EFFECTS OF CROPING SYSTEM AND FERTILIZER ON SWEET CORN AND VEGETABLE SOYBEAN INTERCROP

By

ABDULKADIR IMAN SH. MOHAMOUD

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

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DEDICATION
TO MY BELOVED PARENTS AND FAMILY

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

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Chairman : Associate Professor Zakaria Bin Abdul Wahab, PhD

Faculty : Agriculture

Corn (*Zea mays* L.) and soybean are two important crops world wide, due to their diversified use. The Malaysian climate is suitable for the production of these two crops but the country imports large quantity of corn and soybean grains per annum to satisfy the country's demand. These two crops are grown in association in other parts of the world for the sake of yield advantage or risk minimization. However, the available literatures indicate that increased corn yield and declined soybean yield, as well as reduced yield of both corn and soybean under intercropping systems, or no change on yield. Shading, higher nutrient and water uptake by corn was attributed as the major factor causing yield decline of soybean in intercrop. Shading, higher nutrient and water uptake by corn was attributed as the major factor causing yield decline of soybean in intercrop. However, insufficient efforts have been made to study the compatibility of these two crops and effect of fertilizers on soybean and corn intercrop under Malaysian conditions

Hence, this research has been carried out in 2004/2005 to determine the effect of cropping systems and fertilizer levels on growth, yield, root morphology, light

interception, nutrient uptake and utilization efficiency of sweet corn and vegetable soybean as well as their effect on soil fertility, and protein content of soybean grain. Sweet corn and vegetable soybean were grown in rhizoboxes. Treatments were five cropping systems and three fertilizer levels in factorial combinations. Intercropped vegetable soybean without root separation (Cs3) and with geotextile root separation (Cs5) resulted in 11.2% higher harvest index (HI) than mono-crop vegetable soybean (Cs2). Cs3 had 16.1% higher grain yield and 20.7% more Mg accumulation in the grain than mono-crop vegetable soybean. Intercropped vegetable soybean without root separation and with geotextile root separation enhanced N, K and Ca utilization efficiency of vegetable soybean compared to mono-crop vegetable soybean. Absence of root separation (Cs3) and geotextile root separation (Cs5) did not have significant influence on yield of sweet corn. Mono-crop sweet corn and intercropped sweet corn with plastic sheet root separation had higher total root length compared to intercropped sweet corn without root separation and with geotextile root separation. Intercropped sweet corn with plastic sheet root separation at the highest fertilizer level (Cs4F3) had higher N, K, Ca and Mg utilization efficiency than mono-crop sweet corn. Increasing fertilizer levels enhanced growth and yield of both crops; although increasing fertilizer level more than the recommended rate reduced the total root length and root surface area of vegetable soybean. Increasing fertilizer level from 50% recommended rate (F1) to 100% recommended rate (F2) improved stem (24%), pod (35%), seed (44%) and total dry weight (27%) per plant of vegetable soybean. When the fertilizer level was increased further from 100% (F2) to 150% (F3), stem (17%), pod (19%), seed (17%) and total dry weight (18%) per plant was also enhanced. Similarly, increasing fertilizer level from F1 to F2 enhanced cob fresh weigh (76%) as well as shelled cobs (90%) and total dry weight (95.5%) per

plant of sweet corn. Further increase of fertilizer levels from F2 to F3, enhanced cob fresh weight (63%), total dry matter (59%), and seed dry weight (143%) and shelled cob dry weight (57%). There was a positive correlation between growth and yield; yield and nutrient uptake of sweet corn and vegetable soybean, and this indicates better crop response to fertilizer applications. Plastic sheet and geotextile root separation significantly enhanced available soil P after harvest of the crops. In vegetable soybean grown soils, increasing fertilizer level from the lowest level to the medium (F2) improved soil P by 29.1%, further increase of fertilizer level from F2 to F3 (highest level) enhanced soil P by 23.2 %; the exchangeable soil K was enhanced from the medium to highest fertilizer level by 30%. In sweet corn grown soil, available P and exchangeable soil K increased from the lowest to the medium fertilizer level by 96% and 19% respectively, and no further increase was recorded. Hence, intercropped vegetable soybean is a better option than mono-crop vegetable soybean, and better nutrient use is main factor for improved soybean yield in Cs3. The current recommended fertilizer rate is not enough and 150% of the recommended rate seems to be the best choice in this work.

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

KESAN SISTEM PENANAMAN DAN PEMBAJAAN KE ATAS TANAMAN JAGUNG MANIS DAN KACANG SOYA YANG DI TANAM SECARA BERSELANG

Oleh

ABDULKADIR IMAN SH. MOHAMOUD

September 2006

Pengerusi: **Profesor Madya Zakaria Wahab, PhD**

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Jagung (Zea mays) dan kacang soya merupakan tanaman yang ditanam secara meluas seluruh dunia, berdasarkan kepada kepelbagaian penggunaannya. Walaupun iklim di Malaysia sangat sesuai untuk kedua tanaman ini tetapi negara masih lagi mengimpot dengan kuantiti yang banyak bagi memenuhi keperluan negara.Tanaman ini ditanam diseluruh dunia memandangkan hasilnya yang tinggi serta mempunyai kurang risiko. Walaubagaimanapun, ada kajian serta literatur menunjukkan dengan menggunakan kaedah tanaman berselang diantara dua tanaman ini menyebabkan salah satu dari tiga perkara iaitu peningkatan hasil jagung akan mengurangkan hasil soya,pengurangan hasil kedunya atau tiada perubahan . Tanaman jagung akan menyebabkan naungan,pengambilan nutrient dan air yang tinggi adalah faktor utama yang menyebabkan hasil soya menjadi rendah melalui sistem tanaman berselang. Walaubagaimanapun kajian masih lagi diperlukan bagi membuktikan kesan keduanya terhadap tanah di Malaysia.

Oleh itu, kajian ini telah dijalankan pada tahun 2004/2005 menggunakan tanaman jagung dan kacang soya untuk melihat kesannya menggunakan sistem tanaman beselang dan penggunaan baja yang di berikan pada paras berbeza ke atas paras pertumbuhan, hasil,bentuk akar, penembusan cahaya dan pengambilan nutrien . Ianya juga bagi melihat kesan ke dua tanaman ini terhadap kesuburan tanah, dan kandungan protin yang terdapat di dalam biji kacang soya.

Jagung manis dan soya ditanam dalam kotak "rhizo".Rawatan adalah terdiri dari 5 sistem tanaman dan 3 paras baja dalam kombinasi faktorial.Soya yang ditanam berselang tanpa pengasingan akar(Cs3) dan dengan geotekstil pengasingan akar(Cs5) menghasilkan indek tuaian 11.2% lebih tinggi berbanding soya yang ditanam secara tanaman tunggal (Cs2). Cs3 menghasilkan hasil bijirin 16.1% lebih tinggi dan 20.7% Mg lebih dalam bijirin berbanding dengan yang ditanam secara tunggal.Tanaman berselang tanpa pengasingan akar dan dengan pengasingan geotekstil akar meningkatkan penggunaan N,K dan Kalsium secara berkesan berbanding tanaman tunggal. Tanpa pengasingan akar (Cs3) dan pengasingan akar geotekstil tidak mempengaruhi secar signifikan terhadap hasil jagung. Jagung yang ditanam secara tunggal dan berselang dengan plastik pengasingan akar menghasilkan akar yang lebih panjang secara keseluruhannya berbanding Jagung yang ditanam secara tanaman berselang tanpa pengasingan akar dan dengan pengasingan akar geotekstil.Tanaman Jagung menggunakan pengasingan akar berplastik dengan paras baja yang paling tinggi (Cs4F3) menununjukkan paras N,K, Kalsium dan Mg yang lebih tinggi berbanding jika ditanam secara tunggal. Peningkatan paras baja akan meningkatkan pertumbuhan dan hasil kedua tanaman; walaupun peningkatan paras baja lebih dari yang disyorkan mengurangkan panjang

akar keseluruhannya dan permukaan akar bagi kacang soya.Peningkatan paras baja dari 50% kadar yang disyorkan (F1) kepada 100% kadar disyorkan (F2) memperbaiki batang (24%) , lengai(35%) ,biji benih (44%) dan berat kering keseluruhannya (27%) bagi setiap pokok kacang soya.Bila paras baja ditingkatkan lebih dari 100% (F2) kepada 150% (F3) maka , batang (17%) ,lengai(19%) , bijibenih (17%) dan jumlah berat kering (18%) setiap tanaman akan meningkat. Begitu juga, peningkatan paras baja dari F1 kepada F2 akan meningkatan berat bersih tongkol jagung (76%) dan tongkol tanpa bijibenih((90%) dan jumlah berat kering (95.5%) setiap tanaman jagung.Peningkatan paras baja dari F2 kepada F3 ,juga akan meningkatkan berat bersih tongkol jagung (63%), jumlah berat kering (59%), dan berat kering bijibenih (143%) dan berat kering shell tongkol .Terdapat perhubungan korelasi yang positif di antara pertumbuhan dan hasil; hasil dan pengambilan nutrien jagung dan kacang soya , dan ini menunjukkan respon tanaman yang lebih baik terhadap penggunaan baja.Plastik dan pengasingan akar geotekstil meningkatkan unsur P yang tersedia dalam tanah selepas penuaian.tanah yang ditanam dengan kacang soya ,akan menyebabkan penggunaan paras baja dari paras yang paling rendah kepada paras sederhana (F2) akan dapat memperbaiki dan meningkatkan P dalam tanah sebanyak 29.1% .Begitu juga dengan menggunakan paras baja dari paras F2 kepada F3 (paras tertinggi) meningkatkan P dalam tanah sebanyak 23.2%; pertukaran K dalam tanah bertambah dari sederhana kepada paras baja tertinggi sebanyak 30% .Bagi tanah yang ditanam jagung pula , P yang tersedia dan pertukaran K dalam tanah akan meningkat secara kadar terus dengan meningkatkan penggunaan paras baja dari yang paling rendah kepada paras baja yang sederhana sebanyak 96% dan 19% , dan tiada lagi peningkatan selepas itu direkodkan.

Dengan kata lain, melalui system tanaman berselang di antara kacang soya dan Jagung manis adalah pilihan terbaik berbanding tanaman tunggal. Penggunaan nutrien yang lebih baik adalah faktor utama untuk meningkatkan hasil soya dalam Cs3. Pada masa kini kadar pengesyoran pembajaan masih belum mencukupi dan sebanyak 150% adalah kadar cadangan dan yang terbaik dalam kajian ini.

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I certify that an Examination Committee has met on 25th September 2006 to conduct the final examination of Abdulkadir Iman Sh. Mohamoud on his Doctor of Philosophy thesis entitled "Effects of Cropping System and Fertilizer on Sweet Corn and Vegetable Soybean Intercrop" 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:

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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:

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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 any other institutions

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ABDULKADIR IMAN SH. MOHAMOUD

Date:

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ANOVA	Analysis of variance
BNF	Biological nitrogen fixation
Ca	Calcium
CEC	Cation exchange capacity
DAS	Days after sowing
EARO	Ethiopian Agricultural Research Organization
FAO	Food and Agricultural Organization
HI	Harvest index
K	Potassium
LER	Land equivalent ratio
Mg	Magnesium
MOP	Muriate of potash
N	Nitrogen
P	Phosphorus
PLER	Partial land equivalent ratio
Ppm	Parts per million
RCBD	Randomized complete block design
RFR	Recommended fertilizer rate
R1	Beginning of bloom stage of soybean
R2	Full bloom stage of soybean
R3	Beginning of pod
R4	Full pod stage
R5	Beginning of seed formation
R6	Full seed development

R7	Beginning of maturity
SAS	Statistical analysis system
TSP	Triple super phosphate
UPM	Universiti Putra Malayisa