MAJOR INSECT PESTS OF YARD LONG BEAN (*Vigna sesquipedalis*) AND THEIR MANAGEMENT WITH SOME PROMISING INSECTICIDES

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CERTIFICATE

This is to certify that the thesis entitled, **"MAJOR INSECT PESTS OF YARD LONG BEAN (*Vigna sesquipedalis*) AND THEIR MANAGEMENT WITH SOME PROMISING INSECTICIDES."** Submitted to the Department of Entomology, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Department of Entomology embodies the result of a piece of bona fide research work carried out by **MOST. NAJMUS SAMA**, **Registration No. 08-2993** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated:June,2015
Dhaka,
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Professor Dr. Mohammed Ali
Supervisor

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ABSTRACT

An experiment was conducted in the farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla nagor, Dhaka, Bangladesh during March to June 2014to study the major insect pests of yard long bean (*Vignasesquipedalis*) and their management. The seeds of Kegornatki were used as the test crop for the experiment. The experiment consisted of seven treatments *viz*. T_1(Emamectin benzoate (wonder 5G) @ 1g/L of water), T_2(Volium flexi 30EC @ 0.5 ml/L of water), T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water), T_4(Imidachloprid @ 0.5 ml/L of water), T_5(Abamectin 1.8 EC @ 1.2 ml/L of water), T_6(Neem oil @ 5 ml/L + Trix) and T_7(Untreated control). The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Data on the number of pests per plant, number and weight of healthy and infested pod and percentage of pod infestation in number and weight, yield contributing characters and yield of yard long bean were recorded and statistically analyzed. Significant variation was found among the different treatments regarding different parameters of the crop. Incidence of major insect pests of yard long bean was recorded for the entire cropping season and aphid, jassid, pod borer and epilachna beetle were observed. At early, mid and late pod stage, the lowest % pod infestation (in number) (10.60 %, 5.27 % and 10.03 % respectively) was observed from Voliam flexi 300SC, while the highest infestation (36.87%, 31.01% and 38.99% respectively) was recorded in Untreated control. Similar results were found for pod infestation in weight basis. The highest yield per hectare was recorded from Voliam flexi 300SCwhile the lowest yield was recorded from Untreated control.

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CHAPTER I
INTRODUCTION

Among the vegetables, yard long bean (*Vigna sesquipedalis*) is a delicious vegetable belonging to the Febaceae family. It is an important leguminous vegetable grown very profitably all over Bangladesh. It is also known as asparagus bean, sting bean, snake bean or body bean (Purseglove, 1977). It is mostly grown in Chittagong, Chittagong Hill Tracts (CHTs), Faridpur, Noakhali, Comilla and Rangpur districts. At present, it is extensively grown in Dhaka, Chittagong, Comilla, Narsingdi, and Jessore districts and also other districts in Bangladesh. It is extensively grown in kharif season when there is a shortage of vegetables supply in the market.

Yard long bean is a rich source of essential vitamins and commonly grown during kharif season. It contains 50 g calories, 9.0 g of total carbohydrates, 3.0 g of proteins, 0.2 g total fat and 0.8 g of minerals (Anon., 2013). Yard long bean is one of the economically important vegetable crops in Bangladesh. The area occupied by this crop was 5857.49 hectare and the production was 21348 tone during the year 2008- 2009 (Anon., 2010). It is one of the vegetables having exporting potential in Bangladesh.

The importance of yard long bean is of high significance from growing season point of view. In Bangladesh, vegetables are produced less than 30% in kharif season and more than 70% in rabi season (Hossain and Awrangzeb, 1992). Its cultivation intensity is found in Dhaka, Jessore, Comilla, Noakhali and Chittagong, but for the last ten years it has been seen growing extensively in Jessore, Khulna, Chittagong region as well (Aditya, 1993). Despite the prospect of yard long bean high incidences of insect pests have limited the crop into its low yield and poor quality. Farmers in our country face various problems including the availability of quality seeds, fertilizer and manures, irrigation facilities, modern information in the fields of technical and instrumental inputs, pests and diseases in cultivation of the crop (Rashid, 1993), Among them, insect pests are the most important factor to lose the yield of yard long bean significantly in every season and every year. The yield loss in yard long bean due to insect pests is reported to be about 12-30% (Hossain and Awrangzeb, 1992). According to Alam (1969), it is attacked by nine different insect species.

During the cultivation, yard long bean faces various problems in pest management (Rashid, 1993). It is especially attractive to Aphids (*Aphis craccivora*), Jassid (*Amrasca devastans*), White fly, Green leaf hopper, Epilachna bettle, Jute hairy catterpiller and red spider mite (*Tetranychus* spp.). Greasy cutworms (*Agrotis ipsilon*) often cause damage just after emergence of branches of yard long bean (Grubben, 1993). The insect pests have been reported as one of the serious problems to yard long bean cultivation in the country (Rashid, 1999). One of the major constraints for this bean production in Bangladesh is the attack of pod borer, *Maruca testulis* (Dutta *et al*., 2004). Legume pod borers' populations have been found to reduce up to 100 percent of crop yields in pigeon pea in Bangladesh (Rahman *et al*., 1981). Aphid, another destructive pest, causes damage by sucking sap from flowers, buds, pods and tender branches of the plants and reduces the viability of plant (Thaker *et al*., 1984). Reports on the insect pests incidence and their management techniques for the yard long bean in its major growing areas of Bangladesh are scanty. The present study was, therefore, undertaken to know the insect pest incidence and their level of infestation in yard long bean.

There are several pest control methods for controlling aphid, jassid, epilachna beetle and pod borer such as cultural (Sharma, 1998), natural and applied biological (Karim, 1995) and chemical control measures (Rahman and Rahman, 1988). Insecticides are highly effective, rapid in curative action and relatively economical. Recently, a large number of chemicals as well as botanicals have been reported as an effective control measure of insect pests in yard long bean. To overcome and minimize the pests attack on yard long bean and to increase the ultimate production of yard long bean, the research work will be drawn in various ways. Keeping the above in mind, the present study was under taken to fulfill the following objectives:

1. To identify the major insect pests attacking yard long bean and their intensity of infestation.
2. To develop a suitable management technique for controlling the insect pests of yard long bean.
3. To evaluate some effective control tactics for the management of the major insect pests of yard long bean.

CHAPTER II

REVIEW OF LITERATURE

The aphid, jassid, pod borer, epilachna beetle considered as important and most damaging pest of yard long bean. Substantial works have been done regarding its infestation intensity, loses incurred by them, existing management practices and others at home and abroad. Although the review could not be made so comprehensive due to limited scope and facility, it is hoped that most of the relevant information available in and around Bangladesh could be collected and reviewed. However, these studies are reviewed below covering the aforesaid areas.

2.1 Control measure of major insect pests of leguminous plant

Uddin *et al*. (2013) conducted an investigation in intensive yard long bean growing areas such as Jessore, Dhaka, Narsingdi, Comilla and Chittagong of Bangladesh to know the pest incidence and their level of infestation on yard long bean. In the studied areas there were at least nine out of ten insect pests at different growth stages, which were aphid, pod borer, thrips, red mite, leaf miner, leaf beetle, green sting-bug, jute hairy caterpillar, hooded hopper and semilooperin descending order. It was revealed that aphid and pod borer were the major insect pests in the study areas. They were found to severely infest in yard long beans. Semilooper caused minor damage which occurred only in Jessore, Chandina and Mirshawrai sample areas.

Most major groups of insecticides, especially organophosphorus and carbamates, have been tested and some of them found effective against wide variety of aphid on economically important crops. Pirimicarb a selective aphicideis widely used to control various species of aphids. Other chemicals include acephate, dimethoate, endosulfan, menazon, and thiometon which have been recommended for aphid control. Other sprays found promising on crops include neem (Dreyer, M. 1987) and petroleum oil (El-Tom, 1987). Combinations of selective insecticides, predators and parasites, cultural methods and resistant cultivars have potential of controlling the pest on a sustainable basis. In groundnut, monitoring pest populations to time insecticide spray application is combined with the use of cultural methods and resistant cultivars (Misra *et al.*, 2003). In Bangladesh the IPM involving using malathion along with natural predation of *Menochilus sexmaculatus* was successful in controlling *A. craccivora* on beans (Ahmad *et al.*, 1985).


Plate 1: Attack of black aphid on yard long bean plant

Dandale *et al.* (1984) reported the superiority of cypermethrin, fenvalerate and endosalfan in reducing pod borer infestation in red gram. Four sprays of 0.08% cypermethrin (at flowering, at 50 and 100% flowering and at 100% pod setting) afforded complete protection against *Maruca testulalis* on pigeon pea in Bangladesh in winter season of 1987-88. But Rahman and Rahman (1988) reported that dimethoate was not as effective as cypermethrin. But no such trial has so far been conducted on bean in Bangladesh. Several commonly used insecticides such as endosulfan, carbaryl, methomyl, monocrotophos have been found effective against *Maruca testulalis* G. on yard long bean (Lalasangi, 1988).

The biology of *Aphis gossypii* was studied by Kandoria and Jamwal (1988) in greenhouse cages in the Punjab, India, during August-October 1986. Nymphal development lasted for 8.38, 8.30 and 8.25 days. Nymphal survival was highest on okra (96%), followed by aubergine (95%) and *Capcicum annuum* (92%). Adult longevity was 11.66, 11.48 and 10.95 days on aubergines, *Capcicum annuum* and *Hibiscus esculntum*, respectively, and the generation time was 19.35, 19.94 and 19.22 days on these crops.

Kumar and Urs (1988) evaluated the seasonal incidence of *A. devastans* bean in Karnataka, India, in 1983-85 showed that infestation of shoots and fruits started in the 2nd and 6th weeks after germination, respectively. Crops sown in any month had infestation from the 3rd to 5th weeks in both years of the study. The infestation level on fruits varied from 8.4 to 53.8 and 9.2 to 73.2% in different weeks during 1983-84 and 1984-85, respectively. The pooled data revealed an infestation level varying from 12.6 to 32.6% and 13.6% to 46.7% in crops sown in different months in 1983-84 and 1984-85, respectively. The crop suffered heavily in the 10th week after sowing in 1983-84 and in the 11th week after sowing in 1984-85. Infestation was more severe in crops sown in warmer months than in those sown in rainy or cooler months.

The optimum time and spray interval for application of 0.05% monocrotophos (Nuvacron 40 EC) for the control of the cicadellid, *Amrasca biguttula biguttula* were determined by Srinivasan and Krishnakumar (1988) in Karnataka, India. Two applications of monocrotophos, 21 and 35 days after germination, gave the most effective and economical control. Application of carbofuran (Furadan 3G) @ 1 kg a.i./ha at sowing did not control cicadellids in later stages of crop growth and yield was reduced by 37.9% in comparison with the most effective treatment.

Plate 2: Adult jassid feeding the leaf of yard long bean

Verma (1989) tested Lindane, endosulfan, fenitrothion, methyl-O-demeton [demeton-O-methyl], phosalone, monocrotophos, dimethoate, Sevimol [carbaryl], Sevisulf [carbaryl plus sulfur], permethrin and deltamethrin were tested by against control of the cicadellid *Amrasca biguttula biguttula* in the field in India. Deltamethrin at 0.01 and 0.02% resulted in a 100% reduction of the cicadellid population, 15 days after spraying. Lindane was the least effective treatment, resulting in 44-46% mortality, 15 days after the 1st spray. In the laboratory, the time for 50% mortality (LT50) for permethrin, monocrotophos, endosulfan, fenitrothion, phosalone, malathion and lindane at the recommended concentration was 9.8, 8.0, 5.1, 4.0, 3.3, 3.2 and 0.6 days, respectively.

Kumar *et al.* (1989) evaluated the critical time of insecticidal application for control of *Aphis gossypii* and *Amrasca biguttula biguttula* on bean was investigated in Karnataka, India. Application of insecticide (monocrotophos 36 EC at 500 g a.i./ha) 21-42 days after germination resulted in the lowest infestation of both pests and the highest cost : benefit ratio.

Application of carbofuran 3G at 1 kg a.i./ha at the time of sowing did not give effective control at the later crop stages.A schedule of insecticide sprays using decis (Deltamethrin) and systoate (Dimethoate) on 35, 45, 55 and 65 days after planting was investigated in Benin to determine the most effective treatment against the pyralid *M. testulalis* on cowpea (Atachi and Sourokou, 1989). Application of deltamethrin, cypermethrin or fenvalerate @ 0.008% or dimethoate, fenitrothrin, malathion, quinalphos or monocrotophos @ 0.008% or endosulfan 0.10% one at flowering and then at pod setting stage would be highly effective. However, at lower infestation, insecticide application would not be economically advisable.

Plate 3: Adult larvae of pod borer

Singh and Brar (1994) carried out an experiment sown on May 15 in Ludhiana, Punjab, India, harboured the highest mean population of Amrasca biguttula biguttula and Earias spp., followed by the crop sown on May 30. Maximum damage by Earias spp. was observed sown on June 15 and lowest on okras sown on July 30. The highest fruit yield was obtained by sowing the crop on May 15.

Crops protected from the insect pests gave a greater fruit yield than the control and the losses in yield varied from 32.06 to 40.84%.Application of deltamethrin, cypermethrin or fenvalerate or cyfluthrin (Bethroid 0.50 EC) at the rate of 1.0 ml /L of water may be helpful for the control of the pod borer

(Karim, 1995). The red spider mite, *Tetranychus macfarlanei*, so far recorded as a minor pest in South and Central Gujarat, India, is rapidly becoming a pest causing considerable damage, aubergines and cotton by Rai *et al.* (1995). Dubey *et al.* (1998) conducted a field experiment in Madhya Pradesh cv. Parbhani Kranti, 9 treatments were compared for the control of E. vittella. The application of 1 kg phorate a.i./ha basally + single spray of monocrotophos (0.05%) 30 DAS (days after sowing) followed by 4 sprays of cypermethrin (0.006%) (45, 55, 65 and 75 DAS) produced the lowest infestation level on fruits (12.68%) and the highest marketable fruit yield (10.42 t/ha).

Satpathy *et al.* (1998) reported that both sowing time and crop growth stage influenced the insect population significantly in bean crop sown from 15 May to 15 July during the 1996 and 1997 cropping season in Varanasi, Uttar Pradesh, India. The crop was found to be most susceptible to the jassids (*Amrasca biguttula)* at 50 DAS, where as peak population of jassids were observed in the first sown crop. However, maximum yield was obtained from the crop sown in the first week of June. Although a considerable number of jassids were present during this period, suitable growing conditions resulted in maximum yield.

A field experiment was conducted by Adiroubane and Letchoumanane (1998) during 1994 to evaluate efficacy of 3 plant extracts, sacred basil (*Ocimum sanctum)*, Malabar nut (*Adhatoda vesica*), Chinese chaste tree (*Vitex negundo*) and synthetic insecticides (endosulfan and carbaryl) and their combination products in controlling okra jassids, *Amrasca biguttula biguttula* and fruit-borers, *Earias* spp. during the rainy season in 1994 by spraying them at 10, 25 and 40 days after sowing. All the treatments suppressed both the jassid population and fruit borer incidence.

Rai and Satpathy (1999) carried out an experiment to find out the effect of sowing date and insecticides in controlling the insect pests of okra, studied in a field experiment conducted in Varanasi, Uttar Pradesh, India during 1996 and 1997, showed that there is gradual increase in jassid population with advancement of sowing date up to mid-June. Thereafter it declined substantially. However, late-sown crops suffer more from borers. Crops sown in the second week of July (S6) recorded maximum fruit damage which was lowest on 25 May (S2)-sown crops.

Monocrotophos at 500 g a.i./ha controlled the jassids more effectively than cypermethrin at 50 g a.i./ha.Studies were carried out by Praveen and Dhandapani (2001) during January-March 2000 at Coimbatore, Tamil Nadu, India to evaluate the effectiveness of different biological control agents against the major pests of okra, i.e. leafhopper (*Amrasca biguttula biguttula*), sweet potato whitefly (*Bemisia tabaci)*, cotton aphid, and the fruit-boring insects, *Helicoverpa armigera* and *Earias vitella*. The results revealed that release/application of the predator, *Chrysoperla carnea* (25000 larvae ha-1 release-1) + Econeem 0.3% (0.5 l/ha) for three times at 15-day intervals starting from 45 days after sowing was found to be effective in reducing the population of sucking pests as well as the fruit-borers. The percent fruit damage by *Heliothis armigera* (8.61%) and *E. vitella* (9.21%) was also reduced. Fruit damage in untreated control was recorded as 22.56 and 22.6%, respectively.

2.2 Chemical Insecticide use

Ali and Karim (1993) reported monocrotophos methamidophos and bifenthrin gave 91-97.53% mortality on the 2nd days post-treatment, and 73.27-79.17% mortality 30 days post- treatment of *Amrasca devastans* on cotton, Equivalent figures for dimethoate formulations were 56.50-72.37%, carbofuran had no effect on the 2nd day post treatment and gave only 8.72% mortality. All the insecticides tested were toxic to parasitoids and predators of *A. devastans* up to 30 days post -treatment.

Search of review reveals that bear pod bean control is dominated by chemical approaches. In India, a number of insecticides have been evaluated for the control of pod borer in pulses including pigeon pea (Rahman, 1989). But no such trial has so far been conducted on bean in Bangladesh. Several commonly used insecticides such as endosulfan, carbaryl, methomyl, monocrotophos have been found effective against Maruca testulalis G. on cowpea (Singh, 1977; Lalasangi, 1988). Cypermethrin was sprayed at 0.2 kg a.i./ha to control different densities of pyralid M. testulalis larvae when infestation in flowers reached 10, 20, 30, 40 and 50% in 1985 and 10; 20 and 30% in 1986 (Ogunwolu, 1990). Four sprays of 0.08% cypermethrin (at flowering, at 50 and 100% flowering and at 100% pod setting) afforded complete protection against Maruca testulalis on pigeon pea in Bangladesh in winter season of 1987-88. But dimethoate was not as effective as cypermethrin (Rahman and Rahman, 1988).

A schedule of insecticide sprays using decis (Deltamethrin) and systoate (Dimethoate) on 35, 45, 55 and 65 days after planting was investigated in Benin in 1985 to determine the most effective treatment against the pyralid *M. testulalis* on cow pea (Atachi and Sourokou, 1989). Broadley (1977) obtained control of *M. testulalis* with methomyl when applied at 337-450g (a.i.)/ha. Because of hidden nature of larval and pupal stages of the pest, it is difficult to control Maruca pod borer by chemical or other conventional means. Application of deltamethrin, cypermethrin or fenvalerate @ 0.008% or dimethoate, fenitrothrin, malathion, quinalphos or monocrotophos @

0.008% or endosulfan 0.10% one at flowering and then at pod setting stage would be highly effective. However, at lower infestation, insecticide application would not be economically advisable (Rahman, 1989). Application of deltamethrin, cypermethrin or fenvalerate or cyfluthrin (Bethroid 0.50 EC) at the rate of 1.0 ml/1 of water may be helpful for the control of the pod borer (Karim, 1995). Dandale *et al.* (1984) reported the superiority of cypermethrin, fenvalerate and endosalfan in reducing pod borer infestation in red gram. Spraying of synthetic pyrethroid insecticides at the rate of 1 ml per liter of water has been recommended for the control of the pest (Karim, 1993). Among the various control measures so far been reported for the management of the pod borer, chemical control appeared as comparatively effective and predominant one.

Four sprays of 0.08% cypermethrin (at flowering, 50 and 100% flowering and 100% pod setting) afforded complete protection against *Maruca testulalis* on pigeon pea in Bangladesh in winter season of 1987-88. But Dimethoate was not as effective as Cypermethrin (Rahman and Rahman, 1988). A schedule of insecticide sprays using Decis (Deltamethrin) and Systoate (Dimethoate) on 35, 45, 55 and 65 days after planting was investigated in Benin in 1985 to determine the most effective treatment against the pyralid *M. testulalis* on cow pea (Atachi and Djihou, 1994).

2.3 Neem product use

Azadirachtin has been exempted from residue tolerance requirements by the US Environmental Protection Agency for food crop applications. Azadirachtin exhibits good efficacy against key pests. Azadirachtin has minimal to no impact on non-target organisms, is compatible with other biological control agents and has a good fit into classical Integrated Pest Management programmes (Islam, 1999).

Neem (*Azadirachta indica*) seed oil, a botanical pesticide have also been used to control different insect pests of important agricultural crops in different countries of the world. More than 2000 species of plants have been reported to posses' insecticidal properties (Grainge and Ahmed, 1988). The neem tree (*Azadirachta indica*) is one of them. The development and use of botanical pesticides become an integral part of the integrated pest management (IPM) strategies. Stoll (1992) summarized the potential benefits of botanical pesticides which diminish the risk of resistance development,, natural enemy elimination, secondary out break of pest and ensure overall safety to the environment.

Experiment with botanical pesticides has also been conducted in Bangladesh on a limited scale. Islam (2004) reported that extract of leaf, seed and oil of neem, showed potential as antifeedants or feeding and oviposition deterrents for the control of brown plant hopper, green leaf hopper, rice hispa and lesser rice weevil. He also conducted experiments to ascertain the optimal doses of the extract against rice hispa, and pulse beetle. Addition of sesame or linseed oil to extract of neem resulted in higher mortality of the grubs and in greater deterrence in feeding and oviposition compared to those obtained with neem extract alone (Islam, 2006).

The seed and leaves of the neem tree contain terpenoids with potent anti-insect activity. One of the most active terpenoids in neem seeds is "azadirachtain" which acts as an antifeedant and growth disrupter against a wide range of insect pest at microgram levels. The active terpenoids in neem leaves include nimbin, deactylnimbin and thionemone (Simmonds *et al.*, 1992).

During last two decades neem oil and extracts from leaves and seeds have been evaluated as plant protectant against a wide range of arthropod and nematode pests in several countries of the world. Although, most of the trails are laboratory based but it is not scanty in case of field condition. Ketkar (1976) reviewed 95 and Jacobson (1985) reviewed 133 papers on neem and documented neem's potential in the management of arthropods pests (Warthen, 1979).

Grainge and Ahmed (1988) and Saxena (1988) summarized the effectiveness of neem oil against 87 arthropods and 5 nematodes, 100 insects and mites and 198 different species of insects, respectively.

Experiment with botanical pesticides has also been conducted in Bangladesh on a limited scale. Islam (1983) reported that extract of leaf, seed and oil of neem, showed potential as antifeedants or feeding and oviposition deterrents for the control of brown plant hopper, green leaf hopper, rice hispa and lesser rice weevil. He also conducted experiments to ascertain the optimal doses of the extract against rice hispa, and pulse beetle. Addition of sesame or linseed oil to extract of neem resulted in higher mortality of the grubs and in greater deterrence in feeding and oviposition compared to those obtained with extract alone (Islam, 1986).

A methanol suspension of 2-4% of the neem leaves have been used against the caterpillar of diamondback moth, *Plutella xylostella* and it was as effective as either synthetic insecticides mevinphous (0.05%) or deltamethrin in (0.02%) in Togo (Dreyer, 1987). In Thailand, a field trail showed that piperanyl butoxide increased the efficacy of neem and the combination was as active as cypermethrin (0.025%) against *Plutella xylostella* and *Spodoptera litura*, which revealed that neem oil with synthetic insecticides may have some synergetic effect in controlling insect pests. Fagoonee (1986) used neem in vegetable crop protection in Mauritius and showed neem seed kernel extract was found to be effective as deltamethrin

(Decis) against the Plutella xylostella and Crocidolomia binotalis. He also found neem extract alternate with insecticides gave best protection against*Helicovarpa armigera*.

Neem product have been used to control vegetable pests under field condition and good control of *Plutella xylostella* and Pyralid, Hellula undalis on cabbage was achieved with weekly application of 25 or 50 gm neem kernel powder/liter of water (Dreyer, 1987). The leaf extract of neem tested against the leaf caterpillar of brinjal, Selepa docilis Bult. at 5% concentration had a high anti-feedant activity with a feeding ratio of 28.29 followed by 3% having only medium anti-feedant properties with 23.89 as the feeding ratio (Jacob and Sheila, 1994).

Entomologist of many countries including India, The Philippines, Pakistan and Bangladesh have conducted various studies of neem against different insect pests. Most of the cases the investigators have used a particular concentration of the neem extract. Neem seed kernel extracts (3-5%) were effective against *Nilapervata lugens, Nephotettix spp.*, *Marasmia patnalis, Oxya nitidula* and Asian gall midge. Neem leaf extract, however, is less effective than neem seed kernel extract. But the same extract of 5-10% was highly effective, inclusive of *Scirpophaga incertulas* and thrips (Jayaraj, 1991). Damage by leaf folders was reduced by 3% neem oil. Neem seed kernel extracts reduced egg deposition on rice seedling by *Nephotettix* spp. and *Nilapervata lugens* (Jayaraj, 1991). Neem seed kernel extract was an effective antifeedent to pigeon pea pod borer. He also found that there has been no adverse effect, even though neem was systemic. According to him neem oil can be used @ 1-3% without any problem. But 5% neem oil will cause phytotoxicity in many plants. The effect of neem oil is systemic, though not persistent (Jayaraj, 1991).

At 3%, the initial phytotoxicity effects is minimum and the plant can recover completely. Thus, neem oil should be applied at concentrations not beyond 3% (Jayaraj, 1991).

Most of the cases, the user of neem oil use it at different doses ranged from 0.5-50% (Krishnaiah and Kalode, 1991). They use different emulsifier to mixe neem oil with the water. Neem oil normally stay separately on the upper surface of the water. In a field observation of neem oil Krishanaiah and Kalode (1991) used soap as emulsifier with water.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted in the experimental field of Sher-e-Bangla Agricultural University, Dhaka, during March to June, 2014 to study the major insect pests of yard long bean and their management. Required adopted materials and methodology are described below under the following sub-heading.

3.1 Location

The study was carried out in the Farm of Sher-e-Bangla Agricultural University Sher-e-Bangla Nagar, Dhaka, Bangladesh. The location of the experimental site is 23°74' N latitude and 90°35' E longitude and an elevation of 8.2 m from sea level.

3.2 Characteristics of soil

The soil of the experimental area belongs to the Modhupur Tract under AEZ No. 28 and was dark grey terrace soil. The selected plot was medium high land and the soil series was Tejgaon. The characteristics of the soil under the experimental plot were analyzed in the Soil Testing Laboratory, SRDI Khamarbari, Dhaka and it has presented in Appendix II.

3.3 Weather condition of the experimental site

The climate of experimental site was under the subtropical climate, characterized by three distinct seasons, the monsoon or the rainy season from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October. Details of the metrological data related to the temperature, relative humidity and rainfalls during the period of the experiment (March to June 2014) was collected from the Bangladesh Meteorological Department, Dhaka and presented in the Appendix I.

3.4 Land preparation

The soil was well prepared and good tilth was ensured for commercial crop production. The target land was divided into 21 equal plots.The uni plot size was 2m x 3m having 0.75 m space between the blocks and 1m between the plots.Each plot contained2 pits.Standard dosages of cowdung and fertilizers were applied as recommended by Rashid (1993) for yard long bean @ 12kg of cowdung, 60 gm urea, 100 gm TSP and 100 gm MP respectively per pit. Again 30gm urea was applied as top dressing after each flush of flowering and fruiting in three equal splits

3.5 Collection of seed and sowing

The seeds of Kegornatki were collected from Mirpur, Dhaka. For rapid and uniform germination the seeds of yard long bean were soaked for 12 hours in water. Seeds were then directly sown in the middle of March, 2014 in soil. After germination the seedlings were sprayed with water by a sprayer.

3.6 Cultural practices

After sowing, a light irrigation was given. Subsequent irrigations were applied in all the plots and whenever requited. Thinning, weeding in the plots was done at regular interval.

3.7 Treatments

The experiment was laid out with seven treatments including one untreated control and replicated three time using Randomized Complete Block Design (RCBD).

The treatments of the experiment are as follows:

T_1 (Emamectin benzoate (wonder 5G) @ 1g/L of water)
T_2 (Voliam flexi 300SC @ 0.5 ml/L of water)
T_3 (Lamda cyhalothrin 2.5EC @ 1 ml/L of water)
T_4 (Imidacloprid 200SL @ 0.5 ml/L of water)
T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water)
T_6 (Neem oil @ 5 ml/L + 2ml/L Trix)
T_7 (Untreated control)

3.8 Collection of treatment materials

The neem oil was collected from Chawkbazar. Dhaka and the Trix liquid detergent were collected from the local market of Agargaon bazaar. Emamectin benzoate, Voliam flexi 300 SC, Lamda cyhalothrin 2.5 EC, Imidacloprid 200SL and Abamectin 1.8 EC were collected from local market.

3.9 Procedure of spray application

Neem oil with 2ml/L trix (@ 5 ml/L of water) , Emamectin benzoate, Voliam flexi 300 SC, Lamda cyhalothrin 2.5 EC, Imidacloprid and Abamectin 1.8 EC were sprayed in assigned plots and dosages by using

Knapsack sprayer. The spraying was always done in the afternoon to avoid bright sunlight. The spray materials were applied uniformly to obtain complete coverage of whole plants of the assigned plots. Caution was taken to avoid any drift of the spray mixture to the adjacent plots at the time of the spray application. At each spray application the spray mixture was freshly prepared.

3.10 Data collection and calculation

The effectiveness of each treatment in reducing selected insect under the present study infestation was evaluated on the basis of some pre-selected parameters. The following parameters were considered during data collection.

Data were taken for aphid, jassid, epilachna beetle and pod borer from each plant. Aphid, jassid, were counted from top leaves of the plant.Epilachna beetle were counted from top leaves and branches of the plant. Pod borer were counted from the infested pod of yard long bean. Data on number of insects were recorded at an interval of 10 days commencing from first incidence and continued up to the harvest of the crop.

3.11 Number and weight of healthy and infested fruits

Data were collected on the basis of the number and weight of healthy and infested pods in each treatment.

3.12 Pod infestation

3.12.1 Percent pod infestation by number

After harvesting the healthy pods and the infested pods were separated by visual observation. The number of healthy pods and infested pods were counted and the percent pods infestation for each treatment was calculated by using the following formula:

$$\% \text{ Pod infestation (by number)} = \frac{\text{Number of infested pods}}{\text{Total number of pods observed}} \times 100$$

3.12.2 Percent pod infestation by weight

After harvest at each fruiting stage, the total pods were sorted into healthy and infested once for each treatment. On the basis of weight of healthy pods and infested pods the percent pods infestation was calculated.

$$\% \text{Pod infestation (by weight)} = \frac{\text{Weight of infested pods}}{\text{Total weight of pods observed}} \times 100$$

3.13 Pod yield

Pod yield was measured by adding the total harvest attaining from all harvest in individual plot and converted into per hectare yield.

3.13.1 Increase or decrease of yield over control

Increase or decrease over control was calculated using the following formula:

$$\text{Percent increase of yield over control} = \frac{\text{Harvested yield} - \text{Control yield}}{\text{Control yield}} \times 100$$

3.14 Statistical analysis

The data obtained for different characters were statistically analyzed to find out the significance of the difference among the treatments. The mean values of all the characters were evaluated and analysis of variance was performing by the `F' (variance ratio) test. The significance of the difference among the treatments combination means were estimated by the Duncans's Multiple Range Test (DMRT) test at 5% level of probability.

CHAPTER IV
RESULT AND DISCUSSION

The study was carried out at Sher-e-Bangla Agricultural University farm, Sher-e-Bangla Nagar, Dhaka, Bangladesh. The results have been presented and discussed, and possible explanations have been given under the following headings:

4.1 insect pest incidence

4.1.1 Early pod stage

Statistically significant variation was found at early stage aphid as major insect pests of yard long bean (Table 1). In case of aphid, the lowest number per plant (8.10) was recorded from T_2 (Voliam flexi 300 SC @ 0.5 ml/L of water) followed by T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water) and T_6 (Neem oil @ 5 ml/L + 2ml Trix), whereas the highest number (22.67) was found from T_7(Untreated control).

For jassid infestation, there was a highly significant variation found at early stage jassid of yard long bean (Table 1). The findings showed that attraction of Jassid, the lowest number of jassid per plant (4.67) was recorded from T_2 (Voliam flexi 300 SC @ 0.5 ml/L of water) followed by T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water) and T_6 (Neem oil @ 5 ml/L + 2mlTrix), whereas the highest number (18.20) was found from T_7(Untreated control).

In case of pod borer, the lowest number per plant (1.33) was recorded from T_2 (Voliam flexi 300 SC @ 0.5 ml/L of water) followed by T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water) whereas the highest number (12.70) was found from T_7(Untreated control.

Again, considering the number of Epilachna beetle, no Epilachna beetle was found with the treatment of T_2 (Voliam flexi 300SC @ 0.5 ml/L of water) and T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water) whereas the highest number (9.90) was found from T_7(Untreated control).

Table 1.Effect of different treatments on major insect pest per plan (by number) atearly pod stage of yeard long bean

Treatment	Aphid	Jassid	Pod borer	Epilachna beetle
T_1	13.17 c	9.10 d	2.13c	1.70 d
T_2	8.10 g	4.67 g	1.33 d	0.00 e
T_3	14.22 b	11.30 b	5.20 b	4.33 c
T_4	12.37 d	10.50 c	1.90 c	1.33 d
T_5	9.70 f	7.33 e	1.80 c	0.00 e
T_6	10.30 e	5.10 f	4.36 b	5.67 b
T_7	22.67 a	18.20 a	12.70 a	9.90 a
LSD 0.05	0.568	0.667	0.403	0.577
Level of Significance	0.01	0.01	0.01	0.01
CV (%)	4.89	6.37	5.266	4.752

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

T_1 = Emamectin benzoate (wonder 5G) @ 1g/L of water
T_2 = Voliam flexi 300SC @ 0.5 ml/L of water
T_3 = Lamdacyhalothrin2.5EC @ 1 ml/L of water
T_4 = Imidacloprid 200SL @ 0.5 ml/L of water
T_5 = Abamectin 1.8 EC @ 1.2 ml/L of water
T_6 = Neem oil @ 5 ml/L + 2ml Trix
T_7 = Control (Untreated)

4.1.2 Mid pod stage

At mid pod stage of yard long bean, highly significant variation was showed in aphid infestation of yard long bean (Table 2).The lowest number of aphid per plant (3.80) was recorded from T_2 (Voliam flexi 300SC @ 0.5 ml/L of water) followed by T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water) and T_6(Neem oil @ 5 ml/L + 2ml Trix), T_4(Imidacloprid 200SL @ 0.5 ml/L of water) and T_1 (Emamectin benzoate (wonder 5G) @ 1g/L of water) whereas the highest number (28.50) was found from T_7(Untreated control).

Again, the experimental findings showed that at mid stage, jassid infestation of yard long bean varied significantly (Table 2). Result revealed that the lowest number per plant (2.87) was recorded from T_2 (Voliam flexi 300SC @ 0.5 ml/L of water) followed by T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water) and T_6 (Neem oil @ 5 ml/L + 2ml Trix), While the highest number (22.67) was found from T_7(Untreated control).

In case of pod borer, the lowest number (4.33) was found from T_2(Voliam flexi 300SC @ 0.5 ml/L of water) followed by T_5(Abamectin 1.8 EC @ 1.2 ml/L of water) whereas the highest number of pod borer per plant (18.67) was found from T_7(Untreated control).

Again, the lowest number of epilachnabeetle (0.33) was observed by T_2(Voliam flexi 300SC @ 0.5 ml/L of water) whereas the highest number (14.67) was found from T_7(Untreated control).

Table 2. Effect of different treatments on major insect pests per plant (by number) at mid pod stage of yard long bean

Treatment	Aphid	Jassid	Pod borer	Epilachna beetle
T_1	6.50 c	5.60 d	5.00 c	3.00 c
T_2	3.80 e	2.87 f	4.33 c	0.33 e
T_3	7.80 b	7.90 b	7.80 b	4.67 b
T_4	6.20 c	6.77 c	4.80 c	2.67 c
T_5	4.90 d	4.30 e	4.67 c	1.33 d
T_6	7.77 b	4.10 e	7.67 b	5.00 b
T_7	28.50 a	22.67 a	18.67 a	14.67 a
LSD 0.05	0.596	0.632	0.782	0.785
Level of Significance	0.01	0.01	0.01	0.01
CV (%)	5.27	4.89	5.371	4.852

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

T_1 = Emamectin benzoate (wonder 5G) @ 1g/L of water

T_2 = Volium flexi 30EC @ 0.5 ml/L of water

T_3 = Lamdacyhalothrin 2.5EC @ 1 ml/L of water

T_4 = Imidachloprid200SL @ 0.5 ml/L of water

T_5 = Abamectin 1.8 EC @ 1.2 ml/L of water

T_6 = Neem oil @ 5 ml/L + 2mlTrix

T_7 = Control (Untreated)

4.1.3 Late pod stage

Yard long bean at late pod stage influenced in positively that applied of the experimental pesticide the number of attraction of aphid was decreased (Table 3).

The lowest number of aphid per plant (10.40) was recorded from T_2 (Voliam flexi 300SC @ 0.5 ml/L of water) followed by T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water), T_4 (Imidacloprid 200SL @ 0.5 ml/L of water) and T_1 (Emamectin benzoate (wonder 5G) @ 1g/L of water) while the highest number (26.40) was found from T_7(Untreated control) followed by T_6 (Neem oil @ 5 ml/L + 2mlTrix) and T_3 (Lamdacyhalothrin 2.5EC @ 1 ml/L of water).

On the other hand, the experimental treatments showed that at late stage of Jassid of yard long bean varied in statistically significant (Table 3). Result treated that the lowest number per plant (8.57) was recorded from T_2 (Voliam flexi 300SC @ 0.5 ml/L of water) followed by T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water) and T_6 (Neem oil @ 5 ml/L + 2ml Trix), while the highest number (23.60) was found from T_7(Untreated control).

In case of pod borer, the lowest number (1.67) was found from T_2(Voliam flexi 300SC @ 0.5 ml/L of water) followed by T_5(Abamectin 1.8 EC @ 1.2 ml/L of water) whereas the highest number of pod borer per plant (18.33) was found from T_7(Untreated control).

Again, considering the presence of epilachna beetle, no epilachna beetle was found with the treatment of T_2 (Voliam flexi 300SC @ 0.5 ml/L of water) and T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water) whereas the highest number (20.40) was found from T_7(Untreated control).

Table 3. Effect of different treatments on major insect pests per plant (by number) at late pod stage of yard long bean

Treatment	Aphid	Jassid	Pod borer	Epilachna beetle
T_1	14.67 c	12.77 d	3.20 c	2.33 d
T_2	10.40 e	8.57 f	1.67 d	0.00 f
T_3	16.80 b	14.70 b	4.60 b	4.67 bc
T_4	14.27 c	13.80 c	2.33 c	1.80 e
T_5	12.00 d	10.33 e	1.67 d	0.00 f
T_6	16.57 b	10.67 e	4.67 b	5.00 b
T_7	26.40 a	23.60 a	18.33 a	20.40 a
LSD 0.05	0.756	0.573	0.857	0.669
Level of Significance	0.05	0.05	0.05	0.05
CV (%)	6.791	8.732	7.256	

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

T_1 = Emamectin benzoate (wonder 5G) @ 1g/L of water

T_2 = Volium flexi 30EC @ 0.5 ml/L of water

T_3 = Lamdacyhalothrin 2.5EC @ 1 ml/L of water

T_4 = Imidachloprid 200SL @ 0.5 ml/L of water

T_5 = Abamectin 1.8 EC @ 1.2 ml/L of water

T_6 = Neem oil @ 5 ml/L + 2mlTrix

T_7 = Control (Untreated)

4.2 Pod infestation

4.2.1 Pod infestation at early pod stage

Highly significant variation was found for yard long bean at early pod stage in positively that the experimental pesticide influenced to sustain the maximum pod was free from infestation. Significant differences were obtained in number of healthy, infested pods, percent infestation at early pod stage for different treatments in controlling major pest of yard long bean (Table 4).

Result revealed that the maximum number of healthy pod (9.58) was found from T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water) which was statistically identical with T_2 (Voliam flexi 300SC @ 0.5 ml/L of water) and followed T_4 (Imidacloprid 200SL @ 0.5 ml/L of water), T_6 (Neem oil @ 5 ml/L + 2ml Trix) and T_1 (Emamectin benzoate (wonder 5G) @ 1g/L of water). While the lowest number of healthy pod (6.32) was recorded from T_7(Untreated control) and T_3 (Lamdacyhalothrin 2.5EC @ 1 ml/L of water).

The lowest number of infested pods per plant (1.03) was found T_2 (Voliam flexi 300SC @ 0.5 ml/L of water) followed T_1 (Emamectin benzoate (wonder 5G) @ 1g/L of water). On the other hand, the highest number of infested pods (2.33) was recorded from T_7(Untreated control) followed by T_3 (Lamdacyhalothrin 2.5EC @ 1 ml/L of water), T_4 (Imidacloprid @ 0.5 ml/L of water) and T_6 (Neem oil @ 5 ml/L +2ml Trix).

In case of percent pod infestation, the lowest infested pods per plant in number (9.58%) was recorded from T_2 (Voliam flexi 300SC @ 0.5 ml/L of water) followed by followed T_5(Abamectin 1.8 EC @ 1.2 ml/L of water), again the highest infested pods (26.94 %) was recorded in T_7(Untreated control). Pod infestation reduction over control in number was estimated and the highest value (53.80%) was recorded from T_2 (Voliam flexi 300SC @ 0.5 ml/L of water) followed by T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water) whereas the lowest reduction of pod infestation over control (17.72%) was found from T_3 (Lamdacyhalothrin 2.5EC @ 1 ml/L of water) followed by T_6 (Neem oil @ 5 ml/L + 2 ml Trix).

Weight of healthy and infested pod, % infestation by weight showed statistically significant variation at early pod stage for different management practices in controlling major pest of yard long bean (Table 5). In the weight of healthy pods, the highest weight per plant was recorded from T_2 (Voliam flexi 300SC @ 0.5 ml/L of water) (126.32 g) which was followed T_5(Abamectin 1.8 EC @ 1.2 ml/L of water), while the lowest weight of healthy pods was obtained from T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water) (101.75 g) which was closely followed by T_6 (Neem oil @ 5 ml/L + 2mlTrix).

The lowest weight of infested pods per plant was observed from T_2 (Voliam flexi 300SC @ 0.5 ml/L of water) (9.42 g) which was followed by T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water). On the other hand, the highest weight of infested pods was obtained from T_7(Untreated control) (20.76 g).

Regarding % pod infestation, the lowest infested pods per plant in weight was observed from T_2 (Voliam flexi 300SC @ 0.5 ml/L of water) (6.94 %) which was closely followed by T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water) where the highest infested pods was recorded in T_7(Untreated control) (18.50 %) .

Pod infestation reduction over control in weight was estimated and the highest value was found from the treatment T_2 (Voliam flexi 300SC @ 0.5 ml/L of water) (38.13%) which was followed by T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water) and the lowest reduction of pod infestation over control from T_3 (Lamdacyhalothrin 2.5EC @ 1 ml/L of water) (11.26%) followed by T_6 (Neem oil @ 5 ml/L + 2ml Trix).

Table 4. Effect of different treatments in controlling major insect pests of yard long bean at early pod stage in terms of pod infestation (by number)

Treatment	Number of pods			
	Healthy	Infested	% Infestation	Reduction over control (%)
T_1	8.24 b	1.62 d	16.43 c	30.38
T_2	9.72 a	1.03 e	9.58 e	53.80
T_3	7.44 c	1.75 b	19.04 b	17.72
T_4	8.33 b	1.75 b	17.36 c	31.80
T_5	9.58 a	1.56 c	14.00 d	51.58
T_6	8.18 b	1.78 b	17.87 c	29.43
T_7	6.32 d	2.33 a	26.94 a	--
LSD 0.05	0.792	0.128	1.491	--
Level of Significance	0.05	0.01	0.05	--
CV (%)	7.654	4.723	8.226	--

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

T_1 = Emamectin benzoate (wonder 5G) @ 1g/L of water

T_2 = Voliam flexi 300SC @ 0.5 ml/L of water

T_3 = Lamdacyhalothrin 2.5EC @ 1 ml/L of water

T_4 = Imidachloprid 200SL @ 0.5 ml/L of water

T_5 = Abamectin 1.8 EC @ 1.2 ml/L of water

T_6 = Neem oil @ 5 ml/L + 2mlTrix

T_7 = Control (Untreated)Table

5. Effect of different treatments in controlling major insect pests of yard long bean at early pod stage in terms of pod infestation (by weight)

Treatment	**Pods by weight**			
	Healthy	**Infested**	**% Infestation**	**Reduction over control (%)**
T_1	109.50 d	13.14 d	10.71 c	19.74
T_2	126.32 a	9.42 f	6.94 e	38.13
T_3	101.75 f	14.78 b	12.68 b	11.26
T_4	115.42 c	13.62 c	10.55 c	26.21
T_5	118.64 b	11.18 e	8.61 d	29.73
T_6	107.36 e	14.56 c	11.94 c	17.40
T_7	91.45 g	20.76 a	18.50 a	--
LSD 0.05	2.283	0.826	1.43	--
Level of Significance	0.05	0.01	0.01	--
CV (%)	9.384	5.622	6.273	--

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

T_1 = Emamectin benzoate (wonder 5G) @ 1g/L of water

T_2 = Voliam flexi 300SC @ 0.5 ml/L of water

T_3 = Lamdacyhalothrin 2.5EC @ 1 ml/L of water

T_4 = Imidachloprid 200SL@ 0.5 ml/L of water

T_5 = Abamectin 1.8 EC @ 1.2 ml/L of water

T_6 = Neem oil @ 5 ml/L +2ml Trix

T_7 = Control (Untreated)

4.2.2 Pod bearing status at mid pod stage

Statistically significant differences were observed in number of healthy, infested pods, percent infestation at mid pod stage for different management practices in controlling major pest of yard long bean (Table 6).In the number of healthy pods, the highest number per plant was recorded from T_2(Voliam flexi 300SC @ 0.5 ml/L of water) (14.22) which was T_5(Abamectin 1.8 EC @ 1.2 ml/L of water) and T_4(Imidacloprid 200SL @ 0.5 ml/L of water), while the lowest number of healthy pods was obtained from T_7(Untreated control) (8.77) which was followed by T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water).

The lowest number of infested pods per plant was observed from T_2 (Voliam flexi 300SC @ 0.5 ml/L of water) (0.75) which was closely followed by T_1 (Emamectin benzoate (wonder 5G) @ 1g/L of water) and T_5(Abamectin 1.8 EC @ 1.2 ml/L of water), on the other hand, the highest number of infested pods (2.72) was obtained from T_7(Untreated control).

In case of % pod infestation, the lowest infested pods per plant in number was observed from T_2(Voliam flexi 300SC @ 0.5 ml/L of water) (5.01%) followed by T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water) and T_1(Emamectin benzoate (wonder 5G) @ 1g/L of water), again the highest infested pods was recorded in T_7(Untreated control) (33.67%) followed by T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water).

Pod infestation reduction over control in number was estimated and the highest value was found from the treatment T_2(Voliam flexi 300SC @ 0.5 ml/L of water) (62.14%) and the lowest (28.05%) from T_3 (Lamdacyhalothrin 2.5EC @ 1 ml/L of water).

Healthy and infested pod, % infestation in terms of weight showed statistically significant variation at mid pod stage for different management practices in controlling majorinsect pest of yard long bean (Table 7).

In the weight of healthy pods, the highest weight per plant was recorded from T5 (199.30 g) which was statistically identical with T_2 (Voliam flexi 300SC @ 0.5 ml/L of water) (182 g) followed T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water); while the lowest weight of healthy pods was obtained from T_7(Untreated control)(125 g) followed by T_3 (Lamdacyhalothrin 2.5EC @ 1 ml/L of water) and T_6 (Neem oil @ 5 ml/L + 2ml Trix).

The lowest weight of infested pods per plant was observed from T_2 (Voliam flexi 300SC @ 0.5 ml/L of water) (9.48 g) which was followed by T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water). On the other hand, the highest weight of infested pods was obtained from T_7(Untreated control) (38.15 g) followed by T_3 (Lamdacyhalothrin 2.5EC @ 1 ml/L of water) treatment.

In terms of % pod infestation, the lowest infested pods per plant in weight (4.95 %) was observed fromT_2 (Voliam flexi 300SC @ 0.5 ml/L of water) followed by T_5 (Abamectin 1.8 EC @ 1.2 ml/L of water) and T_1 (Emamectin benzoate (wonder 5G) @ 1g/L of water), again the highest infested pods (23.38 %) was recorded in T_7(Untreated control) followed by T_3 (Lamdacyhalothrin 2.5EC @ 1 ml/L of water).

Pod infestation reduction over control in weight was estimated and the highest value was found from the treatment T_2 (Voliam flexi 300SC @ 0.5

ml/L of water) (45.60 %) and the lowest reduction of pod infestation over control from T_3 (Lamdacyhalothrin 2.5EC @ 1 ml/L of water).

Table 6. Effect of different treatments in controlling major insect pests of yard long bean at mid pod stage in terms of pod infestation (by number)

Treatment	Number of pods (by number)			
	Healthy	Infested	% Infestation	Reduction over control (%)
T_1	12.26 c	1.18 e	8.78 e	39.79
T_2	14.22 a	0.75 f	5.01 f	62.14
T_3	11.23 c	1.84 b	14.08 b	28.05
T_4	13.12 b	1.45 d	9.95 d	49.60
T_5	13.64 b	1.12 e	7.59 e	55.53
T_6	12.40 c	1.60 c	11.43 c	41.39
T_7	8.77 d	2.72 a	23.67 a	--
LSD 0.05	1.625	0.624	1.221	--
Level of Significance	0.05	0.01	0.05	--
CV (%)	8.239	4.274	7.539	--

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

T_1 = Emamectin benzoate (wonder 5G) @ 1g/L of water
T_2 = Voliam flexi 300SC @ 0.5 ml/L of water
T_3 = Lamdacyhalothrin 2.5EC @ 1 ml/L of water
T_4 = Imidacloprid 200SL @ 0.5 ml/L of water
T_5 = Abamectin 1.8 EC @ 1.2 ml/L of water
T_6 = Neem oil @ 5 ml/L + 2 ml Trix
T_7 = Control (Untreated)

Table7. Effect of different treatments in controlling major insect pests of yard long bean at mid pod stage in terms of pod infestation (by weight)

Treatment	Pods by weight (g)			
	Healthy	**Infested**	**% Infestation**	**Reduction over control (%)**
T_1	148 d	14.10 d	8.70 d	18.40
T_2	182 a	9.48 e	4.95 e	45.60
T_3	134 f	21.48 b	13.82 b	7.20
T_4	154 c	17.12 c	10.00 c	23.20
T_5	168 b	13.58 d	7.48 d	34.40
T_6	140 e	17.90 c	11.34 c	12.00
T_7	125 g	38.15 a	23.38 a	--
LSD 0.05	2.364	1.184	1.402	--
Level of Significance	0.05	0.05	0.05	--
CV (%)	8.892	4.359	5.637	--

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

T_1 = Emamectin benzoate (wonder 5G) @ 1g/L of water

T_2 = Voliam flexi 300SC @ 0.5 ml/L of water

T_3 = Lamdacyhalothrin 2.5EC @ 1 ml/L of water

T_4 = Imidacloprid 200SL @ 0.5 ml/L of water

T_5 = Abamectin 1.8 EC @ 1.2 ml/L of water

T_6 = Neem oil @ 5 ml/L + 2 ml Trix

T_7 = Control (Untreated)

4.2.3 Pod infestation at late pod stage

Statistically significant differences were observed in number of healthy and infested pods, percent infestation at late pod stage for different management practices in controlling major pest of yard long bean (Table 8). In the number of healthy pods, the highest number per plant (12.36) was recorded from T_2(Voliam flexi 300SC @ 0.5 ml/L of water) which was statistically similar with T_5(Abamectin 1.8 EC @ 1.2 ml/L of water) (11.24) and T_4(Imidacloprid @ 0.5 ml/L of water) (11.14) whereas the lowest number of healthy pods (8.54) was obtained from T_7(Untreated control) followed by T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water) and T_6(Neem oil @ 5 ml/L + 2 ml Trix).On the other hand, the highest number of infested pods (3.33) was obtained from T_7(Untreated control) followed by T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water) (2.10)and the lowest infested pods per plant in number (1.24) was observed from T_2(Voliam flexi 300SC @ 0.5 ml/L of water) followed by T_1(Emamectin benzoate (wonder 5G) @ 1g/L of water) (1.48),T_4(Imidacloprid @ 0.5 ml/L of water) (1.40) and T_5(Abamectin 1.8 EC @ 1.2 ml/L of water) (1.42).

As regards % pod infestation, the lowest infested pods per plant in number (9.12%) was observed from T_2(Voliam flexi 300SC @ 0.5 ml/L of water) which was statistically identical with T_5(Abamectin 1.8 EC @ 1.2 ml/L of water), T_1(Emamectin benzoate (wonder 5G) @ 1g/L of water) and T_4(Imidacloprid @ 0.5 ml/L of water). Again, the highest infested pods (28.05%) was recorded in T_7(Untreated control) followed by T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water) and T_6(Neem oil @ 5 ml/L + 2 ml Trix). Pod infestation reduction over control in number was estimated and the highest value (44.73%) was found from the treatment T_2(Voliam flexi 300SC @ 0.5 ml/L of water) and the lowest reduction of pod infestation over control (17.92%) from T_7(Untreated control).

Weight of healthy and infested pod and % infestation by weight showed statistically significant variation at late pod stage for different management practices in controlling major pest of yard long bean (Table 9). In the weight of healthy pods, the highest weight per plant (144.78 g) was recorded from T_2(Voliam flexi 300SC @ 0.5 ml/L of water) followed by T_5(Abamectin 1.8 EC @ 1.2 ml/L of water) (132.57 g) and T_4(Imidacloprid 200SL @ 0.5 ml/L of water) (128.32 g) while the lowest weight of healthy pods (90.66 g) was obtained from T_7(Untreated control) followed by T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water) (115.30 g) and T_6(Neem oil @ 5 ml/L + 2 mlTrix) (117.40).The lowest weight of infested pods per plant (11.36 g) was observed from T_2(Voliam flexi 300SC @ 0.5 ml/L of water) whereas the highest weight of infested pods (28.34 g) was obtained from T_7(Untreated control) followed by T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water) (21.62 g).

With respect to % pod infestation, the lowest infested pods per plant in weight (7.28%) was observed from T_2(Voliam flexi 300EC @ 0.5 ml/L of water) followed by T_5(Abamectin 1.8 EC @ 1.2 ml/L of water) (9.42%) whereasthe highest (23.82%) was recorded in T_7(Untreated control) followed by T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water) (15.79%). Pod infestation reduction over control in weight was estimated and the highest value was found from the treatment T_2(Voliam flexi 300SC @ 0.5 ml/L of water) (59.70%) and the lowest from T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water) (27.18%) treatment.

Dandale*et al*. (1984) reported that four sprays of 0.08% cypermethrin afforded complete protection against Marucatestulalis on pigeon pea in

Bangladesh. Rahman and Rahman (1988) reported that dimethoate was not as effective as cypermethrin. Several commonly used insecticides such as endosulfan, carbaryl, methomyl, monocrotophos have been found effective against Marucatestulalis G. on yard long bean (Lalasangi, 1988). Kumar et al. (1989) reported that application of carbofuran 3G at 1 kg a.i./ha at the time of sowing did not give effective control at the later crop stages. A schedule of insecticide sprays using decis (Deltamethrin) and systoate (Dimethoate) on 35, 45, 55 and 65 days after planting was investigated in Benin to determine the most effective treatment against the pyralid M. testulalis on cow pea (Atachi and Sourokou, 1989). Application of deltamethrin, cypermethrin or fenvalerate @ 0.008% or dimethoate, fenitrothrin, malathion, quinalphos or monocrotophos @ 0.008% or endosulfan 0.10% one at flowering and then at pod setting stage would be highly effective.

Table 8. Effect of different treatments in controlling major insect pests of yard long bean at late pod stage in terms of pod infestation (by number)

Treatment	Number of pods			
	Healthy	**Infested**	**% Infestation**	**Reduction over control (%)**
T_1	10.78 c	1.48 d	12.07 d	26.23
T_2	12.36 a	1.24 e	9.12 d	44.73
T_3	10.07 c	2.10 b	17.26 b	17.92
T_4	11.14 ab	1.40 d	11.16 d	30.44
T_5	11.24 ab	1.42 d	11.22 d	31.62
T_6	10.44 c	1.78 c	14.57 c	22.25
T_7	8.54 d	3.33 a	28.05 a	0.00
LSD 0.05	1.132	0.126	2.985	--
Level of Significance	0.05	0.05	0.05	--
CV (%)	8.263	5.837	8.229	--

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

T_1 = Emamectin benzoate (wonder 5G) @ 1g/L of water
T_2 = Voliam flexi 300SC @ 0.5 ml/L of water
T_3 = Lamdacyhalothrin 2.5EC @ 1 ml/L of water
T_4 = Imidacloprid 200SL @ 0.5 ml/L of water
T_5 = Abamectin 1.8 EC @ 1.2 ml/L of water
T_6 = Neem oil @ 5 ml/L + 2 mlTrix
T_7 = Control (Untreated)

Table 9. Effect of different treatments in controlling major insect pests of yard long bean at late pod stage in terms of pod infestation (by weight)

Treatment	Pods by weight (g)			
	Healthy	**Infested**	**% Infestation**	**Reduction over control (%)**
T_1	121.24 d	14.56 d	10.72 d	33.73
T_2	144.78 a	11.36 f	7.28 e	59.70
T_3	115.30 e	21.62 b	15.79 b	27.18
T_4	128.32 c	14.22 d	9.98 d	41.54
T_5	132.57 b	13.78 e	9.42 d	46.23
T_6	117.40 e	17.55 c	13.00 c	29.49
T_7	90.66 g	28.34 a	23.82 a	0.00
LSD 0.05	3.624	0.835	2.361	--
Level of Significance	0.05	0.05	0.05	--
CV (%)	10.44	6.38	7.12	--

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

T_1 = Emamectin benzoate (wonder 5G) @ 1g/L of water

T_2 = Voliam flexi 300SC @ 0.5 ml/L of water

T_3 = Lamdacyhalothrin 2.5EC @ 1 ml/L of water

T_4 = Imidacloprid 200SL @ 0.5 ml/L of water

T_5 = Abamectin 1.8 EC @ 1.2 ml/L of water

T_6 = Neem oil @ 5 ml/L + 2 mlTrix

T_7 = Control (Untreated)

4.3.5 Number of pods per plant

Number of pods per plant of yard long bean showed statistically significant variation for different management practices in controlling major insect pests (Fig. 1). The highest number of pods per plant was recorded (62.30) from T_2(Voliam flexi 300SC @ 0.5 ml/L of water) which was followed by T_5(Abamectin 1.8 EC @ 1.2 ml/L of water) (58.62), while the slowest number (40.60) was recorded from T_7(Untreated control) which was followed by T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water) (48.95).

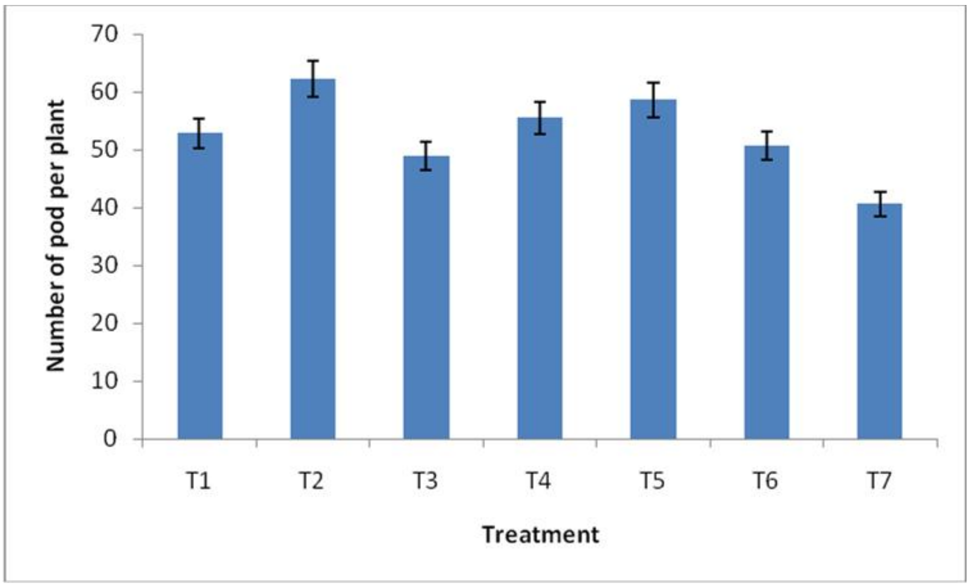

Figure 1. Effect of different treatments in terms of pods per plant in number of yard long bean

T_1 = Emamectin benzoate (wonder 5G) @ 1g/L of water

T_2 = Voliam flexi 300SC @ 0.5 ml/L of water

T_3 = Lamdacyhalothrin 2.5EC @ 1 ml/L of water

T_4 = Imidacloprid 200SL@ 0.5 ml/L of water

T_5 = Abamectin 1.8 EC @ 1.2 ml/L of water

T_6 = Neem oil @ 5 ml/L + 2 mlTrix

T_7 = Control (Untreated)

4.3.6 Healthy pod length

Length of healthy pod of yard long bean showed statistically significant variation for different management practices in controlling major insect pests (Fig. 2). The longest healthy pod (55.36) was recorded from T_2(Voliam flexi 300SC @ 0.5 ml/L of water) followed by T_5(Abamectin 1.8 EC @ 1.2 ml/L of water) (53.51 cm), T_4(Imidacloprid @ 0.5 ml/L of water) (51.75 cm) and T_1(Emamectin benzoate (wonder 5G) @ 1g/L of water) (50.75 cm), while the shortest healthy pod (43.72 cm) was measured from T_7(Untreated control) followed by T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water) (48.20 cm) and T_6(Neem oil @ 5 ml/L + 2 ml Trix) (48.80 cm).

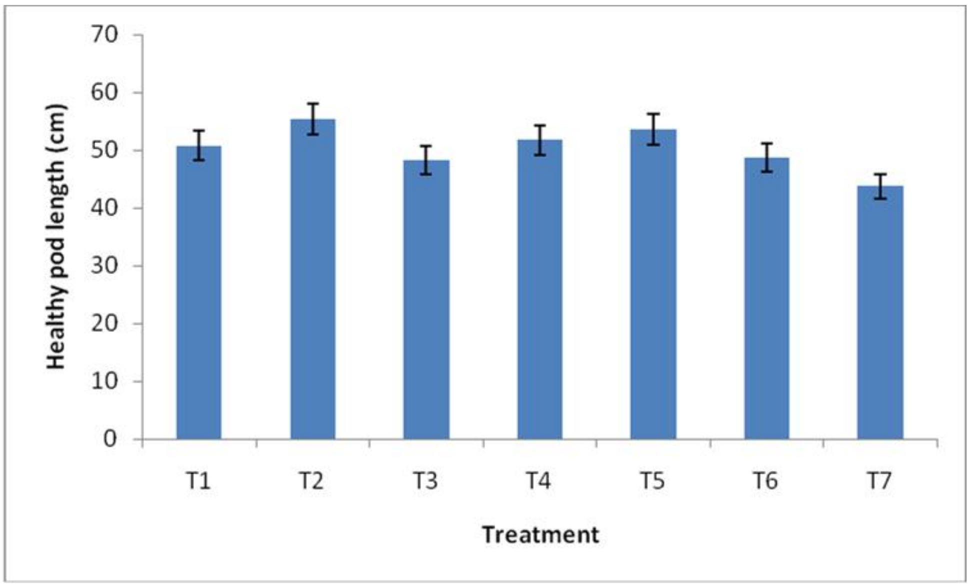

Figure 2. Effect of different treatments in terms of healthy pods per plant in length of yard long bean

T_1 = Emamectin benzoate (wonder 5G) @ 1g/L of water

T_2 = Voliam flexi 300SC @ 0.5 ml/L of water

T_3 = Lamdacyhalothrin 2.5EC @ 1 ml/L of water

T_4 = Imidacloprid 200SL @ 0.5 ml/L of water

T_5 = Abamectin 1.8 EC @ 1.2 ml/L of water

T_6 = Neem oil @ 5 ml/L + 2 mlTrix

T_7 = Control (Untreated)

4.3.7 Yield per hectare

Yield per hectare of yard long bean showed statistically significant variation for different management practices in controlling major insect pests (Table 11). The highest yield per hectare (23.48 t/ha) was recorded from T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water) followed by second highest yield (22.33 t/ha) obtained from T_5(Abamectin 1.8 EC @ 1.2 ml/L of water) and third highest yield (21.75) was from T_4(Imidacloprid 200SL @ 0.5 ml/L of water). On the other hand, the the lowest yield per hectare (12.26 t/ha) was recorded from T_7(Untreated control) followed by T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water) (19.77 t/ha). Yield increase over control was estimated and the highest value was found from the treatment T_2(Voliam flexi 300SC @ 0.5 ml/L of water) (91.52%) and the lowest yield increase over control was from T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water) (62.26%). Yield loss in yard long bean due to insect pests is reported to be about 12-30% (Hossain and Awrangzeb, 1992).

Table 10. Effect of different treatments in terms of yield per hectare of yard long bean and yield increase over control

Treatment	Yield per hectare (ton)	Increase over control (%)
T_1	20.20 d	64.76
T_2	23.48 a	91.52
T_3	19.77 f	61.26
T_4	21.75 c	77.41
T_5	22.33 b	82.14
T_6	19.84 e	61.83
T_7	12.26 g	--
LSD 0.05	0.367	--
Level of Significance	0.05	--
CV (%)	8.349	--

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

T_1 = Emamectin benzoate (wonder 5G) @ 1g/L of water

T_2 = Voliam flexi 300SC @ 0.5 ml/L of water

T_3 = Lamdacyhalothrin 2.5EC @ 1 ml/L of water

T_4 = Imidacloprid 200 SL @ 0.5 ml/L of water

T_5 = Abamectin 1.8 EC @ 1.2 ml/L of water

T_6 = Neem oil @ 5 ml/L + 2 mlTrix

T_7 = Control (Untreated)

CHAPTER V
SUMMARY AND CONCLUSION

An experiment was carried out in the farm field of Sher-e-Bangla Agricultural University, Sher-e-Bangla nagor, Dhaka, Bangladesh during from March to June 2014 for identifying major insect pests of yard long bean (*Vignasesquipedalis*) and their management. The seeds of Kegornatki were used as the test crop for the experiment. The experiment consisted of seven treatments *viz.* T_1(Emamectin benzoate (wonder 5G) @ 1g/L of water), T_2(Voliam flexi 300SC @ 0.5 ml/L of water), T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water), T_4(Imidacloprid 200SL @ 0.5 ml/L of water), T_5(Abamectin 1.8 EC @ 1.2 ml/L of water), T_6(Neem oil @ 5 ml/L + 2 mlTrix) and T_7(Untreated control).

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Data on the number of pests per plant, number and weight of healthy pod, infested pod and percentage of pod infestation in number and weight, yield contributing characters and yield of yard long bean were recorded and statistically analyzed.Significant variation was found among the different treatments regarding different parameters of the crop.

Results revealed thatin case of number of aphids per plant at early, mid and late pod stage, the lowest presence (8.10, 3.80 and 10.40 respectively) was observed in T_2(Voliam flexi 300SEC @ 0.5 ml/L of water) whereas the highest (22.67, 28.50 and 26.40 respectively) was in T_7(Untreated control).

Similarly, the lowest number of jassid per plant at different cropping stages (4.67, 2.87 and 8.57 at early, mid and late pod stage respectively) was found inT_2(Voliam flexi 300SC @ 0.5 ml/L of water) whereas the highest (18.20, 22.67 and 23.60 respectively) was observed in T_7(Untreated control).

Again, the lowest number of pod borer per plant at different cropping stages (1.33, 4.33 and 1.67 at early, mid and late pod stage respectively) was found by T_2(Voliam flexi 300SC @ 0.5 ml/L of water) whereas the highest (12.70, 18.67 and 18.33 respectively) was observed in T_7(Untreated control).

Results also revealed that the lowest number of epilachna beetle per plant at different cropping stages (0.00, 0.33 and 10.00 at early, mid and late pod stage respectively) was found by T_2(Voliam flexi 300SC @ 0.5 ml/L of water) where the highest (9.90, 14.67 and 20.40 respectively) was observed in T_7(Untreated control).

In relation to the % pod infestation, the lowest infested pods per plant in number at early, mid and late stage (9.58%, 5.01% and 9.12% respectively) were recorded from T_2(Voliam flexi 300SC @ 0.5 ml/L of water) whereas the highest infested pods per plant in number (26.94 %, 23.67% and 28.05% respectively) were recorded from T_7(Untreated control).

In relation to the pod infestation reduction over control by number, the highest infested pods at early, mid and late stage (53.80%, 62.14% and 44.73% respectively) were recorded from T_2(Voliam flexi 300SC @ 0.5 ml/L of water) whereas the lowest at early and mid stage(17.72%, and 28.05% respectively) were recorded from T_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water) and at late stage (17.92%) from T_7(Untreated control).

In relation to the % pod infestation by weight, the lowest infested pods per plant, at early, mid and late stage (6.96%, 4.95% and 7.28% respectively) were recorded from T_2(Voliam flexi 300SC @ 0.5 ml/L of water) whereas the highest (18.50%, 23.38% and 23.82% respectively) were recorded from T_7(Untreated control).

In relation to the pod infestation reduction over control by weight, the highest at early, mid and late stage (38.13%, 45.46% and 59.70% respectively) were recorded from T_2(Voliam flexi 300SC @ 0.5 ml/L of water) whereas the lowest (11.26%, 7.20% and 27.18% respectively) were recorded from fromT_3(Lamdacyhalothrin 2.5EC @ 1 ml/L of water)

The highest number of pods per plant (62.30) was recorded from T_2(Voliam flexi 300SC @ 0.5 ml/L of water), while the lowest number (40.60) was recorded from T_7(Untreated control). The longest healthy pod (55.36 cm) was recorded from T_2(Voliam flexi 300SC @ 0.5 ml/L of water), while the shortest healthy pod (43.72 cm) was measured from T_7(Untreated control). The highest yield per hectare (23.48 ton) was recorded from T_2(Voliam flexi 300SC @ 0.5 ml/L of water) while the lowest yield per hectare (12.26 ton) was recorded from T_7(Untreated control). Yield increase over control was estimated and the highest value (91.52%) was found from the treatment of T_2(Voliam flexi 300SC @ 0.5 ml/L of water) and the lowest yield increase over control (61.26%) was from T_7(Untreated control).

From the above findings, it can be concluded that the results obtained from treatment of T_2(Voliam flexi 300SC @ 0.5 ml/L of water) gave the best performance in respect of insect infestation and yield. T_5(Abamectin 1.8 EC @ 1.2 ml/L of water) also gave the promising effect with the same consideration. Considering the performance of all treatments, T_2(Voliam flexi 300SC @ 0.5 ml/L of water) can be treated as the best treatments. Further experiment can be conducted with the same respect with more options to justify the present findings.

CHAPTER VI

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CHAPTER- VII
APPENDICES

Appendix I. Monthly records of Temperature, Rainfall, and Relative humidity of the experiment site during the period from March 2014 to June 2014

Year	Month	Air Temperature (^0c)			Relative humidity (%)	Rainfall (mm)	Sunshine (hr)
		Maximum	Minimum	Mean			
2015	March	33.60	29.50	31.60	72.70	3.00	227.00
2015	April	33.50	25.90	299.20	68.50	1.00	194.10
2015	May	34.90	27.00	30.95	61.00	2.00	221.50
2015	June	35.60	29.30	32.45	72.65	2.50	229.40

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1207.

Appendix II. The mechanical and chemical characteristics of soil of the experimental site as observed prior to experimentation

Particle size constitution:

Sand	:	40 %
Silt	:	40 %
Clay	:	20 %
Texture	:	Loamy

Chemical composition:

Constituents	:	0-15 cm depth
P^H	:	6.4
Total N (%)	:	0.07

Available P (µ gm/gm)	:	18.49
Exchangeable K (meq)	:	0.07
Available S (µ gm/gm)	:	20.82
Available Fe (µ gm/gm)	:	229
Available Zn (µ gm/gm)	:	4.48
Available Mg (µ gm/gm)	:	0.825
Available Na (µ gm/gm)	:	0.32
Available B (µ gm/gm)	:	0.94
Organic matter (%)	:	1.4

Source: Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

Appendix III. Analysis of variance of the data in terms of pods per plant in number at early, mid and late podding stage of yard long bean as influenced by different pest management

Source of variation	Degrees of freedom	Mean square											
		Early pod stage				Mid pod stage				Late pod stage			
		Aphid	Jassid	Pod borer	Epilachna beetle	Aphid	Jassid	Pod borer	Epilachna beetle	Aphid	Jassid	Pod borer	Epilachna beetle
Replication	2	0.036	0.202	0.060	0.007	0.055	0.012	0.030	0.005	0.012	0.006	0.009	0.008
Treatment	6	6.714**	5.618**	3.97**	2.31*	7.03**	6.834**	2.480**	1.031**	4.731*	6.314*	3.021*	2.405*
Error	12	1.024	1.158	0.741	0.145	1.542	1.084	0.630	0.042	0.725	0.652	0.271	0.281

**: Significant at 0.01 level of probability

*: Significant at 0.05 level of probability

Appendix IV. Analysis of variance of the data in terms of pods per plant in number at early, mid and late podding stage of yard long bean as influenced by different pest management

Source of variation	Degrees of freedom	Mean square								
		Early pod stage			Mid pod stage			Late pod stage		
		Healthy	Infested	% Infestation	Healthy	Infested	% Infestation	Healthy	Infested	% Infestation
Replication	2	0.044	0.088	0.367	0.536	0.241	1.562	1.389	1.237	1.842
Treatment	6	2.39*	2.31**	4.342*	2.356*	4.289**	5.336**	4.348*	6.599*	6.297*
Error	12	0.201	0.825	1.366	0.244	1.268	1.392	1.647	1.529	2.759

**: Significant at 0.01 level of probability

*: Significant at 0.05 level of probability

Appendix V. Analysis of variance of the data in terms of pods per plant in weight at early, mid and late podding stage of yard long bean as influenced by different pest management

Source of variation	Degrees of freedom	Mean square								
		Early pod stage			Mid pod stage			Late pod stage		
		Healthy	Infested	% Infestation	Healthy	Infested	% Infestation	Healthy	Infested	% Infestation
Replication	2	0.081	0.044	0.054	0.067	0.162	0.014	0.387	0.249	0.346
Treatment	6	7.732*	5.344**	6.249**	6.548*	4.739*	7.374*	6.289*	4.247*	4.761*
Error	12	1.361	0.278	1.168	2.261	0.274	1.268	1.231	0.277	1.186

**: Significant at 0.01 level of probability

*: Significant at 0.05 level of probability

Appendix VI. Analysis of variance of the data on yield contributing characters and yield of yard long bean as influenced by different pest management

Source of variation	Degrees of freedom	Mean square						
		Length of edible part (cm)	Edible portion (%)	Length of non-edible part (cm)	Non edible portion (%)	Number of pod per plant	Healthy pod length (cm)	Yield per hectare (ton)
Replication	2	1.356	1.246	1.579	1.467	0.012	0.241	0.226
Treatment	6	8.247*	6.227*	6.145*	8.347*	7.429*	4.312*	4.156*
Error	12	2.356	1.567	3.244	2.687	2.356	2.759	1.127

*: Significant at 0.05 level of probability

LIST OF ABBRIVIATIONS

BARI	=	Bangladesh Agricultural Research Institute
CBR	=	Cost Benefit Ratio
cm	=	Centimeter
^{0}C	=	Degree Centigrade
DAS	=	Days after sowing
et al.	=	and others *(at elli)*
Kg	=	Kilogram
Kg/ha	=	Kilogram/hectare
g	=	gram (s)
LER	=	Land Equivalent Ratio
LSD	=	Least Significant Difference
MP	=	Muriate of Potash
m	=	Meter
P^{H}	=	Hydrogen ion conc.
RCBD	=	Randomized Complete Block Design
TSP	=	Triple Super Phosphate
t/ha	=	ton/hectare
%	=	Percent