BIOLOGY AND DAMAGE ASSESSMENT OF DIFFERENT STORED GRAINS INFESTED BY RICE MOTH, *CORCYRA CEPHALONICA* (STAINTON) IN THE LABORATORY

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DECEMBER, 2016

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BY

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REG. NO.: 15-06963

A Thesis
Submitted to the Faculty of Agriculture
Sher-e-Bangla Agricultural University, Dhaka
in partial fulfilment of the requirements
for the degree
of

MASTER OF SCIENCE (MS)
IN
ENTOMOLOGY

SEMESTER: JULY-DECEMBER, 2016

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CERTIFICATE

This is to certify that the thesis entitled **'Biology and damage assessment of different stored grains infested by rice moth, *corcyra cephalonica* (stainton) in the laboratory'** 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 *bonafide* research work carried out by **Fahima Arbin**, Registration number: **15-06963** under my supervision and 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, received during the course of this investigation has duly been acknowledged.

Dated: December, 2016
Dhaka, Bangladesh

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ACKNOWLEDGEMENTS

The author first wants to articulate her enormous wisdom of kindness to the Almighty Allah for His never ending blessing, protection, regulation, perception and assent to successfully complete of research and prepare thesis.

The author likes to express her deepest sense of gratitude to her respected Supervisor **Prof. Dr. Mohammed Ali,** Department of Entomology, Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh for her scholastic guidance, support, encouragement, valuable suggestions and constructive criticism throughout the study period and gratuitous labor in conducting and successfully completing the research work and in the preparation of the manuscript writing including data analysis.

The author expresses the deepest sense of gratitude, sincere appreciation and heartfelt indebtedness to her respected Co-Supervisor **Prof. Dr. Tahmina Akter** Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka for her scholastic guidance, innovative suggestion, constant supervision and inspiration, valuable advice and helpful criticism in carrying out the research work and preparation of this manuscript.

The author express the sincere respect to the **Dr. Mst. Nur Mohal Akhter Banu,** Chairman, Examination Committee, Department of Entomology and all the teachers of the Sher-e-Bangla Agricultural University, Dhaka for providing the facilities to conduct the experiment and for their valuable advice and sympathetic consideration in connection with the study.

The author also expresses heartfelt thanks to all the teachers of the Department of Entomology, SAU, for their valuable suggestions, instructions, cordial help and encouragement during the period of the study.

The author expresses her sincere appreciation to her brother, sisters, relatives, well wishers and friends for their inspiration, help and encouragement throughout the study period.

The author

Date: December, 2016.

BIOLOGY AND DAMAGE ASSESSMENT OF DIFFERENT STORED GRAINS INFESTED BY RICE MOTH, *Corcyra cephalonica* (STAINTON) IN THE LABORATORY

ABSTRACT

Two sets of experiment were conducted in the laboratory of the Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from May to August, 2017 to study biology and damage assessment of different stored grains infested by rice moth, *Corcyra cephalonica* (Stainton) in the laboratory. As experimental materials husked rice was used for biology study and husked rice, wheat and flatted rice were used for damage assessment. The female adult moth lays 169-280 eggs with an average of 240 eggs throughout its life span. The duration of oviposition, incubation, larval and pupal periods of rice moth were 4.0±0.32, 4.20±0.37, 19.00±0.7 and 7.80±0.37 days respectively. The adult longevity was found 9.00 ± 0.89 days for male and 10.80 ± 0.97 days for females. The larval and pupal length was 10.40±0.51mm and 8.60±0.24mm and width was 3.20±0.37 and 3.40±0.40mm respectively. Adult male and female wing span, length and width were 11.00±0.32mm and12.40±0.24mm and 11.20±0.37mm and12.40±0.24mm respectively. At 1st generation in weight basis, the highest infestation was recorded on husked rice (1.30%) and weight loss(0.67%) and the lowest infestation was recorded on flatted rice (0.48%) and weight loss (0.3o%). At 2nd generation in weight basis, the highest infestation was recorded on husked rice (7.06%) and weight loss (2%) and the lowest infestation was recorded on flatted rice (3.71%) and weight loss (0.90%).

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LISTS OF ABBREVIATIONS	
Full word	Abbreviation
and others	*Et al.*
Co-efficient of Variation	CV
Completely Randomized Design	CRD
Gram	g
Id est	i.e.,
Journal	*j*.
Least significant difference	LSD
Videlicet	Viz.,

CHAPTER I

INTRODUCTION

Cereals are said to be the dominant source of nutrition for one-third of the world‟s population and among the cereals; rice (*Oryza sativa*), wheat (*Triticum aestivum* L.) and maize (*Zea mays* L.) constitute about 85% of total global production (Sofia *et al*., 2009). Rice, wheat and maize are an important cereal crop in Bangladesh serving as source of food, feed and industrial raw material. Among the cereals, wheat is the second most important staple food crop in Bangladesh after rice (BBS, 2008). On the other hand, after rice and wheat, maize (*Zea mays* L.) is an important cereal crop in Bangladesh serving as source of food, feed and industrial raw material.

Rice as a cereal grain, it is the most widely consumed staple food for a large part of the world's human population, especially in Asia. Rice are attacked by a wide range of insect pests both in the field and in the storage. The most economically important insect pests of stored rice are the maize weevils (*Sitophilus zeamais*), rice weevils (*Sitophilus oryzae*), lesser grain borer (*Rhyzopertha dominica*), larger grain borer (*Prostephanus truncatus*), Angoumois grain moth (*Sitotroga cerealella*), Indian meal moth (*Plodia interpunctella*), rice moth (*Corcyra cephalonica*) and red flour beetle (*Tribolium castaneum*). Among them *Corcyra cephalonica* is a serious and injurious pest of rice.

Wheat is a cereal grain, originally from the Levant region of the Near East and Ethiopian Highlands, but now cultivated worldwide. This grain is grown on more land area than any other commercial food. It is attacked by various insect pests between harvest and storage. The most economically important insect pests of stored wheat are the granary weevils (*Sitophilus granarius*), maize weevils (*Sitophilus zeamais*), rice weevils (*Sitophilus oryzae*), lesser grain borer (*Rhyzopertha dominica*), larger grain borer (*Prostephanus truncatus*), Angoumois grain moth (*Sitotroga cerealella*), Indian meal moth (*Plodia interpunctella*), rice moth (*Corcyra cephalonica*) and red flour beetle (*Tribolium castaneum*). *Corcyra cephalonica* is a serious and injurious pest of wheat.

Stored grains form bulk of the food worldwide. In India around 70% of stored grains are for personal use of farmers. But poor storage techniques had lead to great financial loss to the farmers. The rice moth, *Corcyra cephalonica* (Lepidoptera: Pyralidae) is one of the most destructive insect pests of the stored grains including paddy grains, rice, jowar and other cereals and is widely distributed in India and many parts of the world (Osman, 1984). *C. cephalonica*, the so far known only living member of the genus *Corcyra*. The larvae of *Corcyra* feeds on almost all sorts of stored food commodities like cereals, cereal products, oilseeds, pulses, spices, dried fruits, nuts, and biscuits. Rice moth is an external feeder of all kinds of grains. The life cycle shows complete metamorphosis. The damage is mainly caused by the larvae which feed on grains under silken webs and render them useless for human consumption (Frenemore and Prakash, 1992). Larva is mainly responsible for damage. Young larva feeds on the broken grain or on the grains, which are already damaged by other insects. As the larvae grow old it becomes capable of feeding on entire grains, which are already damaged by others. Besides polluting the grain with large quantities of frass and silken cocoons, webbing together the grains into large lumps occur. Presence of such webbing leads to serious public discrimination (Tillman and Mulrooney, 2000).

In Bangladesh, most of the farmers are poor and marginal. They store small quantities of rice, wheat and cereal products for consumption and cannot afford expensive control measures. Therefore, they essentially need some cheap, easy, readily available but effective methods for safe storing of rice. So it is necessary to know the biology of *C. cephalonica* as the serious damaging pest of stored grains, and also to assess the extent of damages caused by this pest in rice, wheat and cereal products.

Considering the above perspective the present study was undertaken to fulfill the following objectives-

- To know the biology of rice moth, *Corcyra chephalonica* developed on stored rice
- To assess the extent of damages of different stored grains (Rice, Wheat and Flatted rice) caused by rice moth, *C. chephalonica*

CHAPTER II

REVIEW OF LITERATURE

Rice (*Oryza sativa*), and Wheat (*Triticum aestivum* L.) are the first and second most important cereal crops in Bangladesh (BBS, 2013). Nutritional values as well as diversified uses of rice and wheat prove its importance for cultivation and expansion. Insect pests cause heavy losses of these food grains in storage, particularly at the farm level in tropical countries. The efficient control and removal of stored grain pests from food commodities have long been the goals of entomologists throughout the world as it is a serious problem of stored grain and stored products. Losses due to insect infestation is the most serious problem of cereal grains, pulses, oil seeds in storage,particularly, in villages and towns of developing countries like Bangladesh. The insect, *Corcyra cephalonica* (Pyralidae) is the most destructive and most common pest of stored rice, wheat and cereal products. It is also the most common pest in godowns and stores crops. A search in the literature revealed that the biology of the pest developed on rice varied with environmental conditions, seasons and types of grains. Information about the biology of rice moth on rice, wheat and cereal products is not available in Bangladesh perspective. However, some literatures on such studies relevant to the present study available through literature and CD-ROM search have been reviewed here in brief under the following sub-headings-

2.1 Origin and distribution of Rice moth, *Corcyra cephalonica* (Stainton)

Corcyra cephalonica is found throughout the humid tropics and the subtropics. It is more wide spread and common in Africa than suspected (Hodge, 1979; Haines and Hodges, While *C. cephalonica* found to occur in portions of Europe, Asia, Africa, Southern America, it is by no means truly cosmopolitan. It is also found in Mediterranean region, India and Ceylon, Western Sudan, Brazil, Cuba and West Indies.

2.2 Host of Rice moth *Corcyra cephalonica*

Rice moth is a serious pest of rice and it attacks all cereals in the storage. It is a major pest of stored husked rice, though it commonly attacks wheat, maize, sorghum, barley and oat (Fletcher and Ghosh, 1919). Burkholder (1990) considered the attack of this moth as an index for judging the quality of rice grain.

2.3 Systematic Position

Phylum: Arthropoda

Class: Insecta

Sub-class: Pterygota

Division: Endopterygota

Order: Lepidoptera

Family: Pyralidae

Genus: *Corcyra*

Species: *Corcyra cephalonica*

2.4 Biology of Rice moth, *C. cephalonica*

Mating: Breeding occurs in March to November. Longevity of females is more than males. Sexual activity takes place 15-30 minutes after emergence (Ayyar, 1934). However, sexual activity can be put off several hours and only begins a night following the emergence (Pajni and Gill, 1974). Females mate only once, while males are promiscuous (Carmona, 1958).

Subramanyan and Sreeramalu (1969) noted that females mate only once within the limit of 1-2 days. After this period, if there is no copulation the females begin to lose interest in mating. Sex ratio is normally 1:1.

Oviposition: Adults start laying eggs after 1-2 days of emergence. The eggs are laid on grains, on containers or any surface near grains either singly or in clusters. Eggs are whitish, oval in shape, 0.5mm long and having an incubation period of 4-5 days. Fecundity i.e the total eggs laid by female in lifetime is 150-200 eggs.

Larval period: Larva is creamy white, with a prominent head. It moves about actively and feeds on broken grains. It becomes full grown in 21 to 41 days after moults. The full grown larva is pale whitish, 15mm long with short scattered hairs and no markings on body. Larva undergoes 5 moults and form 6 instars by feeding and growing. It has chewing and cutting type of mouth parts. Larva feeds on broken grains and spins a web to join grains. It hibernates in winter and pupates in spring.

Pupal period: Pupa is creamy white. Larvae prepare silken cocoons among the grains for pupation. Pupation takes place inside a tough, opaque, whitish cocoon. Pupae are non feeding, immotile and dormant stage involving developmental characters of adults. Pupal period lasts for 10 days, may extend upto 40-50 days to tide over the winters. Pupa is 10-12mm. The pupa finally changes into moth in about 10 days. The entire life cycle takes about 33 to 55 days.Six generations passed in a year.

Adult emergence: Adults are pale brown colored. The hind-wings are greyish-brown or pale brown with a darker brown thin vague line along the wing veins. The wings have fringes of hairs along the margins. The wing span is usually about 15-25 mm. When the insect is viewed from above, the adults have distinct "shoulder" and rather broad wings. This distinguishes *C. cephalonica* from other stored product moths. Head bears a projected tuft of scales. (Hodges, 1979; Haines and Hodges, 1991). The labial palps which point forward or downward in the females, are also pointed and long but very short, blunt and inconspicuous in the male (Haines and Hodges, 1991).The adults are nocturnal, short lived-2 to 4 days.

2.5 Nature and extent of damage

Larvae cause the damage by webbing together grains and forming lump and feed from inside it. Heavy infestation causes the entire stock change into a webbed mass with foul order. Grains become unfit for human consumption. Ramesh *et al*. (2000) studied storage losses in unhusked rice in farmer‟s stores of district Kangra, Himachal Pradesh, India, during August 1998. A total of 180 samples collected from six blocks of the district were found to be infested with six species of insects, viz., rice weevil, *Sitophilus oryzae*, lesser grain borer, *Rhizopertha dominica*, rust red flour beetle, *Tribolium castaneum*, saw-toothed grain beetle, *Oryzaephilus surinamensis*, Angoumois grain moth, *S. cerealella* and rice moth *C.*cephalonica. The maximum infestation was 66.14 percent by *S. oryzae* followed by 23.53 percent by *T. castaneum*, 4.59 percent by *O. surinamensis*, 3.80 percent by *C. cephalonica*, 1.14 percent by *S. cerealella* and 0.79 percent by *R. dominica*. On an average 18.09 percent grains were found to be damaged and there were 3.96 percent weight losses due to insect feeding in unhusked rice.

Aviles and Guibert (1986) reported that the pyralid, *Sitotroga cerealella* and the bostrichid *Rhizopertha dominica* were the most important pests of grain and seed rice, respectively and they were able to survive and reproduce under the adverse condition of storage.

Acevedo and Aviles (1985) studied the ability of *C. cephalonica* to infest different types of stored rice grains in Cuba. A pair of adults was caged for 6 days with Petri dishes containing the different types of grains and larvae were sieved from the grains after 10 days. Polished (de-husked) grain contained more larvae than unpolished ones.

Sardar (1976) observed the susceptibility of certain varieties of stored rice to rice moths. The observation indicated that IR 140 was more susceptible to rice moth attack as compared with Dacca-17, IR 5 and Dacca-25.

Shahjahan (1974) stated that an average damage of 8% unhusked rice seeds was observed due to the attack of only Rice moth.

Mookherjee *et al*., (1970) observed the extent of damage due to insect pests of stored seeds. They collected the seeds of rice, corn, wheat, barley, jowar and bajra and stored at different levels. These seeds were examined in the laboratory for insect infestation. The study revealed that the damage varied from 0 to 70%, 0 to 100%, 0 to 75%, 0 to 22.7%, 0 to 11% and 0.9% in the above mentioned 6 seeds, respectively.

2.6 Effect of Environment on Pest Survival

Corcyra cephalonica is able to breed on a wide range of food products with varying developmental periods (Carmona. 1958; Hodges, 1979; Allotey. 1991). It is known to survive and breed on a variety of stored foods such as cereals, pulses and oil seeds (Hodges, 1979; Cox *et. al*., 1981; Osman, 1984; Allotey and Kumar, 1985; Krishna and Mishra, 1985). This probably contributes to its cosmopolitan distribution. Allotey (1982) recorded *C. cephalonica* adult emergence of 64.5% on a standard medium comprising wheat bran /maize

/glycerol; 8:8:1 w/w and 46% on cocoa beans under ambient laboratory conditions. The survival rate of an insect on its host depends on how effective or nutritious the host serves as food for the insect. Survival rate of *C. cephalonica* from egg to adult on both maize and groundnut had been reported to be 70% (Allotey. 1991); 69% and 48%on millet and sorghum, respectively (Osman, 19S4) Russell *et. al*., (1980) noted that at 28°C and 70% r.h., the percentage survival rates of the larvae of the African strain of *C. cephalonica* to adult on millet and sorghum were 36% and 58%, respectively.

The developmental period of *C. cephalonica* from egg to adult varies from one food to another. Allotey (1991) recorded 38 and 35.5 days on maize and groundnut respectively. The developmental period was found to be 60 and 63 days on maize flour and whole maize grains, respectively (Carmona, 1958). The developmental period on pulses is slower than on cereals. Fifty days was recorded on chickpeas while 78 days on black bean flour (Hodges, 1979).

C. cephalonica develops faster on whole forms of some products and on flour forms of others. For instance, development is faster on whole sorghum than its flour (Rao, 1954; Uberoi, 1961). However, on wheat flour and maize flour the developmental periods were shorter than on the whole forms; 66, 60, and 76 days, respectively (Cormona, 1958). *C. cephalonica* only develops within the temperature range of 60 and 75°C (Shazali and Smith, 1986).

Sexual activity takes place 15-30 minutes after emergence (Ayyar, 1934). However, sexual activity can be put off several hours and only begins a night following the emergence (Pajni and Gill, 1974). Females mate only once, while males are promiscuous (Carmona, 1958).

Subramanyan and Sreeramalu (1969) noted that females mate only once within the limit of 1-2 days. After this period, if there is no copulation the females begin to lose interest in mating. Sex ratio is normally 1:1.

Oviposition begins about two hours after emergence and reaches its maximum on the second and third days (Pajni and Gill, 1974). Mean value of about 153.6 and 209.87 eggs were recorded on maize and groundnut, respectively (Allotey, 1991). The eggs are sticky and usually laid on the food or among the sack fibres (Haines and Hodges, 1991). They take about 4 days to hatch. On crushed sorghum the eggs took a mean of 4.3 days to hatch at temperature of 25°C and r.h of 40%. At 30°C and 70% r.h on the same food the mean incubation period was 4.1 days (Shazali and Smith, 1986).

Corcyra cephalonica has mean egg hatchability of about 70 - 85% (Hodges, 1979; Allotey, 19S6). Larval developmental period of *C. cephalonica* was recorded to be 27.8 and 26.5 days 25°C and 60% r.h and 30°C and 60% r.h respectively, on crushed sorghum (Shazali and Smith, 1986). Shazali and Smith (1986) recorded the pupal developmental period of this insect as 13.9 and 8.9 days at 25°C and 60% r.h. and 30°C and 60% r.h., respectively on the same food medium.

2.7 Factors regulating loss of grain in storage

2.7.1 Biotic factors

Gentile and Trematerra (2004) recorded a total of twenty insect pests in stored grain and *Troqiumpul satorium, Ephestiae lutella, Plodia interpunctella, Sitotroga cerealella, Cryptolestes ferrugineus, Oryzaephilus surinamensis, Rhyzopertha dominica, Sitophilus* *granaries, Sitophilus oryzae* and *Tribolium castaneum* being the most dominant pests. *Corcyra cephalonica* occurred during post harvest storage.

Chudhary and Mahla (2001) reported that insect pests of stored cereal food grains varied depending upon the prevailing climatic conditions and reported that about 10 (ten) insect species were infested in stored grains.

Samuels and Modigli (1999) observed that wheat was infested by rice weevil, rust red flour beetle and Rice moth when was stored in jute bags, peruse, metal bins and polyethylene bags for 6 (six) months.

Both biotic and abiotic factors are responsible for the loss of stored grain in storage. Baloch *et al.*, (1994) revealed that the major biotic factors influencing grain loss during storage were insects, moulds, birds and rats.

2.7.2 Abiotic factors

Abiotic factors including temperature, humidity and storage condition, all affect environmental conditions in storage. High temperature causes deterioration, while low temperature is good for storage. High temperature accelerates the respiration of grain, which produces carbon dioxide, heat and water, conditions favourable for spoilage. Humidity equally impacts on storage of grains. Increasing humidity increases spoilage, while decreasing humidity is good for storage for any crop (Baloch *et al.*, 1994). The type of storage plays a fundamental role in storage efficiency. In case of concrete or mud storage structure can absorb water or allow the water vapors to pass through, in case of a jute bag, the bio-chemical changes and mould attack are minimal, but the risk of insect infestation increases. Sun drying or turning of food grain has many advantages as it provides an opportunity for inspection and precautionary measures to avoid spoilage. Aeration greatly minimizes mould growth, insect activity and respiration of the seed. Further aeration provides a cooling action and equalizes the temperature throughout the mass of the grain stored (Baloch *et al*., 1994).

Climate conditions, grain conditions at storage, grain and pest control practices all contribute to the rate of loss caused by insects and mould growth. As these factors interact, it is difficult to isolate them or identify one factor, which has a direct influence on loss. Average statistics for loss, whether for storage types, areas, or quantities of grain stored are inconclusive. An average figure for loss for a region or a country holds no significance unless a decision regarding a new system of storage, or new pest control technique is required. Nevertheless average loss figures are always sought (Baloch *et al*., 1994).

2.8 Storage structure for protection of stored grain

Singh (2001) made a survey on the storage structures used by the farming community in North Bihar, India. He reported that they owned at least 13 different types of storage structures for storing of their agricultural products. Among all gunny bags were maximum (25.78%), however, the farmers use different types of structures at a time.

Mandal *et al*., (1984) reported that average losses and deterioration of grains in silo/godown storage were estimated to be 1.5% and for warehouse storage to be 2.8%. Among the existing structures used by the private sector, bamboo made “dole” was suitable for short term storage.

Local storage structures which are commonly used in rural India and Bangladesh fail to provide complete grain protection from insects. In general, these structures are not moisture proof. The moisture content is high in stored grain which facilitates insect multiplication. The longer the storage period, higher is the insect infestation (Prakash, 1982).

Ramesh *et al*., (2000) studied storage losses in unhusked rice in farmers" stores of district Kangra, Himachal Pradesh, India, during August 1998. A total of 180 samples collected from six blocks of the district were found to be infested with six species of insects, viz., rice weevil, *Sitophilus oryzae*, lesser grain borer, *Rhizopertha dominica*, rust red flour beetle, *Tribolium castaneum*, saw-toothed grain beetle, *Oryzaephilus surinamensis*, angoumois grain moth, *S. cerealella* and rice moth, *Corcyra cephalonica*. The maximum infestation was 66.14 percent by *S. Oryzae* followed by 23.53 percent by *T. castaneum*, 4.59 percent by *O. surinamensis*, 3.80 percent by *C. cephalonica*. 14 percent by *S. cerealella* and 0.79 percent by *R. dominica*. On an average 18.09 percent weight losses was observed due to insect feeding in husked rice.

2.9 Toxicity Test

For successful storage of produce, it is essential to control insect pests. The control measures normally used include physical, hygienic, biological, chemical etc. These are used to manipulate the storage environment to make it less favourable for the insects (Allotey. 1991). Contact insecticides and fumigants have been widely used method to control storage pests. Due to the fact that *C. cephalonica* attacks mostly consumables, restrictions have been placed on the types of pesticides to use to control them (Entwistle, 1972).

Pyrethrins of plant origin are accepted by consumer countries of rice and wheat for the control of *C. cephalonica* and other pests. This is because such pyrethrins have low mammalian toxicity, breakdown rapidly, unstable to sunlight and hydrolyse easily by alkalis (Entwistle, 1972).

Synthetic pyrethroid, fenvalerate (at 0.02 and 0.03%) and deltamethrin (at 0.002 and 0.003%) have been found to be highly toxic to the larvae of *C. cephalonica* compared to 66.7% mortality produced by malathion after 96 hours of exposure (Mishra *et. al*., 1988).

Between 48 and 72-hours, deltamethrin was the most effective compound (Mishra *et. al*., 1988). On the basis of LC 50S, deltamethrin was the most toxic compound followed by cypermethrin and permethrin when these chemicals were tested against the larvae and adults of *C. cephalonica* and *Ephestia cautella*. Deltamethrin was also more toxic than DDT, lindane, Malathion, and etrimfos against these pests (Yadav, 1987). Etrimfos and deltamethrin were judged to be superior for large-scale use especially as wettable powders and suitable for subtropical conditions (Yadav, 1987).

Fumigation with methyl bromide at 24 g/m2 for 18 hours was effective against most stored produce insects including *C. cephalonica* larvae in cups and adults in gunnysacks. Fumigating with methyl bromide at 16 g/m3 for three days under vacuum conditions or with phosphine at 1.0 g a.i/m3 for three days under normal atmosphere was safe, economical, quick and effective, giving 100% mortality of larvae and eggs of *C. cephalonica* (Rao, *et.al*., 1991). The fumigants: aluminum phosphide (phosphine). Ethylene dibromide, methyl iodide and ethyl formate were also found to be effective against eggs and larvae of, *C. cephalonica* (Bowry, 1985).

Chander and Ahmed (1986) recorded that powdered rhizomes of *Acorus calamus* mixed with samples of wheat grains at 1, 2 and 5% w/w were lethal to first instar larvae of *C. cephalonica* in treated grains.They also reported that powdered leaves *Cleroden druminerme*, *Tylophora asthmatica*, and *Justicia betonica* reduced adult emergence of *C. cephalonica* by 91,78 and 54% respectively, at 1% w/w. Petroleum extract of water hyacinth (*Eichhorria crassipes*) effectively controlled the larval stage of this pest (Rani and Jamil,1989). Rathod and Neelagund (1992) reported that *Bacillus ceresus* is an effective alternative pathogen to *B. thuringiensis* against *C. cephalonica*.

CHAPTER III

MATERIALS AND METHODS

Experiment 1: Study of the bio-ecology of Rice moth, *Corcyra cephalonica* (Stainton) development on different stored grains in the laboratory

The study was conducted in the laboratory of the Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from May to August 2016. Husked Rice, wheat and flatted rice were used as experimental materials which were collected from farm's store house of Sher-e-Bangla Agricultural University. The initial stock culture (Plate 1) of rice moth, *Corcyra cephalonica* was taken from the Department of Entomology, Sher-e-Bangla Agricultural University. Male and female adult moths (Plate 2) were sorted under a simple microscope on the basis of their abdominal characteristics. The male abdomen is thinner, pointed and blackish when viewed from the ventral side where as in females; the abdomen is bulky, longer without any blackish coloration and larger in size. The biology of *Corcyra cephalonica* was studied on husked rice, wheat and flatted rice under laboratory conditions by maintaining them at room temperature during 2016. The collected moths were enclosed in petridish for successful mating and oviposition.

3.1.1 Collection of eggs for the study of biology

For ensuring supply of fresh egg a mass rearing of *C. cephalonica* (Stainton) was carried out in a specimen jar (Plate 4). After mating of the adult male and female and laying eggs, the fresh eggs were collected and reserved in a Petri-dish (Plate 5).

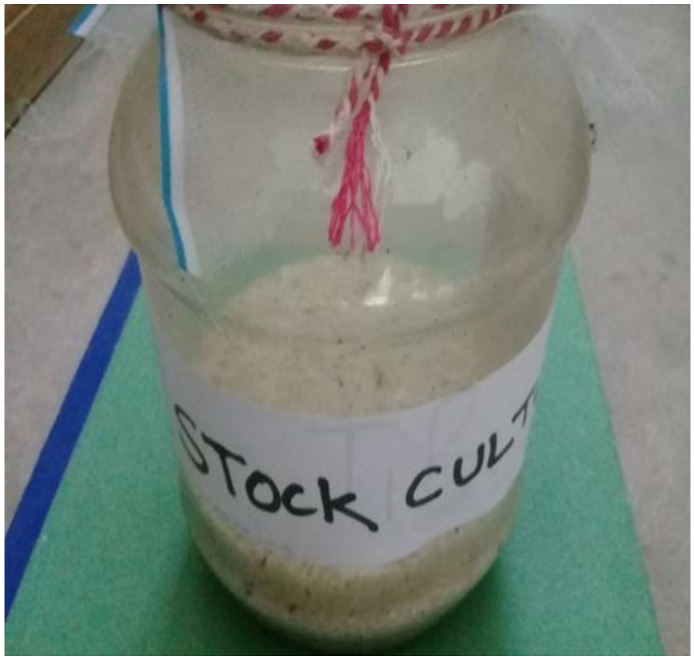

Plate-1: Stock culture of *Corcyra cephalonica* (Stainton) with husked rice.

Plate-2: Male moth of *C. cephalonica* (Stainton)

Plate-3: Female moth of *Corcyra cephalonica* (Stainton)

Plate 4: Adult moths of *C. cephalonica* kept in a specimen jar for mating

3.1.2 Biology of *C.cephalonica*

Eggs (Plate 5) were transferred on pieces of green paper in Petridish (2 cm ht. × 10 cm dia.) for hatching. After hatching (Plate 6) the newly hatched larvae (Plate 7) of *C. cephalonica* were transferred in Petri dishes containing husked rice. The morphological characteristics of the larvae (Plate 6) and pupae (Plate 7) were studied and recorded during the period of larval and pupal development, respectively.

Data pertinent to growth and developmental stages of *C. cephalonica* such as incubation period, larval period, pupal period and adult longevity were recorded during the study. The incubation period was measured by the time interval between egg laying and larval hatching. Larval and pupal periods were recorded by dissecting infested grains with the help of a blade and observed under the microscope. The emerged adults of *C. cephalonica* were kept in the petridishes till their death and the adult longevity was recorded.

Plate 5: Fresh eggs of Rice moth, *C. cephalonica*

Plate 6: Larva of *C. cephalonica* (Stainton)

Plate 7: Pupa of *C. cephalonica* (Stainton)

3.1.3 Length and width of different stages of the insect

The length and width of different larval instars of the insect were measured under sterio-microscope and longer parts were measured with the help of slide calipers.

3.1.4 Design of the experiment

The experiment was laid out in CRD (Completely randomized design) with 5 replications.

3.1.5 Data recorded

- No. of egg deposition per selected sample
- Oviposition period
- Incubation period
- Larval period
- Pupal period
- Adult longevity
- Abundance of different growth and developmental stages

Experiment 2: Damage assessment of different stored grains caused by Rice moth

The experiment was conducted to study the extent of damages of different stored grains infested by Rice moth during the period from July to December 2016. A brief description of the experimental site, experimental design, treatments, data collection and analysis of different parameters under the following headings are presented below:

3.2.1 Experimental material

Stored husked rice, wheat and flatted rice were collected from the Agricultural Farm of Shere-Bangla Agricultural University, Dhaka and bought from local market. Collected stored grains were kept in 15 plastic pots each having one kg per pot and were placed in the room under ambient temperature of the laboratory under the Department of Entomology, Sher-e-Bangla Agricultural University.

3.2.2 De-infestation of rice, wheat and flatted rice

Before artificial infestation of husked rice, wheat and flatted rice with rice moth, the husked rice and the other test grains were dried in the sun for few days. Nawab Ali *et al*., (1980) reported that solar heat treatment of grains destroys the initial insect infestation in the grains before storage.

3.2.3 Collection and rearing of Rice moth

The process of collection of eggs of rice moth, *C. cephalonica* (Stainton) has been described in 3.1.1 of the experiment 01.

3.2.4 Experimental design and layout

The experiment was laid out in Completely Randomized Design (CRD) ambient temperature condition of the laboratory. There were five replications for each of the treatments.

Plate-8: Experimental set up with husked rice, wheat and flatted rice to determine damage assessment by Rice moth

3.2.5 Estimation of different status of damage of Rice moth

Efficacy of different grain protectants against *C. cephalonica* were evaluated considering adult emergence, adult life span and grain weight loss from treated and untreated grains of husked rice, wheat and flatted rice. Data were collected on different parameters stated below-

3.2.5.1 Observation on adult emergence

50 gm of insect free husked rice, wheat and flatted rice were taken into Petridishes. Five pairs of newly emerged adult rice moth were released carefully in each of the Petridishes. Insect mortality was recorded at 24 hours intervals up to 3 days. New adults started emerge

from the grains after 24-28 days of infestation. The number of emerged rice moth at different days from each of the treated Petri dishes including control, was recorded. The emerged adult moths were counted by opening the lid. A few rice moths became visible on the surface of grains. Regular observation (daily) taken on the five pairs of moths, initially released in each of the petridishes, provided the data for calculation of adult life span and mortality.

Plate-9: Infested husked rice with larva and pupa of *C. cephalonica*

Plate-10: Infested husked wheat due to of *C. cephalonica*

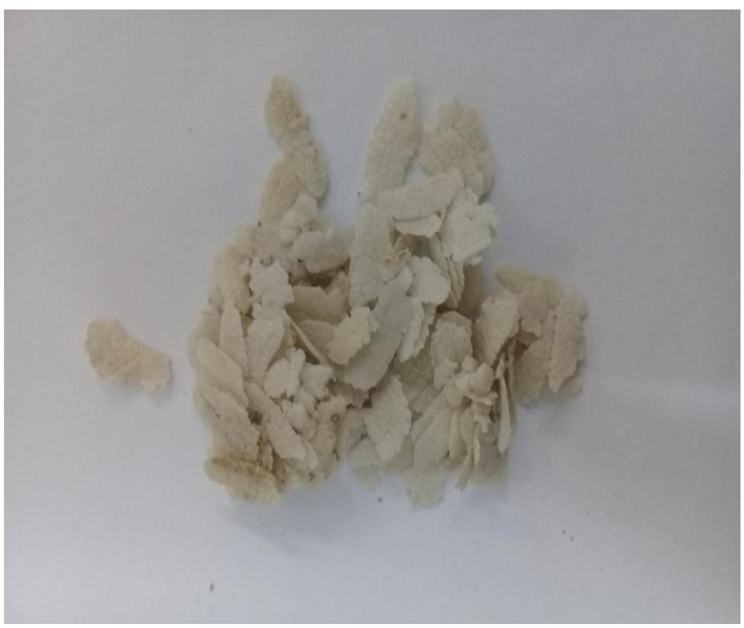

Plate-11: Infested husked wheat due to of *C. cephalonica*

3.2.5.2 Extent of damage and weight loss

When the emergence of the rice moth was completed the final weight of seeds was taken to obtain the weight loss. Sieving and winnowing was done to clean the husked rice, wheat and flatted rice. The clean seeds except those having holes in each Petri dish were weighed separately. The weight losses of grains were found out by subtracting the final weight from the initial weight (50 gm). The weight losses were converted into percentage of weight loss of rice, wheat and maize seeds. From the above mentioned data, percentage of weight loss, percentage (%) of infested seeds (by weight), percentage reduction in infestation and percent protection of weight loss over control were calculated as follows:

$$\%\ \text{Weight loss} = \frac{\text{Initial weight of seeds} - \text{Final weight of seeds}}{\text{Initial weight of seeds}} \times 100$$

$$\%\ \text{Infestation (by weight)} = \frac{\text{Weight of infested seeds}}{\text{Total weight of seeds}} \times 100$$

3.2.6 Statistical analysis

The data obtained from the experiments were statistically analyzed on one factor CRD with the help of computer based programme MSTAT-C software. The means were separated following Duncan‟s Multiple Range Test (DMRT) and Least Significance Difference (LSD) wherever necessary at 5% level of probability.

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to study the biology and assess the damages of different stored grains caused by rice moth *Corcyra cephalonica* (Stainton) in the laboratory. The results have been presented using different Table, figured plates and discussed with possible interpretations under the following headings and sub headings:

4.1 Biology of rice moth, *Corcyra cephalonica* (Stainton) developed on different stored grains

4.1.1 Mating and Oviposition

The rice moth, *C. cephalonica* (Stainton) adults started mating after 24 hrs of emergence. On husked rice grains the female moth laid 169-280 eggs with an average of 240 eggs throughout its life (Table 4.1.1). *C. cephalonica* laid eggs singly or in groups of 4-7 eggs. Dhotmal and Dumbre (1982) reported that 40.88 to 57.88 eggs were laid by a female on different rice varieties in a laboratory test and found that fine grain varieties were preferred for egg laying. Newly hatched eggs were white. The oval shaped eggs, measuring about 0.5 mm in diameter, hatched within a week.

Table 4.1.1. Age specific fecundity of rice moth, *Corcyra cephalonica* on husked rice in the laboratory condition

Insects	Number of laid eggs				Total number of eggs
	1st day	2nd day	3rd day	4th day	
1st pair	108	86	56	10	260
2nd pair	90	76	54	43	263
3rd pair	106	82	42	15	245
4th pair	90	72	52	30	244
5th pair	83	48	30	20	181
6th pair	98	80	65	22	265
7th pair	98	78	59	45	280
8th pair	103	86	67	12	268
9th pair	88	66	40	32	226
10th pair	69	51	30	19	169
Average	**93**	**72**	**49**	**24**	**240**

4.1.2. Developmental period of different life stages of the rice moth, *C. cephalonica*

The newly hatched larvae were yellowish white in color with light brown heads. Larval period were 19.00 ± 0.71 days and pupal period were 7.80±0.37 days were reared on in husked rice (Table 4.1.2).The oviposition period were 4.0±0.32 days and incubation period were 4.20±0.37 days observed on husked rice. The adult longevity were found 9.00 ± 0.89 days for male on husked rice and 10.80 ± 0.97 days for females when developed on husked rice (Table 4.1.2.).

Table 4.1.2. Developmental period of different life stages of the rice moth, *Corcyra cephalonica* feeding on husked rice in the laboratory

Developmental stages	Duration (Days)	Statistics
Oviposition period	4.0±0.32	P<0.003
Incubation period	4.20±0.37	P<0.002
Larval period	19.00±0.71	P<0.000
Pupal Period	7.80±0.37	P<0.000
Adult longevity		
Male	9.00±0.89	P<0.000
Female	10.80±0.97	P<0.000

4.1.3 Morphometric measurement of different life stages of *Corcyra cephalonica*

Morphometric measurement revealed that in consideration of larva, length was 10.40 ± 0.51 mm for husked rice and width was 3.20 ± 0.37 mm for husked rice. In pupal condition, length was 8.60 ± 0.24 mm for husked rice and width was 3.40 ± 0.40 mm for husked rice. In case of male adult wing span, length was 11.00 ± 0.32 mm for husked rice and width was 12.40±0.24 mm for husked rice. In consideration of female adult wing span, length was 11.20±0.37 mm for rice, whereas the width was 12.40 ± 0.24 mm for husked rice (Table 4.1.3).

Table 4.1.3. Morphometric measurement of different life stages of rice moth, *Corcyra cephalonica* observed on husked rice in the laboratory

Life stages	Size (mm)	
	Length	Width
Larva	10.40±0.51	3.20±0.37
Pupa	8.60±0.24	3.40±0.40
Adult wing span		
Male	11.00±0.32	12.40±0.24
Female	11.20±0.37	12.40±0.24

4.1.4 Day specific mortality of larvae of rice moth observed in husked rice

The total mortality of larvae of Rice moth at different day observation data range was 4-7 with an average of 5.6±1.34 and total percent of larval mortality was 20 observed in husked rice in the laboratory.

Table 4.1.4.Day specific mortality of larvae of rice moth observed on husked rice in the laboratory

Replication	Mortality of larvae				Total mortality of larvae	Percent of larval mortality
	Day- 1	Day-2	Day-3	Day-4		
Rep-1	2	4	1	0	1.75±1.70	25.00
Rep-2	1	3	2	1	1.75±0.90	25.00
Rep-3	2	0	3	0	1.25±1.50	17.86
Rep-4	0	1	2	1	1.0 ±1.81	14.29
Rep-5	1	1	0	3	1.25±1.25	17.86
Average	**1.20**	**1.80**	**1.60**	**1.00**	**5.6±1. 34**	**20.00**

4.1.5 Day specific pupal mortality of rice moth, *C. cephalonica* observed in husked rice

The total mortality of pupa of Rice moth at different day observation data range were 3-6 with an average of 1.05±0.25 and percent of pupal mortality was 20 observed in husked rice in the laboratory.

4.1.5. Day specific mortality of pupa of rice moth, *C. cephalonica* observed in husked rice

Replication	Mortality of pupae				Total mortality of pupae	Percent of pupal mortality
	Day-1	Day-2	Day-3	Day-4		
Rep-1	2	0	1	3	1.5±1.29	28.57
Rep-2	0	2	1	1	1±0.81	19.05
Rep-3	0	1	0	2	0.75±0.95	14.29
Rep-4	1	1	3	0	1.25±1.25	23.81
Rep-5	2	0	0	1	0.75±0.95	14.29
Average	**1.00**	**0.80**	**1.00**	**1.40**	**1.05±0.25**	**20.00**

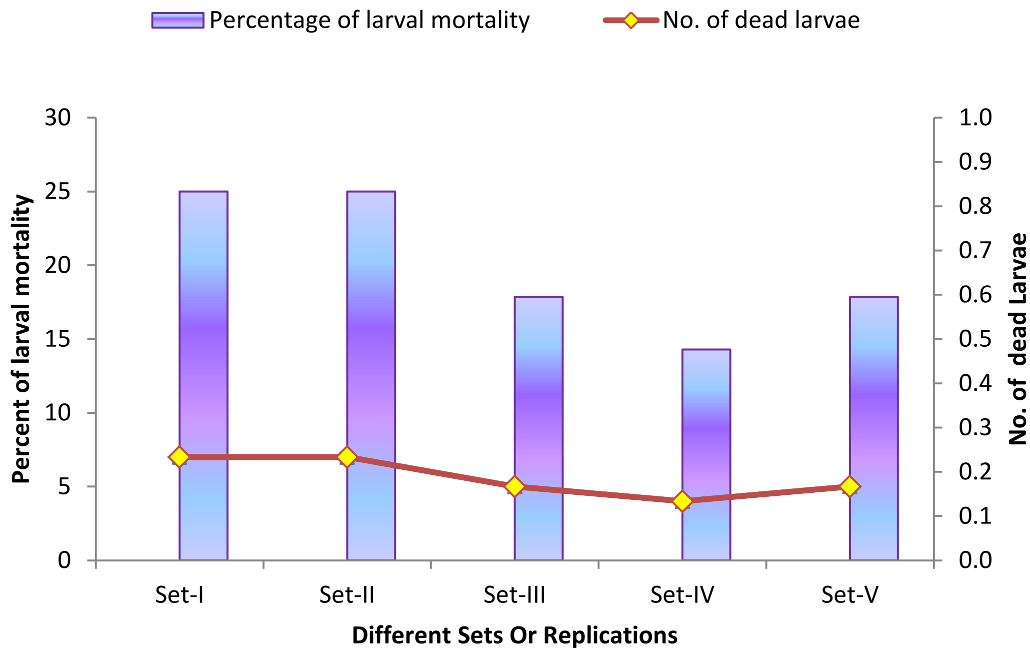

Figure 1: Percent of larval mortality and no. of dead larvae at the different days in different sets

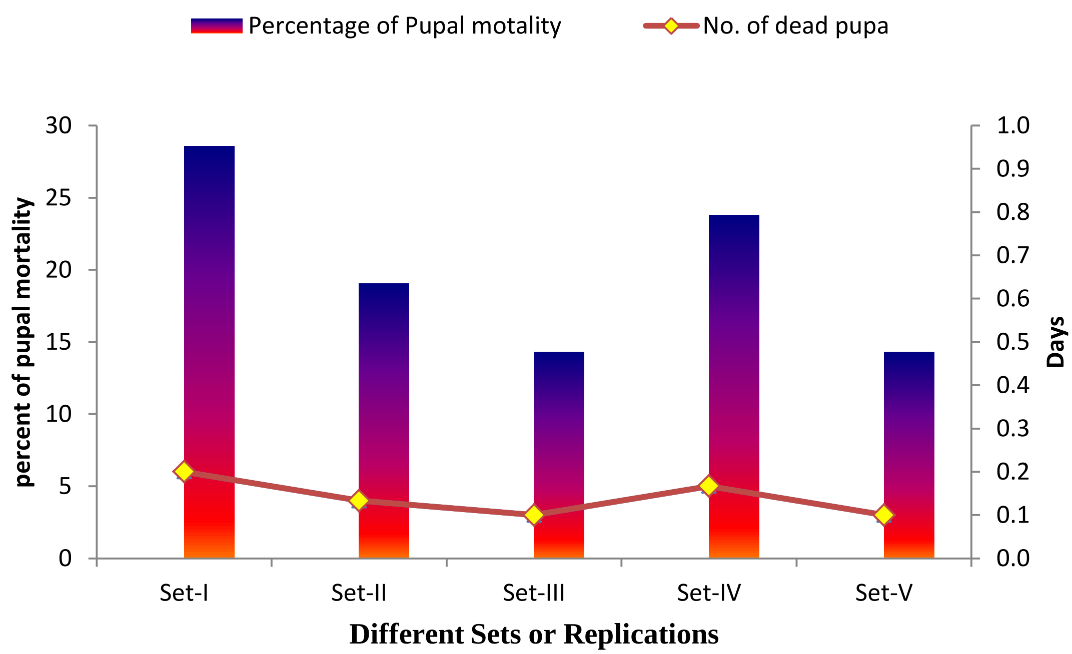

Figure 2: Percent of pupal mortality and no. of dead pupa at the different days in different sets

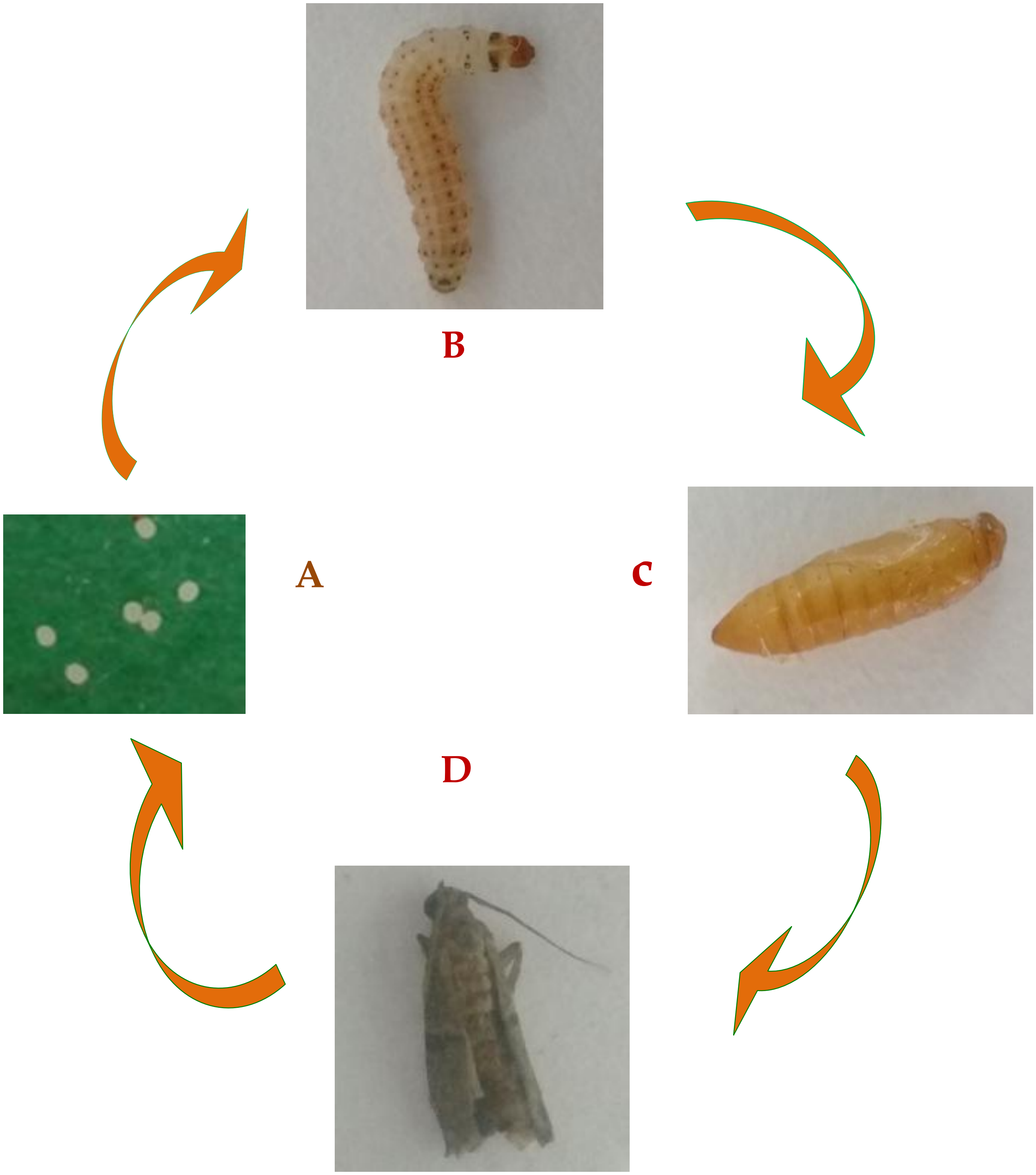

Plate 12: Life cycle of rice moth (C. *cephalonica*), **A.** Egg, **B.** Larva, **C.** Pupa and **D.** Adult

4.2 Assessment of damage caused by rice moth, *C. cephalonica* in different stored products

4.2.1 Effect of different treatments for adult emergence

Adult emergence of Rice moth for 1st and 2nd generation varied significantly for different stored products (Table 4.2.1). At 1st generation, the highest (65.00) number of adults emerged on rice grains which was followed (42.00) by the number that emergence on wheat grains, while the lowest (35.00) number of adults was recorded for rice stored grains. In the 2nd generation, the highest (180.00) number of adults emerged on husked rice which was followed (130.00) by the number that developed on wheat grains, while the lowest (110.00) was recorded for flatted rice.

4.2.1. Effect of different treatments for adult emergence of rice moth, *C. cephalonica* at 1st and 2nd generation in the laboratory

Treatments	Adult emerged at	
	1st generation	2nd generation
Husked rice	65.00a	180.00a
Wheat	42.00b	130.00b
Flatted rice	35.00c	110.00c
LSD(0.05)	3.69	11.76
Level of significance	0.01	0.01
CV(%)	5.66	6.10

In a column means having same letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at the indicated percent level of probability and numeric data represents the mean value of replications.

4.2.2 Number of dead insects of rice moth, *C. cephalonica* after different times

Number of cumulative dead insects showed statistically significant variation for different stored grains after 24, 48 and 72 hours of observation (Table 4.2.2). After 24 hours of observations, the highest number of dead insects (8.00) was recorded in husked rice whereas 4 insects were found dead on wheat and 3 were found on flatted rice. After 48 hours of observations, the highest number of dead insects (4.00) was recorded in husked rice followed (3.00) by wheat grain but no dead insect was observed for flatted rice. After 72 hours of observations, the highest number of dead insects (4.00) were recorded in flatted rice which was followed (3.00) by husked rice but the lowest (2.00) dead insect was observed for wheat (Table 4.2.2). Data revealed that the highest survival rate of rice moth was on the flatted rice.

4.2.2. Number of dead insects of rice moth after different times in stored products

Treatments	No. of dead insects after		
	24 hrs	48 hrs	72 hrs
Husked rice	8.00a	4.00a	3.00b
Wheat	4.00b	3.00b	2.00c
Flatted rice	3.00c	0.00c	4.00a
LSD(0.05)	0.553	0.314	0.377
Level of significance	0.01	0.01	0.01
CV(%)	8.02	9.76	9.15

In a column means having same letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at the indicated percent level of probability and numeric data represents the mean value of 5 replications.

4.2.3 Effect of different products on percent infestation and total weight of products caused by rice moth, *C. cephalonica* in stored condition at 1st generation

The highest weight of healthy seeds was recorded on flatted rice (49.76g) which was closely followed by that of wheat grain (49.63g) whereas, the lowest was observed on husked rice (49.36 g) by weight basis at the time of development of 1st generation. Consequently, the highest weight of infested seed was recorded on husked rice (0.640g) which was significantly different from those of the others. In case of % infestation, the highest infestation was recorded on husked rice (1.30%) which was statistically different from those of all other test grains (Table 4.2.3).

4.2.3 Effect of different products on percent infestation and total weight of products caused by rice moth, *C. cephalonica* in stored condition at 1st generation

Different products	Total weight of seeds		Infestation (%)
	Healthy(gm)	Infested(gm)	
Husked rice	49.36b	0.64a	1.30a
Wheat	49.63a	0.28b	0.56b
Flatted rice	49.76a	0.24b	0.48b
LSD(0.05)	0.19	0.04	0.08
Level of significance	0.01	0.01	0.01
CV(%)	0.29	9.68	8.19

In a column means having same letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at the indicated percent level of probability and numeric data represents the mean value of 5 replications.

Plate 13: Infested wheat grain with larvae and pupa of *C. cephalonica*

Plate 14: Completely damaged grain due to *C. cephalonica* with larval & pupal chamber and oozes materials

4.2.4 Effect of different products on percent infestation and total weight of products caused by rice moth, *C. cephalonica* in stored condition at 2nd generation

The same trend of infestation levels, like 1st generation was observed for 2nd generation also. The highest weight of healthy seeds was recorded on flatted rice (48.21 g) which was closely followed by wheat grain (47.00 g) and the lowest was observed in husked rice (46.70 g). In case of the weight of infested grains, the highest weight of infested product was recorded on husked rice (3.296g) which was statistically different from all of other products. In case of percent infestation, the highest infestation was recorded on husked rice (7.060%) which was statistically different from others (Table 4.2.4).

4.2.4 Effect of different products on percent infestation and total weight of products caused by Rice moth in stored condition at the 2nd generation

Different products	Total weight of seeds		Infestation (%)
	Healthy	Infested	
Husked rice	46.70b	3.29a	7.06a
Wheat	47.00b	3.00b	6.38b
Flatted rice	48.21a	1.79c	3.71c
LSD(0.05)	0.60	0.23	0.53
Level of significance	0.01	0.01	0.01
CV(%)	0.93	6.41	6.82

In a column means having same letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at the indicated percent level of probability and numeric data represents the mean value of 5 replications.

4.2.5. Weight loss due to rice moth infestation of stored products of husked rice, wheat and flatted rice at different generation of rice moth, *C. cephalonica*

Treatments	Weight loss (%)	
	1st generation	2nd generation
Husked rice	0.67a	2.00a
Wheat	0.49b	1.00b
Flatted rice	0.30c	0.90b
LSD(0.05)	0.075	0.151
Level of significance	0.01	0.01
CV(%)	10.27	8.31

In a column means having same letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at the indicated percent level of probability and numeric data represents the mean value of 5 replications.

4.2.5. Weight loss due to rice moth infestation of stored products of husked rice, wheat and flatted rice at different generations of rice moth, *C. cephalonica*

At 1st generation in case of weight loss, the highest weight loss was recorded on husked rice (0.67%) which was statistically different from all other products and the lowest weight loss was recorded on flatted rice (0.30%). At 2nd generation in case of weight loss, the highest weight loss was observed on husked rice (2%) followed by wheat grains (1%), whereas the lowest weight loss was recorded on flatted rice (0.90%) in Table 4.2.5.

4.2.6. Correlation between percent of infestation and weight loss of husked rice grain by rice moth, *C. cephalonica*

Correlation study was done to establish the relationship between percent of infestation and weight loss of husked rice grain. From the figure 3, it was revealed that positive correlation was observed between the parameters. It was evident that the equation y = 0.087x + 0.440 gave a good fit to the data and the co-efficient of determination (R^2 = 1.00) fitted regression line had a significant regression co-efficient. It may be concluded from the figure that percent of infestation was strongly as well as positively correlated with weight loss of husked rice grain. Weight loss of husked rice grain was increased due to increase of percent of infestation.

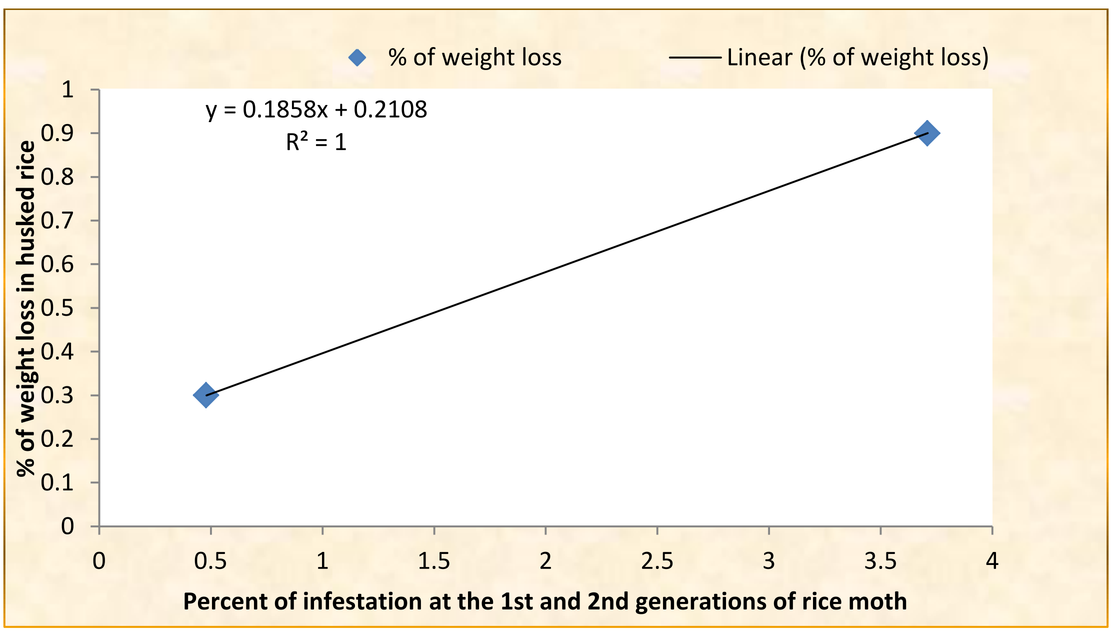

Figure 3: Relationship between percent of infestation and weight loss of husked rice grain at the 1st and 2nd generations of rice moth, *C. cephalonica*

4.2.7. Correlation between percent of infestation and weight loss of wheat grain by rice moth, *C. cephalonica*

Correlation study was done to establish the relationship between percent of infestation and weight loss of wheat grain. From the figure 4, it was revealed that positive correlation was observed between the parameters. It was evident that the equation y = 0.087x + 0.440 gave a good fit to the data and the co-efficient of determination (R^2 = 1.00) fitted regression line had a significant regression co-efficient. It may be concluded from the figure that percent of infestation was strongly as well as positively correlated with weight loss of wheat grain. Weight loss of wheat grain was increased due to increase of percent of infestation.

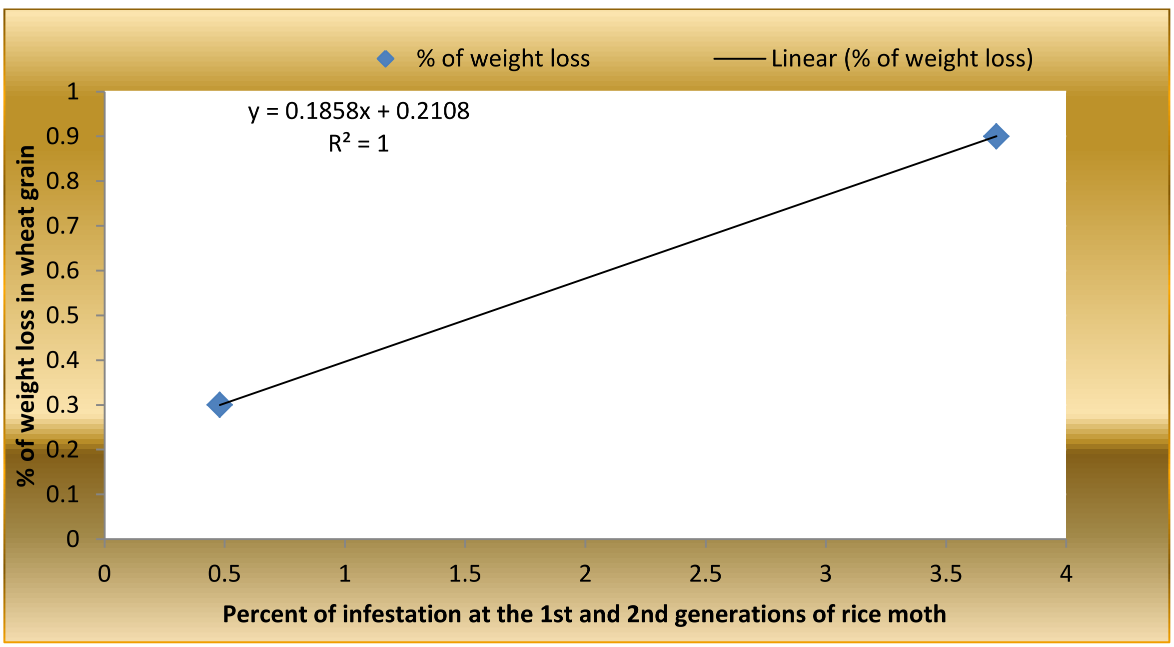

Figure 4: Relationship between percent of infestation and weight loss of wheat grain at the 1st and 2nd generations of rice moth, *C. cephalonica*

4.2.8. Correlation between percent of infestation and weight loss of Flatted rice by rice moth, *C. cephalonica*

Correlation study was done to establish the relationship between percent of infestation and weight loss of Flatted rice. From the figure 5, it was revealed that positive correlation was observed between the parameters. It was evident that the equation y = 0.185x + 0.210gave a good fit to the data and the co-efficient of determination (R^2 = 1.00) fitted regression line had a significant regression co-efficient. It may be concluded from the figure that percent of infestation was strongly as well as positively correlated with weight loss of Flatted rice. Weight loss of Flatted rice was increased due to increase of percent of infestation.

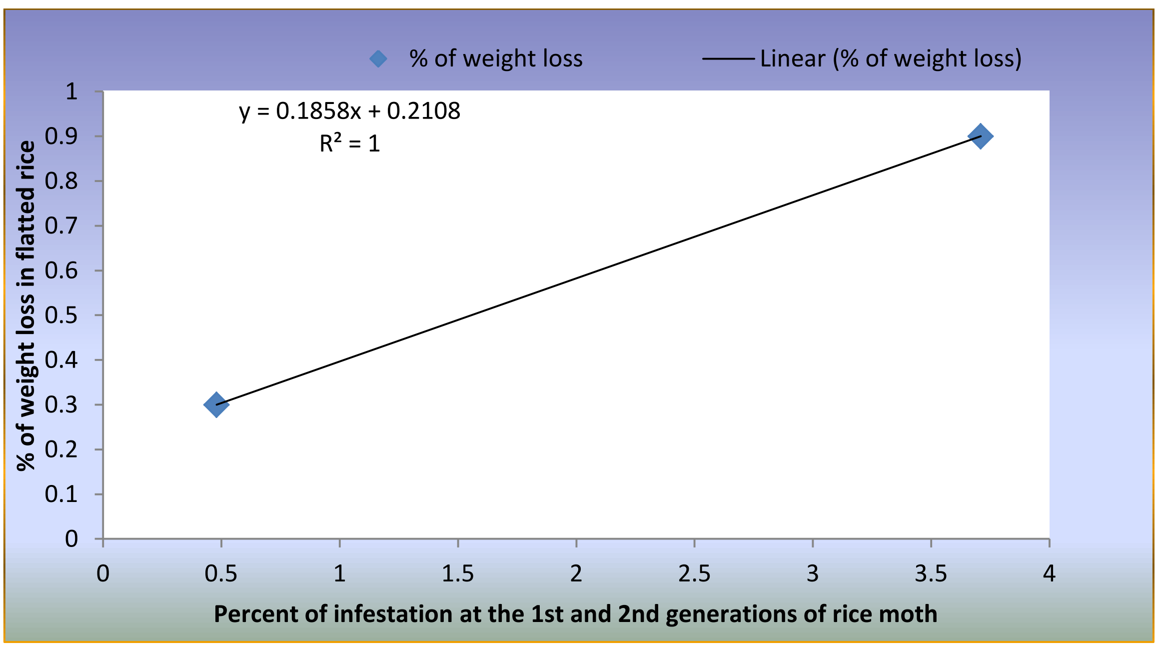

Figure 5: Relationship between percent of infestation and weight loss of flatted rice at the 1st and 2nd generations of rice moth, *C. cephalonica*

CHAPTER V

SUMMARY AND CONCLUSION

Two experiments were conducted in the laboratory of the Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from May to August, 2016 to study biology and damage extent of different stored grains caused by rice moth *Corcyra cephalonica* (Stainton) in the laboratory. Husked rice, wheat and flatted rice were used as experimental materials.

The rice moth, *C. cephalonica* (Stainton) adults started mating immediately within 15-30 minutes after emerged. The female moth laid eggs on the husked rice but the total number of eggs varied for different replications. The highest numbers of eggs were found to be laid on husked rice and that varied from 169-280 eggs with an average of 240 eggs throughout its life cycle.The larval periods were 19.00 ± 0.71 days when they developed on husked rice. The pupal periods were 7.80±0.37 days were reared on in husked rice. Male adult longevity was 9.00 ± 0.89 dayson husked rice, whereas 10.80 ± 0.97 days for female adult longevity. The observed larval length was found 10.40 ± 0.51mm and the width was 3.20 ± 0.37 mm for husked rice. In pupal condition, length was 8.60 ± 0.24 mm for husked rice and width was 3.40 ± 0.40 mm for husked rice. In case of female adult wing span, length was 11.20±0.37 mm for husked rice, whereas the width was 12.40 ± 0.24 mm for husked rice. In consideration of male adult wing span, length was 11.00 ± 0.32 mm for husked rice and width was 12.40±0.24 mm for husked rice. The total mortality of larvae of rice moth at different day observation, data rage was 4-7 with an average of 5.6±1.34 and percent of larval mortality was 20 observed in husked rice in the laboratory. The total pupal mortality rice moth at different day observation, data rage was 3-6 with an average of 1.05±0.25 and percent of pupal mortality was 20 observed in husked rice in the laboratory.

Adult emerged of rice moth for 1st and 2nd generation varied significantly for different stored products. At the 1st generation, the highest (65.00) number of adults emerged on rice grains which was followed (42.00) by the number that emergence on wheat grains, while the lowest (35.00) number of adults was recorded for rice stored grains. In the 2nd generation, the highest (180.00) number of adults emerged on husked rice which was followed (130.00) by the number that developed on wheat grains, while the lowest (110.00) was recorded for flatted rice.

Number of cumulative dead insects showed statistically significant variation for different stored grains after 24, 48 and 72 hours of observation. After 24 hours of observations, the highest number of dead insects (8.00) was recorded in husked rice whereas 4 insects were found dead on wheat and 3 were found on flatted rice. After 48 hours of observations, the highest number of dead insects (4.00) was recorded in husked rice followed (3.00) by wheat grain but no dead insect was observed for flatted rice. After 72 hours of observations, the highest number of dead insects (4.00) were recorded in flatted rice which was followed (3.00) by husked rice but the lowest (2.00) dead insect was observed for wheat. Data revealed that the highest survival rate of rice moth was on the flatted rice.

The highest weight of healthy seeds was recorded on flatted rice (49.76g) which was closely followed by that of wheat grain (49.63g) whereas lowest was observed on husked rice (49.36 g) by weight basis at the time of development of 1st generation. Consequently, the highest weight of infested seed was recorded on husked rice (0.64g) which was significantly different from those of the others. In case of % infestation, the highest infestation was recorded on husked rice (1.30%) which was statistically different from those of all other test grains.

The highest weight of healthy seeds was recorded on flatted rice (48.21 g) which was closely followed by wheat grain (47.00 g) and the lowest was observed in husked rice (46.70 g).In case of the weight of infested grains, the highest weight of infested product was recorded on husked rice (3.296g) which was statistically different from all of other products. In case of percent infestation, the highest infestation was recorded on husked rice (7.060%) which was statistically different from others.

At 1st generation in case of weight loss, the highest weight loss was recorded on husked rice (0.67%) which was statistically different from all other products and the lowest weight loss was recorded on flatted rice (0.30%). At 2nd generation in case of weight loss, the highest weight loss was observed on husked rice (2%) followed by wheat grains(1%), whereas the lowest weight loss was recorded on flatted rice(0.90%).

Conclusion

The Rice moth, *Corcyra cephalonica* (Stainton) is one of the most serious pests of different stored grains at post harvest level. The moth develops through egg, five larval instars, pupa, pre-pupa and adult stages. The duration for different developmental stages of the moth varied for different stored grains. The grain weight loss increased with the increase in percentage of infestation levels. Considering the adult mortality, adult emergence, weight of healthy and infested husked rice, wheat and flatted rice and percent infestation was related to the damage assessment of the products.

Recommendation

Considering the situation of the present experiment, further studies in the following areas may be conducted:

1. Influence or impact of different environmental factors may be studied in different seasons of the year;
2. Studies on the efficiency of different control measures of stored grain pests.

CHAPTER VI

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