EFFECTS OF PLANT SUPPORT SYSTEM AND INTERCROPPING WITH LONG BEAN (*VIGNA SINENSIS*) ON GROWTH, YIELD AND FRUIT QUALITY OF RED DRAGON FRUIT (*HYLOCEREUS POLYRHIZUS*)

By

MARTINI MOHAMMAD YUSOFF

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Master of Agricultural Science

May 2006

Specially dedicated

to my husband, family and friends for their continued

support and everlasting love

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

EFFECTS OF PLANT SUPPORT SYSTEM AND INTERCROPPING WITH LONG BEAN (*Vigna sinensis*) ON GROWTH, YIELD AND FRUIT QUALITY OF RED DRAGON FRUIT (*Hylocereus polyrhizus*)

By

MARTINI MOHAMMAD YUSOFF

May 2006

Chairman : Associate Professor Mohd Ridzwan Abdul Halim, PhD

Faculty : Agriculture

Climbing epiphytic cacti, particularly members of the genera *Hylocereus* known as pitaya or dragon fruit, have recently drawn much attention of growers worldwide because of their economic value as food products and also owing to their high nutritive and medicinal values. These cacti are branched climbers needing strong structures to ensure their vigorous growth and heavy fruit yield for maximum yield production. Various designs of structure have been used to provide such support. In addition, it normally takes 12 to 18 months for dragon fruit to bear fruits after planting. Thus, it would be useful if intercropping could be practiced during this juvenile period of dragon fruit. Therefore a study was conducted to determine the effects of using three plant support systems, the pole, T bar trellis and V shape on growth, yield and fruit quality of dragon fruit and to evaluate the use of long bean as an intercrop with dragon fruit.

Red dragon fruit (*Hylocereus polyrhizus*) as the main crop and long bean (*Vigna sinensis*) as the intercrop were used in this study. Two experiments were conducted, one involving field planting of dragon fruit with the respective support systems intercropped with long bean while the other was conducted using box planting to evaluate root interaction between dragon fruit and long bean.

In the first experiment, the support systems indicated significant effects during the reproductive stage of dragon fruit resulting in differences in total number of flower buds produced, percentage of flowers aborted, fruit number and total fruit weight. Dragon fruit plants using the pole system showed 17–38% more flower buds produced, 15–36% more fruits and 24% heavier total fruit weight compared to those of the T-bar trellis and V- shape systems, respectively. There were also significant effects of plant support systems on soluble solid concentration (% Brix) where T-bar trellis and pole systems showed 7% higher in the value of soluble solid concentration than the V-shape system. Intercropping had no influence in all the parameters measured.

Support systems did not have any significant effect on the vegetative characteristics of dragon fruit plants, such as days to produce new shoot from planting, number of shoots produced per cutting, stem diameter of dragon fruit, total stem surface area, chlorophyll content of stem and length of branch. Support systems also showed no significant effects on fruit size and days to attain fruit maturity in dragon fruit, and in the yield of long bean (two cycles). Similarly, fruit quality including fruit pH, peel and pulp colour and titratable acidity were not affected by different support systems or intercropping.

Intercropping of long bean with dragon fruit, however, increased the incidence of insect damage.

Based on the cost of the support system and yield of fruit obtained, the most cost effective support system is the pole system, which had the highest potential for fruit yield to recover its higher initial cost of construction especially if cheaper construction materials were made available. Although the V-shaped and T-bar trellis support systems had lower cost of construction than the pole system, their lower fruit yield would not generate high farm income over a longer period. Besides the pole support system had the advantage of simpler construction design and easier weed control.

Land equivalent ratio (LER) for intercropping was shown to be higher than monocropping as indicated by an LER value greater than 1. Relative value total (RVT) of the V-shape system was higher than those of pole and T-bar trellis systems. Intercropping of dragon fruit and long bean also resulted in higher profitability index compared to dragon fruit as a sole crop.

In the second experiment, dragon fruit showed 87% greater root volume when grown with long bean with the presence of soil partition than when grown as a monocrop in boxes. This indicated that there was more competition for root space between the dragon fruit plants when they were grown as a monocrop than when they were intercropped with long bean. Dragon fruit roots grow laterally while those of long bean grow deeper with prominent tap root system. Dragon fruit planted with long bean with or without the

soil partition had higher total root surface area compared with dragon fruit as a sole crop. Similar trend was detected in average root diameter of dragon fruit.

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

KESAN_KESAN SISTEM SOKONGAN TANAMAN DAN PENANAMAN SELINGAN KACANG PANJANG (*Vigna sinensis*) KE ATAS PERTUMBUHAN, HASIL DAN KUALITI BUAH NAGA MERAH (*Hylocereus polyrhizus*)

Oleh

MARTINI BT MOHAMMAD YUSOFF

Mei 2006

Pengerusi : Profesor Madya Mohd Ridzwan Abdul Halim, PhD

Fakulti : Pertanian

Ketika ini kaktus jenis memanjat, terutamanya daripada genus *Hylocereus* yang dikenali sebagai pitaya atau buah naga, telah mendapat banyak perhatian daripada penanam-penanam di merata dunia kerana nilai ekonominya sebagai produk makanan dan di samping ianya juga terkenal dengan kandungan nilai pemakanan dan perubatan yang tinggi. Kaktus ini yang bercabang dan memanjat memerlukan struktur yang kuat untuk menyokong pertumbuhannya yang cepat dan hasil yang tinggi bagi menjamin pengeluaran hasil yang maksimum. Pelbagai rekabentuk struktur sokongan telah digunakan. Di samping itu buah naga mengambil masa 7 ke 12 bulan untuk berbuah selepas ditanam. Dalam tempoh juvenil buah naga, adalah bermanfaat sekiranya dilakukan selingan tanaman. Oleh itu, satu kajian telah dijalankan untuk menentukan kesan penggunaan tiga sistem sokongan penanaman : tiang, T bar trelis dan bentuk V ke atas pertumbuhan, hasil dan kualiti buah naga dan menilai kesesuaian kacang panjang sebagai tanaman selingan dengan buah naga.

Buah naga merah (*Hylocereus polyrhizus*) sebagai tanaman utama dan kacang panjang (*Vigna sinenis*) sebagai tanaman selingan telah digunakan dalam kajian ini. Dua eksperimen telah dijalankan, satu melibatkan penanaman buah naga di lapangan dengan sistem-sistem sokongan yang dipilih dan diseling dengan kacang panjang manakala satu lagi dilaksanakan dengan menggunakan kotak penanaman untuk menilai tindakbalas akar antara buah naga dengan kacang panjang.

Dalam eksperimen pertama, sistem-sistem sokongan menunjukkan kesan yang signifikan ke atas jumlah tunas bunga yang dihasilkan, peratus bunga gugur, bilangan buah dan jumlah berat buah semasa peringkat reproduktif buah naga. Pokok buah naga yang menggunakan sistem sokongan tiang menunjukkan 17-38% lebih banyak tunas bunga dihasilkan, 15-36% lebih banyak buah dan 24% lebih jumlah berat buah berbanding sistem-sistem T bar trelis dan bentuk V. Kesan-kesan yang signifikan juga ditunjukkan oleh sistem-sistem sokongan yang digunakan ke atas kemanisan buah (% Brix) di mana sistem-sistem T bar trelis dan tiang menunjukkan 7% lebih tinggi dalam nilai kemanisan buah berbanding sistem bentuk V. Selingan tanaman tidak mempengaruhi semua parameter yang diukur.

Penggunaan sistem-sistem sokongan tidak menyebabkan sebarang kesan yang signifikan ke atas ciri-ciri vegetatif pokok-pokok buah naga seperti bilangan hari untuk tunas keluar, bilangan tunas keluar untuk setiap pokok, diameter batang, jumlah luas permukaan batang, kandungan klorofil dalam batang, panjang batang dan hasil kacang (dua pusingan/kitaran). Sistem sokongan juga tidak menunjukkan kesan-kesan yang signifikan ke atas saiz buah dan bilangan hari untuk mencapai buah matang. Kualiti

buah termasuk pH buah, warna kulit dan isi buah dan keasidan dalam buah juga tidak dipengaruhi oleh sistem-sistem sokongan atau oleh selingan tanaman. Selingan tanaman kacang panjang dengan buah naga meningkatkan serangan serangga perosak.

Berdasarkan kepada kos sistem sokongan dan juga hasil yang diperolehi, kos sistem sokongan yang paling efektif adalah sistem tiang yang berpotensi tinggi untuk menghasilkan buah yang dapat membayar balik kos pembinaan asal yang tinggi, terutamanya jika terdapat bahan-bahan pembinaan yang murah. Walaupun sistem bentuk V dan T bar trelis melibatkan kos pembinaan yang rendah berbanding sistem tiang, hasil buahnya yang rendah tidak dapat memberi pendapatan ladang yang tinggi dalam jangkamasa panjang. Selain itu, rekabentuk sistem tiang adalah lebih ringkas dan mudah dalam pengawalan rumpai.

Nisbah persamaan tanah (LER) menunjukkan adalah lebih baik mengamalkan selingan tanaman daripada menanam satu jenis tanaman sahaja dengan nilai LER lebih daripada satu. Jumlah nilai relatif untuk sistem V adalah lebih tinggi berbanding sistem-sistem tiang dan T bar trelis. Selingan tanaman buah naga dan kacang panjang juga menunjukkan indeks keuntungan yang lebih tinggi berbanding tanaman buah naga sahaja.

Dalam eksperimen kedua yang menggunakan kotak, buah naga menunjukkan 87% lebih tinggi isipadu akar apabila ditanam dengan kacang panjang dengan kehadiran pembahagi tanah berbanding jika ditanam bersendiri sahaja di dalam kotak. Ini menunjukkan persaingan yang lebih tinggi untuk ruang akar di antara pokok-pokok buah

naga apabila buah naga sahaja ditanam berbanding jika buah naga ditanam dengan kacang panjang. Akar buah naga tumbuh menjalar manakala akar kacang panjang tumbuh lebih mendalam dengan sistem akar tunjangnya. Buah naga yang ditanam dengan kacang panjang, dengan adanya pembahagi tanah atau tidak, menunjukkan luas permukaan akar buah naga yang lebih tinggi berbanding jika hanya tanaman buah naga sahaja. Keadaan yang sama berlaku bagi purata diameter akar buah naga.

ACKNOWLEDGEMENTS

My utmost appreciation and heartfelt gratitude go to my supervisor Associate Prof. Dr. Mohd. Ridzwan Abdul Halim for his guidance, advice and support throughout the course of this study leading to the completion of the thesis. My sincere thanks are extended to Assoc. Prof. Dr Mahmud Tengku Muda Mohamad, Assoc. Prof. Dr Syed Omar Syed Rastan and Dr Zainudin Meon of the supervising committee for their assistance and encouragement.

My deepest appreciation is dedicated to Mr. Mohd. Ariff Omar, my sister Masnira, Emi and Azahar, my brother Marzuki, Mr. Fitri, Mr. Han, Mr. Abd. Kadir, Miss Hollena Nori and Miss Zaharah, for their assistance and support throughout the duration of my study. Also to Mak, Cik and Ma for their prayers and support.

I am also thankful to all staff of Universiti Agriculture Park, U.P.M, Soil Science Laboratory of Faculty Agriculture, Food Technology Laboratory of Faculty of Food and Technology for their assistance in conducting many of the analyses and also to many individuals who have directly or indirectly assisted me in carrying out the study.

I certify that an Examination Committee has met on 4 May 2006 to conduct the final examination of Martini Mohammad Yusoff on her Master of Agricultural Science thesis entitled "Effects of Plant Support System and Intercropping with Long bean (*Vigna sinensis*) on Growth, Yield and Fruit Quality of Red Dragon Fruit (*Hylocereus polyrhizus*)" 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:

Mohd. Fauzi Ramlan, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Hawa Jaafar, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Mohd Mat Lassim, PhD
Associate Professsor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Mike A. Nagao, PhD
Professor
College of Tropical Agriculture and Human Resources
University of Hawaii
(External Examiner)

_____

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

Date:

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

Mohd. Ridzwan Abdul Halim, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Syed Omar Syed Rastan, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Mahmud Tengku Muda Mohamad, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Zainudin Meon, PhD
Malaysian Agriculture Research and Development Institute (MARDI)
Serdang Selangor
(Member)

_____

AINI IDERIS, PhD
Professor/Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations 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.

_____

MARTINI MOHAMMMAD YUSOFF

Date:

TABLE OF CONTENTS