UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF GRAFTED SALT-TOLERANT ROCKMELON (Cucumis melo L.) USING VARIOUS SALINITY SOURCES TO IMPROVE PLANT PERFORMANCE

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FP 2022 20

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillments of the Requirements for the Degree of Master of Science

November 2021

Abstracts of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Nowadays, there is an increase in demand for high fruit quality of rockmelon for local and export market. To improve fruit quality, salt addition in nutrient solution is a viable approach that can be implemented. However, excess and continuous supply deleteriously affects the rockmelon's growth and yield. One of the potential strategies to utilize varying sources of salinity for fruit quality improvement without causing growth and yield reduction is by growing grafted rockmelon using salt-tolerant *Cucurbitaceae* rootstock. Therefore, the objectives of this research are to determine a suitable rockmelon scion age to be grafted on cucurbit rootstocks, to identify the salinity tolerance levels of grafted rockmelon and to evaluate the growth, physiological process, yield and fruit quality of salt-tolerant grafted rockmelon under varying salinity sources. Three scion ages (8, 13 and 18 days after sowing; DAS) of rockmelon (cv. Glamour) were grafted onto two types of *Cucurbitaceae* viz. bottle gourd (*Lagenaria siceraria*) and bitter gourd (*Momordica charantia*). These factorial combinations were arranged in a Randomized Complete Block Design (RCBD) with three replications. Rockmelon scion ages at 13 and 18 DAS were found to be suitable for both cucurbit rootstocks, as they exhibited higher scion height, leaf number, leaf and stem dry weight compared to 8 DAS. Thus, 13 DAS scion age of rockmelon which served as the fastest scion produced was selected to be used for grafting in the subsequent study. The following experiment involved grafting of 13 DAS rockmelon scion age onto three cucurbit rootstocks (self-grafted, bottle gourd, bitter gourd) and subjected to four levels of NaCl salinity (0, 25, 50, 75 mM). These factorial combinations were arranged in a RCBD with three replications. Among graft combinations, rockmelon/ bottle gourd was classified as the least salt-sensitive due to its capability to reduce

toxic ions (Na^+ and Cl^-) accumulation in the leaf, acquired moderate plant water status among others while having the least significant relationships in growth reductions under saline conditions. Furthermore, NaCl levels at 75 mM were found to be detrimental on most of the growth parameters, leaf gas exchanges and relative water content, which further causes ionic stress that negatively affected nutrient availability in rockmelon. Therefore, graft combination of rockmelon/ bottle gourd and salinity level at 50 mM were selected to be tested in the last experiment. In the last experiment, rockmelon/ bottle gourd was subjected to four types of salinity sources (Basic nutrient solution; BNS, NaCl (50 mM) + BNS, KNO_3 (50 mM) + BNS, high strength nutrient solution; NS). These treatments were arranged in a RCBD with four replications. It is revealed that, salinity induced by NaCl (50 mM) salt and high strength NS is capable to increase fruit quality components without interfering the physiological process. When treated with KNO_3 (50 mM) salt, most of the growth and fruit quality parameters were sustained. However, the physiological process such as photosynthetic pigments was significantly impaired. Yield component such as fruit weight were decreased regardless of salinity sources by NaCl (28.8%), KNO_3 (28.26%) and high strength NS (27.72%) applications as compared to BNS treatment. Overall, 13 DAS scion age is recommended to be grafted with bottle gourd as a salt-tolerant rootstock for rockmelon. Taking into account the cost saving factor, incorporation of NaCl (50 mM) in nutrient solution is a feasible approach on rockmelon/ bottle gourd due to high fruit quality results whilst sustaining all the physiological process.

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

PENGHASILAN CANTUMAN ROCKMELON (*Cucumis melo* L.) YANG TAHAN KEMASINAN BAGI PENGGUNAAN KEMASINAN YANG PELBAGAI UNTUK MENINGKATKAN PRESTASI TANAMAN

Oleh

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Pada masa ini, terdapatnya peningkatan dalam permintaan terhadap rockmelon yang berkualiti tinggi bagi tujuan pasaran tempatan dan eksport. Untuk meningkatkan kualiti buah, penambahan garam ke dalam larutan nutrien merupakan pendekatan yang relevan untuk dipraktikkan. Bagaimanapun, pemberian yang berlebihan dan berterusan mengakibatkan kesan yang buruk terhadap pertumbuhan dan hasil rockmelon. Salah satu strategi yang berpotensi untuk menggunakan sumber kemasinan bagi peningkatan kualiti buah tanpa menyebabkan penurunan pertumbuhan dan hasil adalah melalui penanaman rockmelon yang dicantum menggunakan penanti *Cucurbitaceae* yang toleran kepada kemasinan. Maka itu, objektif kajian ini dijalankan adalah untuk menentukan umur scion rockmelon yang sesuai untuk dicantumkan ke atas penanti cucurbit, untuk mengenalpasti tahap ketahanan cantuman rockmelon terhadap kemasinan dan untuk menilai pertumbuhan, proses fisiologi, hasil dan kualiti buah cantuman rockmelon yang toleran terhadap kemasinan pada sumber kemasinan yang pelbagai. Tiga umur scion (8, 13 dan 18 hari lepas penyemaian; DAS) rockmelon (varieti Glamour) dicantumkan ke atas dua jenis *Cucurbitaceae* iaitu labu botol (*Lagenaria siceraria*) dan peria katak (*Momordica charantia*). Gabungan faktorial ini disusun di dalam rekabentuk rawak blok lengkap (RCBD) dengan tiga replikasi. Umur scion rockmelon pada 13 dan 18 DAS dilihat bersesuaian untuk kedua-dua penanti cucurbit, di mana ianya mempamerkan tinggi scion, bilangan daun, berat kering daun dan batang yang lebih tinggi dibandingkan kepada 8 DAS. Maka, 13 DAS umur scion rockmelon yang mana berupaya menjadi scion yang terpantas untuk dihasilkan adalah dipilih untuk digunakan bagi cantuman pada kajian yang berikutnya. Eksperimen yang seterusnya melibatkan cantuman scion rockmelon yang berusia 13 DAS yang dilakukan ke atas tiga penanti cucurbit

(rockmelon, labu botol, peria katak) dan dirawat menggunakan empat tahap kemasinan NaCl (0, 25, 50, 75 mM). Gabungan faktorial ini disusun di dalam RCBD dengan tiga replikasi. Antara kombinasi cantuman, rockmelon/ labu botol diklasifikasikan sebagai paling kurang sensitif kepada kemasinan disebabkan oleh kemampuannya untuk mengurangkan pengumpulan ion-ion toksik (Na^+ and Cl^-) di daun, beroleh status air pokok yang sederhana antara semua, di samping memiliki pertalian ketara yang paling kurang dalam pengurangan pertumbuhan di bawah keadaan yang masin. Selain itu, tahap NaCl pada 75 mM dilihat menjejaskan pada hampir kesemua parameter pertumbuhan, pertukaran gas daun dan kandungan air relatif, di mana seterusnya menyebabkan tegasan ion yang secara negatifnya mempengaruhi kedapatan nutrien di dalam rockmelon. Maka itu, kombinasi cantuman rockmelon/ labu botol dan kadar kemasinan pada 50 mM adalah dipilih untuk diuji pada eksperimen yang terakhir. Di dalam eksperimen terakhir ini, rockmelon/ labu botol dirawat menggunakan empat jenis sumber kemasinan (Larutan nutrien asas; BNS, NaCl (50 mM) + BNS, KNO_3 (50 mM) + BNS, larutan nutrien asas berkepekatan tinggi). Kajian membuktikan bahawa, kemasinan yang dirawat menggunakan garam NaCl (50 mM) dan larutan nutrien asas berkepakatan tinggi berupaya untuk meningkatkan komponen kualiti buah tanpa menjejaskan proses fisiologi. Apabila diaruh menggunakan garam KNO_3 (50 mM), hampir keseluruhan parameter pertumbuhan dan kualiti buah adalah tidak terjejas. Walaubagaimanapun, proses fisiologi seperti pigmen fotosintesis adalah terjejas dengan ketara. Komponen hasil seperti berat buah adalah berkurangan tanpa mengira sumber kemasinan pada aplikasi NaCl (28.8%), KNO_3 (28.26%) dan larutan nutrien asas berkepakatan tinggi (27.72%) apabila dibandingkan dengan rawatan larutan nutrien asas. Secara keseluruhannya, 13 DAS umur scion adalah dicadangkan untuk dicantumkan dengan labu botol sebagai penanti yang tahan kemasinan kepada rockmelon. Mengambil kira faktor kos, penggunaan NaCl (50 mM) di dalam larutan nutrien adalah pendekatan yang terbaik pada rockmelon/ labu botol disebabkan penghasilan kualiti buah yang tinggi di samping tidak menjejaskan keseluruhan proses fisiologinya.

ACKNOWLEDGEMENTS

First and foremost, I wish to express my utmost thanks and eternal indebtedness to the Almighty Allah for giving His blessing and providing me with the strength to accomplish this research successfully.

I would like to express my sincere and profound appreciation to the chairman of my supervisory committee, Dr. Muhamad Hazim Bin Nazli who has contributed much effort in guiding and providing me with great knowledge throughout my study. Finding adequate words is difficult for express my gratitude to my former supervisor, Assoc. Prof. Dr. Yahya Bin Awang, for his continuous support, great supervision and insightful ideas and comments. Thank you for making me a better researcher than I was two years ago, and I shall miss this fantastic experience very much. I would like to also extend my gratitude to the members of my supervisory committee, Dr. Juju Nakasha Binti Jaafar and Dr. Zulhazmi Bin Sayuti for their kind encouragement and useful advice.

My acknowledgment also goes to the officers from Agrotechnology Park UPM, Mr. Sayyidina Hamzah Bin Muhammad, Mr. Suhaimi Bin Ab. Rahim and Miss Wan Suhana Binti Wan Talib for their valuable support along this research especially in providing myself with technical advices. Special thanks to Mr. Mazlan Bin Bangi and Mr. Mohd Norhaizan Bin Saliudin from Department of Crop Science, UPM for assisting me in completing my laboratory works. A special gratitude also goes to Dr. Rozlaily Binti Zainol and Dr. Azlina Binti Masdor from MARDI for permitting me to use the laboratory facilities to complete my biochemical analysis. I am also greatly indebted, and would like to extend my sincere appreciation to my dearest friends Mr. Muhammad Najib Bin Othman Ghani, Mr. Aziz Bin Rashid, Mr. Erwan Shah Bin Shari, Mr. Hairi Bin Mad Zin, Mr. Albert Ting Koon Soon, Mr. Zul Helmey Bin Mohamad Sabdin, Mr. Mohd Shahril Firdaus Bin Ab Razak, Md Aiman Takrim Bin Zakaria, Mr. Mohamad Rais Bin Hasan and Mrs Zalina Binti Ahmad for their encouragements and support which had contributed in one way or another to this work.

I would like to take this opportunity to dedicate this master thesis for my beloved wife Mrs. Nor Dalila Binti Nor Danial and loving children, Muhammad Danish Rayyan and Muhammad Akid Rayhan for their love, understanding, and continuous support that accompanied me through this journey. My honest heartfelt appreciation towards my parents Sabaniah Binti Ismail and Hassan Bin Arshad for their blessings and prayers to complete my study as well as my siblings and extended family, Hj Ismail group for always landing me a helping hand. Finally, thank you MARDI for providing this scholarship and giving me this wonderful opportunity.

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

mM	Milimolar
mmol/L	Milimolar per litre
MPa	Megapascal
RWC	Relative water content
μmol	Micromole
nmol	Nanomole
DW	Dry weight
FW	Fresh weight
TW	Turgid weight
EC	Electrical conductivity
MDA	Malondialdehyde
ROS	Reactive oxygen species
dS/m	Decisiemens per metre
TW	Turgid weight
K/Na	Potassium to sodium ratio
N	Newton
°C	Degree celsius

CHAPTER 1

INTRODUCTION

Rockmelon which is also known as muskmelon (*Cucumis melo* L.*)* is a short-term horticultural crop that belongs to the *Cucurbitaceae* family. It is contained with source of antioxidants such as carotenes and flavonoids and being enriched with vitamin B, vitamin C, folate and panthothenic acid. It is also high in fiber, low in fat and cholesterol free, as well as source of many essential nutrients including potassium and magnesium (Lester, 1997). In Malaysia, rockmelon is commercially grown to fulfill the demand for local and export markets in the form of fresh fruit and processed products. Over the years, rockmelon productions have increased drastically to 45.56% since 2012-2018 with total productions recorded at 5,845.71 mt in 2018 (Department of Agriculture, 2018). The increase in production areas is due to high demand from consumers for a high fruit quality of rockmelon. According to Lester (2006), fruit quality characteristics including sweetness, taste, texture and flavour are the most important reason that highly preferred by the consumers in melon productions.

In order to increase fruit quality, salinity application by supplementation of salt into nutrient solution is a feasible approach and fairly easy to be adapted. Accumulation of salt may increase the root zone solute which further caused low soil water potential. Thus, the plant had reduced their water absorbtion capacity that increased dry-matter components. Increased in dry matter components ultimately enhanced fruit quality attributes including total soluble solid, total titratable acidity and sugar acid ratio. This is accordance with Costa *et al.*, (2013) that the fruit quality enhancement was accompanied by the increase of dry-matter concentration which is associated with water uptake reduction. It also has been broadly reported that, salinity could enhance fruit quality attributes and this has been demonstrated for a number of crops, such as tomato and watermelon (Machado and Serralheiro, 2017). Unfortunately, there is no current research regarding this approach has been conducted on rockmelon to this point in time.

While, excess and continuous supply of salt could lead to salinity development and deleteriously affect the rockmelon's growth, physiological process and yield. Reduction of growth and physiological process under saline environment simultaneously resulted to lower yield productions. Lower fruit yield in salinized rockmelon is not marketable as the fruit is perceived to be of a lower grade. Since, rockmelon has been classified as moderately sensitive to salt stress among cucurbit species (Pessarakli, 2016), supplementation using different sources of salinity can be done to improve fruit quality without causing growth and yield reduction (Zhang *et al.*, 2016).

Therefore, rockmelon variety that is tolerant to salinity is needed for enabling the use of various sources of salinity. Developing such salt tolerance variety through the selection and conventional breeding program is time-consuming with low commercial success due to the complexity of the traits, as salt resistance characteristics contain dynamic genetic and physiological interactions (Flowers, 2004).

Hence, grafting among potential salt-tolerant cucurbit rootstocks has a higher potential to increase the salt tolerance level in rockmelon. By using salt-tolerant grafted rockmelon from grafting procedure established, the salinity tolerance level could be enhanced and the various sources of salinity can be utilized for the growth and yield improvement without interfering in the physiological process. This research may contribute to the future development of growing rockmelon with salt addition, which will improve fruit quality without causing growth and yield reduction. Knowledge produced in this study may be useful in improving rockmelon development practices in Malaysia as well as exploiting new research pathways for rockmelon in the future. Considering these factors, this research is thus necessary to be done with the objectives:

1. to determine the suitable age of rockmelon scion to be grafted on potential salt-tolerant cucurbit rootstocks
2. to identify the salinity tolerance levels of rockmelon grafted on potential salt-tolerant cucurbit rootstocks
3. to evaluate the growth, physiological process, yield, and fruit quality of rockmelon grafted on salt-tolerant rootstock under varying salinity sources.

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