



**UNIVERSITI PUTRA MALAYSIA**

**DEVELOPMENT OF SOLAR HEATER BOXES AND MANAGEMENT OF  
*Callosobruchus maculatus* FABRICIUS (COLEOPTERA: BRUCHIDAE)  
ON SEED ADZUKI BEAN**

**RAGAA MOHAMMED ELBASHIER ELHADAA**

**FP 2011 24**

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**By**

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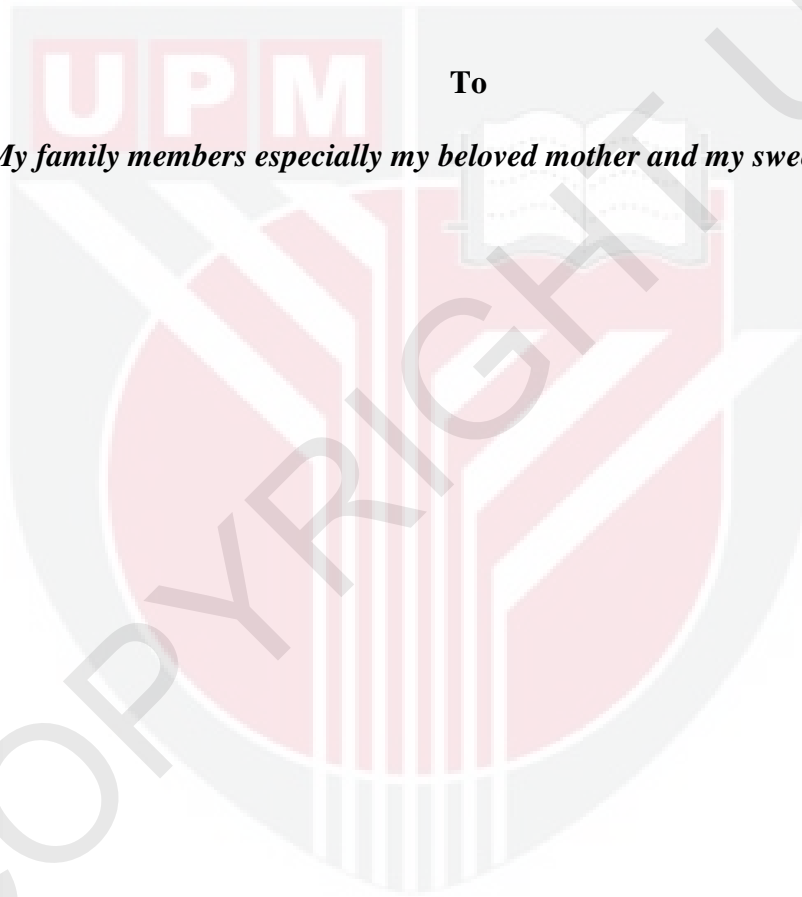
**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in  
Fulfillment of the Requirements for the Degree of Doctor of Philosophy**

**October 2011**

## DEDICATION

To

*My family members especially my beloved mother and my sweet daughter*



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

**DEVELOPMENT OF SOLAR HEATER BOXES AND MANAGEMENT OF *Callosobruchus maculatus* FABRICIUS (COLEOPTERA: BRUCHIDAE) ON SEED ADZUKI BEAN**

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**October 2011**

**Chairman: Professor Rita Muhamad Awang, PhD.**

**Faculty: Agriculture**

The selection and evaluation of solar heater boxes for trapping solar energy to disinfect legume grains was described. The effectiveness of five materials (cardboard, plywood, Perspex timber and metal) was investigated. Results showed that, cardboard and plywood were the best materials for seed treatment as they trap and retained more heat compared to Perspex and timber solar heater boxes. In addition, they are cheaper and easier to handle compared to metal. It was also concluded that, aluminum foils combined with black paint was the best lining than if aluminum foils or black paint used separately. The effect of seed depth on solar energy trapping inside cardboard and plywood solar heater boxes was also evaluated. Temperatures trapped in cardboard solar heater boxes with 7 kg of adzuki bean seeds were 53.3°C which was 13.9% higher than temperature trapped in plywood solar heater boxes. The effect of solar heat on development of *C. maculatus* was evaluated. A temperature of 66.4°C was achieved in

solar heater boxes within 15 minutes which caused 100% mortality of adults and 4<sup>th</sup> larval instars. Egg hatchability decreased by 70% and 66.7% in plywood and cardboard respectively compared with untreated eggs. To verify the effect of solar temperatures, another experiment was done using the oven. Results showed that, times needed for 100% adult's mortality were 10, 20, 50 and 70 minutes with temperatures of 70, 60, 50 and 40°C respectively. The effect of solar heat on seed quality of adzuki beans *V. angularis* was also determined. Results showed that, exposure to cardboard and plywood solar heater boxes did not show enormous effect on germination characters for adzuki bean seeds. In addition, experiment in oven was done for more verification. Exposure to temperatures of to 40, 50, 60, and 70°C did not affect germination of adzuki bean seeds. The effectiveness of cardboard solar heater boxes and a method using direct sun exposed seeds covered with plastic (open method) in trapping solar energy was evaluated. The influence of these methods on development of *C. maculatus* and seed quality of adzuki bean seeds was determined. Results showed that, cardboard solar heater boxes trapped temperature mean 11.6% higher than the temperature mean trapped in the open method. Both methods affect the development of *C. maculatus*. Percentage of adult mortality of 26.7% was caused by the open method compared to 46.7% adult mortality for cardboard solar heater boxes. Complete mortality occurred for eggs treated in cardboard solar heater boxes. Cardboard solar heater boxes could trap solar radiation and retained heat as much as possible compared to open method. Both methods have no adverse effect on seed quality of adzuki bean seeds.

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

**PEMBANGUNAN KOTAK HEATER PEMANAS SOLAR DAN PENGURUSAN  
CALLOSOBRUCHUS MACULATUS FABRICUS ( COLEOPTERA:  
BRUCHIDAE) KEATAS KACANG ADZUKI**

Oleh

**RAGAA MOHAMMED ELBASHIER ELHADAA**

**Oktober 2011**

**Pengerusi: Professor Rita Muhamad Awang, PhD.**

**Fakulti: Pertanian**

Pemilihan dan penilaian kotak pemanas solar untuk memerangkap tenaga solar untuk menyahjangkit bijian kekacang telah diterangkan. Keberkesanan lima bahan (kadbod, papan lapis, perspex, kayu dan logam) telah disiasat Keputusan menunjukkan bahawa, kadbod dan papan lapis adalah bahan-bahan yang terbaik untuk rawatan benih kerana ia memerangkap dan mengekalkan lebih banyak haba berbanding dengan pemanas solar perspex dan kotak kayu . Di samping itu, ia lebih murah dan lebih mudah untuk dikendalikan berbanding logam. Kesimpulan juga telah dibuat bahawa, foil aluminium yang digabungkan dengan cat hitam adalah lapisan yang terbaik jika dibandingkan dengan foils aluminium atau cat hitam yang digunakan secara berasingan. Kesan kedalaman benih bagi memerangkap tenaga solar di dalam kotak kadbod dan papan lapis pemanas solar adalah juga dinilai. Suhu yang terperangkap di dalam kotak kadbod

pemanas solar dengan 7kg benih kacang adzuki adalah  $53.3^{\circ}\text{C}$  iaitu 13.9% lebih tinggi daripada suhu yang terperangkap di dalam kotak pemanas solar papan lapis. Kesan haba solar bagi perkembangan *C. maculatus* telah dinilai. Suhu  $66.4^{\circ}\text{C}$  telah dicapai dalam kotak pemanas solar dalam tempoh 15 minit yang menyebabkan 100% kematian golongan dewasa dan peringkat 4 instar larva. Keupayaan menetas telur menurun sebanyak 70% dan 66.7% dalam papan lapis dan kadbod masing-masing berbanding dengan telur yang tidak dirawat. Untuk mengesahkan kesan suhu solar, satu lagi kajian yang telah dilakukan dengan menggunakan ketuhar. Keputusan menunjukkan bahawa, masa yang diperlukan untuk kematian orang dewasa 100% ialah 10, 20, 50 dan 70 minit dengan suhu  $70, 60, 50$  dan  $40^{\circ}\text{C}$  masing-masing. Kesan haba solar kepada kualiti benih biji adzuki *V. angularis* juga ditentukan. Keputusan menunjukkan bahawa pendedahan kepada kotak pemanas solar kadbod dan papan lapis tidak menunjukkan kesan yang amat besar ke atas ciri-ciri percambahan biji benih kacang adzuki. Di samping itu, eksperimen di dalam ketuhar telah dilakukan untuk pengesahan lanjut. Pendedahan kepada suhu hingga  $40, 50, 60$ , dan  $70^{\circ}\text{C}$  tidak mempengaruhi percambahan biji benih kacang adzuki. Keberkesanan kotak pemanas solar kadbod dan kaedah yang menggunakan pendedahan matahari terhadap benih yang ditutup dengan plastik (kaedah terbuka) dalam memerangkap tenaga solar telah dinilai. Pengaruh kaedah ini terhadap pembangunan *C. maculatus* dan kualiti benih kacang adzuki telah ditentukan. Keputusan menunjukkan bahawa, kotak pemanas solar kadbod memerangkap purata suhu 11.6% lebih tinggi daripada purata suhu yang terperangkap melalui kaedah terbuka. Kedua-dua kaedah ini memberi kesan kepada perkembangan *C. maculatus*. Peratus kematian dewasa sebanyak 26.7% adalah disebabkan oleh kaedah

terbuka berbanding dengan 46,7% kematian dewasa untuk kotak pemanas solar kadbod. Mortaliti penuh berlaku kepada telur-telur yang dirawat di kotak pemanas solar kadbod. Kotak pemanas solar kadbod memerangkap sinaran suria dan mengekalkan haba sebanyak mungkin berbanding kaedah terbuka. Kedua-dua kaedah tidak mempunyai kesan yang buruk kepada kualiti benih kacang adzuki.





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I certify that an Examination Committee has met on **18/10/2011** to conduct the final examination of Ragaa Mohammed Elbashier Elhadaa on her Doctor of Philosophy thesis entitled “THE DEVELOPMENT OF SOLAR HEATER BOXES FOR THE MANAGEMENT OF *CALLOSOBRUCHUS MACULATUS* (COLEOPTERA: BRUCHIDAE) AND SEED QUALITY OF ADZUKI BEAN” 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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Date:

## DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously and is not concurrently, submitted for any other degree at University Putra Malaysia or other institutions.

---

**RAGAA MOHAMMED ELBASHIER ELHADAA**

Date: 18 October 2011

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