EFFECTIVENESS OF SOME INSECTICIDES FOR CONTROLLING ONION THRIPS (*Thrips tabaci* Lindeman*)* IN ONION

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Dedicated To

My Beloved Parents

DEPARTMENT OF ENTOMOLOGY

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CERTIFICATE

This is to certify that thesis entitled, **"Effectiveness of Some Insecticides for Controlling Onion Thrips (*Thrips tabaci* Lindeman) in Onion"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **Master of Science in Entomology,** embodies the result of a piece of bona fide research work carried out by **Md. Mizanur Rahaman**, **Registration No. 09-03555** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated:

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ABSTRACT

The experiment was conducted at the Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh to study the effectiveness of some insecticides for controlling thrips during the period from November 2014 to March 2015. The experiment consists of the following management practices: T_1: Actara 25 WG @ 0.2g/L of water ; T_2: Nitro 505 EC @ 2ml/L of water; T_3: Admire 200SL @ 0.5ml/L of water; T_4: Neem Oil @ 4ml/L of water; T_5: Malathion 57EC @ 2ml/L of water; T_6: Tapnor 40 EC @ 2ml/L of water and T_7: Untreated control. All the treatments were applied at 7 days intervals. The plants treated with T_1 treated plot of onion (Actara 25 WG @ 0.2g/L of water), resulted significantly the lowest percentage of infested leaf compared to those of other treatments during vegetative stage, bulb formation stage and bulb filling stage. The tallest plant (41.26 cm) was recorded from T_1 treatment (Actara 25 WG @ 0.2g/L of water), while the shortest plant was found from control (29.30 cm). Significantly the highest yield was obtained in plant under the treatment T_1. The treatments T_2 (Nitro 505 EC @ 2ml/L of water) and T_3 (Admire 200SL @ 0.5ml/L of water) also gave more or less similar result as treatment T_1. The yield contributing characters have found the highest in T_1 treatment for girth of bulb, weight of individual bulb and yield per hectare. The highest benefit cost ratio (4.64) was also found in T_1 may be due to the minimum infestation and cost compared to the other treatments.

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Introduction

CHAPTER I

INTRODUCTION

Onion belongs to the genus *Allium* and family Alliaceae (Hanelt, 1990). There are more than 500 species within the genus *Allium*, of these most are bulbous plants. Onion (*Allium cepa* L.) is an important herbaceous bulb crop in the world. In Bangladesh, it ranks first in production (989000 MT) and second in area (125101 ha) among the spices (BBS, 2013). It covers almost 36% of the total areas under spices. The mean yield of onion in Bangladesh is very low (5 t/ha) compared to world average of 17.27 t/ha. In world production onion ranks third (46,750 thousand MT) only after tomato (1,50,259 thousand MT) and cabbage (54,503 thousand MT) in terms of annual world production in the year 2012. According to Vavilov (1951) the primary center of origin of onion lies in central Asia. It originated in an area which includes Iran, Pakistan and its northern mountains region. The major onion producing countries in respect of total production are China, India, USA, Japan, Turkey, Brazil and Egypt. During winter, onion is widely cultivated all over Bangladesh. And its cultivation is concentrated in the greater districts of Faridpur, Pabna, Rajshahi, Jessor, Mymensingh, Comilla and Rangpur. 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. Bangladesh has to import a big amount of onion from neighbouring and other countries to meet up its demand every year.

Onion contains protein, fat, vit.-A, vit.-B, iron and calcium. It is relished for its pungency which is due to presence of a volatile oily substance known as allyl propyl disulphide . Onion is a multipurpose crop. The edible portion of an onion plant are fleshy scale leaves and flower stalk. The bulb is a modified organ consisting of thickened leaf sheaths and the stem plates. It has manifold uses such as spices, vegetable, salad, dressing etc. It is used in cooking (soups, sauces, dried fish, sandwich, meat etc.) as much for flavoring materials. It has many medicinal properties and is applied on bruises and wounds. It also relieves head sensation and insect bites.

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. The situation is particularly critical in a country like Bangladesh where per hectare recommended amount is seldom used in production. As a result, 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.

Onion thrips is the most important and injurious insect pest of onions. This insect causes significant economic losses, by reducing yields by 30-50% (Nault *et al*., 2012). In Kenya, thrips are present in all onion growing areas and can cause up to 59% loss in yield (Waiganjo *et al*., 2011). Moderate to severe thrips feeding causes reduced bulb size. Immature and adult thrips prefer to feed on young leaves in the inner neck of plants. 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. Insecticides are a major tool for their control, but thrips are prone to develop resistance. Long term sustainable management of thrips includes crop cultural practices, onion varietal resistance, biological control and insecticides resistance management.

Currently, the most important tool for commercial onion growers is the judicious use of insecticides. It’s important to use different classes of insecticides within a season because the more often a particular class is used, the higher the chances are of onion thrips becoming resistant to insecticides has been a key problem. The main reasons lay in the life history characteristics of onion thrips: reproduction by parthenogenesis, high reproductive potential and short generation time. To prolong the effectiveness of insecticide, it is important to limit the number and frequency of insecticide application. Insecticides vary in their toxicity to thrips life stages. Most insecticides are effective in killing the early larval stage (Instar 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. Insecticides are lethal to most, but not all individual and those that survive are able to pass on this ability to their offspring. Insecticides grouped by class (i.e.mode of action) that are effective in reducing thrips on onions.

Considering the present situation it is necessary to identify suitable management practices of onion thrips. Therefore, the present experiment was conducted with the following objectives:

1. To identify the incidence of onion thrips in different stages of crop growth.
2. To evaluate the infestation of thrips on onion production against different treatment.
3. To findout the most effective insecticide against onion thrips.

Chapter II
Review of Literature

CHAPTER II

RIVIEW OF LITERATURE

Onion is one of the important major spice crops in Bangladesh as well as many as countries of the world. Onion thrips is the most destructive pest of onion. For controlling onion thrips it is necessary to have a concept of the origin and distribution, bionomics of thrips, host range, onion thrips damage to onion, monitoring, action thresholds, management tactics of the pest. Farmers mainly control onion thrips through use of different chemicals. But the concept of management of pest employing eco-friendly materials gained momentum as mankind become more safely about environment. Use of botanicals is the recent approaches for pest control that was commonly practiced. Nevertheless, some of the important and informative works and research findings related to the control through chemicals and botanicals so far been done at home and abroad have been reviewed in this chapter.

2.1 Origin and Distribution of Onion Thrips

Onion thrips is a global pest of onion grown between sea level and 2000 m (Lewis, 1973). Onion thrips is a native of the Mediterranean region but has become a major pest of agricultural crops throughout most of the world (Mound and Walker 1982; Mound, 1997). Severe damage to various crops has been reported in Africa, Asia, Europe, North and South America, and Australasia (Mound, 1997, Boateng *et al.*, 2014). Hot and dry weather can lead to an increase in onion thrips populations and the severity of thrips injury to onion. The reason behind this is likely a combination of factors including a shorter generation time and a reduction in mortality from rain and plant pathogens. Heavy rains have been shown to wash onion thrips from plants (Harris *et al.*, 1935, North and Shelton, 1986). Additionally, water stress may impact the nutritional quality of onion plants and also increases the attractiveness of the plants to thrips (Lewis, 1973).

2.2 Bionomics of Thrips

Onion thrips can reproduce asexually (parthenogenesis) and sexually. The most common reproductive mode is thelytoky, a parthenogenesis in which females are produced from unfertilized eggs. Onion thrips also reproduce via arrhenotoky, a parthenogenesis in which males are produced from unfertilized eggs; females are produced from fertilized eggs. Onion thrips that reproduce via thelytoky differ genetically from those that reproduce via arrhenotoky (Toda and Murai, 2007, Kobayashi and Hasegawa, 2012). In the United States and Japan, both arrhenotokous and thelytokous populations of onion thrips have been collected from onion (Nault *et al.,* 2006, Kobayashi and Hasegawa 2012, Jacobson *et al*. 2013). In some instances, arrhenotokous and thelytokous onion thrips populations can occur in the same field (Nault *et al.,* 2006).

The adult stage overwinters in the soil in onion fields (Larentzaki *et al*., 2007), in small grain and hay fields. Adults are more mobile than immature and pupal stages because they can fly. Adults often fly to and land on clothes or exposed skin because of the thrips attraction to white and yellow colors. Adults are elongated with body color varying with temperature from yellow to brown (Murai and Toda 2002). The forewings and hind wings are fringed and pale in color. Mouthparts are piercing-sucking, antennae are 7-segmented, and eyes are gray (Patel *et al*., 2013). Generally, adult females are 1.0–1.3 mm in length, and males are 0.7 mm in length. Adult longevity varies from 16–42 d on garlic (Changela 1993) and 28–30 d on onion (Patel *et al*., 2013). Females exhibit a 1 week pre oviposition period and can lay eggs up to 3 week.

Onion thrips adults emerge from overwintering sites in the spring and may fly to colonize weed hosts and volunteer onion plants before subsequent generations infest onion crops (Larentzaki *et al.,* 2007, Hsu *et al*., 2010). Winged adults are weak fliers but can fly from plant to plant or be carried long distances via wind (Carter and Sorenson, 2013).There are six to eight generations per season (Hoffmann *et al*., 1996). In Kentucky, development time from egg to adult is estimated to be 20 d, with six to eight generations per year. Carter and Sorenson (2013) reported five to eight generations per year. Females lay eggs singly by inserting them into leaf tissue. Only one end of the egg is in proximity to the tissue surface to allow emergence of immatures. Eggs are microscopic, white or yellow, and kidney-shaped. As eggs mature, they develop an orange tinge and eventually reddish eye spots become evident. On onion, the average length and width of eggs are 0.23 mm and 0.08 mm, respectively (Patel *et al*., 2013). Incubation period is 4–5 d on onion (Fekrat *et al*., 2009). Hatching occurs in 2–3 d under laboratory conditions (Pourian *et al*., 2009), while it may take 5–10 d under cooler field conditions as reported in Utah. The first and second instars are active feeding stages. The first instar is small, 0.35–0.38 mm in length, semitransparent and dull white, changing later to yellowish white. The second instar is larger and yellow (Patel *et al*., 2013). Larvae are 0.7–0.9 mm in length with red eyes. The abdomen is divided into eight distinct segments and has a large posterior segment that is conical in shape. Duration of the first instar varies from 2 to 3 d, and the second instar can range from 3 to 4 d (Pourian *et al*., 2009).

The prepupa and pupa (1.0–1.2 mm in length) are relatively inactive, nonfeeding stages. Pupation normally takes place at the base of the onion's apical meristem or within the soil (Rueda and Shelton 1995). The average length of the prepupa is 0.9 mm and the width is 0.23 mm. The prepupa is whitish-yellow and lasts for 1–3 d. In completely formed pupae, the antennae are folded back over the head and wing pads are well developed. The pupae are yellowish white, changing to yellow before adult emergence. The pupal period varies from 3–10 d among different geographical regions (Patel *et al*., 2013).

2.3 Host Range

Onion thrips have an extremely wide host range compared with other thrips species. Reports of their host range vary from more than 140 plant species in over 40 families (Ananthakrishnan, 1973) to more than 355 species of flowering plants. Some onion thrips populations exclusively utilize a single plant species like tobacco (Brunner *et al.*, 2004), while other populations may establish on hosts from multiple plant families

(Nault *et al.*, 2014). Onion thrips also can reproduce on cultivated crops and weedy plants (Diaz-Montano *et al.*, 2011). Notably, the extent and frequency by which onion thrips damage crops varies across plant species. Onion is its preferred host and onion is one of the crops it damages the most. In contrast, onion thrips attack potato, sweet potato, and mustard, but none are damaged to a level that would routinely cause economic damage. 25 weed species supported reproductive populations of onion thrips, especially Brassica weed species such as Barbarea vulgaris Ait. f., Sinapis arvensis L.,and Thalspi arvense L. (Smith *et al.,* 2011).

2.4 Onion Thrips Damage to Onion

Feeding Injury

Onion thrips have very distinctive feeding behaviors by punching through the leaf surface and then extracting sap from plant cells. During this process, thrips release substances that help predigest the tissue. After this, they siphon off the plant contents and consume mesophyll cells, which eventually results in a loss of chlorophyll and reduced photosynthetic efficiency (Boateng *et al*., 2014). Damage appears as silvery patches or streaks on the leaves (Rueda and Shelton 1995). Severe feeding injury by onion thrips is also associated with tiny black "tar" spots, which is excrement from thrips). Feeding on leaves also can create an entry point for plant pathogens.

Plant and Bulb Damage

Generally, onion is most sensitive to thrips feeding injury when plants are young and when bulbs are rapidly enlarging. Water loss from damaged leaf surfaces may cause stress and reduce plant growth and may accelerate leaf senescence, both of which may shorten the period bulbs enlarge. In New York, a 30–50% reduction in bulb yield (smaller bulb sizes) can occur due to severe thrips damage (Nault and Shelton, 2008); Thrips also may feed on onion bulbs following harvest and during storage, and this can cause scars that reduce the aesthetic appearance and quality of bulbs (Mayer *et al.*, 1987).

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 aleathery' 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 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.

Onion thrips may serve as a vector of Alternaria porri, the fungus that causes purple blotch. A. porritypically enters onion leaves through stomata and the epidermal cell layer, but fungal penetration becomes easier when the leaf surface has been damaged by onion thrips. Therefore, measures against onion thrips should also be considered while planning control of A. porri (Thind and Jhooty, 1982). Recently, onion thrips was shown to transmit a bacterial pathogen, Pantoea ananatis, to onion (Dutta *et al.*, 2014). P. ananatis causes center rot in onion and has caused substantial economic losses in the United States. Feeding by onion thrips did not result in the increased incidences of the fungal pathogen Botrytis allii Munn in stored onions (Mayer *et al*., 1987).

2.5 Monitoring

Early detection of a pest problem is a key element for designing integrated pest management strategies. In many cases, infestation of onion thrips begins along field edges rather than other parts of the field (Nault and Shelton, 2012). The density of onion thrips in onion fields can be assessed in multiple ways.

Field Inspection

To make management decisions for onion thrips, in situ examination of the onion plant is required. Onion thrips adults and larvae can be visually identified and counted more easily after opening the neck of the onion plants (Shelton *et al*., 1987). Inspection should primarily be concentrated on the youngest leaves in the lowest center part of the neck, which is a preferred feeding site for thrips (Rueda and Shelton, 1995). Older leaves that have been folded over may also be a preferred feeding site for the pest. Scouting onion fields for onion thrips should start at an early phenological stage such as the 4–5 leaf stage, as the thrips population may increase rapidly at this time under ideal weather conditions (Rueda and Shelton, 1995).
Recommended number of sampling sites within an onion field varies in accordance with field size. For large onion fields (>2 ha), 10 sampling sites with five plants per site (total of 50 plants per field) has been recommended (Rueda and Shelton, 1995). Additionally, thrips infestations tend to be higher near the field borders early to mid-season, and then they eventually disperse within the field. Early in the season, control measures can target crop borders, which may slow spread of the pest to the entire field and save money because the entire field is not treated (Shelton *et al.,* 1987).

Laboratory-Based Methods

Thrips activity can be monitored using sticky cards (Kuepper, 2004; Trdan *et al*., 2005). Sticky cards are collected from the field after a certain period and then examined under a microscope to assess the presence and species of thrips (Mo, 2006). Thrips densities on onion plants can be determined by removing plants from the field and taking them to the laboratory where plants can be immersed in ethanol or soapy water for a few minutes followed by filtering the contents through a fine mesh sieve. Thrips on the mesh are visualized using a hand lens or a microscope and then counted. Alternatively, the onion leaves can be cut into pieces and then placed in a funnel connected with a collection vial (Mo, 2006). A cotton wick containing a few drops of turpentine can be placed on the top of plant material (Mo, 2006). Turpentine will repel the thrips into the collection vial, where they can be counted. These methods are more accurate for determining the number of immatures in a sample because adults may have flown away during collection.

2.6 Action Thresholds

An action threshold for onion thrips is defined as the average thrips number per plant that will cause economic yield loss if the infestation is not controlled (Nault and Shelton, 2010). Knowledge of action thresholds for onion thrips can help onion growers optimize insecticide applications and other management tactics. Benefits include making fewer applications, saving time and money, and potentially mitigating insecticide resistance development. Action thresholds for onion thrips may vary depending on geographic region, cultivar, plant stage, plant architecture, and insecticide efficacy. For example, an action threshold of 13 thrips per plant during mid-season has been effective in California for dry bulb, fresh-market onion (Kuepper, 2004). This threshold value is adjusted based on plant age in that fewer thrips are tolerated on young plants and more thrips are tolerated on mature plants (Kuepper, 2004). The recommended action threshold is higher for tolerant varieties as compared with susceptible ones. For instance, an action threshold level of 20 or more thrips per plant is suggested for the thrips-tolerant varieties, whereas a lower level of 15–30 thrips per plant is suggested for susceptible cultivars (Cranshaw, 1989). Plant architecture (e.g., cultivars with flat sided leaves and compact growth habits harbor more thrips as compared with cultivars with openly spaced leaves) may also impact thresholds.

Action thresholds for onion thrips on onion vary from one to three thrips larvae per leaf depending on insecticide efficacy (Nault and Shelton, 2010). For example, spinetoram (Radiant SC) can effectively manage onion thrips using a threshold level of three thrips larvae per leaf. In contrast spirotetramat (Movento), methomyl (Lannate LV), and abamectin (Agri-Mek SC) need to be applied at one thrips larva per leaf (a more conservative threshold) to manage infestations (Nault and Shelton, 2010, 2012). Thus, it is important to consider all influential factors before selecting an action threshold to use in making onion thrips control decisions.

2.7 Management Tactics

The use of insecticides is the most common management tactic for onion thrips infestations in commercial onion production. Host plant resistance is another tactic that has received attention, but no onion cultivars that have a high level of thrips resistance are commercially available. Cultural and biological control practices have been examined in commercial onion fields to manage thrips, but many are not used because they may be less effective than insecticides and are more expensive and labor intensive. Below we describe tactics that have been evaluated for thrips management in commercial onion fields.

Insecticides

Insecticides vary in their toxicity to different life stages of thrips. Larvae are often more likely to be killed by insecticides compared with other stages. Spirotetramat (Movento) is a good example of an insecticide that is effective against larvae, but much less so against adults (Guillen *et al.*, 2014). Adults can fly quickly when disturbed and also have a thicker cuticle (external covering) than larvae, which makes them more difficult to kill. Prepupae and pupae seek protection in the soil or at the base of onion plants, escaping contact by most insecticides.

Despite their availability and ease of use, insecticide resistance has been a historical problem (Gill and Garg, 2014). The inability to control onion thrips infestations in onion using organophosphate (e.g., azinphosmethyl, diazinon, and methyl parathion) and synthetic pyrethroid (e.g., cypermethrin, and permethrin) insecticides has been observed across the United States (Cranshaw, 1989, Shelton *et al.*, 2006). Onion thrips collected from commercial onion fields were shown to be resistant to methomyl (Lannate LV) and λ-cyhalothrin (Shelton *et al.*, 2003, 2006). In Ontario (Canada), insecticide resistance in onion thrips populations from onion fields was reported for λ-cyhalothrin, deltamethrin, and diazinon (MacIntyre-Allen *et al.*, 2005b). In Auckland (New Zealand), onion thrips tested resistant to diazinon, deltamethrin, and dichlorvos (Martin *et al.*, 2003). In Australia, onion thrips from onion fields were resistant to α-cypermethrin (164-fold), λ-cyhalothrin (606-fold), diazinon (27-fold), dimethoate (5.2-fold), although no resistance was reported to omethoate, malathion, and methidathion (Herron *et al.*, 2008).

Managing resistance to insecticides is critical given that this is the principal tactic used to manage thrips. Resistance can be mitigated by limiting the frequency of insecticide applications, rotating insecticides used in a sequence (based on groups or modes of action), and maintaining thorough coverage to prolong the effectiveness of insecticides (Gill and Garg 2014). Applying insecticides to onion using a high spray volume will provide better coverage of the foliage and better thrips control. Inclusion of a penetrating surfactant is critical for improving the efficacy of insecticides that have systemic and translaminar movement within onion plants to control onion thrips (Nault *et al.,* 2013).

Synthetics

A number of synthetic insecticides are registered for control of onion thrips inthe United States. Of these products, only five active ingredients have consistently demonstrated excellent onion thrips control in New York field trials: abamectin, cyantraniliprole, spinetoram, spinosad, and spirotetramat (Nault and Hessney, 2010).

Spinetoram is highly effective against larvae and adults with residual activity of more than seven days. Spinosad is similar to spinetoram except the residual activity is shorter. Abamectin and cyantraniliprole have provided moderate to excellent control of onion thrips larvae and adults, and had a residual activity of 5–7 d. Spirotetramat is systemic with a residual activity of >10 d, but it does not work well against adult onion thrips or late in the season when plants are maturing. Spirotetramat is suggested for use early in the season when it can easily move systematically in the plant and also adult populations are often lower than they are in late season. Abamectin, cyantraniliprole, spinetoram, and spirotetramat must penetrate the leaves for maximum effectiveness (Nault and Shelton 2012).

Botanicals

Botanicals may offer protection against onion thrips, especially when combined with other management tactics. Efficacy of some botanical products tends to be lower than efficacy of synthetic products (Nault and Hessney, 2010), so their use may be more practical in situations where onion thrips infestations are low to moderate. In a field experiment in India, efficacy of neem seed powder extract, neem soap, essential oils from basil or tulsi (Ocimum tenuiflorum syn. O. sanctum), and scented Geranium (Pelargonium graveolens) was compared with the efficacy of commonly used synthetic insecticides such as dimethoate, acephate, and fipronil for onion thrips control (Krishna Moorthy *et al.*, 2013). The lowest mean thrips population and the highest marketable yield were achieved by applying fipronil, while neem-based formulations were less effective relative to untreated control (Pandey *et al.*, 2013).

Chapter III

Materials and Methods

CHAPTER III
MATERIALS AND METHODS

The experiment was conducted to study the effectiveness of some insecticides against onion thrips in onion during the period from November 2014 to March 2015. The details materials and methods of this experiment are presented below:

3.1 Experimental site

The experiment was conducted at the Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh, which is situated in $23^{0}74^{/}$N latitude and $90^{0}35^{/}$E longitude (Appendix I.).

3.2 Soil

The soil of the experimental area belongs to the Modhupur Tract (UNDP, 1988) corresponding AEZ No. 28 and is shallow red brown terrace soil. The characteristics of the soil under the experimental plot were analyzed in the Soil Testing Laboratory, SRDI, Dhaka and has been presented in Appendix II.

3.3 Climate

The climate of experimental site was subtropical, characterized by 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). Meteorological data related to the temperature, relative humidity and rainfall during the experimental period was collected from Bangladesh Meteorological Department (Climate Division), Sher-e-Bangla Nagar and has been presented in Appendix III.

3.4 Planting material

Onion (Taherpuri) was used as the test crop of this experiment. This onion variety is most popular in Bangladesh and its quality is more standard than other local or high yielding varieties. The seeds were collected from Manikgonj, Bangladesh.

3.5 Land preparation

The land was first opened with the tractor drawn disc plough. Then the soil was ploughed and cross ploughed. Ploughed soil was then brought into desirable fine tilth by the operations of ploughing, harrowing and laddering. The stubble and weeds were removed. Experimental land was divided into unit plots following the design of experiment. The plots were spaded one day before seed sowing and the basal dose of fertilizers was incorporated thoroughly with the soil.

3.6 Manures and Fertilizers application

Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MP) were used as a source of nitrogen, phosphorous, and potassium, respectively. Manures and fertilizers that were applied to the experimental plot presented in Table 1. The total amount of cowdung, Urea, TSP and MP was applied as basal dose at the time of land preparation.

Table1: Fertilizer was applied as per recommended doses (BARC, 1997). Doses of fertilizer and manure were as follows:

Name of the nutrient element	Name of the Fertilizer	Fertilizer dose (kg/ha)	Fertilizer applied during final land preparation (kg/84 m^2 land)	Rest installments (Urea)(kg/84m^2 land)		
				1st	2nd	3rd
N	Urea	320	0.67	0.67	0.67	0.67
P	TSP	415	3.49	-	-	-
K	MP	168	1.41	-	-	-
S	Gypsum	100	0.84	-	-	-
Zn	ZnO	5	0.12	-	-	-
B	Boric powder	5	0.12	-	-	-
	Manure	10000	84			

3.7 Treatments of the experiment

The experiment consists of the following management practices:

T_1=Actara 25 WG @ 0.2g/L of water at 7 days intervals.

T_2= Nitro 505 EC @ 2ml/L of water at 7 days intervals.

T_3= Admire 200SL @ 0.5ml/L of water at 7 days intervals.

T_4= Neem Oil @ 4ml/L of water at 7 days intervals.

T_5= Malathion 57EC @ 2ml/L of water at 7 days intervals.

T_6=Tapnor 40 EC @ 2ml/L of water at 7 days intervals.

T_7=Untreated control

Application of insecticides: All the insecticides used as treatments were applied at 7 days interval.

3.8 Experimental layout and design

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. An area of 19 m × 10 m was divided into three equal blocks. Each block was divided into 7 plots, where 7 treatment combinations were allocated at random. There were 21 unit plots altogether in the experiment. The size of the each unit plot was 2 m × 2 m. The distance maintained between two blocks and two plots were 1.0 m and 0.5 m, respectively.

3.9 Raising of seedlings and transplanting

Onion seeds of taherpuri variety were sown directly in the Nursery bed. The beds were lightly irrigated regularly for ensuring proper growth and development of the seedlings. Fourty day old healthy seedlings were transplanted in the experimental plots. Before transplantation, the top of seedling’s leaves, at length of 10 to 12 cm from the base was cut with a sharp knife, the roots were also cut at 2 cm from the base (a usual practice followed by farmers which may help decreased transpiration and faster root development). The prepared seedling was transplanted, as per design and spacing in the evening and watered on the next following days up to establishment of seedling. A good number of seedlings were transplanted at the border for later use as gap fillers.

3.10 Intercultural operations

3.10.1 Irrigation

Irrigation was given as per requirement of the land with regular intervals. First irrigation was given after a days of transplanting and continued up to harvesting of crop. Water cane with perforated mouth piece was used for soft discharged of water. Irrigation was generally followed the each weeding of the crops.

3.10.2 Gap filling

The dead or sick seedlings were replaced by healthy seedlings within a week after transplantation. The damaged plants were also replaced by border plant through gap filling.

3.10.3 Weeding and mulching

Weeding and mulching were done when required to keep the crop free from weeds, for better soil aeration and conserve soil moisture. The common weeds were *Cynodon dactylon* L. (Durba grass), *Cyperus rotundus* L. (Mutha) etc. Weeding was done carefully keeping the delicate plants undisturbed.

3.11 Crop sampling and data collection

Five plants from each treatment were randomly marked inside the central row of each plot with the help of sample card.

3.12 Monitoring and data collection

The onion plants of different treatment were closely examined at regular intervals commencing from germination to harvest. The following data were collected during the course of the experiment-

•Number of healthy leaves per plant

- Number of infested leaves
- Leaves infestation in number (%)
- Number of thrips per plant
- Number of infested bulbs
- Girth of bulb
- Weight (g) of healthy bulb
- Weight (g) of infested bulb
- Plant height at harvest (cm)
- Individual bulb weight (g)
- Bulb yield per plot (kg)
- Bulb yield per hectare (ton)

3.13 Determination of leaves damage

All the healthy and infested leaves were counted from 10 randomly selected plants from middle rows of each plot and examined. The healthy and damaged leaves were counted and the percent leaves damage was calculated using the following formula:

$$\%\ \text{Leaves damage} = \frac{\text{Number of damaged leaves}}{\text{Total number of leaves}} \times 100$$

3.14 Harvesting and recording data on yield

Onion bulbs were harvested on 24th March, 2015, at which the plant have been showing the sign of drying out most of the leaves. Onion bulbs were carefully lifted with the help of khupry. To avoid injury, care was taken during harvesting. Then the stalks were cut at 2cm above bulbs and dried in the sun and later weight was taken.

3.15.1 Individual bulb weight

Healthy bulb were collected from the five randomly selected plants and were weighted by a digital electronic balance. The weight was expressed plant^{-1} basis in gram (g).

3.15.2 Bulb yield plot^{-1}

The bulb were collected from 10 each plot in each harvest and weighted. The weight of bulb per plot was expressed in kilogram (kg).

3.15.3 Bulb yield hectare^{-1}

Bulb per plot were converted into hectare and the weight of bulb per hectare was calculated and expressed in ton.

3.16 Preparation of neem oil

The fresh neem oil was collected from chawkbazar, Dhaka and the trix liquid detergent which was collected from local market of Agargaon bazar. 4 ml neem oil was mixed with 1 litre of water and 10 ml of trix detergent was added to prepare the treatment neem oil 4 ml/litre of water.

3.17 Statistical analyses

The data on different parameters as well as yield of onion were statistically analyzed to find out the significant differences among the effects of different management against onion thrips. The mean values of all the characters were calculated and analyses of variance were performed by the ‘F’ (variance ratio) test. The significance of the differences among the mean values of treatment in respect of different parameters was estimated by the Duncan’s Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

Chapter IV

Results and Discussion

CHAPTER IV
RESULTS AND DISCUSSION

The study was conducted to find out the effect of some insecticides for controlling onion thrips in onion in the central farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from November 2014 to March 2015. The analysis of variance (ANOVA) of the data on leaves and different yield contributing characters and yield are given in Appendix IV- VII. The results of comparative effectiveness of treatments consisting of various control measures in reducing the infestation of onion thrips was evaluated. Influence of these treatments on yield, extent of damage were presented and discussed under the following headings and sub headings.

4.1 Insect pest incidence

Incidence of onion thrips was recorded for the entire cropping season. Data were taken from each plant at vegetative stage, bulb formation stage and bulb filling stage to investigate the onion thrips incidence.

4.1.1 Vegetative stage

Statistically significant variation was recorded at vegetative stage for thrips due to different management practices (Table 2). The lowest number of thrips per plant (3.13) was found from T_1 (Actara 25 WG @ 0.2g/L of water at 7 days intervals.) and closely followed (5.70 and 5.80) by T_2 (Nitro 505 EC @ 2ml/L of water at 7 days interval) and T_3 (Admire 200SL @ 0.5ml/L of water at 7 days intervals.) respectively whereas the highest number (13.57) was observed from T_7 (control).

4.1.2 Bulb formation stage

At bulb formation stage, the number of thrips showed statistically significant

Table 2. Effect of different treatments on number of thrips plant^{-1} of onion

Treatments	Number of onion thrips plant^{-1} at different stage		
	Vegetative stage	Bulb formation stage	Bulb filling Stage
T_1	3.13 e	3.00 d	2.53 g
T_2	5.70 d	5.73 c	3.33 f
T_3	5.80 d	5.63 c	4.80 e
T_4	6.53 cd	6.86 b	5.10 d
T_5	7.23 bc	5.86 c	6.40 c
T_6	8.10 b	6.83 b	7.26 b
T_7	13.57 a	11.20 a	9.06 a
LSD(0.05)	0.89	0.59	0.23
CV(%)	7.02	5.16	2.35

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 plants per treatment

In a column means having similar letter(s) did not differ significantly and those having dissimilar letter(s) differed significantly as per 0.05 level of probability

T_1=Actara 25 WG @ 0.2g/L of water.

T_2= Nitro 505 EC @ 2ml/L of water.

T_3= Admire 200SL @ 0.5ml/L of water.

T_4= Neem Oil @ 4ml/L of water.

T_5= Malathion 57EC @ 2ml/L of water.

T_6=Tapnor 40 EC @ 2ml/L of water.

T_7=Untreated control

variation due to different treatment or management practices (Table 2). The lowest number of thrips (3.00) per plant was recorded from T_1 closely followed (5.73, 5.80 and 5.86) by T_2, T_3 and $T_{5,}$ whereas the highest number (11.20) was observed from T_7 (control).

4.1.3 Bulb filling stage

At bulb filling stage, the number of thrips showed statistically significant variation due to different treatment or management practices (Table 2). The lowest number (2.53) of thrips per plant was recorded from T_1 closely followed (3.33) by T_2, whereas the highest number (9.06) was observed from T_7 (control) followed (7.26) by T_6.

Nault and Shelton (2010) reported that onion thrips on onion vary from one to three thrips larvae per leaf depending on insecticide efficacy. Onion thrips adults and larvae can be visually identified and counted more easily after opening the neck of the onion plants (Shelton *et al.*, 1987). Significant leaf infestation occurred in vegetative stage.

Pandey *et al.,* (2013) reported that the lowest mean thrips population found by applying fipronil, while neem-based formulations were less effective relative to untreated control.

4.2 Effect of different treatments on leaf infestation of onion

Number of healthy leaves plant^{-1}, number of infested leaves plant^{-1} and percent infestation of leaves plant^{-1} at vegetative stage, bulb formation stage and bulb filling stage in controlling onion thrips showed statistically significant difference for some insecticides (Table 3-5).

4.2.1 Vegetative stage

The results revealed that the highest number of healthy leaves plant^{-1} (7.93) was recorded in T_1 treatment followed (7.47 and 7.13) by T_3 and T_4 respectively. Again, the lowest number of healthy leaves plant^{-1}(5.40) was recorded in T_7 (untreated control) treatment followed by (6.53 and 6.67) by T_2 and T_6 respectively.

The highest number of infested leaves (1.07) was recorded in T_7 treatment followed (0.80) by T_5, while the lowest number of infested leaves (0.27) in T_1 which was statistically similar (0.33) with T_3.The percentage of leaves infestation was highest by number (16.49) was recorded in T_7 treatment which was closely followed by (11.51) T_5 treatment. On the other hand, the percentage of leaves infestation was lowest by number (3.30) in T_1 treatment which was followed by (4.27) T_3. The percent of leaves infestation reduction over control in onion was estimated for different management practices and the highest percentage (79.98) was recorded for the treatment T_1 and the lowest (30.16) from T_5 treatment.

From the above findings it was revealed that T_1 (Actara 25 WG) performed as the best treatment in control of thrips among different treatment followed by T_3 (Admire 200SL). Khaliq *et al*. (2014) reported that, a) all the botanicals and chemical insecticides tested caused significant reductions (45-70%) in thrips populations; b) the botanicals gave more than 60% control of thrips compared to the chemical insecticides where acephate was found to be the most effective followed by spirotetramat and spinetoram; and c) the insecticides gave better control than the botanicals.

Table 3. Infestation of onion leaf caused by the onion thrips under different treatments at vegetative stage

Treatment	Number of leaves plant^{-1}			
	Healthy	Infested	% infestation	Reduction over control (%)
T_1	7.93 a	0.27 f	3.30 g	79.98
T_2	6.53 d	0.47 d	6.73 d	59.16
T_3	7.47 b	0.33 ef	4.27 f	74.09
T_4	7.13 c	0.40 de	5.31 e	67.78
T_5	6.13 e	0.80 b	11.51 b	30.16
T_6	6.67 d	0.67 c	9.06 c	45.02
T_7	5.40 f	1.07 a	16.49 a	--
$LSD_{(0.05)}$	0.1591	0.0795	0.4284	--
CV(%)	5.32	7.77	2.99	--

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 plants per treatment
In a column means having similar letter(s) did not differ significantly and those having dissimilar letter(s) differed significantly as per 0.05 level of probability

T_1=Actara 25 WG @ 0.5g/L of water.
T_2= Nitro 505 EC @ 2ml/L of water.
T_3= Admire 200SL @ 0.5ml/L of water.
T_4= Neem Oil @ 4ml/L of water.
T_5= Malathion 57EC @ 2ml/L of water.
T_6=Tapnor 40 EC @ 2ml/L of water.
T_7=Untreated control

4.2.2 Bulb formation stage

The highest number of healthy leaves plant^{-1} (7.72) was recorded in T_1 treatment which was statistically similar with (7.07) T_2. On the other hand the lowest (5.53) number of healthy leaves plant^{-1} was recorded in T_7 treatment which was statistically similar with (5.66 and 6.08) T_6 and T_4, respectively. The highest number of infested leaves by thrips (1.27) was recorded in T_7 treatment, whereas the lowest number of infested leaves (0.28) was recorded in T_1 treatment which was statistically similar with (0.33) T_2 (Table 4).

Table 4. Infestation of onion leaf caused by the onion thrips under different treatments at bulb formation stage

Treatment	Number of leaves plant^{-1}			
	Healthy	Infested	% infestation	Reduction over control (%)
T_1	7.72 a	0.28 c	3.29 d	82.20
T_2	7.07 ab	0.33 bc	4.54 cd	75.63
T_3	6.61 bc	0.48 b	6.55 bc	64.73
T_4	6.08 cde	0.53 b	8.04 b	56.91
T_5	6.47 bcd	0.55 b	7.66 b	58.94
T_6	5.66 de	0.54 b	8.67 b	54.35
T_7	5.53 e	1.27 a	18.63 a	--
$LSD_{(0.05)}$	0.812	0.186	2.921	--
CV(%)	7.07	19.01	10.01	--

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 plants per treatment
In a column means having similar letter(s) did not differ significantly and those having dissimilar letter(s) differed significantly as per 0.05 level of probability

T_1=Actara 25 WG @ 0.5g/L of water.

T_2= Nitro 505 EC @ 2ml/L of water.

T_3= Admire 200SL @ 0.5ml/L of water.

T_4= Neem Oil @ 4ml/L of water.

T_5= Malathion 57EC @ 2ml/L of water.

T_6=Tapnor 40 EC @ 2ml/L of water.

T_7=Untreated control

The highest percentage of infested leaves in number (18.63) was recorded in T_7 treatment, while the lowest percentage of thrips infested leaves by number (3.29) was recorded in T_1 treatment which was statistically similar (4.54) with T_2 and closely followed (6.55) by T_3. Onion leaf infestation percentage reduction over control at bulb formation stage in number was estimated for some insecticides and the highest percentage (82.20) of reduction was recorded for the treatment T_1, while the lowest percentage (54.35) from T_6 treatment (Table 4).

Jianhua (2004) reported that Karate was the best performing insecticide shortly after spraying and in a separate trial comparing the relative effectiveness of Karate and dimethoate, Karate was four times more effective than dimethoate on adults and 14 times more effective on juveniles. Thoeming *et al.* (2003) have also investigated in a similar way on the systemic effects of neem against western flower thrips larvae on primary bean leaves and observed with maximum corrected mortality of 50.6%.

4.2.3 Bulb filling stage

The healthy leaves plant^{-1} was highest (7.01) in T_1 treatment which was statistically similar (6.54 and 6.22) with T_2 and T_3 respectively, while the lowest (4.60) number was recorded in T_7 treatment which was statistically similar with (4.66, 5.07 and 5.53) T_6, T_4 and T_5, respectively. The highest number of infested leaves plant^{-1} (0.63) was recorded in T_7 treatment, whereas the lowest number of infested leaves (0.13) was recorded in T_1 treatment which was statistically similar with (0.18) T_2 (Table 5).

The highest percentage of infested leaves (13.69) was recorded in T_7 treatment. Again, the lowest percentage of infested leaves (1.85) was recorded in T_1 treatment which was closely followed by (2.75, 3.37) T_2 and T_3 respectively. Reduction of leaf infestation percentage over control at bulb filling stage was calculated for some insecticides and the highest percentage (86.49) was recorded for the treatment T_1 and the lowest percentage (38.93) from T_6 treatment (Table 5).

Table 5. Infestation of onion leaf caused by the onion thrips in different treatments at bulb filling stage

Treatment	Number of leaves plant^{-1}			
	Healthy	Infested	% infestation	Infestation reduction over control (%)
T_1	7.01 a	0.13 e	1.85 g	86.49
T_2	6.54 a	0.18 de	2.75 f	79.91
T_3	6.22 ab	0.21 d	3.37 e	75.38
T_4	5.07 c	0.27 c	5.32 d	61.14
T_5	5.53 bc	0.35 b	6.33 c	53.76
T_6	4.66 c	0.39 b	8.36 b	38.93
T_7	4.60 c	0.63 a	13.69 a	--
$LSD_{(0.05)}$	0.934	0.056	0.4937	--
CV(%)	9.26	7.76	4.67	--

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 plants per treatment
In a column means having similar letter(s) did not differ significantly and those having dissimilar letter(s) differed significantly as per 0.05 level of probability

T_1=Actara 25 WG @ 0.5ml/L of water.

T_2= Nitro 505 EC @ 2ml/L of water.

T_3= Admire 200SL @ 0.5ml/L of water.

T_4= Neem Oil @ 4ml/L of water.

T_5= Malathion 57EC @ 2ml/L of water.

T_6=Tapnor 40 EC @ 2ml/L of water.

T_7=Untreated control

4.3 Plant height (cm) of onion

Plant height at harvest of onion showed a statistically significant difference under different treatments (Table 6). The tallest plant of onion (41.26 cm) was found in T_1 treatment which was followed (35.49 cm and 34.88 cm) by T_2 and T_3 treatment respectively. On the other hand, the shortest plant (29.30 cm) was recorded in T_7 treatment which was closely followed (31.51 cm and 32.34 cm) with T_6 and T_4 treatment (Table 6) respectively. Plant height increased with the decrease of leaf infestation level. Probably infestation hinders the normal growth of onion bulb. Plant height of onion increase over control was estimated for some insecticides and the highest percentage (40.82) was recorded for the treatment T_1 and the lowest percentage (7.54) was recorded from T_6 treatment.

Ibrahim *et al.* (2013) reported that significant difference in plant height among the different treatments with Karate treated plants which reached 49 cm in height followed by *N. glauca* and neem leaf compared to the control.

4.4 Girth of bulb (cm)

A statistically significant difference was recorded in terms of girth of onion bulb for some insecticides (Table 6). The maximum girth of onion bulb (13.15 cm) was found in T_1 treatment which was closely followed (12.14 cm and 11.62 cm) by T_2 and T_3 treatment respectively. On the other hand, the minimum girth of bulb (9.73 cm) was recorded in T_7 treatment which was statistically similar (10.32 cm) with T_6 treatment (Table 6) respectively.

Girth of onion bulb increase over control was estimated for some insecticides and the highest percentage (35.11) was recorded for the treatment T_1 and the lowest percentage (6.03) was recorded from T_6 treatment (Table 6).

Table 6. Effect of some insecticides against onion thrips in terms of plant height and girth of onion bulb

Treatments	Individual plant height (cm)	Increase of height over control (%)	Individual bulb girth (cm)	Increase of girth over control (%)
T_1	41.26 a	40.82	13.15 a	35.11
T_2	35.49 b	21.13	12.14 b	24.73
T_3	34.88 bc	19.04	11.62 bc	19.89
T_4	32.34 d	10.38	10.97 cd	12.71
T_5	33.33 cd	13.75	10.78 cd	10.75
T_6	31.51 d	7.54	10.32 de	6.03
T_7	29.30 e	_	9.73 e	_
$LSD_{(0.05)}$	2.065	_	0.8788	_
CV(%)	3.41	_	4.39	_

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 plants per treatment
In a column means having similar letter(s) did not differ significantly and those having dissimilar letter(s) differed significantly as per 0.05 level of probability

T_1=Actara 25 WG @ 0.5g/L of water.
T_2= Nitro 505 EC @ 2ml/L of water.
T_3= Admire 200SL @ 0.5ml/L of water.
T_4= Neem Oil @ 4ml/L of water.
T_5= Malathion 57EC @ 2ml/L of water.
T_6=Tapnor 40 EC @ 2ml/L of water.
T_7=Untreated control

4.5 Individual bulb weight (g)

A statistically significant difference was recorded in terms of individual bulb weight of onion for some insecticides (Table 7). The highest weight of individual bulb weight (27.45 g) was obtained in T_1 treatment. On the other hand, the lowest weight (15.26 g) was recorded in T_7 treatment (Table 7).

Individual bulb weight of onion increase over control was estimated for some insecticides and the highest percentage (79.88) was recorded for the treatment

T_1 and the lowest percentage (22.08) was recorded from T_6 treatment (Table 7).

Ibrahim *et al.* (2013) reported that Dimethoate and Karate treated ones had significantly higher bulb weight than all other treatments, followed by the tree tobacco treated ones which had better bulb weight than other botanicals except the neem leaf**.**

4.6 Yield hectare^{-1} (Kg)

Insecticides showed significant difference in terms of yield hectare^{-1} of onion (Table 7). The highest yield per hectare (6576.50 Kg) was found in T_1 treatment which was closely followed (6047.58 Kg and 6276.73 Kg) by T_2 and T_3 treatment respectively, whereas the lowest yield per hectare (3755.64 Kg) was recorded in T_7 treatment (Table 7).

Bulb yield per hectare of onion increase over control was estimated for some insecticides and the highest value (75.10%) was recorded for the treatment T_1 and the lowest value (28.13%) from T_6 treatment (Table 7).

Malik *et al.* (2003) indicated thrips population densities have an indirect effect on yield. Yield losses due to onion thrips also calculated and resulted 41.07 and 33.6% at Ambo and Guder, respectively.

4.7 Economic Analysis

The analysis was done in order to find out the most profitable insecticides based on cost and benefit of various components. The results of economic analysis of onion showed that the highest net benefit of Tk. 182280 ha^{-1} was obtained in T_1 treatment and the second highest net benefit was found Tk.174280 ha^{-1} in T_3. The highest benefit cost ratio (BCR)(4.64) was estimated for T_1 treatment and the lowest (2.02) benefit cost ratio for T_5 treatment under the trial (Table 8). The highest BCR was found in the treatment T_1 may be due to the minimum infestation compared to the other treatment and the highest yield.

Table 7. Effect of some insecticides on onion thrips in terms of individual bulb weight and yield.

Treatment	Individual bulb weight (gm)	Increase of weight over control (%)	Yield/ha (Kg)	Increase of yield over control (%)
T_1	27.45 a	79.88	6576.50 a	75.10
T_2	22.80 c	49.41	6047.58 b	61.02
T_3	24.88 b	63.04	6276.73 b	67.12
T_4	21.28 cd	39.44	5650.90 c	50.46
T_5	20.30 d	33.02	5156.07 d	37.28
T_6	18.63 e	22.08	4812.46 e	28.13
T_7	15.26 f	_	3755.64 f	-
LSD(0.05)	1.549	_	255	-
CV(%)	4.05	_	2.62	-

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 plants per treatment
In a column means having similar letter(s) did not differ significantly and those having dissimilar letter(s) differed significantly as per 0.05 level of probability

T_1=Actara 25 WG @ 0.5g/L of water.

T_2= Nitro 505 EC @ 2ml/L of water.

T_3= Admire 200SL @ 0.5ml/L of water.

T_4= Neem Oil @ 4ml/L of water.

T_5= Malathion 57EC @ 2ml/L of water.

T_6=Tapnor 40 EC @ 2ml/L of water.

T_7=Untreated control

Table 8. Cost benefit ratio for different treatments

Treatments	Cost of pest Management (Tk.)	Total Yield (t/ha)	Gross return (Tk.)	Net Return (Tk.)	Adjusted net return (Tk.)	Benefit cost ratio
T_1	15000	6.576	197280	182280	69630	4.64
T_2	15000	6.047	181410	166410	53760	3.58
T_3	14000	6.276	188280	174280	61630	4.40
T_4	12000	5.650	169500	157500	44850	3.73
T_5	14000	5.156	154680	140680	28030	2.02
T_6	10000	4.812	144360	134360	21710	2.17
T_7	0	3.755	112650	112650	0	-

In a column, numeric data represents the mean value of 3 replications; each replication is derived from 5 plants per treatment
In a column means having similar letter(s) did not differ significantly and those having dissimilar letter(s) differed significantly as per 0.05 level of probability

T_1=Actara 25 WG @ 0.5g/L of water.

T_2= Nitro 505 EC @ 2ml/L of water.

T_3= Admire 200SL @ 0.5ml/L of water.

T_4= Neem Oil @ 4ml/L of water.

T_5= Malathion 57EC @ 2ml/L of water.

T_6=Tapnor 40 EC @ 2ml/L of water.

T_7=Untreated control

4.8 Relationship between individual bulb weight and yield ha^{-1}

When the data of individual bulb weight and yield $hectare^{-1}$ were regressed a positive relationship was obtained between these two characters. Here the equation y = 0.233x + 0.441 gave a good fit to the data, and the value of the co-efficient of determination (R^2 = 0.950) showed that the fitted regression line had a significant regression coefficient. From the figure 1, it was observed that the lowest weight of individual bulb (15.26 gm) gaves the yield (3.75 t/ha) and the highest weight of individual bulb (27.45 gm) gaves the yield (6.57 t/ha). So the increase of weight of individual bulb weight (12.19 gm) increased the yield (2.85 t/ha) which was produced by using Actara 25 WG treatment. From the figure, it may be concluded that increase the yield $hectare^{-1}$ due to the increase of individual bulb weight of onion.

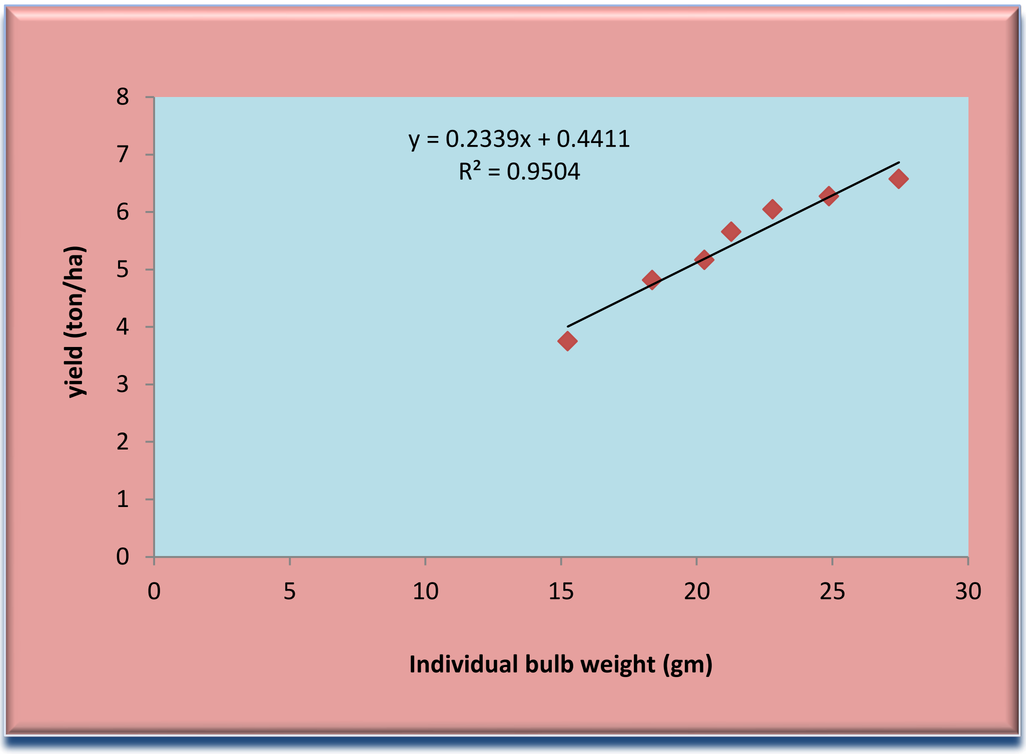

Figure 1: Relationship between individual bulb weight (gm) and yield $hectare^{-1}$

4.9 Relationship between individual bulb girth and yield ha^{-1}

When the data of individual bulb girth and yield hectare^{-1} were regressed a positive relationship was obtained between these two characters. Here the equation y = 0.7758x-3.2587 gave a good fit to the data, and the value of the co-efficient of determination (R^2 = 0.8465) showed that the fitted regression line had a significant regression coefficient. From the figure 2, it was observed that the lowest girth of individual bulb (9.73 cm) gaves the yield (3.75 t/ha) and the highest girth of individual bulb (13.15 cm) gaves the yield (6.57 t/ha). So the increase of individual bulb girth (3.42 cm) increased the yield (2.85 t/ha) which was produced by Actara 25 WG treatment. From the figure, it may be concluded that increase of yield per hectare due to the increase of individual bulb girth of onion.

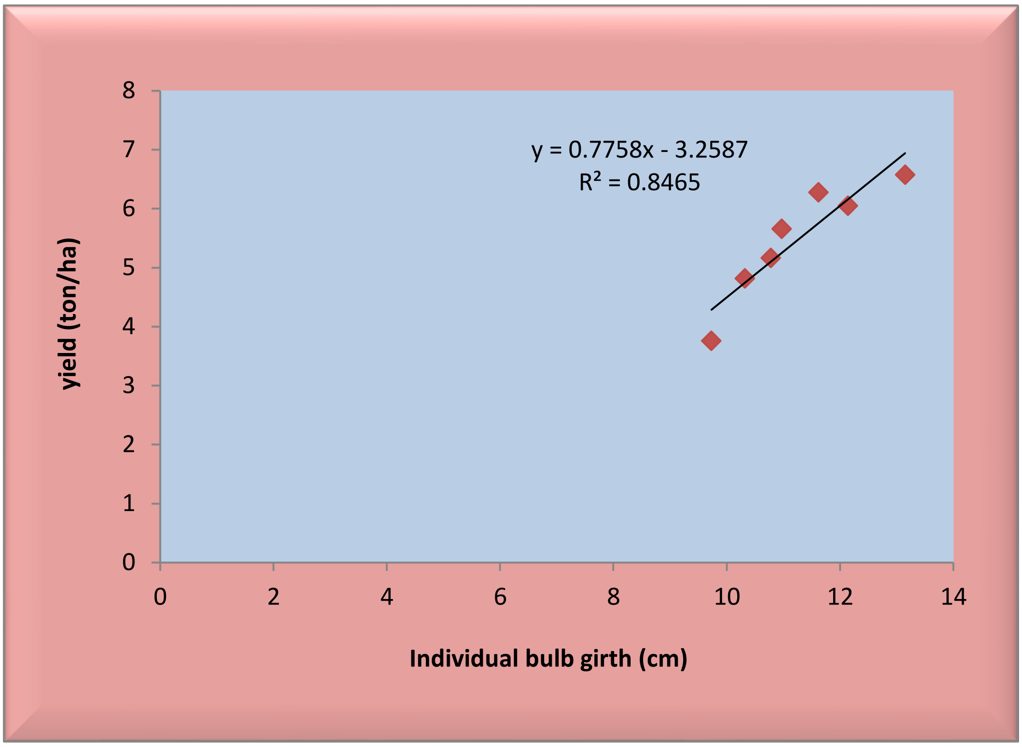

Figure 2: Relationship between individual bulb girth (cm) and yield hectare^{-1}

Plate 1. Field view of vegetative stage of onion

Plate 2. Field view of bulb formation stage of onion

Plate 3: Onion thrips after opening neck of the onion plant

Plate 4: Infested and healthy onion plant by thrips

Chapter V

Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

The study was conducted to find out the effectiveness of some insecticides for controlling thrips in the central farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, Bangladesh during the period from November 2014 to March 2015. Onion (Taherpuri) was used as the test crop of this experiment. The experiment consists of the following management practices: T_1: Actara 25 WG @ 0.2g/L of water; T_2: Nitro 505 EC @ 2ml/L of water; T_3: Admire 200SL @ 0.5ml/L of water; T_4: Neem Oil @ 4ml/L of water; T_5: Malathion 57EC @ 2ml/L of water; T_6: Tapnor 40 EC @ 2ml/L of water and T_7:Untreated control. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications.

Significant difference was observed on the number of thrips plant^{-1} and healthy leaves at vegetative stage, bulb formation stage and bulb filling stage in controlling onion thrips by using some insecticides. At vegetative stage, the lowest number of thrips plant^{-1} (3.13) was found from T_1, whereas the highest number (13.57) was observed from T_7. At bulb formation stage, the lowest number of thrips plant^{-1} was recorded from T_1 (3.00) and the highest number was found from T_7 (11.20). At bulb filling stage, the lowest number of thrips plant^{-1} was obtained from T_1 (2.53) and the highest number was found from T_7 (9.06). At vegetative stage, the highest number of healthy leaves plant^{-1} (7.93) was recorded in T_1 treatment and the lowest (5.40) number in T_7. The highest number of infested leaf (1.07) was recorded in T_7 treatment, while the lowest number (0.27) in T_1 treatment. The highest percentage of infested leaf (16.49) was recorded in T_7 treatment, again the lowest (3.30) in T_1 treatment. Percent onion leaves infestation reduction over control was estimated for different management practices and the highest percent (79.98) reduction over control was recorded for the treatment T_1 and the lowest percent (45.02) from T_6 treatment. At bulb formation stage, the highest number of healthy leaf per plant (7.72) was recorded in T_1, whereas the lowest (5.53) in T_7 treatment. The highest number of infested leaf (1.27) was recorded in T_7 treatment, again the lowest number (0.28) was recorded in T_1 treatment. The highest percentage of infested leaf (18.63) was recorded in T_7 treatment, while the lowest (3.29) in T_1 treatment. Percent onion leaf infestation reduction over control was estimated for different management practices and the highest percentage (82.20) was recorded for the treatment T_1 and the lowest (54.35) from T_6 treatment. At bulb filling stage, the highest number of healthy leaf plant^{-1} (7.01) was recorded in T_1 treatment and the lowest (4.60) in T_7 treatment. The highest number of infested leaf (0.63) was recorded in T_7 treatment, whereas the lowest number (0.13) in T_1 treatment. The highest percentage of infested leaf in number (13.69) was recorded in T_7 treatment, while the lowest (1.85) in T_1 treatment. Percent onion leaf infestation reduction over control was estimated for different management practices and the highest percent (86.49) was recorded for the treatment T_1 and the lowest value (38.93) from T_6 treatment.

Yield contributing characters and yield of onion showed a statistically significant difference by using some insecticides. The tallest plant (41.26 cm) was observed in T_1 treatment and the shortest plant (29.30 cm) in T_7 treatment. The maximum girth of bulb (13.15 cm) was found in T_1 treatment and the minimum girth (9.73 cm) in T_7 treatment. The highest weight of individual fruit weight (27.45 g) was obtained in T_1 treatment and the lowest weight (15.26 g) in T_7 treatment. The highest yield hectare^{-1} (6.576 ton) was obtained in T_1 treatment and the lowest yield hectare^{-1} (3.755 ton) was recorded in T_7 treatment. The highest benefit cost ratio (4.64) was estimated for T_1 treatment and the lowest (2.02) benefit cost ration for T_5 treatment.

Conclusion

Among the treatment Actara 25 WG @ 0.2g/L of water at 7 days intervals was more effective for controlling the onion thrips as well as the highest yield contributing character (girth-13.75 cm, individual bulb weight- 27.45 gm) and yield (6.57 t/ha) of onion. Treatment T_3 consisted of Admire 200SL @ 0.5ml/L of water at 7 days intervals might be chosen as the alternative approach.

Recommendations

Due to some limitations a little number of insecticides were used in this experiment. So, more varieties can be included with more pesticides treatments for the further studies to find out the more profitable yield of onion. Considering the situation of the present experiment, further studies in the following areas may be suggested:

1. Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability.
2. Other management practices may be included in the future study.

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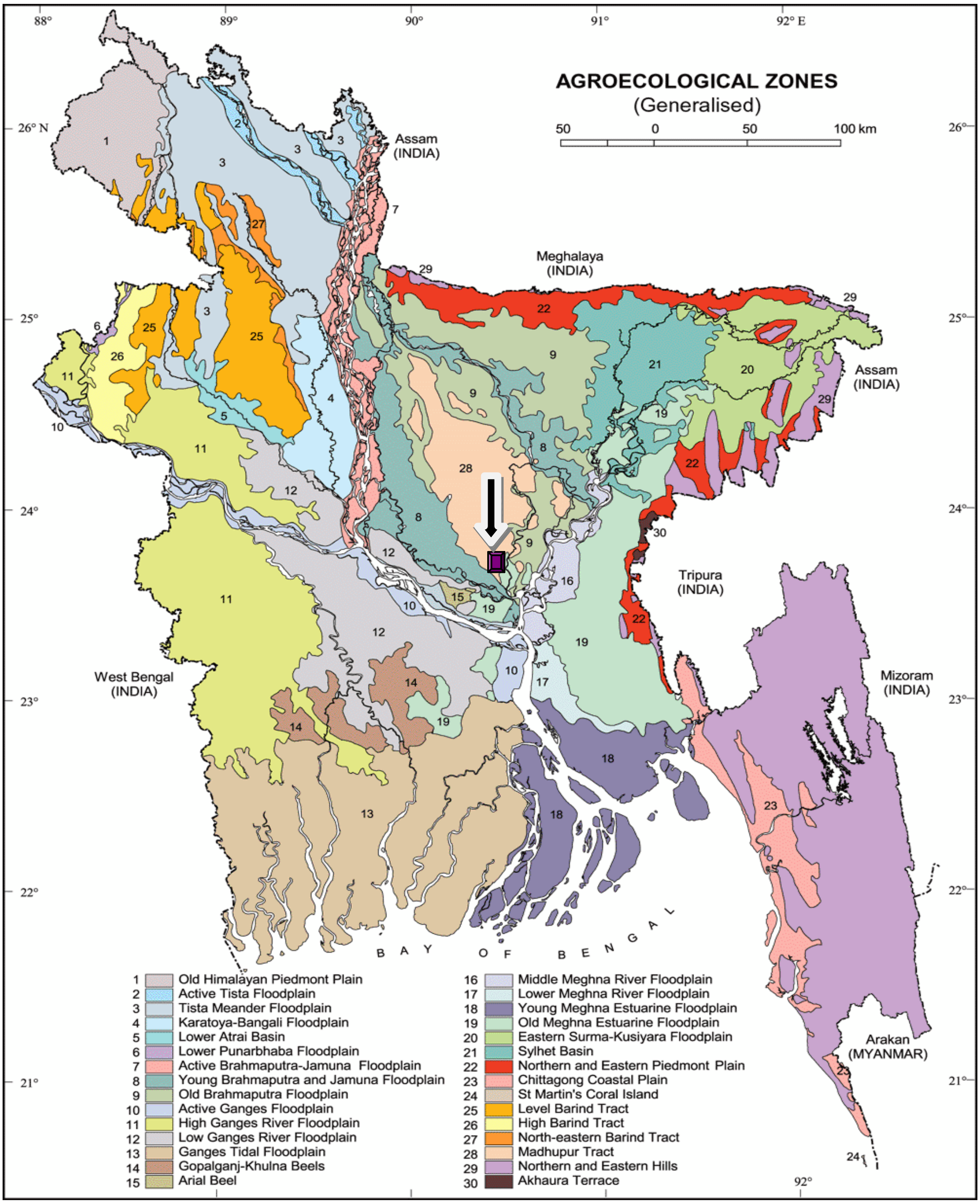
Appendices

APPENDICES

Appendix I: Experimental location in the map of Agro-Ecological Zones of Bangladesh



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

A. Morphological characteristics of the experimental field 2014 .

Morphological features	Characteristics
Location	Central Farm, SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained

B. Physical and chemical properties of the initial soil

Characteristics	Value
% Sand	27
% Silt	43
% clay	30
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Source: SRDI

Appendix III. Monthly record of air temperature, rainfall and relative humidity of the experimental site during the period from November 2014 to March 2015

Year	Month	Air temperature(0^0)			Relative Humidity (%)	Rainfall (mm)	Wind Speed (km/hr)
		Max.	Min.	Average			
2014	November	31.2	17.3	23.4	66.6	0.00	0.6
	December	25	15.7	19.5	68	0.00	1.3
2015	January	24.4	16.4	19.6	72.2	1.27	1.2
	February	29.5	16.9	22.4	51.3	0.00	1.4
	March	32.5	20.4	26.45	66.4	0.00	1.45

Source: Bangladesh Meteorological Department (Climate Division) Agargoan, Sher-e-Bangla Nagar, Dhaka-1207

Appendix IV. Analysis of variance of the data on onion thrips per plant by number as influenced by some insecticides in controlling thrips at different growth stage

Source of variation	Degrees of freedom	Mean square		
		Number of onion thrips plant^{-1}		
		Vegetative stage	Bulb formation stage	Bulb filling stagee
Replication	2	0.072	0.172	0.023
Treatment	6	31.566**	18.153**	15.399**
Error	12	0.252	0.111	0.017

**: Significant at 0.01 level of probability *: Significant at 0.05 level of probability

Appendix V. Analysis of variance of the data on leaves per plant by number as influenced by some insecticides in controlling onion thrips at different growth stage

Source of variation	Degrees of freedom	Mean Square								
		Onion leaves at vegetative stage			Onion leaves at bulb formation stage			Onion leaves at bulb filling stage		
		Healthy	Infested	% infestation	Healthy	Infested	% infestation	Healthy	Infested	% infestation
Replication	2	0.011	0.001	3.134	0.311	0.025	2.272	0.040	0.002	0.166
Treatment	6	2.158**	0.250**	75.657**	1.822**	0.323**	74.658**	2.664**	0.086**	49.982**
Error	12	0.008	0.002	2.598	0.207	0.012	2.693	0.267	0.001	0.077

**: Significant at 0.01 level of probability *: Significant at 0.05 level of probability

Appendix VI. Analysis of variance of the data on plant height and individual bulb girth as influenced by some insecticides

Source of variation	Degrees of freedom	Mean Square	
		Plant height	Individual bulb girth
Replication	2	1.612	0.343
Treatment	6	43.592 **	4.014**
Error	12	1.348	0.244

**: Significant at 0.0 level of probability *: Significant at 0.05 level of probability

Appendix VII. Analysis of variance of the data on individual bulb weight and Yield/ha as influenced by some insecticides

Source of variation	Degrees of freedom	Mean Square	
		Individual bulb weight	Yield/ha (kg)
Replication	2	8.227	8464.266
Treatment	6	48.649**	2854734.664**
Error	12	0.758	20541.979

**: Significant at 0.01 level of probability *: Significant at 0.05 level of probability