 mm/day. The calculated average ET_o was 1.99 mm/day. The estimated pineapple crop coefficient (K_c) value (0.50) was the highest at the early growing stage 1 because of the maximum ET_c occurred from the bare soil and young pineapple with limited transpiration rate. The Kc value for pineapple was 0.30 at stage 2 to 4. The average depth of fertigation in the field using CROPWAT model was 1.67 mm/day. Application of 0, 15 and 30% Na from seawater substitution for K on plant height, number of leaf per plant, D-leaf length, and area, fresh and dry weight was not significantly different. Fruit length, diameter, and weight obtained from Na application at 15, and 30% Na for K substitution were not significantly different from 0% Na (100% K) treatment. The results indicate that up to 30% of pineapple K requirement can be substituted by Na obtained from seawater. Knowing the emitter size and soil water movement could ensure precise placement of water and nutrients in the active roots zone.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KEPERLUAN AIR, PATEN TABURAN AIR DAN PENGGANTIAN KALIUM OLEH NATRIUM DARIPADA AIR LAUT UNTUK PENANAMAN NANAS PADA TANAH BRIS

OLEH

MD. NIAZUDDIN

Mei 2007

Pengerusi: Profesor M. M. Hanafi, PhD, *AMIC*

Fakulti: Pertanian

Nenas merupakan salah satu buahan tempatan yang paling laris di Malaysia, yang mana ianya di tanam di tanah gambut. Namun begitu, Malaysia mempunyai kawasan tanah 'sandy fallow beach ridges interspersed swales (BRIS)' yang begitu luas. Dengan kawasan tanaman yang terhad, peningkatan populasi, dan usaha untuk menambah 'standard of living for BRIS area', ini memerlukan pelaksanaan ke arah orientasi pertanian yang mantap dan berdaya maju. Satu siri kajian di makmal lapangan telah di lakukan dengan menggunakan tanah BRIS untuk menanam nenas. Contoh-contoh tanah Bris telah dikumpul dan untuk menentukan suhu, taburan air keperluan airnya. Satu peralatan khas telah direkabentukuntuk digunakan untuk mengkaji kesan kadar penggunaan air, isipadu air, dan tempoh pembasahan permukaan tanah BRIS. Penggunaan air dengan kadar 2,4 dan 8 liter/ jam telah digunakan bagi tempoh masa yang berbeza. Bagi menentukan pekali tanaman untuk nenas pada tanah BRIS, lisimeter dan panci penyejatan Kelas A telah digunakan untuk menganggar penyejatan rujukan tanaman (ET_c) dan penyejatan rujukan (ET_o) dalam rumah kaca. Model CROPWAT pula telah digunakan untuk mengira

keperluan air tanaman (CWR) bagi nenas. Tiga kadar Na dari gantian air laut bagi K pada 15, 30 dan 60% telah dibandingkan dengan kawalan 0% Na (100% K) berdasarkan 300 kg/hektar pada pertumbuhan nenas. Pembangunan dan hasil penggunaan tanah BRIS dengan menggunakan teknik titisan fertigation dan larutan ini telah diaplikasikan selama 4 bulan dengan penggunaan air pengairan.profil suhu tanah BRIS menunjukkan suhu tanah atas adalah lebih tinggi dari suhu tanah bawahnya, kecuali pada waktu pagi. Meskipun begitu, suhu ini meningkat dengan mendadak sehingga 14.00 jam untuk satu hari dan kemudian suhunya mula menurun. Eksperimen pergerakan air pada tanah normal dan panas pula menunjukkan bentuk permukaan basahnya adalah bulat atau bujur. Dengan meningkatnya kadaralir dalam tempoh yang singkat, pergerakan sisi lebih banyak berlaku jika dibandingkan dengan pergerakan menegak. Dari pemerhatian, pergerakan bertentangan pula akan berlaku apabila kadaralir yang rendah dilakukan bagi tempoh masa yang panjang. Keputusan ini akan memastikan kedudukan air dan nutrient berada peda zon akar aktif. Permukaan air akan meningkat dengan pertambahan suhu tanah bagi kedua-dua arah menegak dan mendatar. Tahap pertumbuhan nenas 'N-36' telah diperbetulkan mengikut panjang pertumbuhannya pada lisimeter. Kedalaman purata pengairan air bagi tahap pertumbuhan 1,2,3 dan 4 adalah 2.43,1.56,1.54 dan 1.55 mm/hari dan purata penyejatan rujukan tanaman (ET_c) yang dikira adalah 0.83,0.73,0.68 dan 061 mm/hari. Nilai bagi penyejatan rujukan (ET_o) pula adalah1.99 mm/hari. Nilai pekali tanaman nenas (K_c) pula menunjukkan bacaan tertinggi pada iaitu 0.50 di mana iai berlaku pada tahap pertumbuhan awal kerana Etc maksimum berlaku dari tanah atas dan nenas yang mengalami prosos tranpirasi yang terhad. Nilai Kc untuk nenas pula adalah 0.30 pada tahap 2 dan 4. penggunaan na sebanyak 0,15 dan 30% dari gantian air laut untuk K pada ketinggian tumbuhan, bilangan daun, panjang D-daun, dan keluasan, kesegaran dan berat kering adalah tidak banyak berubah. Pangang buah, diameter dan beratnya diperolehi dari penggunaan Na sebanyak 15 dan 30% untuk penggantian K juga tidak banyak berubah daripada 100% rawatan K. Keputusan menunjukkan sebanyak 30% keperluan K nenas boleh digantikan dengan Na yang diperolehi dari air laut.

ACKNOWLEDGEMENTS

Praise to Almighty Allah for His blessings, kindness and giving the author proper guidance, strength, and will to complete this study.

The author wishes to express his heartfelt gratitude, indebtedness, and deep sense of respect to Professor Dr. M.M.Hanafi, the Chairman of the Supervisory Committee for his sincere support, guidance, constant encouragement, invaluable suggestions and generous help throughout the study period. He provided the author all facilities needed to complete this works. The author also much indebted and grateful to Dr. Abdul Aziz Zakaria and Dr Mohmmud Che.Husain, members of the supervisory committee for their encouragement, constructive advice and guidance in formulation and execution of the research project and critical review of the manuscript.

The author thankfully acknowledges to the UPM for providing financial support and facilitating him to study in Malaysia. The author also expresses his profound appreciation to the Peninsular Pineapple Plant State, Simpang leggam, Johor, Malaysia; Department of Agricultural Extension (DOA) and Malaysian Metrological Service (MMS) for supply of pineapple plants, weather data and allocation of their land to conduct experiments. Furthermore, he is grateful to the Bangladesh Institute of Nuclear Agricultural (BINA) for providing the deputation and all kinds of help to accomplish his degree.

The author feels proud to express his sincere appreciation and indebtedness to Mr Zainudin Bin Mohammad Ali, Mr. Alias Bin Tahar, Mr.Mohamed Shukri bin

Awang, Mr. Altab Hossain and Hartinee bt. Abbas for their cooperation, help and assistance in glasshouse and field experiments. He would like expressing his special thanks to his friends Mr. Abdullah Al Mamun, Dr. Mirza Mofazzal Islam (Apu) and Mr. Asharaful Islam (Belal) for their helps, inspiration and cooperation. He also wishes to express his appreciation to all of his colleagues, friends and well wishers.

The author respectfully acknowledges the blessings and good wishes of his parent; his teachers, uncles-unties, brothers, sisters, and relatives. He is especially grateful to his late father-in law and mother-in law, who provided lots of encouragement, moral support and looked after his wife and children in his absence. Special gratitude must go to his son Fahim Shahriar and daughter Nilima Farzana Mihi who have faced difficult times during his study period. Without their love, great sacrifice, patience, and support this study would not have been possible.

Finally, and above all, the author's wife Farzana Afrose Asha deserves a lot of thanks and appreciation not only for her love and care, but also for bearing the burden and responsibilities of taking care of their children in his absence, in addition, for active cooperation and support to conduct experiments and encouragement for a higher degree. The author really appreciates the hardship she faced due to his absence.

I certify that an Examination Committee has met on 3rd May 2007 to conduct the final examination of Md. Niazuddin on his Doctor of Philosophy thesis entitled “Water Requirements, Water Distribution Pattern and Potassium Substitution with Sodium from Seawater for Pineapple Cultivation on BRIS soil” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

Y. Bhg. Mohd. Khanif Yusop, PhD
Professor
Department of Land Management
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Jamil Talib, PhD
Associate Professor
Department of Land Management
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Fazlil Illahi Abd. Wahab, PhD
Department of Agricultural Technology
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Gabriels Donald, PhD
Professor
Department of Soil Management and Soil Care
Faculty of Agricultural & Applied Biological Science
Ghent University, Belgium 32-9-264 6036
(External Examiner)

HASANAH MOHD. BT. GHAZALI, PhD
Professor/Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 03 AGUEST 2007

This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee are as follows:

M. M. Hanafi, PhD *AMIC*
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Abdul Aziz Zakaria, PhD
Lecturer
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Mohammud Che Husain, PhD
Deputy Director
Mechanization and Automation Research Center
Malaysian Agricultural Research and Development Institute (MARDI)
(Member)

____
AINI IDRIS, PhD
Professor/Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 9 August 2007

DECLARATION

I hereby declare that the thesis is based on my original work except for quotation and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

MD. NIAZUDDIN

Date: 09 July 2007

TABLE OF CONTENTS **Page**

LIST OF TABLES

LIST OF FIGURES