INSECT PESTS INCIDENCE IN GROUNDNUT AND THEIR MANAGEMENT

MOST. TOFZILA SULTANA

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INSECT PESTS INCIDENCE IN GROUNDNUT AND THEIR MANAGEMENT

By

MOST. TOFZILA SULTANA

Registration No. 13-05776

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Approved by

.....	.....
Prof. Dr. Mohammed Ali	**Prof. Dr. Md. Abdul Latif**
Supervisor	Co- Supervisor
Department of Entomology	Department of Entomology
SAU, Dhaka	SAU, Dhaka

.....

Dr. Mohammed Sakhawat Hossain

Chairman

Examination Committee

Department of Entomology

DEPERTMENT OF ENTOMOLOGY
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207

Memo No: SAU/Entomology/

CERTIFICATE

This is to certify that the thesis entitled **"INSECT PESTS INCIDENCE IN GROUNDNUT AND THEIR MANAGEMENT"** Submitted to the Faculty Agricultural, 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 **MOST . TOFZILA SULTANA, Registration No. 13-05776** 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, 2014
Place: Dhaka, Bangladesh

.....
(Prof. Dr. Mohammed Ali)
Supervisor
Department of Entomology
Sher-e-Bangla Agricultural University

DEDICATED

TO

MY BELOVED PARENTS

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ABSTRACT

The experiment was conducted in the field of Sher-e-Bangla Agricultural University farm, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from December 2013 to May 2014 to study the insect pests incidence in groundnut and their management. Jhingabadam variety was used as a test crop for this experiment. The experiment comprised of the following treatments -T_1**:** Neem oil @ 5 ml with trix 10 ml at 10 days interval; T_2: Dimethoate (Tafhor 40EC) @ 2.0 ml/L of water at 10 ml at 10 days interval; T_3: Imidacloprid (Admire 200SL) 0.5 ml/L of water at 10 ml at 10 days interval; T_4 : Lambda- cyhalothrin (Reeva 2.5 EC) @ 1.0 ml/L of water at 10 ml at 10 days interval; T_5: Tiametoxam + Clorantraniliprole (Voliam flexi 3000SC) @ 0.5 ml/L of water at 10 ml at 10 days interval; T_6: Chlorpyrifos + Cypermethrin (Nitro 505EC) @ 1.0 ml/L of water at 10 ml at 10 days interval; and T_7: Untreated control. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The highest percentage of infested shoots/plant at early, mid, late flowering stage (13.25%, 15.56%, 18.75% respectively) was observed in T_7 treatment while the lowest percentage of infested shoots/plant (3.48%, 3.49%, 3.26% respectively) was observed in T_6 treatment . The highest percentage of infested flowers/plant at early, mid, and late flowering stage (12.04%, 13.69%, 14.70% respectively) was observed in T_7 treatment while the lowest percentage (2.16%, 3.09%, 3.96% respectively) was found in T_6 treatment. The highest plant height (53.30 cm) was recorded in T_6 treatment and the lowest (40.88cm) was found in T_7 treatment . The maximum yield per hectare (2.72 ton) was found in T_6 treatment and minimum yield (1.98 ton) was observed in T_7 treatment. The findings of the current study indicated that spraying of Chlorpyrifos + Cypermethrin (Nitro 505EC) @ 1.0 ml/L of water at 10 days interval was the best effective treatment for the management of major insect pests of groundnut cultivation.

CHAPTER I

INTRODUCTION

INTRODUCTION

Groundnut (Arachis hypogaea L.) also called goober, pindar, groundpea, peanut or earthnut, is an important food, fodder, and cash crop in many countries throughout the world. At present, it is consumed as roasted nuts and major portion used in the confectionary for making biscuits and dry foods. Groundnut oil is also a major vegetable oil and peanut butter is used in food preparations and as an ingredient in confectionery. By-products of groundnut such as peanut cake and meal are used as nutritious feed for cattle. Groundnut is highly nutritious, containing 44-56% oil and 22-30% protein on a dry seed basis (Savage and keenan, 1994). It is an important oilseed crop in Bangladesh on the basis of both in acreage and annual production (Biswas *et al.*, 2000; Mondal and Wahhab, 2001).

Groundnut cultivation covered about 87,000 hectares and produced about 125,000 metric tons of seeds during 2011-12 (Krishi Diary, 2013). The average yield levels of groundnut are lower than the potential yields as well as the world average yields. The low yield of this crop however is not an indication of low yielding potentiality of this crop. However, low yield may be attributed to a number of reasons viz. unavailability of quality seeds of high yielding varieties, delayed sowing after the harvest of transplanted aman rice, fertilizer management, improper or limited irrigation facilities and due to the attack of insect pests. Among different factors insect pests can play an important role for decreasing the production of groundnut in Bangladesh.

Abiotic stress, as the crop is grown under rainfed conditions and biotic stress are the important factors behind such low levels of productivity. Among various biotic stress causing agents, incidence of insect pests is more important. One of the major constraints to the successful groundnut production in Bangladesh is the damage caused by insect and mite pest. Studies reveal that 15-20% of the total oilseed production is lost directly or indirectly by the attack of insect and mite pests every year (Biswas and Das, 2011).

Thirty six species of insect pests were found to infest the different growth stages of groundnut crop at Gazipur, Bangladesh. Among the recorded pest species, the hairy caterpillar, Spilarctia oblique (Walker); common cutworm, Spodoptera litura F; jassid, Empoasca terminalis Distant; leaf miner, Stomoptery xnerteria M. and leaf roller, Anersia ephippias (Meyr.) were considered as the major pests (Biswas, 2014). The sucking insect pests complex comprising thrips (Thrips dorsalis Hood) leaf hoppers (Empoasc amotti), Batracomorphus angustatus Osborn (Cicadulina bipunctata Melichar),(Empoascanara primai Distant) and Leafa mysorensis Distant and aphids (Aphis Craccivora) are the major pests of importance on groundnut crop. Kaul and Das (1986) recorded 12 species of insect pests attacking groundnut crop in Bangladesh. Of these, hairy caterpillar, leaf roller, A. ephippias), and leaf miner, S. nerteria were recorded as major pests. From the survey report of Islam *et al.,* (1983) in the northern Bangladesh revealed that 25 species of insect pests have been recorded in different stages of groundnut crop in those area. Of these, 8 species were considered as serious pests. Biswas *et al.*

(2009) recorded 25 species of insect pests attacking groundnut at Gazipur which were also included in the present record.

In Bangladesh, the management practices of groundnut insect pests are mostly limited to use of insecticides of different chemical groups such as organophosphates, synthetic pyrethroidsand nicotinoids (Deng *et al*., 2002; Sreekanth *et al.,* 2000; Kumar and Krishnaynya, 1999; Ramaprasad *et al.,* 1993).

Plant derived insecticides have a wide range of mode of action such as feeding, deterrents, insecticides, ovicidal and oviposition (Abdullah *et al.,* 2011). The efficacy of botanical products against the insect pests which reported by many researchers (Devaki *et al*., 2004; Malathi *et al.,* 1999; Sharma *et al.,* 1999).

Now-a-days pesticides are widely used to improve the yield and quality of agricultural products and for controlling pests and diseases in crop products but unrestrained application of chemical pesticides for pest control has created pesticide resistance (Vanugopal *et al*., 1994).

Pesticides are developed and applied to destroy or suppress only the target organisms in agricultural crops, but they also affect non-target organisms which are responsible for decreasing the soil fertility (Savonen, 1997). Organic phosphorus is abundant in soils that can contribute to the phosphorus nutrition of plants and microorganisms that result in the hydrolysis and releases free phosphate. Pesticides are generally categorized as insecticides based on their effective function.

Chemical pesticides are commonly used by farmers to protect the crops from various insect pests. Repeated application of the pesticide ultimately reaches the soil, which intern may interact with soil organisms and their metabolic activities decreasing soil pH (Andreu and Pico', 2004). Dependence on chemical insecticides for controlling the insect pests has led to environment and economic ill-health both in physical and mental in addition to being ineffective as the pests have developed resistance. To develop eco-friendly management strategies information on the pest complex, their status incidence and damage severity are of importance.

In view of these, sincere effort were under taken in this direction for evaluating the insecticidal properties of different plant extracts, chemical and their combination against insect pests of groundnut .With conceiving the above scheme in mind, the present research work has been undertaken in order to fulfilling the following objectives:

- To study the infestation status of major insect pests of groundnut.
- To evaluate the different treatments performance against different insect pests of groundnut.

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CHAPTER II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Groundnut is one of the important oilseed crop in Bangladesh and as well as many countries of the world. There are many insect pests of groundnut among them aphid's whitefly, hairy caterpillar, common cutworm, jassid, leaf miner and leaf roller were considered as the major pests. Farmers mainly control the insect pest through use of different chemicals, use of botanicals and also followed by different cultural practices. But there are no define indication of suitable methods in insect pests control of groundnut. Before applying any control measures it is necessary to have an idea related to this pest distribution, pest status and host range, and its biology. The research work in these aspects so far done in Bangladesh and elsewhere is not adequate and conclusive. Nevertheless, some of the important and informative works research findings related to the abundance of groundnut insect pests and control of insects and pests through using botanicals, chemicals and also their integrated uses so far been done at home and abroad gave been reviewed in this chapter under the following heading:

2.1 Major insect pests of groundnut

2.1.1 Aphids

There are six species if aphids that damage cereal. These species include Rhipalosiphum padi, Schizaphis graminurn, Sitobion avenae, Metapoliphiurn durhodum, R. Maidis and Diuraphis noxia. Two of those species commonly known as Russian Wheat Aphid (Diuraphis noxia) and Bird Cherry-Oat Aphid (Rhopalosiphum padi) are considered notorious for their direct and indirect losses.

Russian Wheat Aphid (RWA) is known to be a sporadic insect causing significant yield losses by spreading out from its origin. The Centre of origin for RWA is considered to be central Asian mountains of Caucasus and Tian Shan. The specie could now be found in South Africa, Western United States Central and Southern Europe and Middle East (Webster and Amosson, 1994).

The RWA was first reported in South Africa in 1978 (Walters, 1984) in Mexico during 1980, in United States in 1986 and Canadian Prairie province during 1988 (Gilchrist, *et al*., 1984). RWA is present in almost all significant wheat producing areas of the world except Australia (Hughes and Maywald 1990). RWA attacks most of the cereals including wheat, barley, triticale rye and oat. Alternate hosts of RWA are cool season (crested) and wheat grasses (*Agrophyron spp*.). The economic impact of RWA include direct and indirect losses that have been estimated to be $893 million in Western United States during 1987 to 1992 (Brooks *et al*.,1994) whereas 37% yield losses in winter have been reported in Canadian prairies (Buttts *et al*.,1997) .Direct losses have also been assessed as an increased input cost to insecticides and indirect losses include reduced yield due to RWA infestation.

Climatic condition and temperature in particular, plays a significant role in population dynamics of the aphids. A warmer temperature can potentially accelerate the aphid's growth both in terms of number and size; yet, the extreme temperatures can possibly reduce the survival and spread. RWA is known to be present in its three different morphological types: immature wingless females, mature wingless females and mature winged females. Winged mature females or

adults spread the population and infestation to the surrounding host plants whereas the wingless type or apterous cause damage by curling and sucking the young leaves. Heavily infested plants may typically look prostrated and/or stunted with yellow or whitish streaks on leaves. These streaks, basically, are formed due to the saliva injected by the RWA (Kazemi *et al*., 2001). The most obvious symptoms due to heavy infestations can be reduced leaf area, loss in dry weight index, and poor chlorophyll concentration. Plant growth losses could be attributed mainly due to reduced photosynthetic activity to plants RWA infestation (Millar *et al*., 1994; Burd and Elliott, 1996). The photochemical activity if the plants reportedly inhabited by the RWA feeding from leaves and disruption in electron transport chain (Haile *et al.,* 1999). Spikes can have bleached appearance with their awns tightly held in curled flag leaf. RWA can feed from main stem.

Flag leaf sheath and/or even developing kernels at flowering, resulting in shriveled/empty grain or spike death In the event of sever attack; the wheat tiller can have purplish streaks. Approximately 1% to 0.67% yield losses per percentage of the infested tiller are reported at two tiller stage in Montana and Washington, respectively (Archer *et al.,* 1998). Yield losses can greatly vary due to infestation at different growth stages, duration of infestation and climatic condition (Wind patterns and temperature). A number of bio-types been reported to be present throughout the cereal production areas of the world. These biotypes are classified due to significant difference among them (Girma *et al.,* 1990)

A number of strategies have been deployed to mitigate RWA. Among these strategies, the host plant resistance has been most effective and economic method

to induce antixenosis, antibiosis and/or tolerance against RWA. Its host plant resistance is well known to be nature, and about nine resistance genes have been documented so far. A number of alternate methods to control this pest has been suggested and practiced that include cultural, biological and chemical control methods. Cultural control strategies involved eradication of volunteer and alternate host plants is generally recommended. Another strategy is grazing the volunteer plants which significantly reduce the RWA infestation (Walker and Peairs, 1998). Adjusting planting dates to de-synchronize the insect population dynamics and favorable environment conditions of any particular area can also help to control RWA (Butts, 1992) the enhanced fustigation of infested field, and biological control of RWA is also possible with 29 different species of insect and 6 fungus species for further detail the readers are encouraged to read Hopper *et al*., (1998). Of the predator insect, 4 different species of wasps have become adopted to United States. Besides these cultural practices, chemical control method is also widely practiced with equivocal cost efficiency.

2.1.2 Whitefly

The whitefly cause damage to plant by three means, (i) Large population of nymph and adults suck sap directly from plant greatly reduce yield, (ii) Heavy colonization of B. tabaci can cause serious damage to some crops due to honeydew excreted by all stages, particularly the late nymphal instars which encourages growth of "sooty mould" that affect yield both in quantity and quality and (iii) They reduce crop yield through transmission of viral diseases from crop to crop (Kajita and Alam, 1996).

The adult of whitefly is soft and pale yellow, change to white within few hours due to deposition of wax on the body and wings (Johnson *et al*; 2005.) Eggs are laid indiscriminately almost always on the under surface of the young leaves. The whitefly, B. tabaci is an important worldwide for many vegetable crops as well as tomato. The whiteflies are very small, fragile and active insect, jump from plant to plant with very slight disturbance and because of this there is great difficulty in handling them during experimental work and as well as also management

Brown and Bird (1992) have pointed out the increased prevalence as well as expanded distribution of whitefly borne viruses during the last decade and resulting devastating impact on crop growth and yield. Yield loss range from 20-100 percent, depending on the crop, season, vector prevalence and other factor during the growing season.

The whitefly acts as a mechanical vector of viral diseases for different vegetable crops (Schuster *et al.*, 2009). Young plant may even die in case of severe infestation. The pest is active during the dry season and its activity decreases with the onset of rains. As a result of their feeding the affected plants become yellowish, the leaves became wrinkle, and curl downwards and eventually fallen off. This happens mainly due to viral infection. Bianchini *et al.*, (1981) reported yield loss due to Bean golden mosaic virus (BGMV) varied from 40-100% depending on age, Variety.

One female can lay up to 136 eggs in its life time in mungbean .The nymphs are pale, translucent white, oval, with convex dorsum and flat elongated ventral side.

The whitefly adults and nymphs feed on the plant sap from the underside of the leaves. They secrete honeydew, which later helps the growth of sooty mould fungus thus reducing the photosynthetic area. The infested plants became weakened due to sucking of the plant sap from the leaves and also due to the reduction of photosynthesis of the infested plant parts. Young plant may even be killed in case of severe whitefly infestation in mungbean (Srivastava and Singh, 1976). The infested plant become yellowish, the leaves become wrinkle, curl downwards and eventually they fallen off. This happens mainly due to viral infection where the whitefly acts as a mechanical vector of many viral diseases.

2.1.3 Hairy caterpillar

The name of the insect denotes that there are plenty of hairs on the body of the larval stage of the insect. Adult moth is straw colored and the front pair of wings contains black spot. The body of the larvae is orange colored with both ends are black. In about 15 to 20 days, the caterpillar is fully grown and it measures 2.5 to 4.0 cm. Hairy caterpillar is a widely distributed polyphagous insect pest. The hairy caterpillar attacks the tender leaves of the seedling after hatching and as a result, the growth of the seedling is ceased (Bakhetia *et al.,* 1982).

2.1.4 Thrips

Thrips are another important pests in groundnut. They are small, slim-bodied insects with rasping-sucking mouthparts that puncture plant cells and suck out their contents. Thrips feed on flowers petioles and stigmas; causing deformity of the inflorescence and premature flower shedding Kobro, Sverre (2011).

2.1.5 Jassid

Jassid is a serious pest of groundnut. The female adult insect lays a number egg singly on leaf. Eggs are oviposited into veins and leaf petioles of the groundnut plant (Chaudhary *et al*, 1980). The wingless nymph feed on the plant while passing through several nymphal stages and later emerges as winged adults. Life cycles are completed in three to four weeks. Nymphs and adults generally feed on the underside of the leaf, sucking out the juice and injecting toxic saliva into the cells causing hopper burn. Infested plants are unthrifty and lack vigor and young plants may be stunted (Islam, 1999).

2.1.6 Leaf miner

The leaf miner is considered as the most important insect pest of groundnut in India and particularly in rainfed situations (Reddy, 1988). The pest initially appears as a leaf miner causing short blister like mines. Older larvae fold the leaflets and feed within. As a result, the leaflets turn brown, shrivel and dry up. Severely infested crop gives a burnt up appearance and yield losses can reach up to 76% (Amin, 1985).

Reddy *et al.*, (1991) reported that the population of the leaf miner on selected highland crops was assessed and the percent leaf injury caused by adult and larval leaf miner and effect of leaf miner population and leaf injury on the yield of garden pea, potato, onion, and tomato. Population of leaf miner adult ($8.15/in^2$) and leaf injury (47.5%) were highest in potato. Larval count was highest in onion (3.03/leaf) and leaf injury by miner larva was highest in garden pea (31.25%). Tomato had the lowest count of adult and larval leaf miner and the lowest leaf

injury of all the crops tested. Correlation analysis showed that adult and larval populations were significantly correlated with leaf injury, whereby an increase of one leaf miner adult corresponds to 1.76% leaf injury, and an increase of one leaf miner larva corresponds to 3.06% leaf injury. An increases in leaf injury by leaf miner adult and larva decrease yield by 0.26% and 0.87% respectively.

2.2 Abundance and management of insect pests of groundnut

Anuradha, *et al*., (2015) carried out an experiment to find out the impact of two selected insecticides: phenthoate (Ethyl dimethoxy phosphorothioyl) sulfanyl (phenyl acetate) and λ-cyhalothrin {alpha-cyano-3-phenoxybenzyl-3-(2-chloro 3,3,3-trifluoroprop-1-enyl)-2, 2-dimethyl-cyclopropane-carboxylate} on selected soil enzymes phosphatase and urease were determined in two different soil sample (red sandy loam and black clay soils) of groundnut (*Archis hypogaea* L.) cultivated fields in Anantapuramu district of Andhra Pradesh, India. A laboratory experiment was conducted to determine the effect of selected insecticides, phenthoate (organothio phosphorus) and λ-cyhalothrin (pyrethoid) at different concentrations ranging from 1.0 to10 $kgha^{-1}$ receiving 5.0kg ha^{-1} of selected insecticides were significantly more in both soil samples after 10 days of incubation. The activity of the phosphatase and urease was decreased progressively with the increasing period of incubation up to 30 and 40 days and resulted the significant effect of yield and decreases the insect and pest that present in the soil.

Biswas, *et al*., (2014) reported thirty six species of insect pests were found to infest the different stages of groundnut crop at Gazipur, Bangladesh. Among the

recorded pest species, the hairy caterpillar *Spilarctia oblique* (Walker); common cut worm, *spodoptera litura* F.; jassid, *Empoasca terminalis* distant; leaf miner *Stomopteryx nerteria* M. and leaf roller, *Anersia ephippias* (Meyr.) were considered as the major pests, while the rest were of minor importance on the basis of their population densities/plant, nature and extent of damage and yield reductions. Most of the major and minor pests infested during the vegetative to pre-maturity stages (45-95 DAS) and the maximum infestation occurred during pod formation and pod filling stages (50-80DAS) of the crop.

El- Wakeil, *et al.* (2014) evaluated the efficacy of range of compounds: one botanical insecticide (Neem Azal T/S) and two pyrethroid insecticides , lambda cyhalothrin (Karate 9.4% SC) and deltamethrin (Decis 2.8% EC) were evaluated to control *Rhopalosiphum padi* (L) and *Metopoloophium dirhodum* (Wlk.) in the laboratory ; as well as to contril fruit fly, *Oscinella frit* (L.) .

The later insect was also controlled companying with three species of entomopathogenic nematodes (EPNs) (*Steinernemac arpocapsae*, *S. feltiae* and *Heterorhabditis bacteriophora*). Management of wheat midges with different botanicals was also studiea; Karate (pyrethiod), Biscaya (nenonicotinoid) and Neem Azal T/S were sprayed on wheat at heading stage (GS 55). While fruit fly and wheat midges were managed in winter and spring wheat fields and evaluated at 3, 7, and 15 days after botanicals application. Surveying wheat insects and the associated natural enemies were inspected before and after treating of botanical insecticides. The mortality reached 100% after 24 in *M. dirhodum* and after 48 h in *R. padi*. Most of the tested compounds caused acceptable levels of cereal

aphid's control. All treatments induced reduction in fruit fly infestation and increased larval mortality as well. Karate resulted in significantly lower population densities of fruit fly. Insecticide applications to fields of midge-infested winter wheat significantly reduced the wheat midge damage. Compatibility between natural insecticides and natural enemies is highly required to keep the environment clean.

Twelve species of insect pests were recorded by Kandaloor *et al.,* (2012) on groundnut crop at Chinbamani, (Chikkaballapur). The thrips, leafhoppers and aphids were considered as major sucking insect pests. Plant hopper, eurybrachidbug and pentatomid bug were considered as minor. The population of thrips and leafhopper were more abundant on the crop. Results revealed that maximum activity was recorded during September and the correlation studies were made between the incidence of major sucking insect pests and select weather parameters. Thrips Leafhopper and aphids showed negative correlation with rainfall(r= -0.106, -0.056 and - 0.134, respectively). Thrips showed positive correlation to both maximum (r= 0.277) and minimum temperature (r=0.087). But leafhopper showed negative correlation for minimum temperature (r= - 0.032) and positive correlation with maximum temperature (r=0.314). In case of aphides negative correlation were observed with maximum temperature (r= -0.211) and positive correlation with minimum temperature (r=0.165). With respect to sunshine hours the leafhoppers and aphids showed negative correlation (r= -0.024 and -0.457).

The effect of six different botanical extracts- Orange peel (*Citrus sinensis*); Bitter goured (*Momordica dioica*); Garlic (*Allium vineale*); Marigold; Hot pepper (*Capsicum frutescens*) and Tobacco (*Nicotiana tabacum*) extract on aphid was assessed by Iqbal *et al*. (2011) in field of Adaptive Research Farm, Gujranwala. Aphids were deliberately exposed to the above botanical extracts and then the number of live and dead aphids was counted in meter squire ring on tagged spikelet‘s. The botanical extracts showed varying effect on aphid population. Application of Orange peel extract inflicted consistently the maximum the level of aphid mortality (65.69%) followed by Garlic (57.91%) and Tobacco (57.90%).

Imidacloprid (Confider 200SL) was evaluated by Joshi and Sharma (2009) either alone or with a fungicide (Tilt 0.01%) against aphids. There were seven different treatments, including an untreated control. All the treatments were replicated three times in a similar field environment. Population of aphids was recorded on randomly selected five plants in each plot at different intervals, both before and after spraying. Confidor 200SL @ 400 ml/ha treatment was found most effective against aphids. However, mixing of Confidor 200SL @ 100 ml/ha with Tilt @ 0.01% was found significantly least effective against aphids.

Munyuli *et al*. (2008) recorded abundance and distribution of predators such as coccinellidac, syrphdae, anthocoridae, carabidae, mantodaesta phylinidae, and chrysopidae were observed to be significantly affected by the groundnut cropping system, the rate of insecticide application and not by the groundnut genotypes. Insecticide applications reduced activities of predators at more than 50 & across seasons, study site and cropping systems. Lower pests pressure on groundnut

genotypes, higher abundance of predators and higher groundnut yields were observed to be associated with groundnut/ maize cropping system. Therefore groundnut/maize should be promoted among other biological control conservation strategies at enhancing natural enemies in groundnut system, through habitat manipulation of local environments. This study indicate that generalist predators, through their activities may be important natural enemies of groundnut pests.

The integrated effect of intercropping a synthetic pesticide (monocrotophos) (M) and neem based biopesticides (neem oil 2%) (NO) on three groundnut defoliators damage and also the groundnut production was studies by Sahayaraj and Amalraj (2006).

The monocrotophos and neem combination was found to be very effective in reducing the defoliator infestation. Defoliator's incidence was significantly higher in untreated plots, resulting in significantly lower yield (1539.03 kg ha^{-1}). The groundnut yield was increased (2011.18 kg ha^{-1}) when monocrotophos and neem oil mixture was applied than monocrotophos (1877.77 kg ha^{-1}) and control categories. The estimated avoidable groundnut and black gram yield loss were lower in monocrotophos.

Visalakshimi *et al*. (2005) reported that application of neem effectively reduced the oviposition of *H. armigera* throughout the crop period. Among various IPM components (neem 0.06%, HaNPV 250 L/ha, bird perches one/plot, endosulfan 0.07%), neem and HaNPV found as effective as endosulfan in the terms of reduction larval population and pod damage , further, endosulfan comperatively found toxic to natural enemies present in chickpea eco-system.

The above cited review represents that insect pest management in groundnut suggested that the use of botanical pesticide or chemical pesticide in integrated way was more effect.

CHAPTER III

MATERIALS AND METHODS

MATERIALS AND METHODS

The experiment was conducted during the period from December 2013 to May 2014 to study the incidence of insect pests of groundnut and their integrated management. The details of the materials and method that used to conduct the experiment are presented below.

3.1 Location

The experiment was carried out in the field of Sher-e-Bangla Agricultural University farm. Sher-e-Bangla Nagar, Bangladesh. The location of the experimental site is 23^0 74′ N latitude and 90^0 35′ E longitude and an elevation of 8.2 m from sea level.

3.2 Climate

The climate of experimental site was under the subtropical climate, characterized by three distinct season, the winter 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 (Edris *et al*., 1997). Details of the meteorological data related to the temperature, relative humidity and rainfalls during the period of the experiment was collected from the Bangladesh Meteorological Department, Dhaka and presented in appendix I.

3.3 Soil

The soil of the experimental area belongs to the Modhupur Tract (UNDP, 1988) under AEZ No. 28 and was dark grey terrace soil. The selected plot was medium high land and the soil series was Tejgaon (FAO, 1988). The characteristics of the

soil under the experiment plot were analyzed in the soil testing laboratory, SRDI, Khamarbari, Dhaka and presented in Appendix II.

3.4 Test crop and its characteristics

Jhingabadam (ACC 12) was used as a test crop for this experiment. This variety was developed at the Bangladesh Agricultural Research Institute (BARI) in the year of 1988. The plant height of this variety is 30-35 cm and life cycle 145-155 days for robi season cultivation and 130-140 days for kharif season cultivation.

3.5 Treatments of the experiment

The experiment comprised of the following treatments –

T_1 : Neem oil @ 5ml with trix 10 ml at 10 days interval

T_2 : Dimethoate (Tafgor 40EC) @ 2.0 ml/L of water at 10 days interval

T_3 : Imidacloprid (Admire 200SL) 0.50 ml/L of water at 10 days interval

T_4 : Lambda- cyhalothrin (Reeva 2.5EC) @ 1.0 ml/L of water at 10 days interval

T_5 : Tiametoxam + Chlorantraniliprole (Voliam flexi 3000SC) @ 0.5 ml/L of water at 10 days interval

T_6 : Chlorpyrifos + Cypermethrin (Nitro 505EC) @ 1.0 ml/L of water at 10 days interval

T_7 : Untreated control

3.6 Collection and preparation of treatment components

3.6.1 Neem oil

The fresh neem oil was collected from Chawkbazar, Dhaka and the trix liquid detergent was collected from location market of Agargaon bazar. All sprays were made according to the methods described earlier. For each neem oil application 6 ml neem oil was mixed with 1 litre of water and add 15 ml of trix detergent to prepare the treatment neem oil 6 ml/litre of water. Similarly 5 ml neem oilwas mixed with 1 litre of water and add 12 ml of trix detergent to prepare the treatment neem oil 5 ml/litre of water. 4 ml neem oil was mixed with 1 litre of water and add 10 ml of trix detergent to prepare the treatment neem oil 4 ml/litre of water.

3.7 Experimental design and layout

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Each experiment consists of total 21 plot of size 3.0 m x 2.0 m. All the 7 treatments of the experiment were assigned at random into 7 plots of each block/replication. The layout of the experiment is shown in Figure 1.

3.8 Growing of crops

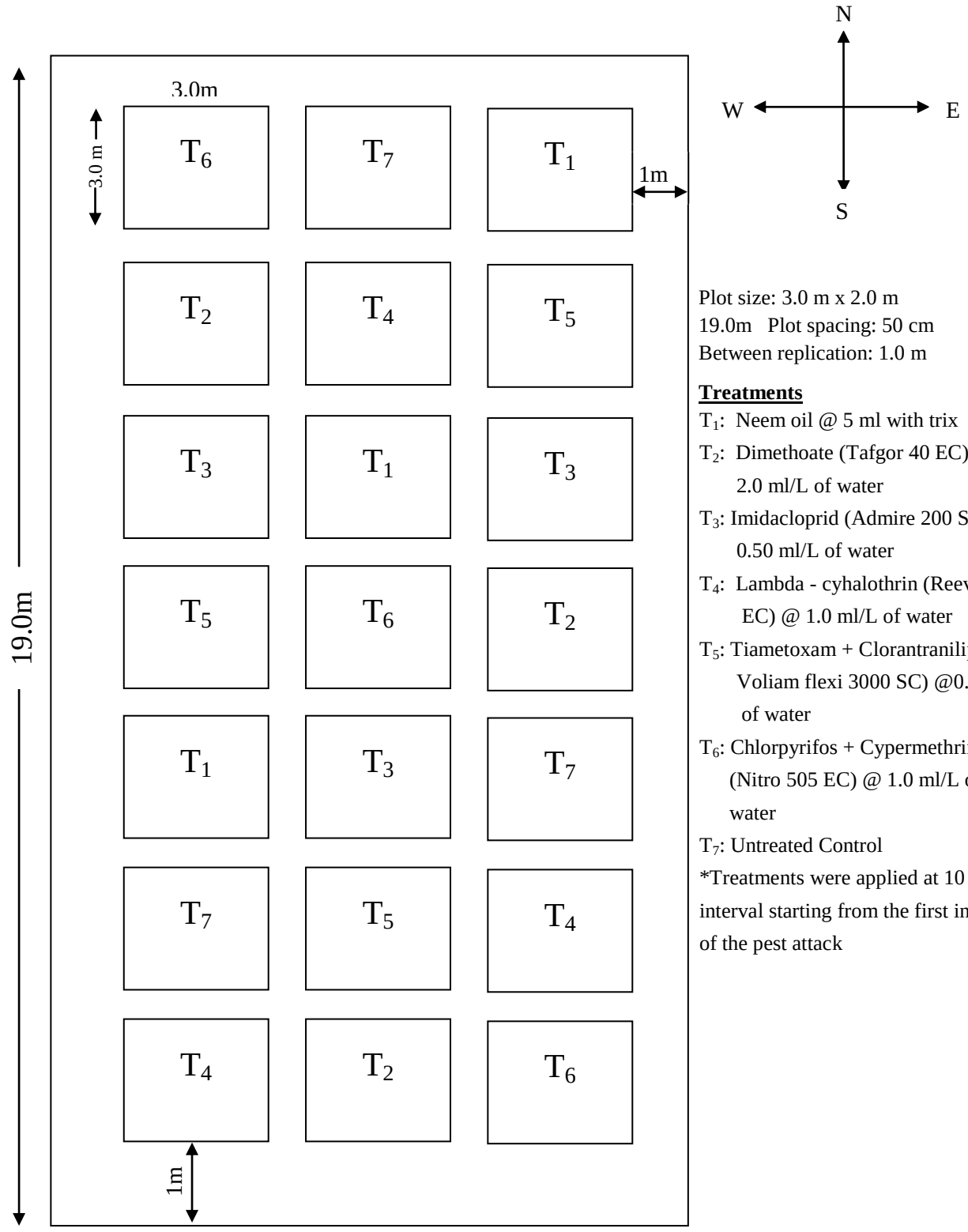
The experiment plot was opened in the second week of November 2013 with a power tiller and was exposed to the sun for a week, after which the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilt. Weeds and stubble were removed and finally obtain a desirable tilth of soil for groundnut seed sowing.

3.9 Fertilizers and manure application

The fertilizers N, P, K, S, Zn and B in the form of Urea, TSP, MP, Gypsum, Zinc sulphate and borax, respectively were applied. The entire amount of TSP, MP, Gypsum, Zinc sulphate and borax were applied during the final preparation of land. Urea was applied in two equal installments at final land preparation and before flowering after 45 days of seeds sowing. The dose and method of application of fertilizer are shown in Table 1.

Table 1. Dose and method of application of fertilizers in groundnut field

Fertilizers	**Dose (kg/ha)**	**Application (%)**	
		Basal	**1st installment**
Urea	30	50	50
TSP	170	100	--
MP	90	100	--
Gypsum	180	100	--
Zinc sulphate	5	100	
Borax	10	100	--



Plot size: 3.0 m x 2.0 m
19.0m Plot spacing: 50 cm
Between replication: 1.0 m

Treatments

T_1: Neem oil @ 5 ml with trix

T_2: Dimethoate (Tafgor 40 EC)@ 2.0 ml/L of water

T_3: Imidacloprid (Admire 200 SL) 0.50 ml/L of water

T_4: Lambda - cyhalothrin (Reeva 2.5 EC) @ 1.0 ml/L of water

T_5: Tiametoxam + Clorantraniliprole Voliam flexi 3000 SC) @0.5 ml/L of water

T_6: Chlorpyrifos + Cypermethrin (Nitro 505 EC) @ 1.0 ml/L of water

T_7: Untreated Control

*Treatments were applied at 10 days interval starting from the first initiation of the pest attack

Figure 1. Layout of the experimental plot

3.10 Intercultural operations

After establishment of seedlings, various intercultural operations were accomplished for better growth and development of the groundnut plant.

3.10.1 Irrigation and drainage

Single irrigation was provided before flowering stage and it was arranged well drained facilities as prevention process of removing rain water if any.

3.10.2 Weeding

Weeding was done in the field to keep the plots free from weeds. Which ultimately ensured better growth and development. The newly emerged weeds uprooted carefully at flowering stage by mechanical means.

3.11 Harvesting, threshing and cleaning

The groundnut was harvested at the maturity of plant and harvesting was done manually from each plot. The harvested crop of each plot was bundled separately, properly tagged and brought to threshing floor. Enough care was taken for harvesting, threshing and also cleaning of ground. The seed cleaned and finally the weight was calculated and converted into per hectare yield.

3.12 Monitoring of insect pests status and data collection

The groundnut plants were closely examined at regular interval commencing from flowering to pod maturity. Insect from 1 square meter area were recorded at 10 days intervals in central rows and starting from early flowering to pod maturity and converted. Aphids, jassids and whiteflies are the flying insect for the collection of data the following techniques was used. At first cover the sampling

plants were covered with poly bag or big plastic jar and then slightly shaken the plant, after few second the poly bag or plastic jar closed carefully. After some time when the insects were died then the insect populations were collected by a needle brush in separate Petri dish and collected the data. In case of hairy caterpillar, a white paper was spread under the sampling plant and shaken the plant. The caterpillars were dropping out the paper and then collect the data. The entire period was divided into early, mid and late flowering stage and the incidence of insect were measured.

3.13 Determination of shoot infestation

Mainly the shoot infestation was caused by the aphids. All the healthy and infested shoot were counted from 1 square meter area in the middle of each plot and examined. The collected data divided in early, mid, late flowering and fruiting stages. The healthy and infested shoot were counted and the percent plant infestation was calculated using the following formula :

$$\%\text{Shoot infestation} = \frac{\text{Number of infested shoot}}{\text{Total number of shoot}} \times 100$$

$$\%\text{ Infestation reduction} = \frac{(\%\text{ Infestation in control} - \%\text{ Infestation in the Concerned treatment})}{\%\text{ Infestation in control}} \times 100$$

3.14 Data recording on yield contributing characters and yield

Data were recorded on yield contributing characters and yield of groundnut on the following parameters-

3.14.1 Plant height

The height of plant was recorded in centimeter (cm) at harvest in the experimental plots. Data were recovered as the average of 10 plants selected at random from the inner rows of each plot after harvest. The height was measured from the ground level to the tip of the growing point of the main branch.

3.14.2 Number of branches per plant

The total number of branches arisen from the stem of a plant was counted as the number of branches per plant.

3.14.3 Percent of normal pods

Five plants from each unit plot were randomly selected at the time of harvest and counted the total number of normal pods then the percentage of normal pods were calculated by the following formula-

$$\text{Percent normal pods} = \frac{\text{Normal pods}}{\text{Total pods}} \times 100$$

3.14.4 Percent of abnormal pods

Aphids attacked the shoot and white fly, jassid attacked the younger leaf of plant inject toxic saliva and the caterpillar feed the leaf gragoriouslly that stunting the plant growth, produce abnormal pods. Thrips attack the flower and damage that causes abnormal pods. Five plants from each unit plot were randomly selected at

the time of harvest and counted the total number of abnormal pods then the percentage of abnormal pods were calculated by the following formula-

$$\text{Percent abnormal pods} = \frac{\text{Abnormal pods}}{\text{Total pods}} \times 100$$

3.14.5 Weight of 1000 seeds

One thousand seeds were counted randomly from the total seeds of cleaned harvested seeds and then weighted in grams.

3.14.6 Yield per hectare

Seed weight per plot was measured form the harvested seeds of groundnut and then converted into hectare into yield and expressed in ton.

3.15 Statistical analysis

The data related to insect pests incidence and different yield contributing characters were statistically analyzed in accordance with Completely Randomized Block Design (RCBD) and analysis of variance (ANOVA) was done. The treatment mean values were separated by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984). Through MSTAT or SPSS program.

CHAPTER IV

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

The experiment was conducted to study the incidence of insect pests of groundnut and their management. The results have been presented by using different table and discussed with possible interpretations under following headings and sub-headings –

4.1 Insect pests incidence

Incidence of insect pests was recorded for the early flowering stage to late flowering stage and aphid, white fly, jassid, hairy caterpillar and thrips was observed. Per plant data for the incidence of insect pests were counted and presented as follows-

4.1.1 Aphid

Number of Aphids showed statistically significant variations due to different management practices in groundnut at early, mid and late flowering stages (Table 2). At early flowering stage, the lowest number of Aphids (0.20) was recorded from T_6 treatment which was statistically similar to T_1 and T_5 (0.30 and 0.60) treatment and followed by T_3, T_2 (0.70 and 1.20) treatment respectively whereas the highest number of Aphids (7.30) was observed from T_7 treatment which was followed by T_4 (2.10) treatment . At mid flowering stage, the lowest number of aphids (0.30) was recorded from T_6 treatment which was statistically similar to T_1 and T_5 (0.40 and 0.80) treatment and followed by T_3, T_2 (1.10 and 1.70) treatment respectively whereas the highest number of aphids (8.00) was observed from T_7 treatment which was followed by T_4 (2.60) treatment. At late flowering stage, the

lowest number of aphids (0.50) was recorded from T_6 treatment which followed by T_1 (0.70) treatment whereas the highest number of aphids (12.10) was observed from T_7 treatment which was followed by T_4 (3.10) treatment. At the total flowering stage, the lowest number of aphids (1.00) was recorded from T_6 treatment which is statistically similar to T_1 (1.40) treatment and followed by T_5, T_3 and T_2 (2.40, 3.30 and 4.80) treatment respectively whereas the highest number of aphids (27.40) was observed from T_7 treatment which was followed by T_4 (7.80) treatment. It is revealed that treatment T_6 {Chlorpyrifos + Cypermithrin (Nitro 505EC) @ 1.0 ml/L of water at 10 days interval} was more effective among the management practices for controlling aphids at flowering stage which was followed by T_1 (Neem oil @ 5 ml with trix 10 ml at 10 days interval).

Table 2. Aphid population at early, mid, late and total flowering stage due to the effect of different treatments

Treatments	Numbers of Aphid population of different flowering stages			
	Early	**Mid**	**Late**	**Total**
T_1	0.30 e	0.40 e	0.70 f	1.40 f
T_2	1.20 c	1.70 c	1.90 c	4.80 c
T_3	0.70 d	1.10 d	1.50 d	3.30 d
T_4	2.10 b	2.60 b	3.10 b	7.80 b
T_5	0.60 d	0.80 d	1.00 e	2.40 e
T_6	0.20 e	0.30 e	0.50 f	1.00 f
T_7	7.30 a	8.00 a	12.10 a	27.40 a
$LSD_{(0.05)}$	**0.13**	**0.20**	**0.23**	**0.46**
CV (%)	**5.78**	**4.34**	**7.22**	**5.34**

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.

Treatments

T_1: Neem oil with trix, T_2: Dimethoate T_3: Imidacloprid

T_4: Lambda- cyhalothrin T_5: Tiametoxam + Clorantraniliprole, T_6: Chlorpyrifos + Cypermethrin

T_7: Untreated Control.

4.2 Shoot infestation of groundnut plant

Shoot infestation of groundnut caused by Aphids in different stage of plant.

4.2.1 At early flowering stage

Number of healthy shoots, infested shoots and percent infestation of shoots showed significant differences at early flowering stage for different management practices of groundnut (Table 3). The highest number of healthy shoots/plant (22.20) was recorded in T_6 treatment which was statistically similar to T_1, T_5 and T_3 (21.40, 21.20 and 20.07) treatment respectively and followed by T_2 (18.47) treatment. On the other hand, the lowest number of shoots/plant (16.13) was found in T_7 treatment which was followed by T_4 (17.40) treatment . The highest number of infested shoots/plant (2.47) recorded in T_7 treatment whereas the lowest number (0.80) was observed in T_6 treatment which was statistically similar to T_1, T_5 and T_3 (0.93, 1.00 and 1.07) treatment respectively and closely followed to T_4 (1.20) treatment. The highest percentages of infested shoots/plant (13.25 %) was attained in T_7 treatment which was followed by T_4 (6.52%) treatment while the lowest percentage of infested shoots/plant (3.48) was found in T_6 treatment which was statistically similar to T_1 and T_5 (4.19 and 4.51) treatment. Percentage infestation reduction over control of groundnut at early flowering stage was estimated for different management practices and the highest value (73.74%) was found in T_6 treatment and the lowest value (50.79%) from T_4 treatment. From the finding it is revealed that spraying of T_6 {Chlorpyrifos + Cypermithrin(Nitro 505EC) @ 1.0 ml/L of water at 10 days interval} was more effective among the management practices for reduction of shoots infestation of groundnut at the early flowering stage which was followed by T_1 (Neem oil @ 5 ml with trix 10 ml at 10 days interval) under the present trial .

Table 3. Effect of different treatments on shoots infestation by aphids at early flowering stage of groundnut

Treatments	Early flowering stage			
	Number of healthy shoots	Number of infested shoots	Shoot infestation (%)	Infestation reduction over control (%)
T_1	21.40 ab	0.93 bc	4.19 de	68.38 b
T_2	18.47 bcd	1.07 bc	5.47 c	58.72 e
T_3	20.07 abc	1.07 bc	5.08 cd	61.66 d
T_4	17.40 cd	1.20 b	6.52 b	50.79 f
T_5	21.20 ab	1.00 bc	4.51 cde	65.96 c
T_6	22.20 a	0.80 c	3.48 e	73.74 a
T_7	16.13 d	2.47 a	13.25 a	
$LSD_{(0.05)}$	**2.83**	**0.25**	**1.00**	
CV (%)	**5.67**	**4.22**	**7.15**	

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Treatments

T_1: Neem oil with trix T_2: Dimethoate T_3: Imidacloprid

T_4: Lambda- cyhalothrin T_5: Tiametoxam + Clorantraniliprole T_6: Chlorpyrifos + Cypermethrin

T_7: Untreated Control

4.2.2 At mid flowering stage

Number of healthy shoots, infested shoots and percent infestation of shoots were different significant among at mid flowering stage different management practices of groundnut (Table 4). The highest number of healthy shoots/plant (29.47) was recorded in T_6 treatment which was statistically similar to T_1 (28.53) and T_2 (26.60) treatment respectively and followed by T_3 (25.47) treatment. On the other hand, the lowest number of shoots/plant (21.00) was found in T_7 treatment which was followed by T_4 (22.53) treatment. The highest number of infested shoots/plant (3.87) recorded in T_7 treatment whereas the lowest number (1.07) was observed in T_6 treatment which was statistically similar to T_1 (1.33) treatment and closely followed by T_5 (1.53) treatment. The highest percentages of infested shoots/plant (15 .56 %) was attained in T_7 treatment which was followed by T_4 (8.16%) treatment while the lowest percentage of infested shoots/plant (3.49) was found in T_6 treatment which was statistically similar to T_1 (4.46%) treatment. Percentage shoots infestation reduction over control of groundnut at mid flowering stage was estimated for different management practices and the highest value (77.57%) was found in T_6 treatment and the lowest value (47.56%) from T_4 treatment. From the finding it is revealed that spraying of T_6 { Chlorpyrifos + Cypermithrin (Nitro 505EC) @ 1.0 ml/L of water at 10 days interval } was more effective among the management practices for reduction of shoot infestation of groundnut at the mid flowering stage which was followed by T_1 (Neem oil @ 5 ml with trix 10 ml at 10 days interval) under the present trial.

Table 4. Effect of different treatments on shoots infestation by aphids at mid flowering stage of groundnut

Treatments	Mid flowering stage			
	Number of healthy shoots	**Number of infested shoots**	**Shoot Infestation (%)**	**Infestation reduction over control (%)**
T_1	28.53 a	1.33 cd	4.46 de	71.34 b
T_2	23.67 cd	1.67 bc	6.61 c	57.52 ef
T_3	25.47 bc	1.60 bc	5.91 cd	62.02 de
T_4	22.53 d	2.00 b	8.16 b	47.56 f
T_5	26.60 ab	1.53 c	5.47 cd	64.85 c
T_6	29.47 a	1.07 d	3.49 e	77.57 a
T_7	21.00 d	3.87 a	15.56 a	
$LSD_{(0.05)}$	**2.75**	**0.40**	**1.50**	
CV (%)	**6.78**	**3.94**	**5.33**	

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Treatments

T_1: Neem oil with trix T_2: Dimethoate T_3: Imidacloprid

T_4: Lambda- cyhalothrin T_5: Tiametoxam + Clorantraniliprole T_6: Chlorpyrifos + Cypermethrin

T_7: Untreated Control

4.2.3 At late flowering stage

Number of healthy shoots, infested shoots and percent infestation of shoots showed significant differences at late flowering stage for different management practices of groundnut (Table 5). The highest number of healthy shoots/plant (33.73) was recorded in T_6 treatment which was statistically similar to T_1 and T_5 (32.87 and 31.60) treatment respectively and followed by T_3 (30.27) treatment. On the other hand, the lowest number of shoots/plant (22.80) was found in T_7 treatment which was followed by T_4 (25.67) treatment. The highest number of infested shoots/plant (5.27) recorded in T_7 treatment whereas the lowest number was observed in T_6 (1.27) treatment which was statistically similar toT_1 (1.53) treatment. The highest percentages of infested shoots/plant (18.75 %) was observed in T_7 treatment which was followed by T_4 (10.27%) treatment while the lowest percentage of infested shoots/plant (3.62%) was found in T_6 treatment which was statistically similar to T_1 (4.45%) treatment. Percentage shoots infestation reduction over control of groundnut at late flowering stage was estimated for different management practices and the highest value (80.69%) was found in T_6 treatment and the lowest value (45.23%) from T_4 treatment. From the finding it is revealed that spraying of T_6 { Chlorpyrifos + Cypermithrin (Nitro 505EC) @ 1.0 ml/L of water at 10 days interval} was more effective among the management practices for reduction of shoots infestation of groundnut at the late flowering stage which was followed by T_1 (Neem oil @ 5 ml with trix 10 ml at 10 days interval) under the present trial.

Table 5. Effect of different treatments on shoots infestation by aphids at late flowering stage of groundnut

Treatments	Late flowering stage			
	Number of healthy shoots	**Number of infested shoots**	**Shoot infestation (%)**	**Infestation reduction over control (%)**
T_1	32.87 ab	1.53 c	4.45 e	76.27 b
T_2	28.53 cd	2.67 b	8.57 c	54.29 e
T_3	30.27 bc	2.53 b	7.74 cd	58.72 d
T_4	25.67 de	2.93 b	10.27 b	45.23 f
T_5	31.60 abc	2.40 b	7.06 d	62.35 c
T_6	33.73 a	1.27 c	3.62 e	80.69 a
T_7	22.80 e	5.27 a	18.75 a	
$LSD_{(0.05)}$	**2.94**	**0.50**	**1.28**	
CV (%)	**5.63**	**10.65**	**8.32**	

In a columm means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Treatments

T_1: Neem oil with trix T_2: Dimethoate T_3: Imidacloprid

T_4: Lambda- cyhalothrin T_5: Tiametoxam + Clorantraniliprole T_6: Chlorpyrifos + Cypermethrin

T_7: Untreated Control

4.2.4 White fly

Number of white fly showed statistically significant variations due to different management practices in groundnut at early, mid and late flowering stage (Table 6). At early flowering stage, the lowest number of white fly (0.30) was recorded from T_6 treatment which was statistically similar to T_1 and T_5 (0.50 and 0.60) treatment and followed by T_3, T_2, and T_4 (1.00, 1. 20 and 1.30) treatment respectively whereas the highest number of white fly (4.70) was observed from T_7 treatment. At mid flowering stage, the lowest number of white fly (0.50) was recorded from T_6 treatment which was statistically similar to T_1 and T_5 (0.60 and 0.80) treatment and followed by T_3, T_2, and T_4 (1.40, 1.50 and 1.70) treatment respectively whereas the highest number of white fly (5.40) was observed from T_7 treatment. At late flowering stage, the lowest number of white fly (0.60) was recorded from T_6 treatment which followed by T_1 (1.00) treatment whereas the highest number of white fly (6.70) was observed from T_7 treatment which was followed by T_4 (2.10) treatment. At the total flowering stage, the lowest number of white fly (1.40) was recorded from T_6 treatment which is statistically similar to T_1 (2.10) treatment and followed by T_5 , T_3 and T_2 (2.60, 4.00 and 4.40) treatment respectively whereas the highest number of white fly (16.80) was observed from T_7 treatment which was followed by T_4 (5.10) treatment. It is revealed T_6 {Chlorpyrifos + Cypermithrin (Nitro 505EC) @ 1.0 ml/L of water at 10 days interval} was more effective among the management practices for the controlling white fly at flowering stage which was followed by T_1 (Neem oil @ 5 ml with trix 10 ml at 10 days interval).

Table 6. White fly population at early, mid, late and total flowering stages due to the effect of different treatments

Treatments	Numbers of White fly population of different flowering stages			
	Early	**Mid**	**Late**	**Total**
T_1	0.50 c	0.60 c	1.00 d	2.10 de
T_2	1.20 b	1.50 b	1.70 c	4.40 c
T_3	1.00 b	1.40 b	1.60 c	4.00 b
T_4	1.30 b	1.70 b	2.10 b	5.10 c
T_5	0.60 c	0.80 c	1.20 d	2.60 d
T_6	0.30 c	0.50 c	0.60 e	1.40 e
T_7	4.70 a	5.40 a	6.70 a	16.80 a
$LSD_{(0.05)}$	**0.32**	**0.41**	**0.28**	**1.01**
CV(%)	**4.34**	**6.02**	**4.12**	

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Treatments

T_1: Neem oil with trix T_2: Dimethoate T_3: Imidacloprid

T_4: Lambda- cyhalothrin T_5: Tiametoxam + Clorantraniliprole T_6: Chlorpyrifos + Cypermethrin

T_7: Untreated Control.

4.2.5 Hairy caterpillar

Number of hairy caterpillar showed statistically significant variations due to different management practices in groundnut at early, mid and late flowering stages (Table 7). At early flowering stage, no hairy caterpillar was recorded from T_6 and T_1 treatment which was followed by T_5 (0.20) treatment whereas the highest number of hairy caterpillar (2.20) was observed from T_7 treatment. At mid flowering stage, the lowest number of hairy caterpillar (0.20) was recorded from T_6 treatment which was statistically similar to T_1 and T_5 (0.30 and 0.40) treatment and followed by T_3, T_2, and T_4 (1.20, 1.40 and 1.70) treatment respectively whereas the highest number of hairy caterpillar (3.40) was observed from T_7 treatment . At late flowering stage, the lowest number of hairy caterpillar (0.4 0) was recorded from T_6 treatment which was statistically similar by T_1 and T_5 (0.50 and 0.70) treatment while the highest number of hairy caterpillar (5.20) was observed from T_7 treatment. At the total flowering stage, the lowest number of hairy caterpillar (0.60) was recorded from T_6 treatment which was statistically similar to T_1 and T_5 (0.80 and 1.30) treatment and followed by T_3, T_2 and T_4 (3.40, 3.80 and 4.00) treatment respectively whereas the highest number of hairy caterpillar (10.80) was observed from T_7 treatment. It is revealed T_6 {Chlorpyrifos + Cypermithrin (Nitro 505EC) @ 1.0 ml/L of water at 10 days interval } was more effective among the management practices for controlling hairy caterpillar at flowering stage which was followed by T_1 (Neem oil @ 5ml with trix 10 ml at 10 days interval).

Table 7. Hairy caterpillar population at early, mid, late and total flowering stages due to the effect of different treatments

Treatments	Numbers of Hairy caterpillar population of different flowering stages			
	Early	**Mid**	**Late**	**Total**
T_1	0.00 d	0.30 c	0.50 c	0.80 c
T_2	0.60 b	1.40 b	1.80 b	3.80 b
T_3	0.60 b	1.20 b	1.60 b	3.40 b
T_4	0.70 b	1.40 b	1.90 b	4.00 b
T_5	0.20 c	0.40 c	0.70 c	1.30 c
T_6	0.00 d	0.20 c	0.40 c	0.60 c
T_7	2.20 a	3.40 a	5.20 a	10.80 a
$LSD_{(0.05)}$	**0.15**	**0.22**	**0.34**	**0.71**
CV (%)	**4.89**	**5.22**	**6.05**	**3.67**

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Treatments

T_1: Neem oil with trix T_2: Dimethoate T_3: Imidacloprid

T_4: Lambda- cyhalothrin T_5: Tiametoxam + Clorantraniliprole T_6: Chlorpyrifos + Cypermethrin

T_7: Untreated Control

4.2.6 Jassid

Number of jassid showed statistically significant variations due to different management practices in groundnut at early, mid and late flowering stages (Table 8). At early flowering stage, no jassid was recorded from T_6 treatment which was followed by T_1 (0.20) treatment whereas the highest number of jassid (2.00) was observed from T_7 treatment. At mid flowering stage, the lowest number of jassid (0.20) was recorded from T_6 treatment which was statistically similar to T_1 andT_5 (0.30 and 0.40) treatment and followed by T_3, T_2 and T_4 (0.90, 1.10and1.10) treatment respectively whereas the highest number of jassid (3.60) was observed from T_7 treatment. At late flowering stage, the lowest number of jassid (0.4 0) was recorded from T_6 and T_1 treatment which was statistically similar to T_5 (0.50) treatment while the highest number of jassid (4.30) was observed from T_7 treatment. At the total flowering stages, the lowest number of jassid (0.60) was recorded from T_6 treatment which was statistically similar to T_1 and T_5 (0.90 and 1.10) treatment and followed by T_3, T_2 and T_4 (2.70, 3.10 and 3.40) treatment respectively whereas the highest number of jassid (9.90) was observed from T_7 treatment. It is revealed that treatment T_6 {Chlorpyrifos + Cypermithrin (Nitro 505EC) @ 1.0 ml/L of water at 10 days interval} was more effective among the management practices for controlling jassid at flowering stages which was followed by T_1 (Neem oil @ 5 ml with trix 10 ml at 10 days interval).

Table 8. Jassid population at early, mid, late and total flowering stages due to the effect of different treatments

Treatments	Numbers of Jassid population of different flowering stages			
	Early	**Mid**	**Late**	**Total**
T_1	0.20 c	0.30 c	0.40 c	0.90 c
T_2	0.60 b	1.10 b	1.40 b	3.10 b
T_3	0.60 b	0.90 b	1.20 b	2.70 b
T_4	0.70 b	1.10 b	1.60 b	3.40 b
T_5	0.20 c	0.40 c	0.50 c	1.10 c
T_6	0.00 d	0.20 c	0.40 c	0.60 c
T_7	2.00 a	3.60 a	4.30 a	9.90 a
$LSD_{(0.05)}$	**0.14**	**0.32**	**0.29**	**0.75**
CV (%)	**4.89**	**5.90**	**3.89**	**6.05**

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Treatments

. T_1: Neem oil with trix, T_2: Dimethoate T_3: Imidacloprid

T_4: Lambda- cyhalothrin T_5: Tiametoxam + Clorantraniliprole T_6: Chlorpyrifos + Cypermethrin

T_7: Untreated Control

4.3 Flower infestation of groundnut plant

Flower of groundnuts are affected by thrips in different stage of plant.

4.3.1 At early flowering stage

Number of healthy flower, infested flower and percent infestation of flower showed significant differences at early flowering stage for different management practices of groundnut (Table 9). The highest number of healthy flowers/plant (28.90) was recorded in T_6 treatment which was statistically similar to T_1 and T_5 (27.30 and 26.10) treatment and followed by T_3 (23.70) treatment respectively and followed by T_2 (18.47) treatment. On the other hand, the lowest number of flowers/plant (2.50) was found in T_7 treatment which was similar to T_4 (20.70) treatment. The highest number of infested flowers/plant (2.80) was recorded in T_7 treatment whereas the lowest number (0.63) was observed in T_6 treatment which was statistically similar to T_1 (0.83) treatment and closed followed by T_5 (1.17) treatment. The highest percentage of infested flowers/plant (12.04 %) was observed in T_7 treatment which was followed by T_4 (6.33%) treatment while the lowest percentage of infested flowers/plant (2.16%) was found in T_6 treatment which was statistically similar to T_1 (3.02%) treatment and percentage flower infestation reduction over control of groundnut at early flowering stage was estimated for different management practices and the highest value (82.06%) was found in T_6 treatment and the lowest value (47.43%) from T_4 treatment. From the finding it is revealed that spraying of T_6 { Chlorpyrifos + Cypermithrin (Nitro 505EC) @ 1.0 ml/L of water at 10 days interval} was more effective among the management practices for reduction of flower infestation of groundnut at the early flowering stage which was followed by T_1 (Neem oil @ 5 ml with trix 10 ml at 10 days interval) under the present trial.

Table 9. Effect of different treatments on flower infestation by thrips at early flowering stage of groundnut

Treatments	Early flowering stage			
	Number of healthy flowers	Number of infested flowers	Flower infestation(%)	Infestation reduction over control (%)
T_1	27.30 a	0.83 c	3.02 d	74.92 b
T_2	22.10 c	1.33 b	5.69 b	52.74 e
T_3	23.70 bc	1.40 b	5.58 b	53.65 de
T_4	20.70 c	1.40 b	6.33 b	47.43 f
T_5	26.10 ab	1.17 b	4.28 c	64.45 c
T_6	28.90 a	0.63 c	2.16 d	82.06 a
T_7	20.50 c	2.80 a	12.04 a	
$LSD_{(0.05)}$	**3.43**	**0.24**	**1.18**	
CV (%)	**5.45**	**6.34**	**4.87**	

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Treatments

T_1: Neem oil with trix T_2: Dimethoate T_3: Imidacloprid

T_4: Lambda- cyhalothrin T_5: Tiametoxam + Clorantraniliprole T_6: Chlorpyrifos + Cypermethrin

T_7: Untreated Control

4.3.2 At mid flowering stage

Number of healthy flower, infested flower and percent infestation of flower showed significant differences at mid flowering stage for different management practices of groundnut (Table 10). The highest number of healthy flowers/plant (44.10) was recorded in T_6 treatment which was statistically similar to T_1 and T_5 (39.83 and 38.90) treatment respectively and followed by T_3 (37.13) treatment. On the other hand, the lowest number of healthy flowers/plant (26.50) was found in T_7 treatment which was similar to T_4 (28.80) treatment. The highest number of infested flowers/plant (4.20) was recorded in T_7 treatment whereas the lowest number (1.40) was observed in T_6 treatment which was statistically similar to T_1 (1.63) treatment and closely followed by T_5 (2.0) treatment. The highest percentages of infested flowers/plant (13.95 %) was attained in T_7 treatment which was followed by T_4 (8.30%) treatment while the lowest percentage of infested flowers/plant (3.09%) was found in T_6 treatment which was statistically similar to T_1 (4.02%) treatment. Percentage flower infestation reduction over control of groundnut at mid flowering stage was estimated for different management practices and the highest value (77.43%) was found in T_6 treatment and the lowest value (39.37%) from T_4 treatment. From the finding it is revealed that spraying of T_6 {Chlorpyrifos + Cypermithrin (Nitro 505EC) @ 1.0 ml/L of water at 10 days interval} was more effective among the management practices for reduction of flower infestation of groundnut at the mid flowering stage which was followed by T_1 (Neem oil @ 5 ml with trix 10 ml at 10 days interval) under the present trial.

Table 10. Effect of different treatments on flower infestation by thrips at mid flowering stage of groundnut

Treatments	Mid flowering stage			
	Number of healthy flowers	Number of infested flowers	Flower infestation(%)	Infestation reduction over control (%)
T_1	39.83 ab	1.63 de	4.02 ef	70.64 b
T_2	29.07 c	2.33 bc	7.45 bc	45.58 e
T_3	37.13 b	2.53 bc	6.43 cd	53.03 d
T_4	28.80 c	2.60 b	8.30 b	39.37 f
T_5	38.90 ab	2.00 cd	4.88 de	64.35 c
T_6	44.10 a	1.40 e	3.09 f	77.43 a
T_7	26.50 c	4.20 a	13.69 a	
LSD $_{(0.05)}$	**5.95**	**0.46**	**1.58**	
CV (%)	**9.22**	**5.67**	**6.06**	

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Treatments

T_1: Neem oil with trix T_2: Dimethoate T_3: Imidacloprid

T_4: Lambda- cyhalothrin T_5: Tiametoxam + Clorantraniliprole T_6: Chlorpyrifos + Cypermethrin

T_7: Untreated Control

4.3.3 At late flowering stage

Number of healthy flower, infested flower and percent infestation of flower showed significant differences at late flowering stage for different management practices of groundnut (Table 11). The highest number of healthy flowers/plant (54.90) was recorded in T_6 treatment which was statistically similar to T_1 and T_5 (49.40 and 46.03) treatment respectively and followed by T_3 (44.77) treatment. On the other hand, the lowest number of flowers/plant (37.17) was found in T_7 treatment which was followed by T_4 (38.83) treatment. The highest number of infested flowers/plant (6.40) was recorded in T_7 treatment, whereas the lowest number (2.27) was observed in T_6 treatment which was statistically similar to T_1 (2.63) treatment. The highest percentages of infested flowers/plant (14 .70 %) was attained in T_7 treatment which was followed by T_4 (9.14%) treatment while the lowest percentage of infested flowers/plant (3.96%) was found in T_6 treatment which was statistically similar to T_1 (5.09%) treatment. Percentage flower infestation reduction over control of groundnut at late flowering stage was estimated for different management practices and the highest value (73.06%) was found in T_6 treatment and the lowest value (37.82%) from T_4 treatment. From this finding it is revealed that spraying of T_6 {Chlorpyrifos + Cypermithrin (Nitro 505EC) @ 1.0 ml/L of water at 10 days interval} was more effective among the management practices for reduction of flower infestation of groundnut at the late flowering stage which was followed by T_1 (Neem oil @ 5 ml with trix 10 ml at 10 days interval) under the present trial.

Table 11. Effect of different treatments on flower infestation by thrips at late flowering stage of groundnut

Treatments	Late flowering stage			
	Number of healthy flowers	**Number of infested flowers**	**Flower infestation (%)**	**Infestation reduction over control (%)**
T_1	49.40 ab	2.63 de	5.09 d	65.37 b
T_2	41.80 cde	3.67 b	8.08 bc	45.03 e
T_3	44.77 bcd	3.47 bc	7.23 c	50.82 d
T_4	38.83 de	3.90 b	9.14 b	37.82 f
T_5	46.03 bc	3.00 cd	6.08 d	58.64 c
T_6	54.90 a	2.27 e	3.96 e	73.06 a
T_7	37.17 e	6.40 a	14.70 a	
$LSD_{(0.05)}$	**6.23**	**0.61**	**1.10**	
CV (%)	**5.45**	**7.62**	**3.98**	

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability.

Treatments

T_1: Neem oil with trix T_2: Dimethoate T_3: Imidacloprid

T_4: Lambda- cyhalothrin T_5: Tiametoxam + Clorantraniliprole T_6: Chlorpyrifos + Cypermethrin

T_7: Untreated Control

4.4 Effect of treatments on yield contributing characters and yield

4.4.1 Plant height at harvest

Plant height of groundnut at harvest showed statistically significant differences in different management practices (Table 12) .The highest plant height (53.30cm) was recorded in T_6 treatment which was statistically similar with other treatment of the experiment expect control and the lowest plant height (40.88cm) was found in T_7 treatment.

4.4.1 Number of branches per plant

Different management practices showed statistically significant differences in terms of number of branches plant^{-1} of groundnut (Table 12) .Data revealed that the maximum number of branches plant^{-1} (17.57%) was found in T_6 treatment which was statistically identical with other treatment expect control, while the minimum number of branches plant^{-1} (12.10%) was observed in T_7 treatment.

4.4.3 Normal pods per plant

Different management practices showed statistically significant differences in terms of normal pods plant^{-1} of groundnut (Table 12). Data revealed that the maximum number of normal pods plant^{-1} (95.77%) was found in T_6 treatment which was statistically identical with other treatment expect control and T_4 while the minimum normal pods plant^{-1} (66.33%) was observed in T_7 treatment.

4.4.4Abnormal pods per plant

Different management practices showed statistically significant differences in terms of abnormal pods plant^{-1} of groundnut (Table 12). Data revealed that the minimum number of abnormal pods plant^{-1} (4.23%) was found in T_6 treatment which was statistically identical with other treatment expect control and T_4 treatment while the maximum abnormal pods plant^{-1} (33.67%) was observed in T_7 treatment.

Table 12. Effect of different treatments on yield contributing characters and yield

Treatments	Plant height (cm)	Number of branches /plant	Normal pods (%)	Abnormal Pods (%)	Weight of 1000 Seeds (g)	Yield per hectare (ton)
T_1	51.56 a	16.17 a	94.18 a	5.82 c	48.31 ab	2.68 a
T_2	48.41 a	15.13 a	89.66 ab	10.34 bc	42.65 bc	2.59 a
T_3	49.66 a	15.80 a	88.15 ab	11.85 bc	46.29 abc	2.62 a
T_4	48.37 a	14.90 a	85.15 b	14.85 b	41.84 c	2.58 a
T_5	50.08 a	16.10 a	92.36 ab	7.64 bc	47.50 abc	2.66 a
T_6	53.30 a	17.57 a	95.77 a	4.23 c	49.92 a	2.72 a
T_7	40.88 b	12.10 b	66.33 c	33.67 a	40.40 c	1.98 b
$LSD_{(0.05)}$	**6.31**	**2.66**	**7.36**	**7.36**	**5.90**	**0.24**
CV (%)	**5.78**	**7.78**	**4.39**	**5.02**	**6.17**	**4.33**

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Treatments

T_1: Neem oil with trix T_2: Dimethoate T_3: Imidacloprid

T_4: Lambda- cyhalothrin T_5: Tiametoxam + Clorantraniliprole T_6: Chlorpyrifos + Cypermethrin

T_7: Untreated Control

4.4.5 Weight of 1000 seeds

Different management practices showed statistically significant differences in terms of weight of 1000 seeds of groundnut (Table 12). Data revealed that the highest weight of 1000 seeds (49.92 g) was found in T_6 treatment which was statistically identical with other treatment expect control and T_4 treatment while the lowest weight of 1000 seeds (40.40) was observed in T_7 treatment

4.4.6 Yield per hectare

Different management practices showed statistically significant differences in terms of yield per hectare of groundnut (Table 12). Data revealed that the highest yield per hectare (2.72 ton) of groundnut was found in T_6 treatment which was statistically identical with other treatment expect control and T_4 treatment while the lowest yield per hectare (1.98 ton) was observed in T_7 treatment

CHAPTER V

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

The experiment was conducted in the field of Sher-e-Bangla Agricultural University farm, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from December 2013 to May 2014 to study the insect pests incidence in groundnut and their management. Jhingabadam (ACC 12) was used as a test crop for this experiment. The experiment comprised of the following treatment-T_1 **:** Neem oil @ 5 ml with trix 10 ml at 10 days interval; T_2: Dimethoate (Tafhor 40EC) @ 2.0 ml/L of water at 10 ml at 10 days interval; T_3: Imidacloprid (Admire 200SL) 0.5 ml/L of water at 10 ml at 10 days interval; T_4 : Lambda- cyhalothrin (Reeva 2.5EC) @ 1.0 ml/L of water at 10 ml at 10 days interval; T_5: Tiametoxam + Clorantraniliprole (Voliam flexi 3000SC) @ 0.5 ml/L of water at 10 ml at 10 days interval; T_6 : Chlorpyrifos + Cypermethrin (Nitro 505EC) @1.0 ml/L of water at 10 ml at 10 days interval; and T_7 : Untreated control. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications.

There were many insect pests of groundnut among them aphids, white fly, hairy caterpillar and jassid were majorly observed in the experimental plot. T_6 {Chlorpyrifos + Cypermethrin (Nitro 505EC) @1.0 ml/L of water at 10 days interval} was more effective among the management practices for controlling the observed pest in early, mid and late flowering stage which was followed by T_1 (Neem oil @ 5 ml with trix 10 ml at 10 days interval).

In case of shoot infestation, at early flowering stage, the highest percentage of infested shoots/plant (13.25%) was observed in T_7 treatment while the lowest percentage of infested shoots/plant (3.48%) was found in T_6 treatment. Groundnut shoots infestation percentage reduction over control at early flowering stage was estimated for different management practices and the highest value (73.74%) was found in T_6 treatment and lowest value (50.79%) from T_4 treatment. At mid flowering stage, the highest percentage of infested shoots/plant (15.56%) was observed in T_7 treatment, while the lowest percentage of infested shoots/plant (3.49%) was found in T_6 treatment.

Groundnut shoot infestation percentage reduction over control at mid flowering stage was estimated for different management practices and the highest value (77.57%) was found in T_6 treatment and lowest value (47.56%) from T_4 treatment. At late flowering stage, the highest percentage of infested shoots/plant (18.75%) was observed in T_7 treatment while the lowest percentage of infested shoots/plant (3.26%) was found in T_6 treatment. Groundnut shoot infestation percentage reduction over control at late flowering stage was estimated for different management practices and the highest value (80.69%) was found in T_6 treatment and lowest value (45.23%) from T_4 treatment.

In case of flower infestation, at early flowering stage, the highest percentage of infested flowers/plant (12.04%) was observed in T_7 treatment while the lowest percentage of infested flowers/plant (2.16%) was found in T_6 treatment. Groundnut flowers infestation percentage reduction over control at early flowering stage was estimated for different management practices and the highest value (82.06%) was found in T_6 and lowest value (47.43%) from T_4 treatment. At mid flowering stag, the highest percentage of infested flower/plant (13.69%) was observed in T_7 treatment while the lowest percentage of infested flowers/plant (3.09%) was found in T_6 treatment. Groundnut flower infestation percentage reduction over control at mid flowering stage was estimated for different management practices and the highest value (77.43%) was found in T_6 treatment and lowest value (39.37%) from T_4 treatment. At late flowering stage, the highest percentage of infested flowers/plant (14.70%) was observed in T_7 treatment while the lowest percentage of infested flowers/plant (3.96%) was found in T_6 treatment. Groundnut flowers infestation percentage reduction over control at late flowering stage was estimated for different management practices and the highest value (73.06%) was found in T_6 treatment and lowest value (37.82%) from T_4 treatment. The highest plant height (53.30 cm) was recorded in T_6 treatment and the lowest plant height (40.88cm) was found in T_7 treatment. The maximum number of branches per plant (17.57%) was found in T_6 treatment while the minimum number of branches per plot (12.10%) was observed in T_7 treatment.

The maximum number of normal pods per plant (95.77%) was found in T_6 treatment while the minimum normal pod per plot (66.33%) was observed in T_7 treatment. The minimum number of abnormal pods per plant (4.23%) was found in T_6 treatment while the maximum abnormal pod per plant (33.67%) was observed in T_7 treatment. The highest weight of 1000 seeds (49.92 g) was found in T_6 treatment and the lowest weight of 1000 seeds (40.40 g) was observed in T_7 treatment. The highest yield per hectare (2.72 ton) was found in T_6 treatment whereas the lowest yield per hectare (1.98 ton) was observed in T_7 treatment.

From the above findings it may be concluded that, aphids, white fly, jassid, hairy caterpillar, thrips are the most serious pests of groundnut. Considering the population per plant in different stages, shoots infestation, flowers infestation, contributing characters of yield and yield per hectare the treatment with T_6 {Chlorpyrifos + Cypermethrin (Nitro 505EC) @ 1.0 ml/L of water at 10 days interval} was the most effective comparison with all other treatments for the management of groundnut. Another suitable treatment among the management practices for groundnut cultivation was T_1 (Neem oil @ 5 ml with trix 10 ml at 10 days interval).

Based on the results of the present experiment, following recommendations may be suggested:

- Nitro 505EC @ 1.0 ml/L of water at 10 days interval my be used for the management of major insect pests of groundnut.
- Such study needs to be conducted in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability.

CHAPTER VI

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APPENDICES

Appendix I. Monthly record of air temperature, relative humidity and rainfall of the experimental site during the period from December 2013 to May 2014

Month	*Air temperature (*C)		*Relative Humidity (%)	*Rainfall(mm) (total)
	Maximum	Minimum		
December,2013	22.4	13.5	74	00
January, 2014	24.5	12.4	68	00
February, 2014	27.1	16.7	67	30
March, 2014	31.4	19.6	54	11
April, 2014	33.2	21.5	56	65
May, 2014	34.5	23.5	62	121

*Monthly average,

*Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka-1212

Appendix II. Characteristics of experimental field soil is analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Agronomy field , SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled

B. Physical and chemical properties of the initial soil

Characteristics	Value
% Sand	27
% Silt	43
% clay	30
Textural class	Silty-clay
pH	5.6
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45