EFFECT OF SOME BOTANICALS ON MORTALITY, ADULT LONGEVITY AND OVIPOSITION OF PULSE BEETLE ON MUNGBEAN

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DECEMBER, 2009

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REGISTRATION NO. 08-03187

A thesis
Submitted to the Faculty of Agriculture,
Sher-e-Bangla Agricultural University, Dhaka
In partial fulfillment of the requirements
For the degree of

MASTER OF SCIENCE

IN

ENTOMOLOGY

SEMESTER: JULY- DECEMBER 2009

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CERTIFICATE

This is to certify that the Thesis entitled, "**EFFECT OF SOME BOTANICALS ON MORTALITY, ADULT LONGEVITY AND OVIPOSITION OF PULSE BEETLE ON MUNGBEAN**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in ENTOMOLOGY**, embodies the result of a piece of *bona fide* research work carried out by **MST. LAIZU**, Registration No. 08-03187 under my supervision and my guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

Dated:
Place: Dhaka, Bangladesh

(Dr. Md. Abdul Latif)
Associate Professor
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Dedicated To
My Beloved Mother

ACKNOWLEDGEMENTS

All the praises, gratitude and thanks are due to the omnipresent, omnipotent, and omniscient Allah who enabled me to complete this Thesis work successfully.The author would like to express her deepest sense of gratitude sincere appreciation to her venerable supervisor Dr. Md. Abdul Latif, Associate Professor, Department of Entomology, Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh, for his continued guidance, support, encouragement, critical but constructive criticisms and invaluable suggestions throughout the study period and successfully completing the research work and in the preparation of the manuscript.She expresses her sincere thanks, earnest obligation and profound gratitude to honorable co-supervisor Mst. Nur Mohal Akhter Banu, Assistant Professor, Department of Entomology, Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh, for her scholastic guidance, helpful comments and constant inspiration throughout the research work and preparation of the thesis.The author is highly grateful to other teachers of the Department of Entomology, SAU for their kind co-operation and help during the study period of MS program. Cordial thanks are also extended to the laboratory assistant Md. Mahbubur Rahman, Md. Nazir and Md. Kalam for their co-operation to complete his research work in the laboratory.Finally she feels heartiest indebtedness to her beloved parents, husband for their patient inspiration, sacrifices, blessing and never ending encouragement.

DECEMBER, 2009 **The author**

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ABSTRACT

The experiments were conducted in the laboratory under the Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from May, 2009 to September, 2009 to evaluate the effectiveness of botanicals against the pulse beetle (*Callosobruchus chinensis*) in mungbean. Considering the effectiveness of different botanicals for the management of *C. chinensis* infesting mungbean seeds, the treatment T_7, T_8 and T_9 comprising Bankolmi, Dhatura and Korobi leaf powder respectively @ 1g/50g seeds performed the best results in respect of adult mortality, oviposition rate, adult emergence, damaged seed and weight loss over control for the species. Considering the highest percent mortality (20%) in treatment T_1 and treatment T_{10} untreated control showed the lowest mortality percent (5%). The lowest rate of oviposition (30.50) was recorded from T_7 and $T_{8,}$ while the highest rate of oviposition (48.00) was recorded in T_3. The lowest number of adult emergence was recorded from T_7 treatment, while the highest number of adult emergence (551.3) was recorded in T_3. The lowest percent grain infestation by number (15%) was recoded from T_7 & T_2 treatments, while the highest percent grain infestation by number (28.75%) was recorded in T_3. The lowest percent weight loss was recorded from T_7 treatment, while the highest percent weight loss was recorded in T_3. Considering the weight of pulse beetle, the lowest weight (13.13 mg) of pulse beetle was recoded from the treatment T_6 and the highest weight (18.17 mg) of pulse beetle were recorded from untreated control. Considering the effectiveness of botanicals on the offspring of treated *C. chinensis* the highest mortality percent (10%) was recoded from the treatment T_7, T_8 and T_9 and the lowest mortality percent (2.5%) was recorded from untreated control. The lowest rate of oviposition (8.75) was recorded from T_8 and while the highest rate of oviposition (14) was untreated control. The lowest number of adult emergence (44.75) was recorded from T_3 treatment, while the highest number of adult emergence (88.75) was recorded from untreated control. The lowest percent grain infestation by number (1.25%) was recoded from T_7 treatment followed by T_8 and T_3, T_1, T_9 treatments respectively, while the highest percent damage by number (10%) was recorded from untreated control. The lowest percent weight loss (0.80%) was recorded from T_3 treatment, while the highest percent weight loss was recorded from untreated control.

CHAPTER I

INTRODUCION

Pulses, the only rich source of vegetable proteins, are common item in the daily diet list of the people of Bangladesh. Eight kinds of pulses such as Lentil, Mungbean, Blackgram, Grasspea, Chickpea, Cowpea, Fieldpea, and Pigeonpea are grown in Bangladesh. Pulses serve as one of the main sources of protein and minerals as well as play a vital socio-economic role in the diet of common people of Bangladesh. Among them mungbean, *Vigna radiata* (L) Wilezek has come up an important pulse crop in Bangladesh. It plays an important role in the dietary pattern of Asian people. Mungbean seed is a nutritious component in the human diet, as well as a in livestock feed. It contains 51% carbohydrate, 26% protein, 4% minerals and 3% vitamins (Yadav *et al*., 1994). Mungbean plant fixes atmospheric nitrogen in symbiosis with soil bacteria to enrich soil fertility as well as it provides useful fodder (Afzal *et al*., 2004). Over the years, pulse production is gradually decreasing (Sarwar *et al.*, 1981). Several factors are responsible for this declining trend of which varietal instability, attack pulses of insect pests and diseases are important. Insect pests attack both in field and storage. The damage in storage is more crucial than damage in the field. About 85% of the pulse growers in Bangladesh store pulses in their house. Unfortunately, in storage, pulses suffer enormous losses due to bruchid attack, infestation starts either in the field on the maturing pod and is carried to the stores with the harvested crops or it originated in the storage itself (Fletcher and Ghosh, 1920). Three species of pulse beetles, viz., *Callosobruchus chinensis* Linn., *C. analis* Fab., and *C. maculates* Fab. have been reported from Bangladesh as the pest of stored pulses (Begum *et al.*, 1984 Rahman *et al*., 1981 and Alam, 1971). Among them *Callosobruchus chinensis* to cause enormous losses to almost all kind of pulses in storage condition. In Bangladesh, commonly called pulse beetle, but in America and Japan it is known as the cowpea weevil or adzuki bean beetle. The degree of damage varies with different kinds of legumes on the basis of exposure time, storage facilities and other factors associated with seeds. Under farmers storage condition as high as 98.04%, 73.20%, 53.00%, 54.37%, 64.33% grains of mungbean, blackgram, grasspea, lentil and chickpea respectively, were reported to the damaged by pulse beetle, *C. chinensis* in Bangladesh (Anon., 1984). The rate of increases or decreases with the duration of storage under normal condition i.e., the longer the duration the higher the damage (Gujar and Yadav, 1978). Control of storage pests by using synthetic chemicals has become a common practice among the farmers and stockholders. It is now widely known that the chemical method has several problems, which include health hazards to the users and grain consumers. It causes residual toxicity, environmental pollution and development of pesticide resistance against bruchids. Sometimes persistent pesticides accumulate in the higher food chain of both wildlife and human and become concentrate by biomagnification (Metcalf, 1975). On the other hand, the traditional method of controlling storage pests by sun-drying is safer to human health and environment. But this method is laborious, time consuming, often expensive and requires suitable drying yard, when large volume of stored grain is involved. Moreover, it depends on favorable weather condition. Recently, the use of different plants and their derivatives has appeared as an effective alternative to the use of poisonous chemical insecticides or the cumbersome traditional methods for the control of various insect pests of crops and storage. In the world, as many as 2400 plant species have been reported that have potential pesticidal properties and biological activity against a wide range of pests (Grainge and Ahmed, 1988). Plant-derived materials are more readily biodegradable, some are less toxic to mammals, may be more selective in action, and may retard the development of resistance. Their main advantage is that they may be easily and cheaply produced by farmers and small-scale industries as crude, or partially purified extracts. It was reported that when mixed with stored-grains, leaf, bark, seed powder or oil extracts of plants reduce oviposition rate and suppress adult emergence of bruchids, and also reduced seed damage rate (Keita *et al*., 2001; Shaaya *et al*., 1997; Onu and Aliyu, 1995 and Talukder and Howse, 1994). Oils of Neem, Royna and Castor and leaf powder of Biskatali, Marigold and Castor were most effective in preventing the egg laying in lentil and chickpea. Leaf powder of Biskatali, Marigold, Castor and Mango were most effective in reducing adult emergence in lentil and chickpea (Bhuiyah, 2001). Camphor showed fumigation toxicity against rice weevil in storage (Latif *et al*. 2005).

Although many reports have been published on the use of plant products against pulse beetle hosted on lentil, cowpea, chickpea, greengram, arhar but information on the use of plant products in mungbean are scanty. Therefore, the present study was undertaken to fulfil the following objectives:

OBJECTIVES

1. To evaluate the effect of some botanicals on adult longevity, mortality, oviposition rate of *C. chinensis*.
2. To determine the protection efficacy of the selected botanicals against *C. chinensis* in storage and
3. To explore the effective botanicals against *C. chinensis*.

CHAPTER II

REVIEW OF LITERATURE

The pulse beetles are the most serious pests of stored pulses in Bangladesh (Rahman, 1971). But very few works have so far been done for evaluating the available legume grains for their preference or resistance to pulse beetle in Bangladesh. However, voluminous reports are available from studies conducted throughout the world including India, Pakistan, Thailand, Japan, U. K. and USA on the host preference of various legumes to infestation by bruchids. Some of the literatures available from various sources including Bangladesh which are relevant to the present study and are reviewed here in brief under the following subheadings:

Biology of pulse beetle Mating

Adults of bruchids are sexually mature at emergence and ready to mate (Raina, 1970). According to Bhuiyan and Peyara (1978) the mating took place immediately after emergence of the adult beetles. In laboratory condition mating lasted for 2 to 3 minutes. When a male and female of *C. chinensis* L. were introduced, the male moved first around rather sluggishly with rapid movement of antennae. This sort of behavioral change is called ‘Activation’ and this activation can not be seen when a male is alone (Nakamura, 1969).

Oviposition and Incubation

The female oviposited within 24 hours of their emergence and mating. Usually from 1 to 3 eggs were laid per pulse grain but as many as 7 eggs were observed in a single grain (Raina, 1970). She also observed that the female laid an average of 78 eggs ranging from 63 to 90 over a period of 8 days at 30^0 C with RH 70% on mungbean. Dharmasena *et al.* (1986) studied twelve varieties of mungbean for identifying seed characteristics contributing to resistance to *Callosobruchus spp.* Varieties with small grains and glossy seed coats were shown to be associated with a higher degree of resistance than large grains with a dull surface. Female bruchids find it more difficult to lay their eggs on the lightly convex and shiny surfaces of small seed. Hard, large and heavy seeds were preferred by *C. chinensis* for oviposition, and heavy seeds were also more susceptible to *C. chinensis* damage. Seeds of a resistant accession had a lower starch and fat content but a higher protein content than the susceptible counterpart. Lambrides (2000) reported that the texture, layer present on the seed coat of some mungbean varieties and small grains size might act as oviposition deterrents. The freshly laid eggs were translucent, smooth and shining but become pale yellowish or grayish white with age. The eggs were elongated and oval in shape (Alam, 1971). The ovipositional period ranged from 3-8 days depending on the season of the year. According to

Bhuiyan and Peyara (1978), the mean oviposition period was 6.83 days in winter and 4.00 days in summer. Govindarajan *et al.* (1981) observed the ovipositional behavior of *C. maculates* F. and *C. chinensis* L. in relation to grain size. Laboratory observations on the effect of seed size on mungbean *(Vigna radiata*) showed that the two bruichds preferred to oviposit on seeds weighing more than the average of those used and the number of eggs laid on them was in proportion to seed weight. Raina (1970) reported that the on an average 78 eggs / female were laid on mungbean seeds at 30^{0} C and at 70% RH by *C. chinensis*. Egg lasted for 3.5, 4 and 5 day, respectively and 94-99% of the eggs were hatched.

Larval period

Razzak and Pundy (1965) observed that the full grown larvae were curved and the dorsal body wall was raised into a segmented dome like structure. According to Alam (1971) the full grown full- larva was 6 mm long, flesh strongly wrinkled, perfectly white except brown color at mouth region. Soon after hatching, the young larvae bored into the seeds and started to consume the contents. According to Dennis (1990) the larva was scarabeiform having five instars developed in about 20 days.

Pupal period

Dennis (1990) reported that the pupation took place inside the seed in a chamber covered by a thin window of testa prepared by a mature larva. The pupae were execrate type with a mean pupal duration of 2.5 days in summer and 4.25 days in winter (Bhuiyan and Peyara, 1978).

Adult emergence

Before emergence, the adult remained a few days inside the pupal chamber. The adult emergence occurred by cutting a window hole and then pushing head and forelegs through it (Razzak and Pundey, 1965). The beetle was dark and inscospicuous in color and its body was clothed with hairs. Bhuiyan and Peyara (1978) reported that the head of the beetle is small, hypognathous and provided with short snout. The males were short lived and smaller than females. The adult was 4 mm long and distinguished from other species by the elevated ivory like spots near middle of the body (Alam, 1971). Arora and Singh (1970) found that the adult generally more around the grains and were also capable of making short fights with hind wings. According to Bhuiyan and Peyara (1978), the average longevity of the male and female were 4.3 and 5.4 days in summer and 7.4 and 9.2 days in winter, respectively. The life cycle of *C. chinensis* L. completed in 30-32, 20-23 and 40-46 days early summer, mid summer and winter seasons, respectively (Bhuiyan and Peyara, 1978).

Male and female identification

The distinctive character of males and females have been well documented by Shukla and Pandey (1977), and Raina (1970), and Rajak and Pundey (1965). Antenna of male are pectinate type with elongated and oblong apical segment and curved towards each other. Pectinaton in antenna become prominent from the 4th to the apical segment. Antenna of female is straight but serrate type with prominent serration in 5th to the apical segment. The apical segment is some what bluntly rounded or ovate in shape.

Male and female pulse beetles easily be distinguished from one another by general appearance. The most distinguishing characteristics is the sex specific coloration of the post abdominal plate that’s called ‘Pygidium’. In the female, the plate is enlarged and is darkly colored on both sides. In the male, the plate is smaller and lacks stripe. In some strains, females are larger in size than males. Also, females are black in coloration and males are brown.

Origin and Distribution of pulse beetle

C. chinensis L. was first reported and described from China in 1958 (Alam, 1971). Though Southgate (1979) has mentioned that the species of bruchidae have their origin in Afro Asian region. According to him, the species of bruchidae in every continent except Antarctica. Through the agency of man bruchids have their cosmopolitan distribution. Most of the species lived in the tropical regions of Asia, Africa, Central and South America. *C. chinensis* L. is of Asian origin, where it is still the dominant species (Dennis, 1990). He mentioned that *C. maculatus* thought to be African. However, both the species are now widely distributed throughout the warmer parts of the world. Other species of *Callosobruchus* recorded as pest include *C. analis* (Fab.) in parts of Asia on *Vigna* species, *C. phaseoli* (Gyllenhal) in Africa, parts of Asia and South America on *Vigna* and *Dolichos lablab*, *C. rghodesinus* in Africa on cowpea *C. sibinnotastus* (pin) in East Africa on *V. subterranea* and C. *theobromae* (Linn) in India on field crops of pigeon pea. Rahman *et al*. (1942) recovered that the bruchidae contains more than 100 injurious species distributed over different part of the world. Among them, 11 injurious species were recorded.

Nature and extent of damage

Begum *et al.* (1982) stated that in Bangladesh *C. chinensis* L. was one of the major pests belonging to *Callosobruchus* spp. causing considerable damage to stored legume grains. Southgate (1979) stated that pulses grown by man had been infested by bruchids since the dawn of agriculture. The larval stage caused only severe damage rendering the seeds unfit for planting and human consumption. In the laboratory study, Rahman (1991) found that the initial presence of 4 larvae or eggs or one pair of *Callosobruchus spp* adult could completely damage 10 g of the pulse grain within 2-4 month depending on the type of the pulses, stage of maturity and species of the beetle. Gujar and Yadav (1978), recorded 55-60% loss by seed weight and 45-66% loss in protein content by the pulse beetle. Results revealed that 50.37-57.58% (Ali *et al.*, 1999) and 37.30-55.30% (Ali and Rahman, 2006). Grain content loss of mungbean seed was occurred by *C. chinensis* and *C. maculatus* respectively. The extent of damage of mungbean seed might be up to 100% during a period of one year storage (Chowdhury, 1961).

Host preference for oviposition

Lale and Kolo (1998) reported that eight local cultivars of cowpea that have been improved for higher yields and pest tolerance which were recently released for cultivation by the International Institute of Tropical Agriculture (IITA), Ibadah, Nigeria, were compared with respect to their susceptibility to the bruchids *C. maculatus* under laboratory conditions (30-35^{0}C and 45-57% RH) Seeds of cultivars Kanannado, T189 KD-391 and Danila with susceptibility indices (SI) OF 0.0, 2.2 and 2.6, respectively and were found to be resistant to bruchid attack and cultivars Babura-4, IT 89 KD 374, Bausse-local, IT89KD- 349 and Alok with SI values of 11.2, 10.9, 7.45, 7.2 and 6.5, respectively, were found to be susceptible. Oviposition and egg viability were significantly reduced on seeds of the resistant cultivars. The total mean number of eggs laid on seeds of the resistant cultivars Kanannado, IT89KD-391 and Danila were 16, 15 and respectively, while 50, 44, 36, 35 and 26 eggs were laid on seeds of susceptible cultivars Babura-4, IT89KD-374, Bausse-local, Aloka-local and IT89KD respectively. The proportion of unhatched eggs laid on resistant cultivars was 98.2, 81.5 and 50.0 for Kanannado, IT89KD-391 and Danila, respectively.

A study conducted by Chavan *et al.*(1997) on the ovipositional preference of *Callosobruchus chinensis* for 70 cowpea lines and they found that cowpea lines with rough seed surface were less preferred, resulting in a small percentage of grains infect in the viability of eggs were noticed. *C. chinensis* distributed eggs uniformly on grains of different cowpea lines and oviposited a small number of eggs/ grain. Brown, black, grey and red coloured seeds were more preferred than white coloured seeds.

Sharmila and Roy (1994) studied the effects of oviposition and development of the bruchid *C. maculats* on nine legume seeds under common storage condition in the Bundelhand region of Madhya Pradesh, India. Bengal gram was most preferred both under choice and no choice conditions. However, under no choice condition, bruchids developed on green gram *(Vigna radiata*) cowpeas, lentils and red gram (pigeon peas). The survey results also showed similar trends.

Piergiovanni *et al.* (1994) analyzed the seeds of an 8 lines differing in storage pest resistance for inhibitors of the following enzymes: porcine amylase, Bacillus amylase, bovine dhymotrypsin and trypsin. A broad variation was observed among samples for all tested inhibitors. Principal component analysis indicated that high levels of both antitrypsic and antiamylasic activity characterize resistant lines. Moreover, high activity of a single inhibitor class is typical of the bruchid *(C. maculatus*) susceptible lines. Hence breeding for high contents of these protein inhibitors could be an effective way of obtaining lines that are naturally resistant to storage to pest attack. A limiting factor in this breeding strategy is the need to reduce the antiamylastic activity before eating.

Shiau *et al*. (1994) studied the oviposition choice of the stored products pest *C. maculatus* by providing females with different ratios of azuki beans (*V. angularis*) and mungbeans (*V. radiata).* The fraction of eggs laid on azuki beans increased with increasing ratio o azuki beans, where as it decreased with a decreasing duration of oviposition. The probability of female encountering azuki beans was significantly higher than for mungbean, but even when the female was provided with the same probability of encounter is still preferred to lay eggs on azuki beans. Females tended to spent more time inspecting azuki than mungbean, but no differences in handling time between the 2 hosts were found.

Ahmed (1992) observed that in all the seasons, lentil and mungbean were highly preferred for oviposition and the emergence of adults were considerably high, while gram and black gram were least preferred for oviposition except high rates of adult emergence for gram and pigeon pea in summer season.

Akhtari *et al.* (1990) studied the feeding and ovipositional preference of pulse beetle, *C. chinensis* L. on different genotypes of bean and its control. They found that *C. chinensis* had less preference for oviposition on seeds of small sized bean (*Lablab purpureus*) genotypes with increased egg deposition on medium to large seeded beans. The damage caused by this insect to small seeded genotypes was below 10% and to medium and large seeded beans was 23-31%. Infested bean seeds without holes but with eggs germinated almost as well as those of healthy seeds and produced normal seedling. Of three insecticides applied to seeds with freshly laid eggs, diazinon reduced adult emergence substantially at all doses. Malathion and Sevin (carbaryl) were ineffective as ovicidal agents.

Chandrakantha and Mathavan (1988) studied the developmental rates and biomass energy of *C. maculatus* on different foods and temperatures in the laboratory in India. They found that the growth rate of C. maculatus was faster in seeds of cowpea followed by mungbean and beans. Larval periods were longer when reared on beans than when reared on mungbean and cowpea

Singh *et al*. (1980) studied in detail the ovipositional preference of *C. chinensis* and *C. maculatus* on different pulses. They reported that the pulse beetle did not show any significant varietal preference for oviposition. The order of preference for *C. chinensis* was cowpea> blackgram> lentil> pigeonpea> chickpea> mungbean> pea whereas, for C. maculatus was chickpea> blackgram> mungbean> pigeonpea> pea> lentil. They also concluded that the oviposition preference was independent of larval development.

From a study on the developmental response of *C. maculatus* and *C. chinensis* to the seeds of 8 pulses in the laboratory in India Yadav and pant (1978) reported that both the species laid eggs on all pulses under study. But only chickpea, pigeonpea, pea, grasspea and mungbean were suitable for the development of both the species. Lentil and unsuitable for *C. maculatus*, blackgram for *C. chinensis* and cluster bean was so far both the species.

Gokhale and Serisvastava (1977) studied the ovipositional preference of *C. maculatus* on different varieties moth bean (*V. aconitifolia*) and found that oviposition preference was unrelated to the suitability of the seeds for burchid development. Larval development was not dependent on the amount of food consumed.

Host status of various pulses for bruchids:

Lambrides and Imrie (2000) screened twenty-six mungbean (*V. radiata*) varieties and accessions for resistance to 4 bruchid species (Coleoptera: Chrysomelidae). On the basis of percentage of seeds damaged, all Australian commercial mungbean varieties tested were highly susceptible to strains of *C. maculatus* and *C. chinensis*, the 2 species that cause most damage worldwide to mungbean in storage. Three accessions (TC1966, ACC23 and ACC41) appeared to have bruchid resistance. All 3 varieties are member of the subspecies *sublobata*, and typically have wild mungbean characteristics of small seed size and the presence of a well-formed texture layer on the seed. These characters may act as oviposition deterrents. Consequently, these assays for determining resistance to bruchid infestation may not be suitable for identifying biochemical resistance of some mungbean genotypes.

Liu-Xuming *et al*. (1998) evaluated both artificial and natural infstation of *C. chinensis* in the identification of resistance source of mungbean (*Vigna radiata*). Some 80 germplasm lines from Asian Vegetable Research and Development Center (AVRDC) and 784 domestic gerplasm lines were tested. The rate of damaged mungbean seeds was used an evaluation index. Some 17 germplasm lines from AVRDC showed moderate resistant to immunity to *C. chinensis* while only 3 landraces from Gangxi showed moderate resistance among domestic germplasm. The greenhouse performance was similar to that in field.

Laboratory experiment was carried by Muhammad *et al*. (1997) in Bangladesh to evaluate eight different strains/ varieties of mungbean (*V. radiata*) (MB-26, MB-48, MB-55, MB-63, MB-66, MB-87, MB-246 and Kanti) for susceptibility to *C. chinensis*, on the basis of the number of egg laid, duration of development of the immature stages, percentage adult emergence, and weight loss due to damage by the pest. The strains MB-46 and Kanti were found to be highly susceptible, with 13.6 and 13.0% loss in weight of seeds, respectively. Strains MB-8, MB-66 were susceptible, and strains MB-63, MB-55 were moderately susceptible. The size, colour and protein content of the seeds had no influence on the susceptibility of mungbean seeds to *C. chinensis*.

Rahman and Schmidt (1997) screened five different; pulses (*L. purpureus*, *V. radiata*, *V. unguiculata* (cowpeas), *Vicia faba* (faba beans) and two varieties of *P. vulgaris*) in the laboratory for their susceptibility of *C. phaseoli* using choice and non-choice tests. The bruchid showed various responses to the seeds with regard to oviposition, larval development and adult emergence. Considering all aspects the insect appeared to be adapted to the seeds of *Lablab purpureus*, but did not develop in the seeds of *P. vulgaris*.

Sison *et al.* (1996) screened several mungbean entries for resistance to *C. chinensis*. Results of both free choice and non-choice tests showed that TC 1966 was highly resistant while the pag-asa series (1, 3, 5 and 7) were susceptible. The life history of *C. chinensis* was also studied on the susceptible variety pag-asa 7. It takes about 21-30 days for the bruchid to complete development (egg to adult emergence). The eggs are laid on the seed coat while the larvae develop inside the seed completing four larval instars there. The larvae develop and feed on the seed leaving only the seed coat. Population takes place in a cell inside the seed and the adult emerges through the entrance hole made by the larva. Adult life span ranges from 5 to 15 days. Descriptions of the various stages are presented (Sison *et al*. 1996).

Modgil and Mehta (1996) observed the effects of *C. chinensis* infestation on the carbohydrate and dietary fibre contents of seeds of chickpea, green gram (*V. radiata*) and pigon pea at 10, 20, 30, 40, 5o, and 60% inestation. With increased level of infestation, levels of energy, starch, total sugars and non-reducing sugars decreased, whereas a significant increase in the amounts of reducing sugars, crude fibre, neutral detergent fibre, acid detergent fibre, hemicellulose, cellulose and lignin was observed.

Khattak *et al.* (1987) evaluated the susceptibility of different varieties of mungbean against *C. maculatus* in the laboratory and found that there are significant differences in the susceptibility among the varieties. Some varieties of mungbean were highly susceptible in terms of adult emergence, percentage weight loss, damage, adult lifespan and developmental period while others were less susceptible but none was immune.

Fuji and Miyazaki (1987) investigated the resistance of beans of various vigna species to infestations with C. chinensis in the laboratory in Japan. They found that *V. mungu V. umbellate, V. amgularis, V. radiata* and *V. trilobata* were susceptible. A race of *V. sublobata,* was also susceptible. This suggests the existence of 2 groups within *V. sublobata*, the supposed progenitor of both *V. mungo* and *V. radiata.*

Kulkarni *et al.* (1985) studied the damage caused by *C. chinensis* to different pulses stored in selected containers and found maximum weight loss of seeds in mungbean and dew bean (*V. acontifolius*) while adult emergence and percentage damage were minimum in pea.

Brewer and Horber (1984) evaluated 16 varities of 7 species of grain legumes for their resistance to *C. chinensis* in the U.S.A. They found that mungbean suffered the highest damage while lentil, broad bean, cowpea and one variety of chickpea had the least damage. Pigeon pea, adzuki bean (*V. angularis*) and most chickpeas were intermediate in infestation. Ovipositional antixenosis in the resistant chickpea variety was due to the rough and almost spiny pericarp. Antibiosis was expressed in lentil, broad bean and cowpea.

Epino and Regesus (1983) reported that the physical characteristics and chemical components of mungbean seed appeared to be correlated with varietal susceptibility to bruchid infestation. Large and heavy seeds were more preferred by the bruchids than small seeds. The resistant accessions had lower percentage of fats and starch but a higher percentage of protein than the susceptible accessions.

Janzen *et al.* (1977) carried out a detailed set of feeding trials using *C. maculatus* and found that several non protein amino acids were lethal at concentrations of 0.1%. They also found that alkaloids were generally the most toxic compounds present in the resident legume seeds.

ALTERNATIVE MANAGEMENT OF PULSE BEETLES INFESTING MUNGBEAN

Control of storage pests by using synthetic chemicals has become a common practice among the farmers and stockholders. It is now widely known that the chemical method has several problems, which include health hazards to the users and grain consumers. It causes residual toxicity, environmental pollution and development of pesticide resistance against bruchids. On the other hand, the traditional method of controlling storage pests by sun-drying is safer to human health and environment. But this method is laborious, time consuming, often expensive and requires suitable drying yard, when large volume of stored grain is involved. Moreover, it depends on favorable weather condition. Recently, the use of different plants and their derivatives has appeared as an effective alternative to the use of poisonous chemical insecticides or the cumbersome traditional methods for the control of various insect pest of crops and storage.

Literatures on some of such studies relevant to the present study collected from various sources including Bangladesh wire reviewed here in brief.

Ahmed *et al*. (2006) conducted an experiment to evaluate the effect of seed containers, indigenous materials and chemicals for the management of pulse beetles in storage. In this experiment, mungbean seeds were stored for two years in different containers with two types of chemicals (napthalene and camphor) and two types of indigenous materials (sand and neem leaf powder). In both years camphor provided better protection than other materials for all the containers and storage period.

Rahman *et al.* (2004) conducted experiments to study the bio-efficacies of different plant/weed derivatives that affect the development of the pulse beetles, *C. maculatus* F. (Coleoptera: Bruchidae) feed on black gram, *V. mungo*, seeds. Plant extracts, powder, ash and oil from nishinda (*Vitex nigundo* L.), eucalyptus (*Eucalyptus globules* Labill), bankalmi *(Ipomoea sepiaria* K.), neem (*Azadirachta indica*), safflower (*Carthamus tinctorius* L.), sesame (*Sesamum indicum* L.) and babla (*Acacia arabica* L.) were evaluated for their oviposition inhibition, surface protectant, residual toxicity and direct toxicity effects on *C. maculatus*. The results showed that plant oils were effective in checking insect infestation.

Veer-Singh and Yadav (2003) conducted a laboratory experiment to evaluate the efficacy of six different oils, i. e. neem (*A. indica*), mehandi (*Lawsonia inermis*), castor (*Ricinus communis*), karanja (*Pongamia pinnata*), mustard (*Brassica juncea*) and olive, against *C. chinensis* in green gram. The seed coating with these oils gave significant protection against *C. chinensis* compared to the untreated control. The oil coating 6-8 h after treatment gave complete protection at doses of 2.5, 5 and 10 ml/kg seeds, whereas partial to complete protection was observed at 90, 150 and 210 days after treatment. Neem and mehandi oils at 10 ml/kg seed were effective even beyond 150 days after treatment, and the rest of the oils were effective even after 280 days of oil treatment. Germination test carried out with the oil-treated seeds at 4 different time intervals (6 to 8 h, 90, 150 and 210 days after treatment) showed significant difference among the treatments and untreated control, but it was beyond 80% in all the treatments; germination in the untreated control ranged from 94.3 to 97.0%. However, the difference became non-significant when the treated seeds were given 8 h exposure to sun.

Dhakshinamoorthy and Selvanarayanan (2002) evaluated the effects of different natural products on the survival of *C. maclatus* infesting stored green gram (*V. radiata*). The treatments comprised leaves (as dried powder) of various plants (neem, nochi [*Vitex negundo*], pungam [*Pongamia pinnata*], citrus and thulsi), fly ash, kitchen ash, castor oil, red earth, malathion (as standard control) and untreated control. Treated seeds were kept in plastic containers and 20 adult beetles were introduced into each container and kept covered with muslin cloth. The results revealed that the mortality of the beetle at 7 days after treatment was highest (100%) in castor oil, followed by neem leaf powder (91.66%).

Haque *et al*. (2002) conducted a comparative study to assess the efficacy of coconut, mustard (*Brassica spp*), sesame, castor, olive, safflower, soyabean, neem

(*A. indica*) oils, and a mixture of the oils, against the pulse beetle (*C. chinensis)* on mungbean under laboratory condition, considering the ovipositional behaviour and adult emergence of the pulse beetle and seed viability of mungbean. No harmful effect was found on oviposition due to oil treatment. However, the percentage of adult emergence was greatly reduced and completely inhibited by the application of oils on the seeds. There was also no adverse effect on the viability of seeds due to different treatments.

Bhuiyah (2001) reported that the oils of neem, Royna and Castor at 6 and 8 ml/kg and leaf of Biskatali, Marigold and Castor @ 5% w/w were most effective in preventing the egg laying in lentil and chickpea and leaf powder of Biskatali, Marigold, Castor and Mango @ 5% were most effective in reducing the adult emergence in lentil and chickpea, whereas the adult emergence were nil in pre and post storage release methods.

Rahman *et al*. (2001) reported the fumigation action of camphor against pulse beetle, *C. chinensis*. In Bangladesh, very little study has so far been reported on the efficacy of camphor against pulse beetles.

Prijono *et al*. (1997) evaluated extracts of 30 species annonaaceae, fabaaceae and meliaceae to *C. maculatus* females (1-2 days old) in petridieshes extracts that yielded at least 90% mortality were considered active. Among the annonaaceae species *Annona squamosa* and *A. glabra* at 0.5% should a good contact effect against *C. maculatus* (> 90% mortality after 3 days and 100% after 5 days): that of

A. muricata had a fairly good contact effect (71.2% mortality after 5 days) : and that if Stelechocarpur was moderately active (58.6% mortality after 5 days). Among the meliaceae species Dysoxy lumcaulfoorum was only one whose seed extract (at 0.5%) possessed a good contact effect against *C. maculatus* (88.3% mortality after 3 days and 100% after 5 days). The seed extract of another meliaceae species, *agalalia elliptica*, showed a fairly good contact effect (76.3% mortality after 5 days. None of the faba seed extracts were effective against *C. maculatus*. Further tests revealed that the LC_{50}S of *A. sqamosa* and *A. glabra* seed extracts against *C. maculatus* were 0.206 and 0.254 at 3 DAT, and o.163 and 0.158 at 5 days after treatment DAT, respectively, the respective figures for the LC_{95} were 0.351 and 0.639% at 3 DAT, and 0.299 and 0.357% at 5 DAT.

Singh *et al*. (1995) observed the effects of various chemical characters of gram (chickpea) varieties on the growth and development of *C. chinensis* in the laboratory. They found fecundity; F_1 progeny and index of susceptibility were comparatively lower on the varieties of gram with characters such as high protein, and low oil and starch contents. The varieties with high protein, and low oil and starch contents showed lower egg deposition, F_1 progeny and index of susceptibility, F_1 progeny index of susceptibility was observed to be positive and highly significant. The protein content of different gram varieties was found to be highly significantly and negatively correlated with fecundity. F_1 progeny and index of susceptibility except in the case of total sugars, which showed a significant negative correlation with index of susceptibility.

Reddy *et al*. (1994) tested pre-storage seed treatment of mungbean (*Vigna radiata*) cv. PS-16 with oils of neem (*A. indica*), karanja (*Pongamia pinnaata*), [Indian] mustard, groundnut and castor (*Ricinus communis*) at 2.5, 5.0 and 10.0 ml/kg seed as a surface protectant against *C. chinensis*. Seeds treated with Thiram 75WP (2.5 g/kg) were used as a control and the effect on seed viability was tested. Karanja oil, mustard oil and castor oil (10ml/kg) were found effective in halting the embryonic development in *C. chinensis* and protected the seed over a period of 21 months. A significant reduction in germination was noticed among the treatments with neem oil and ground oil at 10 ml/kg where seed viability was maintained for up to 6 months, while at the lower dosage (2.5 and 5 ml/kg seed) viability was maintained for up to 18-21 months, respectively. Karanja oil, castor oil and mustard oil even at 10 ml/kg did not show any adverse effects on seed viability for up to 18 and 21 months, respectively. There was a progressive increase in moisture content of the seeds with different treatments during storage which was on par with the control.

Seck *et al.* (1991) against *C. chinensis* in stored cowpeas in the laboratory. Both neem leaves and neem seed powders, mixed with cowpeas at 3% w/w caused 85-90% mortality to adult bruchids in 72h. Seed powders were more effective than the leaf powders.

Babu *et al.* (1989) studied the effect of pre-storage treatment of mungbean (*V. radiata*) variety PS-16 with neem *(A. indica)* karanja (*Pongamia glabra* [*P. pinnata*]), mustard groundnut and castor (*Ricinus communis*) oils, each at 2.5, 5.0 and 10.0 ml/kg seed, on infestation by the bruchid *Callosobruchus chinensis* from May 1985 to August 1987. Treatments with karanja oil (5 and 10 ml/kg) and castor oil (10 ml/kg) effectively reduced oviposition by the bruchid under conditions of artificial infestation, while maintaining a high level of germination for over 18 months of storage under ambient conditions. After 24 months of storage, the yield of neem oil treated seed was significantly lower.

Srivastava *et al.* (1988) tested the essential oils of *Mentha arvnesis*, *Eucalyptus golobulus*, *Cymbopogon winterianus* and *C. maritinii* against *C. chinensis* on seeds of red gram *(Cajanus cajan*). At a concentration of 0.1% *C. martini* was the most effective in preventing oviposition (18.66 eggs/adult 90 days after insect release). At 0.2%, *M. arvensis* was effective and gave complete control of oviposition. Similar result were obtained for adult emergence. They concluded that the essential oils of *M. arvensis* and *C. martini* at 0.2% and *E. globules* and *C. winterianus* at 0.4% could be used for the control of *C. chinensis* on *C. cajan*.

Yadava and Bhatnagar (1987) assessed the efficacy of 6 plant products at 3 doses against the bruchid, *C. chinensis* on stored seeds of cowpea (*V. unguiculata*). The plant products tested were leaf powders of neem, (*A. indica*), dhatura (*Datura alba* D. metal) and oak (*Calotropis procea*), garlic, powder and shell and seed powder of soapnut (*Spindus trifoliatus*). Mortality was low initially, but increased with the time after 1 week; all treatments were significantly superior to the untreated variant. After a period of 5 months, the mean percentage damage to the seeds was 6.9, 7.6, 7.6 and 8.2 for treatments with soapnut shell powder, oak leaf powder, soapnut seed powder and garlic powder compared with 2.2% for malathion at 15 ppm. Leaf powders of neem and dhatura were slightly less effective. None of the treatments had adverse effects on germination of the seeds.

In Egypt, El-ghar and El-sheikh (1987) studied the effectiveness of some plant extracts such as *Clerodendrum enerme. Nerium oleander*, *Ipomea palmata* and *Atriplex lentiformis* against *C. chinensis* on cowpea seeds (*V. sinensis V. unguiculata*) in the laboratory. Contact toxicity was higher for *N. oleander* and *I. palmata* extracts at 5% w/v, but all extracts had some ovipositional deterrence at one or more of the concentrations applied. They found a reduction in the fecundity of adults emerging from eggs laid on the treated seeds, leading to a smaller F_1 generation. At 0.5% w/v the *I. palmata* extract provided 97% protection against *C. chinensis*, followed by extracts of *N. oleander* (94%), *C. inerme* (93%).

Khaire *et al*. (1987) tested vegetable oils in the laboratory at 5 to 10 ml/kg seeds against adults of C. *chinensis* infesting pigeon peas (*Cajanus cajan*); oils of neem and Karanja (*pongamia glabra*) at higher concentration were the most toxic.

In England, Golob and Webley (1980) have complied the information from replies to a questionnnaire and from a study of literature. More than 160 materials have been listed with the country of use, the sources of information, and a brief description of the use. The various types of natural materials have been grouped together as whole plants or parts of plants, plant extracts, vegetable or citrus oil, ashes or minerals. Some of the information relate to traditional use and some to the use of materials in laboratory or field trials.

Pandey and Verma (1977) in their testing (*Custard apple*) seed powder as a protectant of mung (*Phaseolus radiatus*) against pulse beetle, *C. maculates* (F.) at the rates of 0.5, 1.0 and 2 parts per 100 parts of mung by weight. They found that treated seeds were effectively protected against *C. maculatus* for up to 100 days when used at higher rates of dosages. The protection appeared to of repellent in nature, since the treated seeds produced no mortality in adult *C. maculatus.*

In Bangladesh, Das (1987) investigated the effect of various concentrations of neem (*A. indica*) oil on adult mortality and oviposition of *C. chinensis* in the laboratory at 32.5^0C and 83-85% R.H. Ten pairs of newly emerged male and female adults of *C. chinensis* were introduced into pots containing 50g chickpea (*Cicer arietinum*) seed treated at 4, 6, 8 and 10 ml/kg seeds. Adult mortality was significantly greater at all concentrations of treated seeds compared with the untreated seeds. The highest mortality of 100% was observed at 8 and 10ml/kg seeds. The total number of eggs laid on the seeds treated at 6, 8 and 10ml/kg seed significantly lower than the untreated seeds or those treated at 4ml/kg seed. It is concluded that 8ml of oil/kg seed is the most economic concentration to control *C. chinensis* infestation on chickpea seeds.

Rouf *et al*. (1996) in the laboratory of the Department of Entomolgy, Bangladesh Agricultural University (BAU), Mymensingh and found that the leaf powder of neem (*A. indica*), nishinda (*Vitex nigundo*) and biskatali *(Polygonum hydropiper*) alone and in combination of these materials at lower were less effective against the pulse beetle, *Callosobruchus chinensis*. They recorded that biskatali leaf powder @ 4g/50g lentil seeds was most effective in reducing oviposition and adult emergence of the pulse beetle and its intensity of damage and weight loss to lentil seeds. Germinaton of lentil seeds was not affected when treated with biskatali leaf powder. Another study was done by Chowdhury *et al*. (1991) on the effect on some indoor containers and they reported that Improved Tin, Traditional Tin and Polythene lined Motka gave full protection to maize seeds up to 13 months of storage against *Sitophilus spp*, and *Sitotroga cerealella* (OL.) both in periodically open container opened once after the end of the study.

In Africa, Mueke and Apuuli (1987) used vegetable oils and ash for the control of *C. maculatus* in seeds of cowpea (*V. unguiculata*) and observed that castor (*R. communis*) oil was an outstanding agent. Vegetable oils caused mortality to adult beetles and the eggs that were on the seeds failed to hatch. Ash mixed with cowpea seeds afforded satisfactory control against the bruchid. Ash levels of 20 and 30% led to 8.96 and 6.18% damage respectively, as compared with 52.59 for no treatment.

A study was conducted in India by Khan (1986) with the residual activity of rhizome powder of *Acorus calamus* (applied at 0.2%) against *C. chinensis* in stored grains of *Cicer arietinum* was tested in the laboratory at 25^{o}C. When the bruchids were introduced with ranges of 0-30 days. After treatment the progeny did not develop and the percentage of infestation was 0-0.04. When the insects were introduced 45-120 days after treatment, the percentage of infestation were 0.26-0.93 compared to 19.59% for the untreated grains.

A laboratory study done in USA by Su (1984) on the toxicity of acetone extract of the unripe fruit of *Piper nigrum* (black pepper and green pepper) and maybe the hexane extract of the dry fruit of west African pepper (*P. guineese)* to the stored product insects *C. maculatus*, *Sitophilus oryzae*, *Lasioderma serriicorne* and *Tribolium confusum* showed that black pepper gave the highest contact toxicity to *C. maculatus* and *S. oryzae* with green pepper producing toxicity just slightly lower. Black pepper gave the best protection to black eyed peas (*V. unguiculata*) against *C. maculatus*. Both black pepper and green pepper gave good protection to wheat against infestation by *S. oryzae* even the lowest doses of 250 ppm gave 57.1% protection.

Rajasekaran and Kumaraswami (1985) evaluated the effectiveness of extracts of Karanja (*P. glabra*) and neem (*A. indica*) for the control of *Sitophilus oryzae* and *C. chinensis* on sorghum and green gram (*V. radiata*) grain. Coating sorghum grain with karjana extract with 0.4% vol/vol or with neem extract at 1.0% wt/wt. gave complete protection from *S. oryzae*. Coating green gram grain with the 2 extracts at 0.8% wt/wt respectively, gave significant protection from *C. chinensis*.

According to Tikku *et al*. (1981), the factors responsible in preventing the multiplication of *C. chinensis* by vegetable oils could be attributed to the prevention of normal exchange of gases, hardening the outer membrane to prevent hatching, interference with water balance. Interference with the water balance of the eggs and penetration by the oil of the wax layer under the chorion and consequent contact with the embryo were found the most probable factors in completion of developmental cycle.

CHAPTER III

MATERIALS AND METHODS

The study comprising two sets of experiments have been conducted during May to September, 2009 at the laboratory of the Department of Entomology, Sher-e-Bangla Agricultural University (SAU), Dhaka.

In the first experiment, different botanicals were used against pulse beetle and their effectiveness was studied. No botanicals were used in 2^{nd} experiment, only the effect of different botanicals on the offsprings of the treated insects in first experiment was observed.

Experiment 1 : Evaluation of different botanicals against *Callosobruchus chinensis* on mungbean

Source and Culture of Beetles

Pulse beetles infested mungbean seeds were collected from Department of Entomology, SAU, to maintain a laboratory culture. Adult beetles were separated from infested seeds and then transferred to 4 large plastic jars (18cm dia. x 20cm height) and supplied with mungbean seeds. Newly emerged beetles from this stock were used in the experiment.

Materials used under the present study

Seeds of mungbean were used under the present study as susceptible host to *Callosobruchus chinensis*.

Nine plant materials were used against pulse beetles in this study. Common name, Scientific name, Family and plant parts used are given in Table 1.

Table 1. Common name, scientific name, family and plant parts used under present study

Name of plants	Scientific name	Family name	Plant parts used
Neem	*Azadirachta indica*	Meliaceae	Leaf
Nishinda	*Vitex negundo*	Verbenaceae	Leaf
Coromcha	*Carissa carandas*	Apocynaceae	Leaf
Biskatali	*Polygonum hydropiper*	Polygonaceae	Leaf
Naglingom	*Couroupita guianensis*	Lecythidaceae	Leaf
Mahogany	*Swietenia mahogany*	Meliaceae	Leaf
Bankolmi	*Ipomoea aquatica*	Convulvulaceae	Leaf
Dhatura	*Datura gardneri*	Solanaceae	Leaf
Korobi	*Narium oleander*	Apocynaceae	Leaf

Collection and Processing of experimental Materials

Mungbean (*Vigna radiata*) seeds used in this study were collected from local market “Dalpotti” Dhaka. Green leaves of neem (*Azadirachta indica*), nishinda (*Vitex nigundo*), coromcha (*Carissa carandas*), biskatali (*Polygonum hydropiper*), naglingom (*Couroupita guianensis*), mahogany (*Swietenia mahogany*), bankolmi (*Ipomoea aquatica*), dhutura (*Datura gardneri*) and korobi (*Narium oleander*) collected from nearby villages of Gaibandha and Sher-e-Bangla Agricutural University campus, were kept in the shade for 20 days for air drying. The air dried leaves were then made into powder using electric grinding machine. The leaf powders of different plants were stored in polythene bags separately.

Treatments of the experiment

There are 10 treatments that were applied against pulse beetles infesting mungbean in the storage condition given in Table 2.

Table 2. Name and dose of the botanicals used under present study

Name of the botanicals	Dose
Neem (*Azadirachta indica*)	1 g/50 g
Nishinda (*Vitex negundo*)	1 g/50 g
Coromcha (*Carissa carandas*)	1 g/50 g
Biskatali (*Polygonum hydropiper*)	1 g/50 g
Naglingom (*Couroupita guianensis*)	1 g/50 g
Mahogany (*Swietenia mahogany*)	1 g/50 g

Bankolmi (*Ipomoea aquatica*)	1 g/50 g
Dhatura (*Datura gardneri*)	1 g/50 g
Korobi (*Narium oleander*)	1 g/50 g

Procedure

Fifty gram mungbean grains were taken in individual plastic pot (10cm dia. x 12cm height) and mixed thoroughly with specific dose of botanicals selected and no botanicals were used in untreated control. Five pairs of newly emerged adults (male and female) were released in each plastic pot. Each treatment including control was replicated four times. The pots were arranged in randomized complete block design (RCBD) on a wooden table and stored under laboratory condition at temperature ranged from 26.2 to 33.8^{0}C and 75% relative humidity. Efficacy of plant materials as a protectant of mungbean seeds against pulse beetle was evaluated considering percent of mortality, rate of oviposition, adult emergence, percent grain infestation, percent of weight loss and weight of pulse beetle from the treated and untreated seeds. The methods employed to record data on the above mentioned parameters are described separately.

Data Collection And Calculation

Data were colleted on percent mortality, rate of oviposition, adult emergence, percent grain infestation, percent weight loss and weight of pulse beetle.

Percent mortality

Number of dead and alive insects were regularly observed and percent mortality was calculated by using the following formula:

$$\text{Percent mortality (by number)} = \frac{\text{Number of dead beetle}}{\text{Total number of released beetle}} \times 100$$

Oviposition

Data on the rate of oviposition was recorded after 5 days from the release of insects and continued to 9 days. Twenty mungbean seeds were selected randomly from each jar. The selected seeds were carefully examined using magnifying glass and the number of eggs glued on the surface of mungbean seeds were counted.

Adult Emergence

The number emerged adults were counted daily. After every count, adults were removed from each plastic jar to avoid egg laying. This observation was continued from the first day of adult emergence to last day of emergence.

Percent of grain damage

Examination for grain damage by the pulse beetles was done by collecting 20 randomly selected mungbean grains for each of the treatment considering the number of bored seeds. Then the percent damaged grain was calculated according to the following formula :

$$\% \text{ grain damage (by number)} = \frac{\text{Number of bored seeds}}{\text{Total number of seeds}} \times 100$$

Percent of weight loss

After the complete emergence of adults from the egg laying grains, the weight of grains for each pot was recorded separately. Then the percent weight loss was measured using the following formula :

$$\% \text{ grain content loss} = \frac{\text{Weight loss per pot}}{\text{Initial weight of grains per pot}} \times 100$$

Weight loss per pot = (Initial weight- final weight) of grains per pot.

Weight of pulse beetle

After emergence, 5 beetles are collected randomly from each pot and weight was taken by electric balance.

Percent reduction of infestation over control

Data recorded from each treated and untreated control pot were used to calculate and the percent reduction over control in terms of rate of oviposition, adult emergence, percentage of damaged mungbean seeds by number, percentage of weight loss and weight of pulse beetle using the following formula:

$$\text{Percent reduction of infestation over control} = \frac{X_2 - X_1}{X_2} \times 100$$

Where, X_1 = the mean infestation of the treated pot

X_2 = the meaninfestation of the untreated pot

Experiment 2. Effect of botanicals on the offspring of the treated insects

The experiment was carried out in the laboratory during July, 2009 to September, 2009. The experiment was laid out in a Randomized Completely Block Design (RCBD) with four replications.

Procedure

Fifty gram mungbean grains were taken in individual plastic pot (10cm dia. x 12cm height). Two pairs of virgin adults (male and female) emerged from the treated grains of the first experiment were released in each plastic pot. The experiment including control (where no leaf powder was used) was replicated four times. The pots were kept arranging in randomized block design (RCBD) on a wooden table and stored under laboratory condition at temperature ranged from 26.5 to 32.5^{0}C, and relative humidity 81%. Effect of plant materials on the offsprings on mungbean seeds was evaluated considering percent of mortality, rate of oviposition, adult emergence, percent of damaged seeds and percent of weight loss from the treated and untreated seeds.

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to evaluate some botanicals as pest management practices against pulse beetle on mungbean. The results of different parameters under the experiment have been presented, discussed, and possible interpretations also given under the following headings:

Experiment 1 : Evaluation of different botanicals against *Callosobruchus chinensis* on mungbean

Effect on mortality rate

The effect of different botanicals on the mortality of *C. chinensis* is presented in Table 3. The longevity of adult pulse beetle was ranged from 3-8. After three days the highest percent mortality (20%) was found in T_1 (Neem) followed by 15% in T_2 (Nishinda), T_3 (Coromcha) and T_4 (Biskatali) and 12% in T_9 (Korobi) and no significant difference was found in T_1, T_2, T_3, T_4, T_9. But they were significantly different from other treatments. The lowest mortality (5%) was found in T_{10} (Control) followed by 7% in T_6 (Mehogany) and T_7 (Bankolmi). However, no significant difference was found in T_{10}, T_6, T_7, T_8 treatments.

Percent offspring mortality of treated *C. chinensis*

The percent mortality of the offspring of treated *C. chinensis* on mungbean is shown in Figure 1. After three days, the highest percent mortality (10%) were found in T_7 (Bankolmi), T_8 (Dhatura), T_9 (Korobi) followed by 7.5% in T_1 (Neem), T_3 (Coromcha), T_5 (Naglingom), T_6 (Mahogany) and no significant difference was found in T_1, T_3, T_4, T_5, T_6, T_7, T_8, T_9. But significant difference was observed with other treatments. The percent offspring mortality was equal (10%) in T_7 (Bankolmi), T_8 (Dhatura), T_9 (Korobi). The lowest mortality (2.5%) were found in T_{10} (Control) and T_2 (Nishinda) and no significant difference was found in T_{10}, T_2 treatments.

This result supports the findings of Yadava and Bhatnagar (1987), who reported that leaf powders of neem, (*A. indica*), dhatura (*Datura alba* D. metal) and oak (*Calotropis procea*), were significantly superior to the untreated control considering the adult mortality of C. *chinensis*.

Table 3. Percent mortality of adult *C. chinensis* after 3 days of treatment application

Treatments	Adult longevity	Percent adult mortality (%)	% of increase (+) or decrease (-) over control
Neem	3-8	20.0 a	-300.0
Nishinda	3-8	15.0 ab	-200.0
Coromcha	3-7	15.0 ab	-200.0
Biskatali	3-8	15.0 ab	-200.0
Naglingom	3-8	12.0 ab	-140.0
Mahogany	3-8	7.0 b	-40.0
Bankolmi	3-8	7.0 b	-40.0
Dhatura	3-7	10.0 b	-100.0
Korobi	3-8	12.0 ab	-140.0
Control	3-8	5.0 b	
F value		2.27	

Figures indicate original means of four replications
Means with same letter (s) in a column are not significantly different ($P<0.05$)

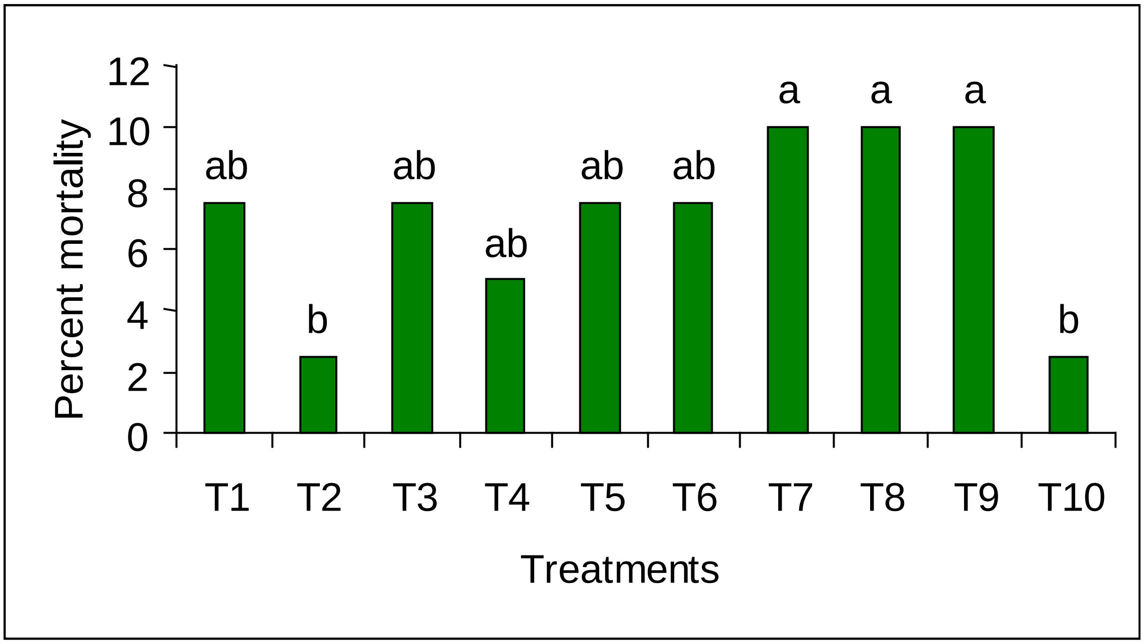

Figure 1. Comparative effects of different plant materials on the percent
offspring mortality of treated *Callosobruchus chinensis*

Treatments

T_1= Neem leaf

T_2= Nishinda leaf

T_3= Coromcha leaf

T_4= Biskatali leaf

T_5= Naglingom leaf

T_6= Mahogany leaf

T_7= Bankolmi leaf

T_8= Dhatura leaf

T_9= Korobi leaf

T_{10}= Untreated control

Oviposition rate

Mean number of eggs laid by *Callosobruchus chinensis* on mungbean seeds ranged from 30.50 to 48.00 (Table 4).

The lowest rate of oviposition (30.50) was found in T_7 (Bankalmi) and T_8 (Dhatura) followed by 32.25 in T_9 (Korobi). Therefore, no significant difference was observed among T_7, T_8, and T_9 regarding the rate of oviposition. The highest rate of oviposition was found in T_1 (Neem) and T_{10} (Control) which was significantly higher than other botanicals. The rate of oviposition was equal 36.50 in T_1 (Neem) and T_{10} (Control). Nishinda (T_2), Coromcha (T_3), Biskatali (T_4), Naglingom (T_5) and Mahogany (T_6) leaf dust encourged the rate of oviposition of the insects and increased percent rate of oviposition over control. Bankolmi (T_7), Dhatura (T_8) and Korobi (T_9) decreased the rate of oviposition of pulse beetle.

Rate of oviposition of offspring of treated *C. chinensis*

The Figure 2. rate of oviposition of offspring of treated *C. chinensis* shows the lowest rate of oviposition (8.75) was found in Dhatura (T_8) followed by 9.75 in Bankolmi (T_7). However, no significant difference was found in Neem (T_1), Nishinda (T_2), but significantly different from other treatments. The rate of oviposition was equal (10.25) in T_1 (Neem), and T_2 (Nishinda). On the other hand, the highest rate of oviposition (14) was found in control which was similar to T_4 and T_5 treatments.

This result supports the findings of Rahman *et al*. (2004), who reported that bio-efficacies of different plant/weed derivatives that affect the development of the pulse beetles, *Callosobruchus maculatus* F. (Coleoptera: Bruchidae) feed on black gram, *Vinga mungo*, seeds. Plant extracts, powder, ash and oil from nishinda (*Vitex nigundo* L.), eucalyptus (*Eucalyptus globules* Labill), bankalmi *(Ipomoea sepiaria* K.), neem (*Azadirachta indica* L.), safflower (*Carthamus tinctorius* L.), sesame (*Sesamum indicum* L.) and babla (*Acacia arabica* L.) inhibited oviposition of pulse beetle.

However the findings contradicts with Rouf *et al*. (1996), they recorded that biskatali leaf powder @ 4g/50g lentil seeds was most effective in reducing oviposition and adult emergence to lentil seeds.

Table 4. Rate of oviposition by *C. chinensis* on mungbean seeds treated with different plant materials

Treatments	No. of grain observed	Average No. of eggs	% of increase (+) or decrease (-) over control
Neem	100	36.50 cd	0
Nishinda	100	38.25 c	+4.794
Coromcha	100	48.00 a	+31.506
Biskatali	100	44.50 ab	+21.917
Naglingom	100	40.75 bc	+11.643
Mahogany	100	39.25 c	+7.534
Bankolmi	100	30.50 e	-16.438
Dhatura	100	30.50 e	-16.438
Korobi	100	32.25 de	-11.643
Control	100	36.50 cd	
F value		15.85	

Means with same letter (s) in a column are not significantly different ($P<0.05$)
Means based on 20 seeds

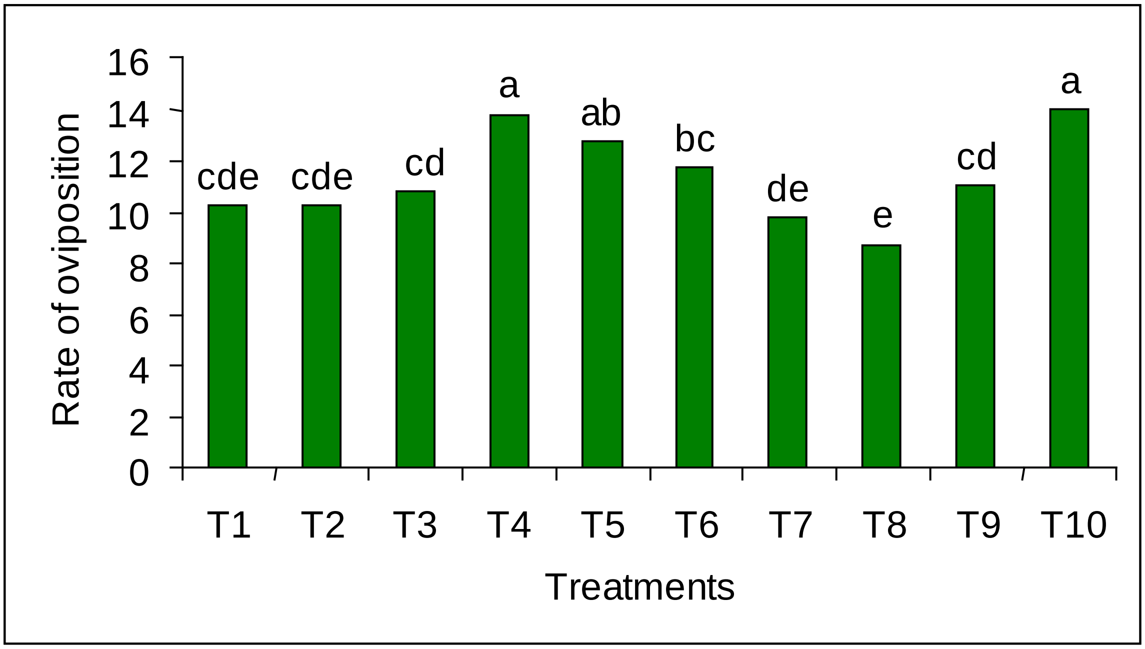

Figure 2. Comparative effects of different plant materials on the rate of oviposition by offspring of treated *C. chinensis* on mungbean

Treatments

T_1= Neem leaf

T_2= Nishinda leaf

T_3= Coromcha leaf

T_4= Biskatali leaf

T_5= Naglingom leaf

T_6= Mahogany leaf

T_7= Bankolmi leaf

T_8= Dhatura leaf

T_9= Korobi leaf

T_{10}= Untreated control

Adult emergence

In Table 5. the number of adults emerged from eggs laid on mungbean seeds treated with different leaf dust was found a similar trend as observed in the oviposition of this insects. The total number of adults emerged from seeds ranged from 249.3 to 551.3 which differed significantly ($P<0.05$) among the treatments (Table 5).

The lowest number of adult emergence 249.3 was found in T_7 (Bankalmi) followed by 293.3 in T_8 (Dhatura) and 297.8 in T_9 (Korobi). Therefore, no significant difference was observed among T_7, T_8, and T_9 regarding the number of adult emergence. The highest number of adult emergence 551.3 was found in T_3 (Coromcha) which was significantly higher than other botanicals including Control. Coromcha (T_3), Biskatali (T_4), Nishinda (T_2) Naglingom (T_5), Mahogany (T_6) and Neem (T_1) leaf dust encourged the adult emergence of the insects and increased percent adult emergence over control. Bankolmi (T_7), Dhatura (T_8) and Korobi (T_9) decreased the adult emergence of pulse beetle.

Adult emergence of offspring of treated *C. chinensis*

The Figure 3. shows the offspring adult emergence of treated *C. chinensis* on mungbean. The lowest number of adult emergence 44.75 was found in T_3 (Coromcha) followed by 52.50 in T_9 (Korobi). Therefore, no significant difference was observed among T_3 and T_9 regarding the number of adult emergence. The highest number of adult emergence 88.75 was found in T_4 (Biskatali) which was significantly higher than other botanicals including control. Biskatali (T_4) and Nishinda (T_2) encourged the adult emergence of the insects. Coromcha (T_3), Korobi (T_9), Bankolmi (T_7), Neem (T_1), Dhatura (T_8), Mahogany (T_6) and Naglingom (T_5) decreased the adult emergence of pulse beetle.

This result supports the findings of Bhuiyah (2002), who reported that the leaf powder of Biskatali, Marigold, Castor and Mango at 5% were most effective in reducing the adult emergence in lentil and chickpea.

However the findings contradicts with Rouf *et al*. (1996), they recorded that biskatali leaf powder @ 4g/50g lentil seeds was most effective in reducing oviposition and adult emergence to lentil seeds.

Table 5. Number of adult *C. chinensis* emerged from mungbean seeds treated with different plant materials

Treatments	Mean No. of adult emergence	% of increase (+) or decrease (-) over control
Neem	437.0 d	+24.324
Nishinda	386.3 e	+9.900
Coromcha	551.3 a	+56.842
Biskatali	487.3 b	+38.634
Naglingom	450.5 d	+28.165
Mahogany	471.8 bc	+34.224
Bankolmi	249.3 h	-29.075
Dhatura	293.3 g	-16.557
Korobi	297.8 cd	-15.277

Control	351.5 f	
F value	184.24	

Figures indicate original means of four replications
Means followed by same letter (s) are not significantly different (P>0.05) from each other by DMRT

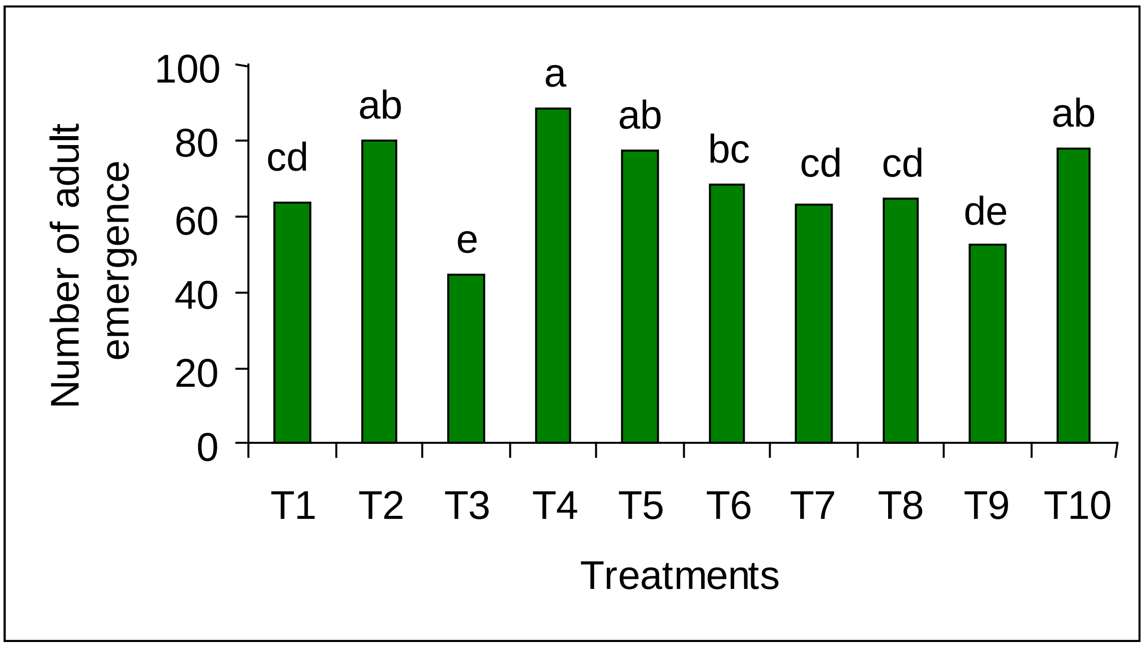

Figure 3. Comparative effects of different plant materials on the adult emergence by offspring of treated *C. chinensis* on mungbean

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Treatments

T_1= Neem leaf

T_2= Nishinda leaf

T_3= Coromcha leaf

T_4= Biskatali leaf

T_5= Naglingom leaf

T_6= Mahogany leaf

T_7= Bankolmi leaf

T_8= Dhatura leaf

T_9= Korobi leaf

T_{10}= Untreated control

Percent grain infestation by number

The extent of damage caused by the pulse beetle on mungbean seeds was determined on the basis of the number of seeds eaten by the developing larvae of the beetle through making holes on them.

In Table 6. the lowest percent of grain infestation (15%) was found in T_7 (Bankalmi) and T_2 (Nishinda) followed by 16.25% and 18.75% in T_8 (Dhatura) and T_9 (Korobi), respectively. The percent grain infestation was equal 18.75% in T_9 (Korobi) and T_5 (Naglingom). Therefore, no significant difference was observed among T_7, T_2, T_8, T_9 and T_5 regarding percent grain infestation by number. The highest percent of grain infestation was found in T_3 (Coromcha), which was significantly higher than other botanicals including control. Coromcha (T_3), Biskatali (T_4), Neem (T_1) and Mahogany (T_6) leaf dust encourged the population of the insects and increased percent grain infestation by number over control. Bankolmi (T_7), Nishinda (T_2), Dhatura (T_8) and Korobi (T_9) decreased grain infestation by reduction of population on growth of pulse beetle.

Percent grain infestation by offspring of treated *C. chinensis*

The Figure 4. shows the percent grain infestation by offspring of treated *C. chinensis* on mungbean. The lowest percent of grain infestation (1.25%) was found in T_7 (Bankolmi) followed by 2.5% and 3.75% in T_8 (Dhatura) and T_9 (Korobi), respectively. The percent grain infestation was equal 3.75% in T_9 (Korobi), T_1 (Neem) and T_3 (Coromcha). Therefore, no significant difference was observed among T_7, T_8, T_9, T_1, and T_5 regarding percent grain infestation by number. The highest percent of grain infestation was found in Control, which was significantly higher than other botanicals.

However the findings contradicts with Rouf *et al*. (1996), they recorded that biskatali leaf powder @ 4g/50g lentil seeds was most effective in reducing intensity of damage. The result varied due to use higher dose of biskatali.

Table 6. Percent grain infestation by *C. chinensis* on mungbean treated with different plant materials

Treatments	No. of grain observed	Number of infested grain	% grain infestation	% of increase (+) or decrease (-) over control
Neem	20	4.500 bc	22.50 bc	+12.50
Nishinda	20	3.000 e	15.00 e	-25.00
Coromcha	20	4.750 a	28.75 a	+43.75
Biskatali	20	4.500 b	23.75 b	+18.75
Naglingom	20	3.750 cde	18.75 cde	-6.25
Mahogany	20	4.000 bc	22.50 bc	+12.50
Bankolmi	20	3.000 e	15.00 e	-25.00
Dhatura	20	3.250 de	16.25 de	-18.75
Korobi	20	3.750 cde	18.75 cde	- 6.25

Control	20	5.750 bcd	20.00 bcd	
F value		8.62	8.22	

Means in a column followed by same letter (s) are not significantly different (DMRT-P<0.05)
Means based on 20 seeds

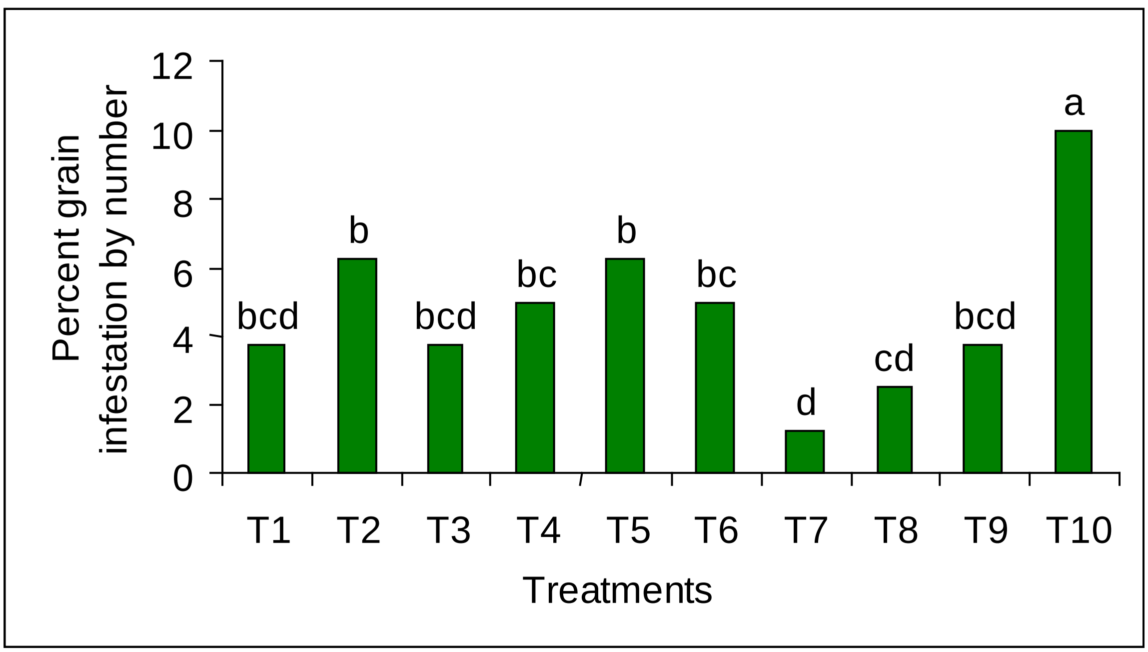

Figure 4. Comparative effects of different plant materials on the percent grain infestation by offspring of treated *C. chinensis* on mungbean

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Treatments

T_1= Neem leaf

T_2= Nishinda leaf

T_3= Coromcha leaf

T_4= Biskatali leaf

T_5= Naglingom leaf

T_6= Mahogany leaf

T_7= Bankolmi leaf

T_8= Dhatura leaf

T_9= Korobi leaf

T_{10}= Untreated control

Weight loss

The weight loss incurred in different treatments varied significantly ($P<0.05$). The amount of weight loss of treated mungbean seeds caused by the pulse beetle ranged from 3.88 to 7.12 (Table 7). The lowest percent weight loss (7.75%) occurred in T_7 (Bankolmi) followed by 8.25% in T_8 (Dhatura) and T_9 (Korobi) having no significant difference between Bankolmi, Dhatura and Korobi. The highest percent weight loss (14.25%) was obtained from T_3 (Koromcha). This value was statistically identical to the values of Biskatali, Mehogany, Naglingom, Neem, Nishinda and untreated control treatments. The highest percent reduction of weight loss (12.42%) over control was found in treatment T_7 comprising Bankolmi leaf powder. Only Bankolmi (T_7), Dhatura (T_8) and Korobi (T_9) reduced the weight loss of mungbean by reduction of infestation of pulse beetle, other treatments increasing weight loss over control by enhancing population growth of the pulse beetle.

Percent weight loss by offspring of treated *C. chinensis*

The Figure 5. shows the percent weight loss by offspring of treated *C. chinensis* on mungbean. The lowest percent weight loss (0.88%) occurred in T_3 (Coromcha) followed by 1.05% in T_8 (Dhatura), 1.2% in T_5 (Naglingom), 1.4% in T_9 (Korobi), 1.45% in T_7 (Bankolmi). 1.5% in T_6 (Mahogany), 1.7% in T_1 (Neem), 1.8% in T_4 (Biskatali) and 1.9% in T_2 (Nishinda) having no significant difference between the treatments. The highest percent weight loss (3.10%) was obtained from T_{10} (Control). All the treatments reduced the weight loss of mungbean by reduction of infestation of pulse beetle.

This result support the findings of Dixit and Saxena (1990) and Uddin (1990), reported that various plant products (powder, extracts and oils) are reported to be effective against the pulse beetle in terms of weight loss.

However the findings contradicts with Rouf *et al*. (1996), they recorded that biskatali leaf powder @ 4g/50g lentil seeds was most effective in reducing weight loss to lentil seeds. The result varied due to use higher dose of biskatali.

Table 7. Percent weight loss of mungbean seeds treated with different plant materials due to damage caused by *C. chinensis*

Treatments	Initial weight (g)	weight loss (g)	%Weight loss	% of increase (+) or

				decrease (-) over control
Neem	50	5.18 d	10.35 d	+16.94
Nishinda	50	4.65 e	9.30 e	+5.10
Coromcha	50	7.15 a	14.25 a	+61.01
Biskatali	50	6.45 b	13.02 b	+47.11
Naglingom	50	5.98 c	11.95 c	+35.02
Mahogany	50	6.25 bc	12.50 bc	+41.24
Bankolmi	50	3.88 g	7.75 g	-12.42
Dhatura	50	4.15 fg	8.25 fg	-6.77
Korobi	50	4.2 f	8.40 f	-5.08
Control	50	4.45 ef	8.85 ef	
F value		121.23	123.30	

Means in a column followed by same letter (s) are not significantly different ($P<0.05$)

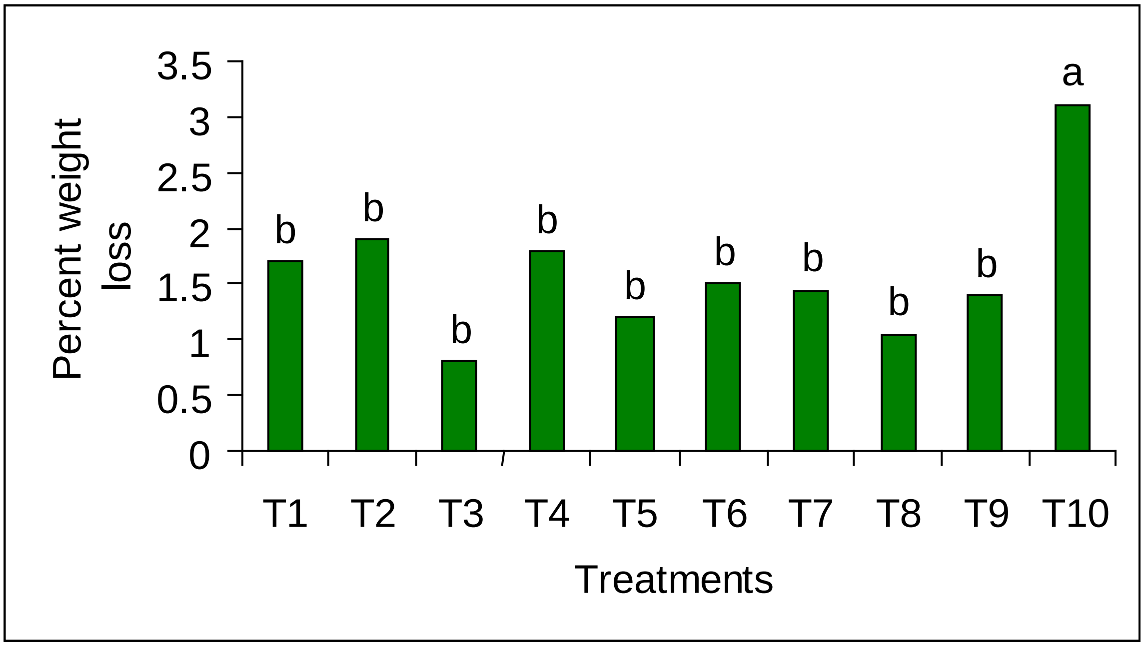

Figure 5. Comparative effects of different plant materials on the percent weight loss by offspring of treated *C. chinensis* on mungbean

Treatments

T_1= Neem leaf

T_2= Nishinda leaf

T_3= Coromcha leaf

T_4= Biskatali leaf

T_5= Naglingom leaf

T_6= Mahogany leaf

T_7= Bankolmi leaf

T_8= Dhatura leaf

T_9= Korobi leaf

T_{10}= Untreated control

Effect on weight of pulse beetle

The data in Table 8. express the weight of 5 adult beetles emerged from the treated seeds. The lowest adult weight (13.13 mg) was obtained in Mehogany (T_6) followed by 13.75 mg in T_7. However, no significant difference was found in Coromcha (T_3), Naglingom (T_5), Mahogany (T_6) and Bankolmi (T_7) but significantly lower from other treatments. On the other hand, the highest weight of 5 adults was found in control which was significantly different from other treatments. Thus dry leaf powder of all plants reduced the adult weight of pulse beetle.

Table 8. Average weight of five adults of *C. chinensis* emerged mungbean seeds under different treatments

Treatments	No. of pulse beetle observed	Average weight of 5 pulse beetle (mg)	% of increase (+) or decrease (-) over control
Neem	5	15.60 bcd	-14.144
Nishinda	5	16.17 b	-11.007
Coromcha	5	14.10 de	-22.390
Biskatali	5	15.68 bcd	-13.703
Naglingom	5	14.27 cde	-21.463
Mahogany	5	13.13 e	-27.738
Bankolmi	5	13.75 e	-24.320
Dhatura	5	15.73 bcd	-13.428
Korobi	5	15.85 bc	-12.768
Control	5	18.17 a	
F value		6.24	

Means in a column followed by same letter (s) are not significantly different (DMRT-P<0.05)

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CHAPTER V

SUMMARY AND CONCLUSION

Two sets of experiments were conducted in the laboratory of the Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from May, 2009 to September, 2009 to evaluate some botanicals applied against mungbean seeds and also evaluate the effect of botanicals on the offspring of the treated insects. The experiment consist of 10 treatments such as T_1 : Neem leaf powder; T_2 : Nishinda leaf powder; T_3 : Coromcha leaf powder; T_4 : Biskatali leaf powder; T_5 : Naglingom leaf powder; T_6 : Mahogany leaf powder; T_7 : Bankolmi leaf powder; T_8 : Dhatura leaf powder; T_9 : Korobi leaf powder and T_{10} : Untreated control. All treatments were applied @ 1g/50g seeds. The experiment was laid out in Randomized complete Block Design with four replications. Data were collected in respect to the percent mortality, oviposition rate, adult emergence, percent grain infestation, percent weight loss and weight of pulse beetle. The obtained data of different parameters were statistically analyzed to find out the significance level of the treatment.

The effectiveness of different treatments applied against *Callosobruchus chinensis* in terms of mortality percent differed significantly. The highest percent mortality was recorded from T_1 (20%) treatment while the lowest percent mortality was recorded from untreated control (5%) treatment and the order of effectiveness among the treatments was Neem> Coromcha> Biskatali, Nishinda> Korobi, Naglingom> Dhatura> Bankolmi, Mehogany.

Considering the rate of oviposition there was no significant effect of T_1, T_2, T_3, T_4, T_5 and T_6 treatments. The lowest rate of oviposition was observed from T_7 & T_8 (30.50) followed by T_9 (32.25) treatment, while the highest rate of oviposition was recorded from T_3 (48.00) treatment. Considering the adult emergence there was no significant effect of T_1, T_2, T_3, T_4, T_5 and T_6 treatments. The lowest number of adult emergence was recorded from T_7 (249.3) followed by T_8 (293.3), T_9 (297.8) treatment, while the highest number of adult emergence was recorded from T_3 (551.3) treatment.

Considering the percent grain infestation there was no significant effect of T_1, T_3, T_4 and T_6 treatments. The lowest percent grain infestation was recorded from T_7 & T_2 (15%) treatment, while the highest percent grain infestation was recorded from T_3 (28.75%) treatment. Considering the percent weight loss there was no significant effect of T_1, T_2, T_3, T_4, T_5 and T_6 treatments. The lowest percent weight loss was recorded from T_7 (7.75%) treatment followed by T_8 (8.25%), T_9 (8.4%)

treatment, while the highest percent weight loss was recorded from T_3 (14.25%) treatment.

The weight of adult pulse beetle differed significantly among the treatments. The lowest weight of pulse beetle was recorded from T_6 (13.13mg) followed by T_7 (13.75mg) treatment, while the highest weight of pulse beetle was recorded from untreated control (18.17mg) treatment. So order of the effectiveness among the treatments was Mehogany> Bankolmi> Coromcha> Naglingom> Neem> Biskatali> Dhatura> Korobi> Nishinda.

The effectiveness of different treatments on the offspring of *Callosobruchus chinensis* was identical. The performance among the treatments gave significant difference. The highest percent adult mortality were recorded from the treatments T_7, T_8, T_9 (10%) followed by T_3, T_1, T_5, T_6 (7.5%) and the lowest percent mortality were recorded from T_2 & T_{10} (2.5%) followed by T_4 (5%) treatment.

Considering the effect of treatments on oviposition rate, the lowest oviposition rate was recorded from T_8 (8.75) followed by T_7 (9.75), T_1, T_2 (10.25) and T_3 (10.75) treatment, while the highest oviposition rate was recorded from untreated control (14) treatment. Considering the number of adult emergence, the lowest number of adult emergence was recorded from T_3 (44.75) treatment, while the highest number of adult was recorded from T_4 (88.75) treatment.

The lowest percent damage grain infestation was observed in T_7 (1.25%) treatment followed by T_8 (2.5%) and T_1, T_9, T_3 (3.75%) treatments, respectively, while the highest percent infestation was found from untreated control (10%) treatment. The percent weight loss was observed lowest in T_3 (0.8%) treatment, while the highest of percent weight loss was recorded from untreated control (3.1%) treatment.

The above results indicate that leaf poweder of Bankolmi, Dhatura and Korobi were the most effective botanicals for the management of pulse beetle in storage. Howover, further studies in the following areas are suggested:

1. Other botanicals may be included in the future study.
2. Proper dose of botanicals shoud be determined.

CHAPTER VI

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