EFFECTIVENESS OF SOME INSECTICIDES FOR CONTROLLING ONION THRIPS (*Thrips tabaci*) FOR QUALITY SEED PRODUCTION

A THESIS

BY

MD.ARSHAD HOSSAIN

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MD.ARSHAD HOSSAIN
Registration No. 12-5231

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APPROVED BY

....	....
Prof. Dr. Mohammed Ali	**Prof. Dr. Abdul Latif**
Supervisor	**Co-supervisor**

....

Dr. Mohammed Sakhawat Hossain
Chairman
Examination Committee

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Dhaka, Bangladesh
June, 2014 **The Author**

DEPARTMENT OF ENTOMOLOGY
Sher-e-Bangla Agricultural University
Dhaka, Bangladesh

CERTIFICATE

This is to certify that thesis entitled, ***"EFFECTIVENESS OF SOME INSECTICIDES CONTROLLING ONION THRIPS FOR QUALITY SEED PRODUCTION"*** *submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE (M.S.)*** *in* ***ENTOMOLOGY,*** *embodies the result of a piece of bona fide research work carried out by* ***Md.Arshad Hossain, Registration No. 12-5231*** *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 duly been acknowledged.

Dated :June,2014 ***Prof. Dr. Mohammed Ali***
Dhaka, Bangladesh ***Supervisor***

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ABSTRACT

The experiment was conducted in the central farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207 during the period from November 2012 to February 2013 to evaluate some promising insecticides against onion thrips. The treatments were T_1= Fipronil @ 2.0 ml/L of water at 7 days interval, T_2= Lambdacyhalothrin @ 1.0 ml/L of water at 7 days interval, T_3= Imidacloprid @ 0.5 ml/L of water at 7 days interval, T_4= Neem Oil @ 4.0 ml/L of detergent at 7 days interval, T_5= Malathion 57 EC @ 2.0 ml/L of water at 7 days interval, T_6 = Sevin 85WP @ 2.0 ml/L of water at 7 days interval, T_7 = Control. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The result revealed that T_2 comprising Lambdacyhalothrin @ 0.5 ml/L of water at 7 days interval performed as the best treatment in reducing thrips population (78.86%) and also increasing flower/stalk, scape diameter, umbel diameter of onion and thousand seed weight. T_1 comprising spraying of Fipronil @ 2.0 ml/L of water at 7 days interval performed satisfactory result in reducing thrips population (76.65%) and also increasing plant height, leaves per plant, scape length, umbel number, flower per umbel, effective flower per umbel, Seed weight (mg) /plant and yield of onion. Spraying of Imidacloprid @ 0.5 ml/L of water at 7 days interval also performed good result in reducing thrips population (72.68%) followed by Neem Oil @ 4.0 ml/L with detergent at 7 days interval, reducing thrips population (45.43%).

ABBREVIATIONS AND ACRONYMS

AEZ	:	Agro-Ecological Zone
et al.	:	And others
BBS	:	Bangladesh Bureau of Statistics
cm	:	Centimeter
CV	:	Coefficient of variation
DAT	:	Days After Transplanting
^oC	:	Degree Celsius
d.f	:	Degrees of freedom
etc.	:	Et cetera
EC	:	Emulsifiable Concentrate
FAO	:	Food and Agriculture Organization
Fig.	:	Figure
g	:	Gram
ha	:	Hectare
p^H	:	Hydrogen ion conc.
J.	:	Journal
Kg	:	Kilogram
LSD	:	Least Significant Difference
L	:	Liter
m	:	Meter
MS	:	Mean sum of square
mm	:	Millimeter
MP	:	Murate of Potash
no.	:	Number
%	:	Percent
RCBD	:	Randomized Complete Block Design
SAU	:	Sher-e-Bangla Agricultural University
m^2	:	Square meter
t	:	Ton
TSP	:	Triple Super Phosphat

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CHAPTER I

INTRODUCTION

Onion (*Allium cepa* Linnaeus.) is an important spice crop in Bangladesh. It ranks first in production (889000 MT) and second in area (125101 ha) among the spices (BBS, 2008). It covers almost 36% of the total areas under spices. The mean yield of onion in Bangladesh is very low (4 t/ha) compared to world average of 18.21 t/ha (FAO, 2004). Consumption of onions has been increasing significantly in the world partly because of the health benefits. (Wang *et al*., 2006 and Havey *et al*., 2004). Onions are also rich in flavonoids and alkenyl cysteine sulphoxides which play a part in preventing heart disease and other ailments in humans (Javadzedah *et al*., 2009; Havey *et al*., 2004 and Gareth *et al*., 2002). During winter, onion is widely cultivated all over Bangladesh. Farmers generally follow traditional method for cultivating onion in Bangladesh. Although production of onion is increasing day by day, but in a land hungry country like Bangladesh, it may not be possible to meet the domestic demand due to increase in population. There is an acute shortage of onion in relation to its requirement. Every year, Bangladesh has to import a big amount of onion from neighbouring and other countries to meet up its demand.

The high demand of onion can only be met by increasing its production vertically. Efficient use of resources can provide the farmers to have higher production from the available resources. Farm level yield of onion is very low compared to their recommended yield. Besides fertilizer management now-a-days insecticidal management is most important to control pest. Insecticide has a great effect to kill insect pest. Among the major factors limiting onion production are diseases and pests such as thrips (*Thrips tabaci*) and cut worms (*Agrotis sp*.) (Muendo and Tschirley, 2004; Rabinowitch and Currah, 2002). Onion thrips (*Thrips tabaci*) which is considered to be the most economically important pest of onion worldwide (Trdan *et al*., 2005) is responsible for causing considerable reduction in yield (Trdan *et al*., 2005; Nawrocka, 2003 and Brewster, 1994). In Kenya, thrips are present in all onion growing areas and can cause up to 59% loss in yield (Waiganjo *et al*., 2008). Currently, growers manage thrips by applying insecticides several times in a growing season. However, most insecticides are ineffective because a large number of thrips are always protected between the inner leaves of the onion plant and the pupal stage is spent in the soil. In addition, *Thrips tabaci* is a very prolific species with many overlapping generations (Alimousavi *et al*., 2007; Shelton *et al*., 2006). Managing thrips is further complicated by lack of natural parasites and the presence of numerous other host plants on which the pest thrives (Brewster, 1994). Development of resistance by onion thrips to most commonly used insecticides has been reported (Martin *et al*., 2003). Besides increasing the cost of production, the use of pesticides has negative effects on the environment and human health which is attributed to high chemical residues (Burkett-Cadena *et al*., 2008). Therefore, there is need to integrate the use of chemicals with other methods of control such as cultural practices and use of resistant varieties in the management of thrips and other pests of onion. One sustainable method of managing pests is intercropping (Trdan *et al*., 2006; Finckh and Karpenstein-Machan, 2002). a system in which a plant species (the intercrop) is grown specifically to reduce pest damage on a main crop. Onion thrips also can be control by insecticide within short term. Intercropping is an important cultural practice that has been utilized in the management of weeds, insect pests and diseases in many crops worldwide (Trdan *et al*., 2006; Finckh and Karpenstein-Machan, 2002). It is traditionally practiced by subsistence farmers in developing countries as a crop production system (Sodiya *et al*., 2010). The system is characterized by minimal use of pesticides and increased land productivity (Ullah *et al*., 2007).

Onion thrips is the most important insect pest of onions. This insect causes significant economic losses, by reducing yields up to 60%. It has also effect on onion seed production. Thrips damage to young onions is more devastating than on larger plants late in the growing season; however, thrips feeding opens up the onion to secondary infections. Therefore it is important to protect the onions from thrips damage throughout the entire growing season. Onion thrips is difficult to control because the mobile stages of this insect are found mainly in the narrow spaces between the inner leaves where spray coverage is difficult to accomplish. In addition, the eggs are laid into the leaf tissues where they may escape control. Re infestation of fields can occur from surrounding non-crop vegetation and immigration of thrips from nearby fields. Currently, the most important tool for commercial onion growers is the judicious use of insecticides.

Objectives

Considering above points the experiment have been undertaken to fulfill the following objectives:

- To identify the incidence of onion thrips in different stages of crop growth
- To find out the most effective insecticide against Onion thrips
- To evaluate the infestation of thrips on onion seed production

CHAPTER II

REVIEW OF LITERATURE

Onion thrips (*Thrips tabaci* Lindeman.) is one of the major harmful insect pests of onion. In most seasons, damage by thrips to newly emerging onion plant occurs to a greater or lesser degree. Attacks are more severe during periods of slow growth and in particular on stony soils. Thrips first appear in most vegetable fields in mid-to-late June and have several overlapping generations throughout the summer months.

2.1 Systematic position

Kingdom : Animalia

Phyllum: Arthropoda

Class : Insecta

Order : Thysanoptera

Family : Thripidae

Genus : *Thrips*

Species : *T. tabaci* (Foster *et al*.,2010)

2.2 Natural history

Thrips are believed to have descended from a mycetophilic ancestor during the Mesozoic, (Grimaldi *et al*., 2004) and many groups still feed upon and inadvertently redistribute fungal spores, but most research has focused on those species feeding on or in association with economically significant crops. Some thrips are predatory, but the majority are phytophagous insects feeding on pollen and the chloroplasts harvested from the outer layer of plant epidermal and mesophyll cells. (Heming *et al*., 1993 and Kirk, 1995). These species are minute organisms that prefer to feed within the tightly packed apical buds of new growth. Feeding usually occurs along the main vein or ribs of leaves and petals. (Lewis, 1973). Flower-feeding thrips may be responsible for pollination while feeding, (Saxena, 1996) but their most obvious contribution to their ecosystem remains the damage they can cause during feeding. This impact may fall across a broad selection of prey items, as there is considerable breadth in host affinity across the order, and even within a species, varying degrees of fidelity to a described host remain (Mound, 2005). Family Thripidae is particularly notorious for members with broad host ranges, and the majority of pest thrips come from this family (Bailey, 1940).

While poorly documented, chemical communication is believed to be important to the group (Blum, 1991). Anal secretions are produced in the hindgut (Howard, 1983) and released along the posterior setae as predator deterrents (Lewis, 1973). Some Phlaeothripidae, such as genera *Kladothrips* and *Oncothrips* form eusocial groups similar to ant colonies, with reproductive queens and nonreproductive soldier castes. Many thrips form galls on plants when feeding or laying their eggs.

2.3 Biology and Ecology

Onion thrips can complete their life cycle in as little as two weeks or as long as one month (Uckland *et. al*., 2013). In New York, onion thrips populations may consist entirely of females that do not need to mate in order to lay fertile eggs (parthenogenesis). Other populations may include males and females and mating may occur (sexual reproduction). Regardless of the mode of reproduction, females lay eggs in onion leaves. Eggs hatch shortly after they are laid and small larvae begin feeding. There are only two instars and after the second completes its development, it moves into the soil and becomes a pre-pupa (Dai *et al*., 2009). The pre-pupal stage transforms into a pupa and remains in the soil. Neither the pre-pupa nor the pupa feeds. Adults generally emerge from the soil five to seven days later and initiate another generation (Diaz-Montano *et al*., 2010).

Thrips are tiny, narrow bodied, black insects of the type known as thunder flies. many generations of thrips are wingless and spend most of the year in the soil, feeding on a wide range of non-legume crops including Brassicae, linseed and sugar beet. As peas or beans begin to emerge in the spring thrips feed inside the tightly rolled leaves of the growing point. Because feeding causes damage to the leaf surface, young leaflets appear pale and slightly distorted and if held to the light, small translucent markings are obvious. On beans, leaves may appear shiny and speckled with sooty black markings. The underside of bean leaves develop a rusty discoloration. By carefully unfolding the leaflets of affected seedlings, thrips may be found in varying numbers. In severe attacks the thrips are too numerous to count (Foster *et al*., 2010). The thrips are tiny, slender-bodied insects, about 0.5 to 5.0 mm long. Adults are either wingless or have four long, narrow wings with few or no veins and fringed with long hairs. Thrips have rasping-sucking mouthparts and gradual metamorphosis. The upper surface of their mouthparts are etched and form a file (Gent *et al*., 2006). The insect feeds by rasping this file across the cuticle of tender plant tissues, the rasping ruptures the plant cuticle, then the thrips sucks the exposed sap. They feed on many plants, attacking flowers, leaves, fruits, and buds; some even are virus vectors. Certain species, however, are predaceous. Thrips occasionally are serious nursery pests as they damage young tender leaves and shoots for example, the onion thrips (*T. tabaci*) attacks new leaves of conifer seedlings (Herron *et al*., 2008).

Jensen (2001) studied that Onion thrips overwinter as adults in New York. Sites for overwintering include the soil within and adjacent to onion fields, on onion culls, in vegetation near onion fields and in other crops such as alfalfa, wheat and clover. In New York, adults emerge from mid-May through June, but do not appear to colonize onions until late June or July. Transplanted onions and early-maturing varieties are often colonized before late-maturing varieties. During the summer, onion thrips may migrate from recently cut alfalfa fields and maturing wheat fields into onion fields. In these situations, there are strong edge effects characterized by high numbers of thrips that invade onion field edges nearest the former host. Similarly, in August and early September, onion thrips migrate from maturing onions (leaves collapsed and drying) into late-maturing varieties. This can happen very quickly in some cases.

In New York, four to six generations of onion thrips occur during the season (Jensen, 2006). The number of generations completed depends on temperature. For example, at a constant temperature of 68° F, only one complete generation would occur in the onion crop. In contrast, two complete generations would occur at a constant temperature of 77° F and four generations at a constant temperature of 86° F. At 86° F, a single female could be responsible for the production of nearly 16 million thrips over a two-month period, which is 76,000 times more than would be produced during the same period at 68° F and 588 times more than would be produced at 86° F (Kendall and Capinera, 1987). The implication of this information is that onion thrips infestations must be prevented from reaching a point when the population begins to increase exponentially. Therefore, thrips densities in the field, insecticide performance and weather conditions must be monitored closely for making control decisions.

(Kiernan *et al*., 2011). studied that stages in the developmental cycle are the egg, first larval stage, second larval stage, prepupa, pupa, and adult. Because of their small size, this pest species like other thrips cannot readily be identified to species even with a hand lens. Adult specimens are usually needed to make species identifications under high microscope magnification.

The entire life cycle (egg to adult) requires about 19 days (Lebedev *et al*., 2012). Large populations are able to develop quickly under Hawaiian weather conditions where there are many overlapping generations throughout the year.

Reproduction of this species in Hawaii is mostly through a process called parthenogenesis in which females are able to reproduce without mating. As a result, populations consist of females at a ratio of 1 male per 1000 females (Sakimura, 1932).

Onions and related Allium crops are subject to a variety of diseases and attack by arthropod pests that can reduce crop yield and quality (Lorbeer *et al*., 2002). Probably the most damaging pests worldwide are the insignificant looking thrips or thunderflies. These are slender insects only about 2 mm long as adults. They are found wherever alliums are grown, but are most severe in the warmer production regions (Brewster, 1994). Soni and Ellis (1990) listed seven species of Thrips as allium pests, the best known of which is *T. tabaci*, the onion thrips, which attacks all edible allium. Onion thrips have a wide range and populations move from one crop to another when conditions change, such as when neighbouring crops are harvested (Shelton and North, 1986). Thus, the temporal and spatial arrival of onion thrips population into onion fields is variable and relatively unpredictable (Gangaloff, 1999).

According to Kranz *et al*. (1977) the number of thrips on a crop can increase rapidly in dry weather and decrease rapidly after rain. They found that large number of thrips attacking a crop at the seedling stage could cause severe or even total losses with onion, cabbage or cotton. However, once established and growing vigorously, most plants could tolerate feeding damage. Adults and nymphs were present from February to harvest (April or May) with peak abundance in early April (Edelson *et al*., 1986). Kranz *et al*. (1977) reported that control of alternative host plants is unlikely to be a useful method except under exceptional circumstances, because of wide host range. The crop may be protected by bringing forward planting date so that the maximum population of thrips does not coincide with the seedling stage. Earlier studies conducted on the insect pest were done in Zaria (Sub-humid zone of Nigeria) by Raheja (1973) which reported that population of thrips gradually built up and reached a peak 50 days after transplanting. Also Kisha (1977) found that few thrips were present on onion crop until mid-February when there was a sudden increase in numbers to peak levels during the first week of April, after which the numbers declined. There has been no study conducted on the seasonal abundance on the insect in this agro ecology (Dry Sub-humid) where bulk of the crop is produced.

Ullah *et al.* (2010) studied that the population density increased from 1.2 to 2.8 thrips/plant during 3rd February to 25th February. During the month of March, its population increased from 3.3 to 34.5 thrips/plant (3rd March to 31st March). The peak population was recorded on 28th April i.e. 100.3 thrips/plant. Afterward the pest population abruptly declined from 78.8 to 3.9 thrips/plant during the month of May. The sudden drop in population may be due to maturation of crop, leaf hardening and migration of thrips to other crops. Hussain *et al*. (1997) ; Hyder and Shariff (1987) also recorded almost similar findings. Hussain *et al*. (1997) reported that population of the *Thrips tabaci* began to build up in early February and reached maximum during April. Tolerance as a mechanism of resistance to the melon thrips, Thrips palmi Karny

(Thysanoptera; Thripidae), in common beans, *Phaseolus vulgaris* L., was evaluated under field and greenhouse conditions. Seven resistant (Brunca, BH-5, BH-60, BH-130, BH-144, EMP 486, and FEB 115) and five susceptible (PVA 773, EMP 514, BAT 477, APN 18, and RAZ 136) bean genotypes were assessed according to adult and larval populations, visual damage and reproductive adaptation scores, and yield components in field trials. From these genotypes, four resistant (Brunca, BH-130, EMP 486, and FEB 115) and two susceptible (APN 18 and RAZ 136) genotypes were selected for quantification of proportional plant weight and height increase changes due to thrips infestation in greenhouse tests. Under medium to high thrips infestation in the field, most resistant genotypes tended to have higher reproductive adaptation and lower yield losses, though they did not always suffer less damage, as compared to susceptible genotypes. In the greenhouse, resistant genotypes showed less reduction in plant dry weight and height increase than did some susceptible ones under the same infestation pressure. Results from both field trials and greenhouse tests suggest the possible expression of tolerance as a mechanism of resistance to *T. palmi* in the resistant genotype EMP 486, and confirm the existence of antixenosis in FEB 115, whereas tolerance might be combined with other resistance mechanisms in Brunca (Islam, 2006).

Kyamanywa (2009) used regression analysis to quantify yield variations in onion due to major insect pests, i.e., aphids (*Aphis craccivora* Koch), thrips (*Megalurothrips usitatus* Trybom), Maruca pod borer, Maruca vitrata Fabricius and a complex of pod-sucking bugs. Variability in pest infestation was created by growing taherpuri in two locations over three seasons and under different insecticide spray schedules. Stepwise regression for individual locations and seasons data indicated that most of the variation in cowpea grain yields was caused by thrips. Kyamanywa (2009) also estimated that to the total variation in onion yields, on average, the major pests contribute 51–69% in Pallisa and 24–48% in Kumi. Thrips alone contribute 35–41% and 13–19% at these two sites, respectively.

Thrips (Thysanoptera) and their predators were investigated from 2005–2007 on a wide range of vegetables grown mostly in the winter period in Çukurova region of Turkey. A total of 2989 adult thrips and 406 thrips larvae were extracted from the vegetables. The adults belonged to 14 thrips species of which Melanthrips spp. were the most dominant species. The dominance of the commonly found pests *Thrips tabaci* and *Frankliniella occidentalis* differed greatly. *F. occidentalis* was the predominant thrips infesting broad bean, lettuce and parsley, while *T. tabaci* was more abundant on leek, onion and pea. The most thrips were collected from flowers or heads of vegetables in early spring. Numbers of predatory insects dwelling on the sampled vegetables were lower in comparison to total numbers of thrips obtained in the years 2006 and 2007. Of the predators, the hemipteran genera lists *Orius laevigatus* and *O. niger* were the most prevalent and high numbers of them were recorded often on flowers of broad bean in winter. Further investigations should be planned to understand clearly the predatory habit of Melanthrips (Atakan, 2008).

The bean flower thrips *(Megalurothrips usitatus*) is one of the most serious pests of common bean (*Phaseolus vulgaris*) in Uganda. Although information is lacking on the pest density at which economic loss occurs (i.e., economic injury level), prophylactic application of insecticides is recommended in Uganda. This study assessed bean-yield losses caused by M. usitatus in both mono-and intercropping situations to determine the relationship between thrips population density and bean yield (Kyamanywa, 2009).

Thrips densities and levels of damage were significantly affected by an interaction between the type of insecticide and the action threshold followed. For Warrior, levels of damage and densities of thrips were very high, regardless of the action threshold used. In fact, thrips densities and damage levels in all Warrior treatments did not differ from those in the untreated control. This occurred despite four weekly sprays following the one thrips/leaf threshold treatment, three applications in the three thrips/leaf treatment and two applications in the five thrips/leaf treatment (Shelton *et al*., 2006).

In contrast, Lannate sprayed following the one thrips/leaf threshold provided significantly better protection of the crop than following a five thrips/leaf threshold. Protection against thrips following the three thrips/leaf threshold provided an intermediate level of control. Three applications were required following the one thrips/leaf treatment, two applications following the three thrips/leaf threshold and one application following the five thrips/leaf threshold. Although all Lannate treatments reduced damage relative to the untreated control, none provided an acceptable level of protection (i.e. mean damage ratings all below eight) (Shock *et al*., 2008). Sokal *et al*. (1995) applied following the one thrips/leaf threshold resulted in the least number of thrips and the least amount of damage in this experiment. This insecticide times threshold combination required only two applications which were spaced 13 days apart.

2.3.1 Eggs

Females have a saw-like structure that helps to make an incision in plant tissue for egg laying. Eggs are placed singly just under the epidermis of succulent leaf, flower, stem or bulb tissue. Eggs are elliptical, approximately 1/125 inch in length. They are whitish at deposition and change to an orange tint as development continues. Hatching occurs in 4-5 days in Hawaii. Females had an ovipositor with saw-like structure that helped to make an incision in plant tissue for egg laying. Eggs were placed singly just under the epidermis of succulent leaf of cucumber, flower, stem or bulb tissue. Eggs were elliptical, approximately 0.25 mm in length. They were whitish at deposition and change to an orange tint as development continued (Arrieche *et al*., 2006 and Bagheri *et al*., 2002). Hatching occurred in 2.82±1.33 days in laboratory conditions.

2.3.2 Larvae

Larvae are whitish to yellowish. There are two larval stages and besides the adults they are the only damaging stages. Larval development is completed in about 9 days. L1 development was completed in about 1.95±1.42 days and L2 was 4.12±0.92 respectively (Lewis, 1973).

2.3.3 Pupae

There are two non- feeding stages called the prepupa and pupa. They do not feed and occur primarily in the soil. Combined prepupal and pupal development is completed in 4-7 days. They occurred primarily in the soil. Combined prepupal and pupal development is completed in 1.03±1.44 and 1.97±0.91 days (MacIntyre-Allen, 2005).

2.3.4 Adults

Nault and Shelton (2010) reported that adults are 1/25 inch long. Their body color ranges from pale yellow to dark brown; wings are unbanded and dirty gray. In Hawaii, this species has a darker form during the rainy season. Males are wingless and exceedingly rare. Females live for about two to three weeks and each can lay about 80 eggs. Adults were about 0.9 mm long. Their body color ranged from pale yellow to light brown; males were exceedingly rare. Adult development was completed in about 14.4±3.13 days (Table, Fig. 7). Females live for 12 to 17 days and each of them could lay about 26.82±5.56 eggs. The egg was inserted by the female in soft plant tissue; it was slightly protuberant and visible to the unaided eye (Reitz, 1999).

2.4 Nature of damage

Onion crop is attacked by several insects such as onion thrips, *T. tabaci* Lindeman; onion fly, Delia (Hylema) antique Meign; cutworm, *Agrotis epsilon* Hufnegel, tobacco leaf eating caterpillar, Spodoptera litura Fabricius and gram pod borer, *Helicoverpa arnigera* (Hubner). Among the insect pests, onion thrips (*Thrips tabaci*) is a major pest and reported to be most serious on onion (Shock, 2009). *Thrips tabaci* causes 40 to 60 per cent foliage injury and 10 to 20 percent yield losses annually (Saunders, 2012). Hence, it was thought worthwhile to study some important aspects of thrips management with view to find out effective control measures for reducing the economic losses caused by the thrips in kharif season.

T. tabaci (L.) feeds on sap from leaf epidermal cells, which become air-filled and thereby exhibit silvery sheen that is characteristics of damage by this insect (Jones and Jones, 1974). Infested leaves may become twisted. Young onion plants are more susceptible and may be killed by heavy thrips attack (Lewis, 1973). Raheja (1973) observed that damage by thrips in early stages of crop growth would seem to be more important and is likely to result in substantial reduction in yield. Anon (2004) found that large number of thrips kill onion seedlings, while damage to older plants by thrips may cause crops to mature early and subsequently reduce yields. This symptom was typically associated with the presence of specks of black frays. Flower petals might also become discolored and deformed. In the open, populations might be very large during hot, dry weather (Lewis, 1997). Onion thrips prefered to feed on the young plant tissue on the newest emerged leaves. When the leaf grew, the previous damage produced by the thrips enlarged, leaving empty spaces in the surface of the leaf. The appearance of the damage was silvery patches. When damage was severe, these small patches could occupy most of the surface of the leaf and the plant could not adequately photosynthesize. The plant lost more water than normal through the damaged tissues and plant pathogens penetrate the injured plant easily. This pest is also important as a vector of tomato spotted wilt virus (TSWV). Only the larvae can acquire the virus (Hristova, 1998; Shelton and North, 1987; Waterhouse, 1987; Zawirska, 1980; Lockwood, 1956; Karadjova and Lindorf, 1932). Mostly in glasshouses, *T. tabaci* colonies could be very large and they could often cause very severe direct and indirect damage (Lewis, 1997). Lewis (1973) observed that time of sowing and harvesting crops can also reduce the severity of injury. Kisha (1977) stated that early transplanted onions were usually well established before attack began in mid-February of 1970-71 and Kisha (1979) added that a mean number of 5-10 nymphs/plant be adopted as a critical level at which commencement of control measures can be made. However, Edelson *et al*. (1989) noted that insecticide applications were initiated when populations of thrips increased above one thrips/plant. If left unsprayed such a population would reach peak levels soon afterwards. The possible reason why this occurred was the parthenogenetic nature of thrips (Shelton *et al*., 1982). Adesiyun (1981, 1982) found that damage caused by shootflies to sorghum planted early in the season was low and insignificant and this low population was on the scanty vegetation during the dry season. Reuda and Shelton (2003) reported that at the end of the season, however, thrips might not be able to survive in abundance because there is not sufficient green vegetation in the surrounding areas, April and May being the driest months of the year. They added that from June- September heavy rains maintained thrips population at low levels in native vegetation where they were not treated.

Onions are most sensitive to thrips injury during the rapid bulb enlargement phase that occurs in dry season particularly during irrigation season November to early June in Ethiopia. Yield reduction due to reduced bulb size is the primary crop loss caused by onion thrips. Accelerated plant maturity and senescence due to thrips injury may truncate the bulb growth period. Following harvest and during storage, thrips may continue to feed on onion bulbs, causing scars that reduce quality and aesthetic appearance of bulbs. *Thrips tabaci* feeding damage results in leaf tissue silvering and photosynthesis reduction, leading to bulb size reduction and yield loss (Childers, 1997).

The characteristic symptom of attack is a silvery sheen of the attacked plant tissue, and white or silvery patches and streaks on leaves. Affected tissue will dry up when the damage is severe. Damaged leaves may become papery and distorted. Infested terminals lose their colour, roll, and drop leaves prematurely. Moreover, *T. tabaci* has been identified as the main vector of an emerging tospovirus, the Iris Yellow Spot Virus (IYSV), which is correlated to bulb size reduction in western states (Gent *et al*., 2004).

Thrips damage incidence and severity were determined every 7 days with damage severity being estimated on a scale of 1-5. Total and marketable bulb yield were determined at physiological maturity (Gachu *et al*., 2012). Damage evident as blotching, expanding leaves at their worst in when cold and dry. Cosmetic damage to pods silvering effect. Only a problem if selling spotted peas. Also giving the leaves a 'leathery' look. Feeding by thrips causes tiny scars on leaves and fruit, called stippling, and can stunt growth. Damaged leaves may become papery and distorted. Infested terminals may discolour, become rolled, and drop leaves prematurely. Petals may exhibit “color break,” which is pale or dark discolouring of petal tissue that was killed by thrips feeding before buds opened. Avocado, citrus, and greenhouse thrips cause silvery to brownish, scabby scarring on the avocado and citrus fruit surface, but this cosmetic damage does not harm the internal fruit quality. Faeces may remain on leaves or fruit long after thrips have left. Where thrips lay eggs on grapes, dark scars surrounded by lighter “halos” may be found on the fruit. Thrips feeding on raspberries, apples, and nectarines can deform or scar developing fruit; sugar pea pods may be scarred or deformed.

2.5 Management

Insecticide use is the major tactic used to manage thrips. However, resistance to insecticides and the lack of highly efficacious products has made control difficult. In New York, we have documented widespread resistance to lambdacyhalothrin (Warrior) and in some thrips populations low levels of resistance to methomyl (Lannate LV). Consequently, it is critical to identify new products for thrips control (Shock and Feibert, 2012).

2.5.1 Cultural manipulation

Plant health adherence through removal of volunteer onion plants and weeds around the cultivated fields and crop rotation would be useful in minimizing thrips populations in an onion field (Waiganjo *et al*., 2008). Gachu *et al*. (2012) reported that intercropping onion with spider plant and carrot reduced thrips population by up to 45.2% and 21.6%, respectively. Waiganjo *et al*. (2008) observed that intercropping snap bean with spider plant significantly reduced the population of spider mites on the former. Other intercropping systems which have significantly reduced thrips population and plant infestation include leek with clover (Belder *et al*., 2000). Leek with carrot, and clover with French bean (Kucharczyk and Legutowska, 2002).

Intercropping of various plant species has also been investigated to compare reductions in colonization rates of onion thrips and overall reductions in yield (Trdan *et al*., 2006). Mulching has also been reported to reduce thrips infestation considerably (Jensen *et al*., 2002). The potential for kaolin as a deterrent to oviposition and feeding of onion thrips on onions (Larentzaki *et al*., 2007). The effect of intercropping on thrips population densities and damage depends, among other factors, on the selection of plants species. In some cases intercropping does increase the population of thrips in susceptible crops. Thus, populations of the onion thrips increase on potatoes when intercropped with shallot and garlic, as does *Caliothrips indicus* on groundnuts intercropped with pigeon pea and mung bean. A mixed cropping habitat is likely to encourage thrips predators, as has been shown for the minute pirate bugs *Orius tristicolor* (Parella and Lewis, 1997).

Ellis and Bradley (1992) reported that blue sticky traps are good for monitoring thrips population and also reported the pest could be well controlled, if the crop debris is destroy properly. Parella and Murphy (1996) used sticky traps to monitor thrips. Rateaver and Rateaver (1993) reported that soil fertility management affects thrips infestation and damage. Lack of adequate soil calcium may invite higher population of thrips. Use of fertilizer not only affects the nutritive value of plants but also impacts the insect pest densities (Cantisano, 1999).

Soil fertility management may also affect thrips infestation and damage. According to one source, a lack of adequate soil calcium may invite higher populations of thrips (Rateaver and Rateaver, 1993). Another writer suggests that nutritional balance can reduce thrips attack. High nitrate levels will invite thrips, and the effects of excessive nitrate are compounded by shortages of potassium, sulfur, boron, and manganese. Foliar applications of soluble calcium and kelp will balance the excess nitrogen. These nutrient levels can be monitored on a weekly basis, using plant tissue analysis, to make accurate adjustments (Anon, 1992). The use of cover crops can affect the number of overwintering thrips. Oats is a better choice, but requires later fall planting than rye or wheat a factor that constrains its use as a cover crop in colder regions (Quarles, 1990). Drought stress increases the susceptibility of onions to thrips damage. Adequate irrigation throughout the growing season is a critical factor in minimizing damage (Fournier *et al.,* 1995). The fact that thrips are color-sensitive suggests that colored mulches may be effective in their control. Louisiana researchers conducted a study to see whether aluminum-coated mulch would repel the pest (Antignus, 1996). The reflective mulch repelled 33 to 68% of the thrips. Ultraviolet-absorbing plastics used to build walk-in field tunnels have proved effective in protecting crops from western flower thrips (Ludger and Jean, 2005). Mulching with wood shavings can be used as a strategy to improve onion yield and bulb size under the agro ecological settings of the area of Mersan (Ludger and Jean, 2005). Regarding thrips population cultural management, the farmers are much interested in the outcome thus 30 cm inter row spacing with 20 cm plant-to-plant distance is recommended for commercial farming of onion (Muhammad *et al*., 2003). *T. tabaci* is the major insect pest of onion in Sokoto State, Nigeria as reported worldwide and that the pest can be effectively managed by early planting/transplanting with bulb yields (Ibrahim and Adesiyun, 2008).

2.5.2 Biological control

There are many beneficial organisms prey to harm onion thrips. Some of these include ladybird beetles, minute pirate bugs, ground beetles, lacewings, hover flies, predatory mites, and spiders (Hoffmann *et. al*., 1996). Some authors observed that the effect of

Beauveria bassiana against the onion thrips was significantly increased after 3 days whereas the effect of Metarhizium against the onion thrips was prolonged unlikely decreasing trend resulting unsatisfactory control of the pest (Shiberu, 2013). *Beauveria bassiana* was most effective when used early at economic threshold level, before large thrips populations have built up. The influence of temperature on the infection process is very important.

According to them, the temperature at which Metarhizium infecting adult thrips is about 23°C and decreases in temperature of 3 to 5°C increase the time to death of the insect about a day. Beauveria species is used as a contact myco-insecticide but survives a relatively short period of time when exposed on a leaf surface. The killing capacity of this fungus at 3rd, 5th, and 7th day was 46.18, 54.31 and 60.67%, respectively (Shiberu, 2013).

Entomopathiogenic fungi, particularly Metharhizium and Beauveriain class Deuteromycetes, are as attractive as biopesticides for use in Integrated Pest Management (IPM), as they combine host specificity with proven safety (Bateman *et al*., 1993). Neil *et al*. (2004) reported that Beauveria infection can kill the insect from 3 to 7 days, leaving a while mass of spores which can spread to other insects. Some authors observed that the effect of *Beauveria bassiana* against the onion thrips was significantly increased after 3 days whereas the effect of *Metarhizium anisopliae* against the onion thrips was prolonged unlikely decreasing trend resulting unsatisfactory control of the pest (Shiberu, 2013). *Beauveriain bassiana* was most effective when used early at economic threshold level, before large thrips populations have built up.

In field trials conducted at the Experiment Station and in a farmer's field near the shores of Lake Victoria, Kenya, applications of 2% or 3% neem seed extract (NSE) @ 200 l/ha with a knapsack sprayer at 38, 47 and 51 days after emergence (DE) of the cowpea crop or 5%, 10% or 20% NSE sprayed @ 10 l/ha with an ultra-low-volume applicator at 31, 39 and 49 DE often significantly reduced the number of larvae of the flower thrips, *Megalurothrips usitatus* (Trybom), in cowpea flowers recorded 2 days after each treatment. Also fewer adults occurred in flowers at 51 DE in plots sprayed with 5%, 10% or 20% NSE. Cowpea grain yield was significantly higher in plots sprayed with 20%

NSE than in untreated control plots and was comparable to the grain yield obtained in plots sprayed thrice with cypermethrin. Because of the low cost of NSE treatment, the net gain was often more when the crop was sprayed with NSE than with cypermethrin. Also, grain quality was superior in neem-treated plots than in untreated or cypermethrin-treated plots (Kidiavai, 2009).

2.5.3 Chemical control

Rao and Swami (1986) found Carbofuran and Endosulfan very effective in reducing the incidence of *T.tabaci*. Warriach *et al*. (1994) studied the effect of Rogor (dimethoate) on *T. tabaci* in onions fields in Pakistan. Two treatments were applied with a 28-day interval. The thrips were present from the 3rd week of October, with a population peak during the 3rd week of December. The variety TBK was somewhat tolerant to the thrips attack as compared to the Phulkara variety. Population build-up was positively correlated with temperature but had a negative correlation with the relative humidity. The pest population was initially suppressed by insecticide treatment but increased after 21 days. The present experiments were carried out to study the population dynamics of *T. tabaci* in Peshawar, to evaluate the efficacy of various insecticides (Confidor®, Tracer®, Actara®, and Megamos®) in comparison with the Thiodan® and check (control) for the management of *T. tabaci*, to calculate cost-benefit ratio for the various treatments and to develop model in relation to meteorological conditions on the pest population.

Field study was carried out at Bangladesh Agricultural Research Institute (BARI) farm during March to August 2005 to find out the most appropriate management practices against thrips of onion. The experiment consisted of seven treatments of various management practices. It was laid out in Randomized Complete Block Design (RCBD) with four replications. The incidence of this pest was first noticed during vegetative and flowering stage. The infestation rate was highest in reproductive stage. Application of Furadan 5G as a seed treatment gave the maximum yield (950.5 kg/ha). On the other hand, minimum yield was found in control treatment. Two times application of Shobicron 425 EC also gave the satisfactory result but it was not economically viable. Neem oil with Trix gave the significant result in comparison with other treatments and it may be environmentally friendly (Kyamanywa, 2009).

In 2006, foliar-applied insecticides were evaluated for their efficacy against onion thrips in a muck field near Potter, New York. Dry bulb onion seeds, var. ‘Barrage’– a yellow 90-day variety, were planted on April 3. Each plot was a single 20-ft long row flanked by an untreated row; rows were spaced apart by 38 cm. Foliar insecticide treatments were applied at 90 gpa and 40 psi using a CO2 –pressurized backpack sprayer equipped with a single fl at fan nozzle (8004VS). All treatments included the non-ionic surfactant Induce at 0.5 percent v/v. Plots were sprayed on July 18 when plants had an average of nine leaves and the density of onion thrips averaged 2.8 thrips larvae/leaf (27 thrips/plant). Additional applications were made on July 24 and 31. Plots were visually rated for thrips damage using a scale ranging from 0 to 11. A rating of 0 reflected complete devastation by thrips (all white leaves rather than green), whereas a rating of 11 indicated zero thrips feeding. A rating of eight or above would be considered commercially acceptable. Number of thrips larvae per plot was recorded seven days after each application, except only three days after the first application. Visual rating of damage was made on Aug. 7.

The onion thrips infestation was high and damage became obvious during late July. Treatments that provided the best protection against onion thrips included all rates of Carzol and Radiant. Several other products, SpinTor, Agri-Mek and Lannate, provided either an adequate or nearly adequate level of protection against thrips damage. In most cases, these treatments also signifi cantly reduced thrips densities to levels below those in the untreated control, but not necessarily to a level that would be considered acceptable. Warrior failed to control onion thrips. Action Threshold Experiment. Timing and frequency of insecticide applications to control onion thrips are affected by weather and other factors such as the residual activity of the product. In 2006, several insecticides and action thresholds were evaluated for thrips control. The insecticides, formetanate hydochloride (Carzol SP), methomyl (Lannate LV) and lambda-cyhalothrin (Warrior) were chose because they are used in New York and were predicted to provide excellent, good and mediocre control, respectively. Action thresholds selected were one, three and five onion thrips larvae/green leaf. Treatments included each insecticide x action threshold combination plus an untreated control.The experiment was conducted in the same commercial onion field described previously. Each plot included four 10-ft long rows, all spaced apart by 38 cm. Application of treatments, assessment of larval densities and visual estimates of damage were conducted as described previously. The one, three and five thrips per leaf thresholds were met on July 18, 24 and 31, respectively.

Carzol applied at a threshold of three thrips/leaf, which required only a single spray, also signifi cantly reduced thrips densities and damage. In fact, this treatment was optimal because it provided a commercially acceptable level of protection using the fewest number of sprays. A mediocre level of protection was attained spraying Carzol at a threshold of five thrips/leaf. Based on our observations, waiting to spray until the infestation reaches five thrips/leaf is far too late because the crop already will have suffered significant damage.

Thiodan® was more effective than other insecticides, followed by Megamos®, except for the data recorded after the first spray (Ullah *et al*, 2010). Our results are comparable with those of Rao and Swami (1986) who reported carbofuran and endosulfan very effective in reducing the incidence of *T. tabaci* on onion. Actara® failed to suppress the population of *T. tabaci*. The non effectiveness of the Actara® against the *T. tabaci* is also reported by Razzaq *et al*. (2003).

Development of resistance by onion thrips to most commonly used insecticides has been reported. Chemicals are the most common practices for onion thrips management. Despite their ease of use and availability of numerous classes or modes of action, rapid development of resistance to insecticides has been a key problem. Many of the earlier registered products for control of onion thrips are losing control efficacy. The main reasons lay in the life history characteristics of onion thrips: reproduction by parthenogenesis (eggs develop without male fertilization so females pass all of their genes to their offspring), high reproductive potential, and short generation time. Earlier studies conducted in 1980s at Melkassa showed that cypermethrin was effective against onion thrips (Abate, 1983). Three to four sprays of cypermethrin at rate of 50 to 75 g a.i/ha when the threshold of five thrips per plant is exceeded was recommended (Abate and Ayalew, 1994). Debere Berehane Agricultural Research Center (DBARC) (2005) reported that the performance of cyhalothrin was lower than that of the insecticide selecron and botanical treatments in experiment carried out in 2003 and 2004 at Shoa robit. Several alternative pesticides are available for controlling thrips. Sulfur, insecticidal soap, and diatomaceous earth have all demonstrated efficacy in suppressing thrips in several crops (Flint, 1999). Being contact pesticides, however, their effectiveness in onions would probably be limited, because the thrips can hide between the leaves.

Insecticides vary in their toxicity to thrips life stages. Most insecticides are effective in killing the early larval stages (Instars I and II) because the young stages are small and actively feeding. Some insecticides are active against adults and only a few have ovicidal (egg) activity. Ludger and Jean (2005) suggested that the pyrethroid insecticide lambda cyhalothrin can be recommended in rotation with other classes of insecticides for the control of onion thrips. However, straight lambda cyhalothrin is not recommended because of the quick resistance buildup to the synthetic pyrethroids (Jensen, 1995).

Eggs are laid within the leaf so are not accessible except to systemic insecticides that are absorbed through the leaf. Prepupa and pupa (Instars III and IV) are non-feeding and seek protection in the soil or at the base of onion plants, escaping contact by most insecticides. Recent research has shown that the majority of onion thrips on a plant are in the non-feeding egg stage (60-75% of total population on an onion plant during late June to August), and thus, not exposed to insecticides and other suppressive tactics (Diane and Daniel , 2008).

CHAPTER III

METERIELS AND METHODS

This chapter deals with the materials and methods those were used conducting the study. It consists of a short description of location of' the experimental plot, characteristics of soil, climate, material used, treatments, layout and design of experiment, land preparation , sowing and gap filling, after cares, harvesting, and collection of data. These are described below:

3.1 Location of the experimental plot

The experiment was conducted in the Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from November 2012 to February 2013.

Plate 1: Onion experimental plot at the firm of Sher-e-Bangla Agricultural University

3.2 Soil

The soil was silty clay in texture having 26% sand, 45% silt and 29% clay and the pH was 5.6. The physio-chemical properties of the soil are presented in Appendix I. The experimental site belongs to the Madhupur Tract Agro Ecological Zone (AEZ-28) as shown in Appendix III. The experimental site was a medium high land.

3.3 Climate

The climate of experimental site was under the sub-tropical climate, characterized by three distinct seasons, 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*., 1979).There was no rainfall during the month of November and December, little rain in January and February. The average maximum temperature during the period of experiment was 33.8°C and the average minimum temperature was 13°C. 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 II.

3.4 Seeds used for experiment

The Experimental material was the bulb of "Taherpuri onion" which is a cherished local cultivar. Taherpur is the onion growing area under Baghmara Upazilla in Rajshahi district. Onion is well grown in this area. According to the name of Taherpur area, this variety is called Taherpuri. It is world famous for its some special characteristics, such as highly pungent, shiny, narrow necked, hat shape, very high keeping quality and compact single bulb. Bulbs were selected from storage." After harvest the tops were removed along with roots. The bulbs were cured in. the shady place and were placed in storage at ambient conditions.

3.5 Experimental Design and layout

The experiment was conducted considering seven treatments and laid out in a Randomized Complete Block Design (RCBD). Each treatment was allocated randomly in three replications. The unit plot size was 3 m × 2 m having 0.75 m space between the blocks and 0.50 m between the plots.

3.6 Treatments of the Experiment

Therefore, seven treatment combinations was tested in this experiment.

T_1= Fipronil @ 2.0 ml/L of water at 7 days interval.

T_2= Lambdacyhalothrin @ 1.0 ml/L of water at 7 days interval.

T_3= Imidachloprid @ 0.5 ml/L of water at 7 days interval.

T_4= Neem Oil @ 4.0 ml/L of detergent at 7 days interval.

T_5= Malathion 57EC @ 2.0 ml/L of water at 7 days interval.

T_6 = Sevin 85WP @ 2.0 ml/L of water at 7 days interval.

T_7 =Control

3.7 Seed processing and treatment

The seeds of Taherpuri of onion were collected from Bangladesh Agricultural Research Institute, Gazipur. Germination test was done before sowing. The rate of germination was found more than 95%. The seeds were treated with Vitavax 200 at the rate of 2 mg per kg seed to protect seedlings against foot and root rot diseases.

3.8 Intercultural operations

3.8.1 Land preparation

The experimental field was first opened by a tractor on 10, November 2012 followed by repeated ploughing and cross ploughing with a power tiller. The soil was allowed to dry up. The clods were broken into small pieces, weeds and stubbles of previous crops were removed and then laddering was done to obtain a good tilth.

3.8.2 Planting

Bulbs were planted on 20 November 2012 according to the treatment. Bulbs were set upright at a depth of 2.5cm (Abedin *et al*., 1999).

3.8.3 Gap filling

Some extra bulbs were also planted at the border of the experimental field. This was done to replace rotten bulbs of the experimental plots by healthy ones according to treatments from the border within 7 days of planting.

3.8.4 Manures and fertilizers

The following doses of manures and fertilizers were applied in the experimental plots as per BARI (2005).

Manures and Fertilizers	**Dose/ha**	**Dose/plot**
Cowdung	10 ton	6 kg
Urea	260 kg	156g
TSP	260 kg	156g
MOP	150 kg	90g

The entire quantity of the well-decomposed cowdung was applied just after opening of the land. The total amount of TSP and half of murate of potash (MOP) were applied during the final land preparation. Total amount of urea and remaining half of MOP were applied in two equal installments; at 30 and 45 days after planting bulbs as the ring method.

3.8.5 Irrigation and mulching

Four irrigations were provided in the field test was done in 25 November, 2012 with a watering can. Subsequent irrigations were applied on 6 December 2012, 20 January 2013 followed by scrapping to break the soil crust.

3.8.6 Weeding and earthing-up

Weeding is the most important aspect in respect of seed production than general production. First weeding was done by hand picking at 20 DAP. Subsequent three weeding were followed by irrigation with "khurpi". At the same time, some soils were put into the bed along with rows from the drain for making the root zone of onion plants strong enough.

3.8.7 Staking

Staking was provided at 65 DAP with bamboo sticks to keep the flowering stalks erect and to protect them from strong wind.

3.8.8 Harvesting

The matured umbels were harvested at different dates when 15-20% of the fruits had exposed black seeds. Umbels were harvested in the morning with a small portion of flowering stalk to prevent shattering of seeds. It was done in between 9 to 20 February, 2013.

3.8.9 Threshing, cleaning, drying and storing

The seeds were threshed by beating the umbels with a soft small stick. Seeds were cleaned by winnowing and dried by spreading in the open sunlight on brown paper until those reached the safe moisture content (9%). After putting the seeds in an airtight polyethylene bag these were kept in dry and cool place at room temperature for laboratory test.

Plate 2: Formation of seed on umbel.

3.10 Data collection

In general, data were collected at various stages of plant growth and development, during harvest and also after post harvest operation

3.10.1 Field data

Data were collected on seed production aspects from randomly selected 10 plants from each plot in each replication in respect of the following parameters.

3.10.1.1 Plant height (cm)

It was measured from ground level up to the tip of the longest leaf. Average plant height was determined from 10 randomly selected plants at 50, 60, 70 and 80 DAS in centimeter (cm) using a wooden meter scale.

3.10.1.2 Number of green leaves per plant

The average number of green leaves was collected from 10 randomly selected plants at 50, 60, 70 and 80 DAS. .

3.10.1.3 Number of tillers per plant

The average number of tiller was counted from 10 randomly selected plants at 50 DAS.

3.10.1.4 Number of umbels per plant

The average number of umbels per plant was recorded from 10 randomly selected plants after completion of flowering.

3.10.1.5 Umbel diameter (cm)

It was determined with a slide-calliper from the umbels of 10 randomly selected plants and later average value was calculated in centimeter (cm).

3.10.1.6 Number of flowers per umbel

It was counted from 10 randomly selected plants at the maximum flowering stage and then the average figure was worked out.

3.10.1.7 Number of seeded fruits per umbel

The average number of seeded fruits per umbels was recorded from 10 randomly selected sampled umbels after harvest.

3.10.2 Data on seed quality

3.10.2.1 Thousand seed weight (g)

After drying at 9% moisture content, thousand seeds were counted from each plot and were weighed with electric balance in gram (g) up to two decimal places.

3.10.2.2 Seed germination percentage

The number of seeds germinated was recorded for each treatment daily. The embryo within the seed is a plant in miniature. In a ripe seed, the plant has stopped growing but is alive and respiring slowly. Once the seeds become germinating, ripe (non-dormant) and provided it has conditions suitable for plant growth, the embryo will then resume its development. This growth is known as germination (ISTA, 1996). Germination percentage was determined by the following formula.

$$\text{Germination percentage} = \frac{\text{Number of normal seedling produced}}{\text{Number of seeds set for germination}} \times 100$$

3.11 Statistical analyses

Data, regarding various characteristics under study collected from the experiment were statistically analyzed by the computer using the statistical package program Mstat C developed by Russel (1986). The means for all the treatments were calculated and the analysis of variance was performed by the `F' variance test. Finally, the significance of difference between pair of means was performed by the least significant difference (LSD) test (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

This chapter comprises the explanation and presentation of the results obtained from the experiment on Effectiveness of some insecticides for controlling onion Thrips (*T. tabaci* Lindeman.) for quality seed production. The data have been presented and discussed and possible interpretations are made under the following sub headings:

4.1 Effects on infestation of thrips under different treatments

From the results in table 1 showed significant variation due to the effect of different management practices on infestation of thrips at different days after sowing (DAS). The highest (11.03/plant) number of thrips/plant was found in T_3 treatment followed by all treatment has no significant difference among them at 50 DAS. But after 60 DAS, the highest (13.38/plant) result was found in T_7 treatment and the lowest (7.46/plant) number of thrips/plant was found in T_2 treatment followed by T_1 (7.58/plant), T_3 (8.14/plant) and T_4 (8.97/plant) treatments respectively has no significant difference among all treatments. Again, the lowest (4.46/plant) number of thrips/plant was found in T_1 treatment followed by T_2 (5.14/plant) and T_3 (6.49/plant) treatments respectively has no significant difference among all treatments and the highest (17.05/plant) number of thrips/plant was found in T_7 treatment which has significant difference among all treatments at 70 DAS. Although, the lowest (2.84/plant) thrips/plant was found in T_2 treatment followed by all treatment has no significant difference except T_7 untreated control plot at 80 DAS. In terms of mean percent reduction over control the highest (78.86%) mean percent reduction over control was recorded in T_2 treatment and lowest (24.44%) was found in T_5 treatment. This result was contradicts with Hoffmann and Frodsham (1996) and Lewis

(1996) also who observed that Fipronil showed best result in management of Onion thrips. But Ullah (2010) observed similar results.

From the above findings it was revealed that T_2 (Lambdacyhalothrin) performed as the best treatment in control of thrips among different treatment followed by T_1 (Fipronil) treatment has no significant difference. As a result, the trend of results in terms of decreasing the mean thrips number per plant was $T_7>T_5>T_6>T_4>T_3>T_1>T_2$.

Table 1: Number of thrips per plant under different treatments on onion

Treatments	**Number of thrips/plant**					
	50 DAS*	60 DAS	70 DAS	80 DAS	Mean	% reduction (-) over control
T_1	9.86 a	7.58 c	4.46 d	3.17 b	3.17 d	76.65
T_2	9.63 a	7.46 c	5.14 d	2.84 b	2.87 d	78.86
T_3	11.03 a	8.14 c	6.49 cd	3.71 b	3.71 cd	72.68
T_4	10.17 a	8.97 bc	8.54 bc	7.41 ab	7.41 bcd	45.43
T_5	10.59 a	10.58 b	10.90 b	10.26 ab	10.26 ab	24.44
T_6	9.00 a	9.46 bc	8.48 bc	9.43 ab	9.43 bc	30.55
T_7	8.59 a	13.38 a	17.05 a	13.58 a	13.58 a	-
$LSD_{(0.05)}$	2.94	2.13	2.77	7.72	2.69	-
CV (%)	16.84	12.80	17.87	60.30	17.27	-

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).

* DAS= Days after sowing

[T_1= Fipronil @ 2.0 ml/L of water at 7 days interval, T_2= Lambdacyhalothrin @ 1.0 ml/L of water at 7 days interval, T_3= Imidachloprid @ 0.5 ml/L of water at 7 days interval, T_4= Neem Oil @ 4.0 ml/L of detergent at 7 days interval, T_5= Malathion 57EC @ 2.0 ml/L of water at 7 days interval, T_6 = Sevin 85WP @ 2.0 ml/L of water at 7 days interval, T_7 = Control]

4.2 Effect of management practices on the number of leaves / plant:

The comparative effectiveness of various treatments on leaf number per plant has been evaluated and presented in Table 2. The data indicated that the highest (14.10/plant) number of leaves was found in T_1 treatment followed by all treatment except untreated control plot having significant different at 50 DAS. Also, the highest (15.85/plant) was found in T_4 treatment followed by all treatment except untreated control plot having significant different at 60 DAS. But after 70 DAS, the highest (16.89/plant) number of leaves was found in T_1 treatment followed by all treatments except untreated control plot having significant difference. Again the highest (18.07/plant) number of leaves was found in T_1 treatment followed by all treatments except T_6 (11.45/plant) treatment.

This result concides with those of Muktadir *et al.* (2001) and Islam (2002) also who observed Fipronil and Lambdacyhalothrin significantly higher leaf number.

Table-2: Number of leaves per plant at different days after sowing

Treatments	**Number of leaf per plant**			
	50 DAS*	60 DAS	70 DAS	80 DAS
T_1	14.10 a	15.79 a	16.89 a	18.07 a
T_2	12.59 ab	14.15 a	15.31 a	16.13ab
T_3	11.60 ab	13.82 ab	15.25 a	15.75ab
T_4	12.49 ab	15.85 a	16.47 a	17.67ab
T_5	11.57 ab	13.06 ab	13.83ab	14.96ab
T_6	11.24 ab	13.26ab	14.43ab	11.45b
T_7	8.28 b	9.81 b	11.28 b	12.34ab
$LSD_{(0.05)}$	4.59	4.04	3.94	6.59
CV (%)	22.06	16.59	15.00	24.39

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).
* DAS= Days after sowing

[T_1= Fipronil @ 2.0 ml/L of water at 7 days interval, T_2= Lymbdacyhalothrin @ 1.0 ml/L of water at 7 days interval, T_3= Imidachloprid @ 0.5 ml/L of water at 7 days interval, T_4= Neem Oil @ 4.0 ml/L of detergent at 7 days interval, T_5= Malathion 57EC @ 2.0 ml/L of water at 7 days interval, T_6 = Sevin 85WP @ 2.0 ml/L of water at 7 days interval, T_7 = Control]

From the above findings it was revealed that T_1 (Fipronil) performed as the best treatment in increasing number of leaves per plant during different management practices of controlling thrips which was followed by all treatments except untreated control. As a result, the trend of results in terms of increasing the plant height at 50 DAS, 60 DAS, 70 DAS and 80 DAS respectively was $T_1>T_2>T_4>T_3>T_5>T_6>T_7$, $T_4>T_1>T_2>T_3>T_6>T_5>T_7$, $T_1>T_4>T_2>T_3>T_6>T_5>T_7$ and $T_1>T_4>T_2>T_3>T_5>T_7>T_6$.

4.3 Effect of flower number and tiller number

Number of flower per stalk was recorded and showed in Table 3. The data indicated that the highest (2.61/stalk) number of flower per stalk was found in T_4 treatment followed by T_3 (2.28/stalk), T_2 (2.23/stalk), T_1 (2.19/stalk) and T_5 (2.04/stalk) treatments respectively having no significance difference among all treatments. The lowest (1.18/stalk) number of flower/stalk was found in T_7 untreated control plot having no significant difference among all treatments except T_4 treatment. In terms of percent increase over control, the highest (121.18%) percent increase over control of number of flower per stalk was found in T_4 treatment and lowest (24.57%) was found in T_6 treatment.

From the above findings it was revealed that Neem Oil @ 4.0 ml/L with detergent at 7 days interval performed as the best treatment in increasing number of flower per stalk during different management practices of controlling thrips which was followed by all treatments except Sevin 85WP @ 2.0 ml/L of water at 7 days interval and untreated control plot has no significant different. As a result, the trend of results in terms of increasing the flower/stalk was $T_4>T_3>T_2>T_1>T_5>T_6>T_7$.

The comparative effectiveness of various treatments on number of tiller per plant has been evaluated as in percent (%) increase on number of tiller per plant over control is presented in Table 3. The data indicated that the highest (3.50/plant) number of tiller per plant was found in T_3 treatment followed by T_1 (3.16/plant), T_2 (3.13/plant), T_5 (2.57/plant) and T_4 (2.50/plant) treatments respectively having no significance difference among all treatments. The lowest (1.44/plant) number of tiller/plant was found in T_7 untreated control plot followed by T_5 (2.57/plant), T_4 (2.50/plant) and T_6 (1.89/plant) having no significant different among all treatments. In terms of percent increase over control, the highest (143.05%) percent increase over control of number of tiller per plant was found in T_3 treatment and lowest (31.25%) was found in T_6 treatment.

Table 3: Effect of flower number per stalk and tiller number per plant

Treatments	**No. of flower/ stalk**	**% increase over control**	**No. of tiller/plant**	**% increase over control**
T_1	2.19 ab	85.59	3.16 ab	119.44
T_2	2.23 ab	88.98	3.13 ab	117.36
T_3	2.28 ab	93.22	3.50 a	143.05
T_4	2.61 a	121.18	2.50 abc	73.61
T_5	2.04 ab	72.88	2.57 abc	78.47
T_6	1.47 b	24.57	1.89 bc	31.25
T_7	1.18 b	-	1.44 c	-
$LSD_{(0.05)}$	1.11	-	1.29	-
CV (%)	31.26		27.99	

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= Fipronil @ 2.0 ml/L of water at 7 days interval, T_2= Lambdacyhalothrin @ 1.0 ml/L of water at 7 days interval, T_3= Imidachloprid @ 0.5 ml/L of water at 7 days interval, T_4= Neem Oil @ 4.0 ml/L of detergent at 7 days interval, T_5= Malathion 57EC @ 2.0 ml/L of water at 7 days interval, T_6 = Sevin 85WP @ 2.0 ml/L of water at 7 days interval, T_7 = Control].

From the above findings it was revealed that T_3 performed as the best treatment in increasing number of tiller per plant during different management practices of controlling thrips which was followed by all treatments except T_6 (Sevin) and T_7 (untreated control plot). As a result, the trend of results in terms of increasing the tiller/plant was $T_3>T_1>T_2>T_5>T_4>T_6>T_7$.

4.4 Effect of Scape length, Scape diameter, Umbel number and Umbel diameter

The comparative effectiveness of various treatments on Scape length, Scape diameter, number of umbel per plant and Umbel diameter has been recorded and presented in Table 4. The data indicated that the scape length was highest (69.80/plant) in T_1 treatment followed by T_2 (68.06/plant), T_3 (63.16/plant) and T_5 (62.52/plant) treated plots, respectively having no significant difference among them. On the other hand lowest length of scape was observed in T_7 (56.64/plant) untreated plot followed by T_3 (63.16/plant), T_4 (60.16. /plant), T_5 (62.52/plant) and T_6 (58.23/plant) treated plots, respectively having no significant difference among them.

The highest (1.60 cm) diameter of scape was found in T_2 treatment followed by all treatment except T_7 treatment that is untreated control plot having significant difference and the lowest (1.20 cm) scape diameter was found in T_7 treatment fo llowed by T_5 (1.33 cm) and T_6 (1.36 cm) was no significance different.

In terms of number of umbel per plant, the data indicated that the highest (3.90/plant) umbel/plant was found in both T_1 and T_2 followed by T_3 (3.88/plant), T_5 (3.49/plant) and T_4 (3.13/plant) treated plots, respectively having no significant difference among them. On the other hand lowest umbel/plant was observed in T_6 (2.52/plant) treatment followed by T_7 (2.57/plant) and T_4 (3.13/plant) treatments respectively having no significant difference among them.

Table- 4: Scape length, Scape diameter, Umbel number and Umbel diameter of Onion

Treatments	Scape length per plant	Scape diameter (cm)	Umbel Number/plant	Umbel diameter (cm)

T_1	69.80 a	1.51 ab	3.90 a	4.49 a
T_2	68.06 ab	1.60 a	3.90 a	5.98 a
T_3	63.16 abc	1.54 ab	3.88 a	5.16 a
T_4	60.16 bc	1.51 ab	3.13 ab	4.31 a
T_5	62.52 abc	1.33 bc	3.49 a	4.51 a
T_6	58.23 c	1.36 abc	2.52 b	4.54 a
T_7	56.64 c	1.20 c	2.57 b	4.36 a
$LSD_{(0.05)}$	7.92	0.25	0.84	1.92
CV (%)	7.11	10.13	14.16	22.74

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= Fipronil @ 2.0 ml/L of water at 7 days interval, T_2= Lambdacyhalothrin @ 1.0 ml/L of water at 7 days interval, T_3= Imidachloprid @ 0.5 ml/L of water at 7 days interval, T_4= Neem Oil @ 4.0 ml/L detergent of water at 7 days interval, T_5= Malathion 57EC @ 2.0 ml/L of water at 7 days interval, T_6 = Sevin 85WP @ 2.0 ml/L of detergent at 7 days interval, T_7 = Control]

The umbel diameter also presented in Table 4. Although, the highest (5.98 cm) umbel diameter was recorded in T_2 treatment but it has no significant different among all treatment including T_7 untreated control plot.

From the above findings it was revealed that T_1 (Fipronil) and T_2 (Lambdacyhalothrin) performed as the best treatment in increasing scape length per plant, scape diameter (cm) and umbel/plant during different management practices of controlling thrips. But all treatment is non significant in terms of umbel diameter. As a result, the trend of results in terms of increasing the Scape length, Scape diameter, Umbel/plant and Umbel diameter respectively was $T_1 > T_2 > T_3 > T_5 > T_4 > T_6 > T_7$, $T_2 > T_3 > T_1 > T_4 > T_6 > T_5 > T_7$, $T_1 > T_2 > T_3 > T_5 > T_4 > T_7 > T_6$ and $T_2 > T_3 > T_6 > T_5 > T_1 > T_7 > T_4$.

4.5 Effect of flower per umbel and effective flower per umbel

The comparative effectiveness of various treatments on flower/umbel and number of effective flower per umbel was recorded and presented in Table 5. The data indicated that the flower/umbel was highest (172.33/umbel) in T_1 treatment followed by T_2

(160.33/umbel), T_3 (156.67/umbel) and T_5 (155.67/umbel) treated plots, respectively having no significant difference among them. On the other hand lowest flower/umbel was observed in T_7 (133.00/umbel) untreated plot followed by T_4 (148.00/umbel), T_5 (155.66/umbel) and T_6 (146.00/umbel) treated plots, respectively having no significant difference among them. In terms of percent increase over control the highest (29.57%) percent increase over control was recorded in T_1 treatment and lowest (9.77%) was found in T_6 treatment.

Those flower who undergo seed production is terms as effective flower. The number of effective flower per umbel was highest in T_1 (147.67/umbel) treatment followed by T_2 (135.33/umbel), T_3 (131.33/umbel) and T_4 (117.00/umbel) treated plots, respectively having no significant difference among them. On the other hand lowest effective flower/umbel was observed in T_7 (91.33/umbel) untreated plot followed by T_4 (117.00/umbel),T_5 (108.00/umbel) and T_6 (110.33/umbel) treated plots, respectively having no significant difference among all treatments. In terms of percent increase over control the highest (61.68%) percent increase over control was recorded in T_1 treatment and lowest (18.25%) was found in T_5 treatment.

Table 5: Number of flower and effective flower per umbel under different Treatments

Treatments	Flower/Umbel	% increase over control	Effective flower/Umbel	% increase over control
T_1	172.33 a	29.57	147.67 a	61.68
T_2	160.33 ab	20.54	135.33 ab	48.17
T_3	156.67 ab	17.79	131.33 ab	43.79
T_4	148.00 bc	11.27	117.00 abc	28.10
T_5	155.67 abc	17.04	108.00 bc	18.25
T_6	146.00 bc	9.77	110.33 bc	20.80
T_7	133.00 c	-	91.33 c	-
$LSD_{(0.05)}$	23.22	-	34.88	-

CV (%)	8.52	-	16.32	-

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= Fipronil @ 2.0 ml/L of water at 7 days interval, T_2= Lambdacyhalothrin @ 1.0 ml/L of water at 7 days interval, T_3= Imidachloprid @ 0.5ml/L of water at 7 days interval, T_4= Neem Oil @ 4.0 ml/L of detergent at 7 days interval, T_5= Malathion 57EC @ 2.0 ml/L of water at 7 days interval, T_6 = Sevin 85WP @ 2.0 ml/L of water at 7 days interval, T_7 = Control]

From the above findings it was revealed that T_1 (Fipronil) performed as the best treatment in increasing both flower number and effective flower number per umbel during different management practices of controlling thrips which was followed by T_2 (Lambdacyhalothrin) has shown similar result. As a result, the trend of results in terms of increasing the flower/umbel and effective flower/umbel respectively was T_1>T_2>T_3> T_5> T_4> T_6> T_7 and T_1> T_2> T_3> T_4> T_6> T_5> T_7.

4.6 Effect of management practices on seed production

The comparative effectiveness of various treatments on Seed weight (mg) /plant and thousand seed weight (mg) was recorded and presented in Table 6. The data indicated that the seed weight (mg) / plant was highest (0.81 mg) in T_1 treatment followed by T_2 (0.71 mg) and T_3 (0.72 mg) treatments respectively having no significant difference among them. On the other hand, lowest seed weight (mg) /plant was observed in T_7 (0.45 mg) untreated plot followed by T_4 (0.50 mg) and T_5 (0.55 mg) treatment respectively having no significant difference among them. In terms of percent increase over control the highest (80.00%) percent increase over control was recorded in T_1 treatment and lowest (11.11%) was found in T_4 treatment.

The highest (2.33 mg) thousand seed weight was recorded in T_2 treatment followed by T_1 (2.14 mg) and T_3 (2.13 mg) treatments respectively having no significant difference among them. On the other hand, lowest thousand seed weight was observed in T_6 (1.52 mg) treatment followed by T_7 (1.78 mg) and T_5 (1.81 mg) treatment respectively having no significant difference among them. In terms of percent increase over control the highest (30.89%) percent increase over control was recorded in T_2 treatment and lowest (-14.60%) was found in T_6 treatment that is below than untreated control plot.

From the above findings it was revealed that T_1 (Fipronil) performed as the best treatment in increasing seed weight (mg)/plant during different management practices of controlling thrips. But thousand seed weight was showed best performance in T_2 (Lambdacyhalothrin) treatment. As a result, the trend of results in terms of increasing the seed weight mg/plant and thousand seed weight respectively was $T_1 > T_3 > T_2 > T_6 > T_5 > T_4 > T_7$ and $T_2 > T_1 > T_3 > T_4 > T_5 > T_7 > T_6$.

Table 6: Onion seed weight per plant under different treatments at harvest

Treatments	Seed weight (mg) /plant	% increase over control	Thousand seed weight (mg)	% increase (+) or decrease (-) over control
T_1	0.81 a	80.00	2.14 ab	20.24
T_2	0.71 ab	57.78	2.33 a	30.89
T_3	0.72 ab	60.00	2.13 ab	19.66
T_4	0.50 cd	11.11	2.01 ab	12.92
T_5	0.55 cd	22.22	1.81 bc	1.68
T_6	0.60 bc	33.33	1.52 c	-14.60
T_7	0.45 d	-	1.78 bc	-
$LSD_{(0.05)}$	0.12		0.48	-
CV (%)	11.41		13.12	-

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= Fipronil @ 2.0 ml/L of water at 7 days interval, T_2= Lambdacyhalothrin @ 1.0 ml/L of water at 7 days interval, T_3= Imidachloprid @ 0.5 ml/L of water at 7 days interval, T_4= Neem Oil @ 4.0 ml/L of detergent at 7 days interval, T_5= Malathion 57EC @ 2.0 ml/L of water at 7 days interval, T_6 = Sevin 85WP @ 2.0 ml/L of water at 7 days interval, T_7 = Control]

4.7 Effect on production of onion

Yield of onion was in per plot and then it was converted into kg/ha. The data showed in Table 7. The data indicated that the highest (593.33 kg/ha) yield was recorded in T_1 treatment followed by all treatments has no significant different except untreated control plot. In terms of percent increase over control the highest (68.98%) percent increase was found in T_1 treatment and lowest (25.63%) in T_6 treatment.

Table 7: Yield of onion seed under different treatments at harvest

Treatments	Yield/plot (g)	Yield (kg/ha)	% increase over control
T_1	356.00 a	593.33 a	68.98
T_2	334.33 a	557.17 a	58.69
T_3	345.33 a	575.50 a	63.91
T_4	324.00 a	540 a	53.79
T_5	287.33 ab	478.88ab	36.38
T_6	264.67 ab	441.00ab	25.63
T_7	210.67 b	351.00 b	-
$LSD_{(0.05)}$	97.28		-
CV (%)	18.04		-

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= Fipronil @ 2.0 ml/L of water at 7 days interval, T_2= Lambdacyhalothrin @ 1.0 ml/L of water at 7 days interval, T_3= Imidachloprid @ 0.5ml/L of water at 7 days interval, T_4= Neem Oil @ 4.0 ml/L of detergent at 7 days interval, T_5= Malathion 57 EC @ 2.0 ml/L of water at 7 days interval, T_6 = Sevin 85WP @ 2.0 ml/L of water at 7 days interval, T_7 = Control]

From the above findings it was revealed that T_1 (Fipronil) performed as the best treatment in increasing yield of onion during different management practices of controlling thrips followed by T_3 (Imidachloprid) shown similar results. As a result, the trend of results in terms of increasing the yield of onion was T_1> T_3> T_2> T_4> T_5> T_6> T_7.

4.8 Effect of management practices on plant height

From the results in table 1 showed significant variation due to the effect of different management practices on plant height per plant at different days after sowing (DAS). The highest (39.99) plant height was found in T_1 treatment followed by T_4 (37.56), T_2 (36.83) and T_3 (36.29) treatments respectively has no significant difference at 50 DAS and the lowest (30.59) plant height was recorded in T_7 untreated control plot followed by T_5 (33.20) and T_6 (32.76) treatments respectively having no significant different. Also, the highest (47.15) was found in T_1 treatment followed by T_4 (42.30), T_2 (42.19) and T_3 (41.46) treatments respectively has no significant difference at 60 DAS and the lowest (34.04) plant height was recorded in T_7 untreated control plot followed by T_5 (38.65) and T_6 (36.15) treatments respectively having no significant different. After 70 DAS, the highest (53.79) was found inT_1 treatment followed by T_3 (48.85), T_2 (48.51) and T_4 (47.20) treatments respectively has no significant difference and the lowest (40.49) plant height was recorded in T_7 untreated control plot followed by T_5 (46.26) and T_6 (41.83) treatments respectively having no significance difference. But the highest (61.48) plant height was found in T_1 treatment followed by T_2 (58.81), T_5 (56.98) T_3 (56.11) and T_4 (56.01) treatments respectively has no significant difference and the lowest (48.41) plant height was recorded in T_6 treatment followed by T_7 (48.55) treatment having no significant difference among all treatments at 80 DAS. The finding is similar to those of Ullah *et al.* (2010) and Waterhouse (1987).

Table 8: Plant height of onion at different days after sowing

Treatments	**Plant height (cm)/plant**			
	50 DAS*	60 DAS	70 DAS	80 DAS
T_1	39.99 a	47.15 a	53.79 a	61.84 a
T_2	36.83 ab	42.19 ab	48.51 ab	58.81 a
T_3	36.29 ab	41.46 bc	48.85 ab	56.11 a
T_4	37.56 a	42.30 ab	47.20 abc	56.01 ab
T_5	33.20 bc	38.65 bcd	46.26 bc	56.98 a
T_6	32.76 bc	36.15 cd	41.83 bc	48.41 c

T_7	30.59 c	34.04 d	40.49 c	48.55 bc
$LSD_{(0.05)}$	4.32	5.65	7.21	7.50
CV (%)	6.88	7.89	8.68	3.03

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).

* DAS= Days after sowing

[T_1= Fipronil @ 2.o ml/L of water at 7 days interval, T_2= Lambdacyhalothrin @ 1.0 ml/L of water at 7 days interval, T_3= Imidachloprid @ 0.5 ml/L of water at 7 days interval, T_4= Neem Oil @ 4.0 ml/L of detergent at 7 days interval, T_5= Malathion 57EC @ 2.0 ml/L of water at 7 days interval, T_6 = Sevin 85WP @ 2.0 ml/L of water at 7 days interval, T_7 = Control]

From the above findings it was revealed that T_1 (Fipronil) performed as the best treatment in increasing plant height during different management practices of controlling thrips which was followed by T_2(Lambdacyhalothrin), T_3 (Imidachloprid), T_4 (Neem Oil) treatments. As a result, the trend of results in terms of increasing the plant height at 50 DAS, 60 DAS, 70 DAS and 80 DAS respectively was $T_1 > T_4 > T_2 > T_3 > T_5 > T_6 > T_7$, $T_1 > T_4 > T_3 > T_4 > T_5 > T_6 > T_7$, $T_1 > T_3 > T_2 > T_4 > T_5 > T_6 > T_7$ and $T_1 > T_2 > T_3 > T_4 > T_5 > T_7 > T_6$.

4.9 Relationship between mean thrips/plant and yield of onion

Figure 1 shows correlation between mean thrips/plant and yield of onion. From this figure it can be concluded that yield of onion was increased when thrips infestation was low. On the other hand, yield was decreased with the increase of thrips infestation.

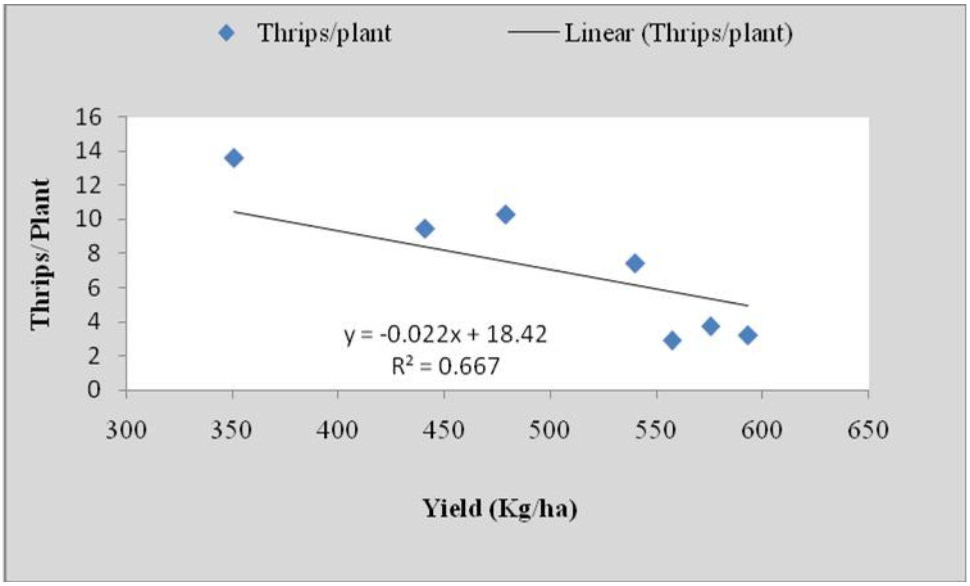

Figure 1: Relationship between thrips and yield.

4.10 Relationship between No of Tiller/plant and effective flower /Umbel

Correlation study was done to established a relationship between No. of tiller/plant and effective flower/Umbel. From the study it was revealed that significant correlation existed between the characters (Figure 2). The regression equation y= 14.35x + 84.37 gave a good fit to the data and value of the co-efficient of determination (R^2 =0.661). From this it can be concluded that the thousand seed weight per plant was decreased with the increase of number of infestation.

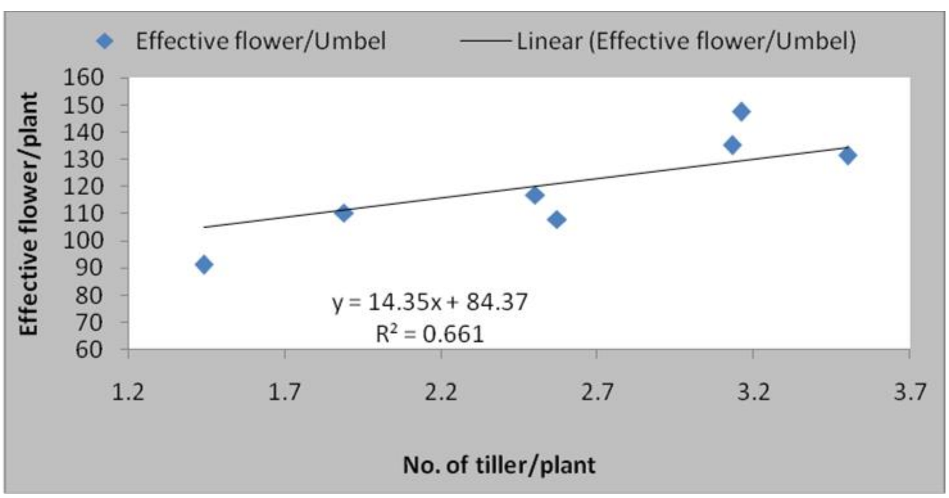

Figure 2: Relationship between No. of tiller/plant and effective flower/Umbel.

4.11 Relationship between effective flower/plant and yield(kg/ha)

Correlation study was done to established a relationship between effective flower/plant and yield (kg/ha). From the study it was revealed that significant correlation existed between the characters (Figure 3). The regression equation y = 3.069x + 139.5 gave a good fit to the data and value of the co-efficient of determination (R^2 = 0.801). From this relations it can be concluded that the yield was decreased with the increase of number of infestation.

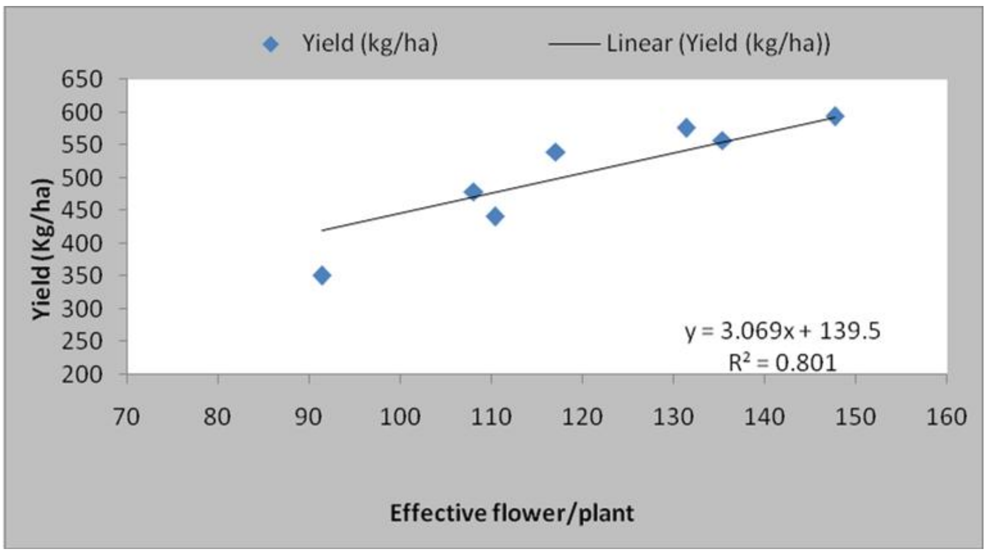

Figure 3: Relationship between effective flower/plant and yield (kg/ha).

CHAPTER V
SUMMARY AND CONCLUSION

Effectiveness of some insecticides for controlling onion thrips (*T. tabaci* Lindeman.) for quality seed production were investigated at the field of the Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from November 2012 to February 2013. There are seven treatments including a botanical and untreated control. These are T_1= Fipronil @ 2.0 ml/L of water at 7 days interval, T_2= Lambdacyhalothrin @ 1.0 ml/L of water at 7 days intervals, T_3= Imidachloprid @ 0.5ml/L of water at 7 days interval, T_4= Neem Oil @ 4.0 ml/L of detergent at 7 days interval, T_5= Malathion 57 EC @ 2.0 ml/L of water at 7 days interval, T_6 = Sevin 85WP @ 2.0 ml/L of water at 7 days interval, T_7 = Control. The experiment was laid out in single factor Randomized Complete Block Design (RCBD) with three replications.

In terms of plant height per plant at different days after sowing, T_1 comprising spraying of Fipronil @ 2.0 ml/L of water at 7 days interval performed as the best treatment in increasing plant height during different management practices of controlling thrips which was followed by Lambdacyhalothrin @ 1.0 ml/L of water at 7 days interval, Imidachloprid @ 0.5 ml/L of water at 7 days interval and Neem Oil @ 4ml/L of detergent at 7 days intervals treatments. As a result, the trend of results in terms of increasing the plant height at 50 DAS, 60 DAS, 70 DAS and 80 DAS respectively was $T_1>T_4>T_2>T_3>T_5>T_6>T_7$, $T_1>T_4>T_3>T_4>T_5>T_6>T_7$, $T_1> T_3> T_2>T_4> T_5 >T_6 >T_7$ and $T_1> T_2 >T_3> T_4 > T_5 >T_7> T_6$.

In terms Number of leaves per plant at different days after sowing, Fipronil @ 2.0 ml/L of water at 7 days interval performed as the best treatment in increasing number of leaves per plant during different management practices of controlling thrips which was followed by all treatments except untreated control. As a result, the trend of results in terms of increasing the plant height at 50 DAS, 60 DAS, 70 DAS and 80 DAS respectively was $T_1>T_2>T_4>T_3>T_5>T_6>T_7$, $T_4>T_1>T_2>T_3>T_6>T_5>T_7$, $T_1> T_4> T_2> T_3> T_6> T_5> T_7$ and $T_1> T_4> T_2 > T_3> T_5> T_7> T_6$.

In terms of Effect of flower number, Imidachloprid @ 0.5 ml/L of water at 7 days interval performed as the best treatment in increasing number of flower per stalk during different management practices of controlling thrips which was followed by all treatments except Sevin 85WP @ 2.0 ml/L of water at 7 days interval and untreated control plot has no significant different. As a result, the trend of results in terms of increasing the flower/stalk was $T_3>T_1>T_2>T_5>T_4>T_6>T_7$. Tiller number/plant also recorded. It was revealed that Neem Oil @ 4.0 ml/L of detergent at 7 days interval performed as the best treatment in increasing number of tiller per plant during different management practices of controlling thrips which was followed by all treatments except Sevin 85WP @ 2.0 ml/L of water at 7 days intervals and untreated control plot. As a result, the trend of results in terms of increasing the tiller/plant was $T_4>T_3>T_2>T_1>T_5>T_6>T_7$.

In terms of scape length, scape diameter, umbel number and umbel diameter of onion, T_1 comprising Fipronil @ 2.0 ml/L of water at 7 days interval and Lambdacyhalothrin @ 1.0 ml/L of water at 7 days interval performed as the best treatment in increasing scape length per plant, scape diameter (cm) and umbel/plant during different management practices of controlling thrips. But all treatment is non significant in terms of umbel diameter. As a result, the trend of results in terms of increasing the Scape length, Scape diameter, Umbel/plant and Umbel diameter respectively was $T_1>T_2>T_3>T_5>T_4>T_6>T_7$, $T_2>T_3>T_1>T_4>T_6>T_5>T_7$, $T_1>T_2>T_3>T_5>T_4>T_7>T_6$ and $T_2> T_3> T_6> T_5> T_1> T_7> T_4$.

In terms of Effect of flower per umbel and effective flower per umbel, Fipronil @ 2.0 ml/L of water at 7 days interval performed as the best treatment in increasing both flower number and effective flower number per umbel during different management practices of controlling thrips which was followed by Lambdacyhalothrin @ 1.0 ml/L of water at 7 days intervals has shown similar result. As a result, the trend of results in terms of increasing the flower/umbel and effective flower/umbel respectively was $T_1>T_2>T_3>T_5>T_4>T_6>T_7$ and $T_1>T_2>T_3>T_4>T_6>T_5>T_7$.

In terms of seed production, Fipronil @ 2.0 ml/L of water at 7 days interval performed as the best treatment in increasing seed weight mg /plant during different management practices of controlling thrips. But thousand seed weight was showed best performance in Lambdacyhalothrin @ 1.0 ml/L of water at 7 days interval treatment. As a result, the trend of results in terms of increasing the seed weight (mg) /plant and thousand seed weight respectively was $T_1>T_3>T_2>T_6>T_5>T_4>T_7$ and $T_2>T_1>T_3>T_4>T_5>T_7>T_6$.

In terms of Yield of onion seed under different treatments at harvest, Fipronil @ 2.0 ml/L of water at 7 days interval performed as the best treatment in increasing yield of onion during different management practices of controlling thrips followed by Imidachloprid @ 0.5ml/L of water at 7 days interval shown similar results. As a result, the trend of results in terms of increasing the yield of onion was $T_1>T_3>T_2>T_4> T_5> T_6> T_7$.

In terms of infestation of thrips under different treatments, Lambdacyhalothrin @ 1.0 ml/L of water at 7 days interval performed as the best treatment in control of thrips among different treatment followed by Fipronil @ 2.0 ml/L of water at 7 days intervals treatment has no significant different. As a result, the trend of results in terms of decreasing the mean thrips number per plant was $T_7>T_5>T_6>T_4>T_3>T_1>T_2$.

Conclusion & Recommendation

1. Based on the above findings of the study it can be concluded that recommended dose of Fipronil @ 2.0 ml/L and Lambdacyhalothrin @ 1.0 ml/L insecticides may be suggested for controlling thrips population in onion seed production.

2. Further study can be conducted with different doses of other promising insecticides.

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CHAPTER VI

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