MANAGEMENT OF MUNGBEAN THRIPS (*MEGALUROTHRIPS DISTALIS*) USING CHEMICAL INSECTICIDES AND NEEM OIL

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CERTIFICATE

This is to certify that the thesis entitled, "**MANAGEMENT OF MUNGBEAN THRIPS (*MEGALUROTHRIPS DISTALIS*) USING CHEMICAL INSECTICIDES AND NEEM OIL**" 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 **HASINA MUMUTAJ**, Registration No. 08-2669 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: December, 2014
Dhaka, Bangladesh

(Prof. Dr. Md. Abdul Latif)
Supervisor

DEDICATED

TO

BELOVED PARENTS

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THESIS ABSTRACT

The experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from March to May, 2014 to manage thrips of mungbean and observe the impact of different chemical insecticides and neem oil on thrips infested mungbean field. The mungbean variety, BARI mung 6 was grown in the field and ten treatments viz., Decis 5EC, Ripcord 10EC, Marshal 20EC, Sevin 85SP, Dursban 20EC, Neem oil, Talstar 2WP, Actara 25WG, Confidor 70WG and an untreated control were set in randomized complete block design (RCBD) with three replications. Insecticides and Neem oil were applied at 7 days interval. The lowest population of thrips (1.25 $plant^{-1}$) was found in Talstar 2WP treated plot which showed maximum percent reduction of thrips. Talstar 2WP also produced the maximum number of flower (16.67 $plant^{-1}$), number of pod (34.27 $plot^{-1}$), number of seed $plants^{-5}$ (885.3), seed weight (36.19 g) and gave the highest yield (2.05 kg/plot) of mungbean. Confidor 70WG also showed a better result considering all the above parameters. Neem oil showed poor effectiveness in managing thrips. The results of present study indicate that the Talstar 2WP was the most effective insecticide against Thrips infestation on mungbean.

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ABBREVIATIONS

AEZ = Agro- Ecological Zone

BARI = Bangladesh Agricultural Research Institute

BBS = Bangladesh Bureau of Statistics

FAO = Food and Agriculture Organization

et al. = And others

pH = Negative logarithm of hydrogen ion

SRDI = Soil Resource and Development Institute

N = Nitrogen

TSP = Triple Super Phosphate

MP = Muriate of Potash

RCBD =Randomized Complete Block Design

DAS = Days after sowing

ha^{-1}= Per hectare

g = Gram

Kg = Kilogram

ml l^{-1}= Milliliter per liter

LSD = Least Significant Difference

CV% = Percentage of coefficient of variance

DMRT = Duncans Multiple Range Test

cv. = Cultivar

spp = Species (plural number)

Fig. = Figure

mg = miligram

viz., = Videlicet (namely)

CHAPTER I

INTRODUCTION

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INTRODUCTION

Mungbean (*Vigna radiata* (L.) Wilczek) belongs to the family Fabaceae, is a good source of protein, carbohydrates, vitamin for mankind all over the world. Being an important short-duration Kharif grain legume, mungbean is grown extensively in major tropical and subtropical countries of the world. Bangladesh grows various types of pulse crops among which grass pea, lentil, mungbean, chickpea, field pea and cowpea are important. It ranks fifth both in acreage and production and contributes 6.5% of the total pulse production in Bangladesh (Anon. 1998). Mungbean is considered as a poor man's meat because it is a good source of protien (Miah, 1990). It contains 51% carbohydrate, 26% protein, 10% water, 4% minerals and 3% vitamins (Peterson, 1965). A minimum intake of pulse by a human should be 80.0 g day^{-1} (FAO, 1999) where as it is only 19.35 g day^{-1} in Bangladesh (BBS, 2009). It is an important source of protein and several essential micronutrients. It contains 24.5% protein and 59.9% carbohydrate, 75 mg calcium, 8.5 mg iron and 49 mg B-carotine per 100g of split daul (Bakr *et al.*, 2004). It has good digestibility and flavor. The global mungbean growing area has increased during the last 20 years at an annual growth rate of 2.5%. The crop has various advantages in cropping system because of its rapid growth, early maturation and atmospheric nitrogen fixation through symbiotic relationship with soil bacteria and improve soil fertility (Yadav *et al.*, 1994). The foliage and stem are also a good source of fodder for livestock as well as a green manure. Among pulses, mungbean is favored for children and the elderly people because of its easy digestibility and low production of flatulence. It is a drought tolerant, grown twice a year and fits well in our crop rotation program. In Bangladesh, it is grown annually on an area of 57 thousand acres and a total production of 20 thousand tones with an average seed yield of 351 kg per acre which is very low as compared to other countries of the region. The reasons of this low yield are numerous but yield losses due to insect pest complex are distinct one.

Mungbean is attacked by different species of insect pests. Insect pests that attack mungbean can be classified based on their appearance in the field as it related to the phonology of mungbean plant. They are stem feeders, foliage feeders, pod feeders and storage pests. This classification is convenient in judging the economic importance of the pest, especially their influence on seed yield, and in devising control measures.

Several insect pests have been reported to infest mungbean and damage the seedlings, leaves, stems, flowers, buds, pods causing considerable losses (Sehgal and Ujagir, 1988). The most damaging insect pests of mungbean recorded so far are, whitefly and thrips.

Thrips is associated mostly with the damage of tender buds and flowers of mungbean. Chhabra and Kooner (1985) have reported extensive damage to the summer mungbean due to flower shedding caused by thrips. The average yield loss of mungbean due to different insect pests has been estimated to be 22 percent.

Despite of its importance, mungbean yields are greatly depressed by a complex of biotic and abiotic factors of which insect pests are the most important. Mungbean is attacked by a number of insect pests which cause a heavy loss to crop. Major insect pests are stemfly, thrips, whitefly, jassid and pod borer. In Bangladesh, insecticides are frequently being used in controlling insect pests of field and horticultural crops.

Though many options are available for the management of these insect pests, farmers in Bangladesh mostly use synthetic chemicals because of their quick effect with or without knowing the ill effects of these chemicals. The control of insect pests in Bangladesh is principally carried out by the conventional use of insecticides. Many workers have tried to control the pests with varying degrees of success by frequent application of insecticides as foliar treatments. However, farmer education for the safe and timely use of the insecticides is very important. Previously many research workers have also used and evaluated different synthetic chemicals against different insect pests, especially against sucking insects of mungbean. These conventional chemical control measures failed to adequately control this pest which resulting in severe yield losses. It is difficult to emphasize the effectiveness of particular synthetic insecticides out of many commercially available ones against certain insect pest. These chemicals should be applied at appropriate dose and at right time against the target pests. For controlling the pest successfully and to save biological agents, judicious application of insecticides is essential. In this experiment an effort will be taken to find out the most effective insecticide in controlling thrips of mungbean. Under these circumstances it becomes necessary to find out some eco-friendly alternative methods for insect pest management in formulating the Integrated Pest Management approach. Because of these limitations, the production of mungbean is very low. Thus, available supply for consumption is low as well as costly that it adversely affects the health of the poor urban and rural people.

Keeping all these problems in view, the present study was undertaken to fulfill the following objectives:

i. to study on the infestation status of thrips on mungbean,
ii. to know the effect of some chemical insecticides and neem oil on thrips and its impact on fruit setting and yield of mungbean and
iii. to find out the effective insecticides/ neem oil for the management of thrips.

CHAPTER II

REVIEW OF LITERATURE

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REVIEW OF LITERATURE

2.1 General review of thrips

Thrips (order Thysanoptera) are minute, slender insects with fringed wings (thus the scientific name, from the Greek word *thysanos* ("fringe") + *pteron* ("wing").Other common names for thrips include thunder flies, thunder bugs, storm flies, thunder blights, storm bugs, corn flies and corn lice. (Tipping, 2008).

The word thrips is used for both the singular and plural forms, so there may be many thrips or a single thrips (Kobro and Sverre, 2011).

In general, thrips are very small insects (a few mm in length) with yellowish orange to brown in color. They belong to the order Thysanoptera and are distinguished from other insect orders by their fringed wings and “punch and suck” mouthparts (Lewis, 1997).

Thrips are unique in having only one mandible, the left one. The right one is resorbed by the embryo (Mound, 2005). The word thrips is from the Greek meaning "woodworm" (Kobro and Sverre, 2011; Kirk, 1996).

2.2 Taxonomy of thrips

The earliest fossils of thrips date back to Permian (*Permothrips longipennis* Martynov, 1935). By the Early Cretaceous, true thrips became much more abundant (Grimaldi *et al.*, 2004).

These families are currently recognized: (Buckman *et al.*, 2013; Mound, 2011)

- Suborder Terebrantia
    - Adiheterothripidae Shumsher, 1946 (11 genera)
    - Aeolothripidae Uzel, 1895 (29 genera) – banded thrips and broad-winged thrips
    - Fauriellidae Priesner, 1949 (four genera)
    - Hemithripidae Bagnall, 1923 (one fossil genus, *Hemithrips* with 15 species)
    - Heterothripidae Bagnall, 1912 (seven genera)
    - Jezzinothripidae zur Strassen, 1973 (included by some authors in Merothripidae)
    - Karataothripidae Sharov, 1972 (one fossil species, *Karataothrips jurassicus*)
    - Melanthripidae Bagnall, 1913 (six genera)
    - Merothripidae Hood, 1914 (five genera) – large-legged thrips
    - Scudderothripidae zur Strassen, 1973 (included by some authors in Stenurothripidae)
    - Thripidae Stevens, 1829 (292 genera in four subfamilies) – common thrips
    - Triassothripidae Grimaldi & Shmakov, 2004 (two fossil genera)
    - Uzelothripidae Hood, 1952 (one species, *Uzelothrips scabrosus*)
    - Suborder Tubulifera
    - Phlaeothripidae (447 genera in two subfamilies)

Bhatti (2006, 1998,1994) provides an alternative classification based on morphological characters that would split the group into two orders and forty different families. This classification has been less accepted by taxonomists as it can be derailed by convergent evolution and does not follow phylogenetic principles of classification.

The family *Thripidae* (*Thysanoptera*: *Terebrantia*) at present comprises more than 2000 described species, which are classified into four subfamilies, Thripinae, Dendrothripinae, Sericothripinae and Panchaetothripinae (Bhatti, 1989).

Thirteen species are included in this genus (Wiki 2013), all breeding in the flowers of Fabaceae some as pests of cultivated legumes (Masumoto, 2010). Recently, *Megalurothrips distalis* (Karny) was recorded from Iran (Mirab-balou and Chen 2011). The members of this genus all have a pair of dorso-apical setae on the first antennal segment, and abdominal tergite VIII with many scattered microtrichia anterior to the spiracles (Mound and Ng 2009).

Thripinae comprising 1600 species in 230 genera worldwide is the largest subfamily (Bhatti, 1989). Members of Thripinae exhibit a wide range of biology. Many species live in flowers, on leaves, some species live in both habitats, particularly the pest species, and a few species are predators. In this subfamily, several genus-groups, which are probably monophyletic, have been recognized, including the Anaphothrips genus-group, the Frankliniella genus-group, the Megalurothrips genus-group, the Scirtothrips genus-group, the Trichromothrips genus-group, the Taeniothrips genus-group and the Thrips genus-group (Mound and Masumoto 2009, Mound 2002, Masumoto Mound and Palmer 1981, and Okajima 2007, 2006,2005).

The Thripinae are a subfamily of thrips, insects of the order Thysanoptera. The Thripinae belong to the common thrips family Thripidae and include around 1,400 species in 150 genera (Mound and Walker, 1982)

Notable members – some of them economically significant pests – are for example *Anaphothrips susanensis*, *Megalurothrips distalis*, *Sciothrips caramomi*, *Scirtothrips dorsalis* (chili thrips), *Sorghothrips jonnaphilus*, *T. hawaiiensis*, *T. palmi* (melon thrips) and *T. tabaci* (onion thrips) (Ananthakrishnan 2004).

Scientific Classification

Kingdom: Animalia

Phylum: Arthropoda

Class: Insecta

Order: Thaysanoptera

Family: Thripidae

Genus: Thrips

(Linnaeus, 1758)

Imai *et al.*, 2001 gave this classification as:

Phylum: Arthropoda

Subphylum: Uniramia

Class: Insecta

Order: Thaysanoptera

Family: Thripidae

Subfamily: Thripinae

Genus: *Megalurothrips*

Species: *Megalurothrips distalis*

Tribe: Thripini

Author: Karny

2.3 Biology of thrips

2.3.1 Distribution

It widespread in China Iran, Korea, India, Indonesia, Sri Lanka, Philippines, Fiji.

(Reitz *et al*., 2011; Tang *et al*., 2002; Zhang *et al*., 1999; Han, 1997 1993 and 1988; Han and Cui, 1992; He *et al*., 1992;Zhang, 1982;Han and Zhang, 1981; Chen, 1979; Kudô, 1974; Takahashi, 1936).

The only previous record of *Megalurothrips* in USA was based solely on females, collected in Alabama, Florida, Georgia, South Carolina, and Tennessee (Diffie *et al.*, 2008). These females were provisionally identified as *M. mucunae* Priesner, based on females in museum collections in Washington and Canberra. However, most species in this genus can be distinguished satisfactorily only in the male sex, because females all look very similar to each other (Palmer, 1987).

2.3.2 Morphology

Mound and Palmer (1981) indicated the following characters for Megalurothrips genus-group: Antennae 8- segmented, ocellar setae pair I present; median metanotal setae at anterior margin; metanotal spinula absent; tergite VIII with postero marginal comb usually interrupted; and sternal discal setae absent.

The males of two species, including *M. distalis*, are easily recognized by an array of short, spear-shaped setae ventrally on the abdomen. A further problem is recognition of the plant species on which these thrips can maintain a population. These thrips are highly vagile, and the females that predominate in all populations and land on many plants on which they cannot breed (Mound, 2013)

The morphology of first and second instars of *M. distalis* and *S. aimotofus was* distinctive from each other and from the larvae of the other species. Ratios of larvae per adult female of each thrips species of less than and greater than one were considered indicative of declining and increasing populations, respectively (Northfield *et al.*, 2008).

Thripidae females use their saw like ovipositor to make an incision into plant tissue and then the egg is embedded into the incision (Lewis, 1973).

2.3.3 Life cycle

Thrips have a short like cycle that can occur in 18 to 22 days under ideal conditions (Lewis, 1997).

There are four immature stages before adulthood, two of which are active and two of which are inactive. The two active immature stages are termed 4 larva 1 and larva 2 and the inactive stages, pre-pupa and pupa (Milne and Walter, 1998).

The two active larval stages ingest all the food required by the thrips for development to the adult stage (Lewis, 1973).

Stage 1 larvae are extremely small, around 0.5 mm in length, and begin to feed very quickly after hatching. The larval diet for both active feeding stages is primarily plant juices, extracted via probing of the leaf surface with piercing and sucking mouthparts and the removal of cell contents. As a result, larvae begin to cause visible plant damage almost immediately after emergence (Lewis, 1973).

2.3.4 Reproduction

Thrips are also aided in their ability to harm crops by their high fecundity and rapid reproductive rates. All thrips have a haploid-diploid reproductive strategy. Females result from fertilized eggs and unfertilized eggs produce male progeny. Also in some species, females can reproduce without males (parthenogenesis) by doubling chromosomes within the egg to produce a female; a process known as thyelytoky. In a few asexual species it is believed temperature or microbe presence or absence determines the offspring's sex (Moritz, 1997).

The length of one full reproductive cycle varies between species; on average it is reported to be 30 days but in warm temperatures it may be as short as two weeks (Zhang *et al.*, 2007).

Eggs are laid in or less commonly on plant tissue; the larva emerges and begins to feed upon the plant. Thrips drop to the ground and seek out a dark sheltered hiding place in which they pupate. The pre-pupal and pupal stages are non-feeding and immobile (unless disturbed) (Thoeming *et al.,* 2003). Cold temperatures will not immediately kill thrips, but will render them temporarily immobile. During the winter months, some thrips species survive on various winter weed hosts continuing to feed and reproduce on days when the temperature is moderately warm.

2.4 Nature of damage

Most thrips are phytophagous, but a few genera will feed on fungi or are considered predatory feeding on other thrips, mite adults and eggs, scale insects, and whiteflies (Mound and Teulon, 1995).

Thrips cause damage to their host plants directly through feeding and oviposition and indirectly through the spread of tospoviruses (Arévalo-Rodriguez, 2006). Thrips feed by “punching” into the plant tissue with their single mandible and sucking out cell contents with a pair of maxillary stylets (Lewis, 1997).

Thrips may also cause indirect damage by transmitting viruses or as passive carriers of fungal and bacterial spores (Childers and Achor, 1995).

Feeding causes cellular evacuation, necrosis, plasmolysis, and cellular collapse, which often spreads to nearby cells up to five cells deep. Some leaf feeding thrips can induce gall formation in plants (Mound, 2005). Feeding on inflorescences can cause drooping and discoloration of petals (Rhainds *et al.*, 2007).

Childers and Achor (1991) found that 73% of thrips larvae emerged from the pistil-calyx units of open flowers, which indicates a preference for these tissues. Ovipostion damage is localized and affects only cells directly adjacent to the oviposition site (Childers and Achor, 1991). Large numbers of thrips can cause economic damage and even abortion of flowers (Arévalo-Rodriguez, 2006).

Thrips prefer to feed on young plants and their ability to transmit diseases through their saliva while feeding.

Larvae tend to cause more damage than adults because they occur in larger numbers and some species are gregarious (Childers, 1997). Their damage to crops includes stunted plant growth, leaf stippling, distortion, blemishes, slowed maturity, plant death, and reduction in yield and quality. Quite often, thrips damage is not readily apparent because effects are delayed; the pest may not even be present by the time damage is noticeable. Oviposition and feeding injury cause direct damage to crops (Childers, 1997).

In 2008, thrips caused an estimated loss of 2, 625 bales of cotton in Virginia (Herbert *et al.*, 2009). At the end of the 2007 tomato season, several large commercial growers reported millions of dollars in losses due to thrips feeding injury (Herbert *et al.*, 2009). In 2009, research showed a 12% yield loss from thrips in non-insecticide treated Virginia peanuts (Herbert *et al.*, 2009).

2.5 Seasonal distribution of thrips

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. 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).

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, as 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, i.e. living on wild flora.

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.

Bakr *et al*. (2004) conducted an experiment in the field against thrips population. They showed that during kharif season, the thrips catching ranged from 21.2-66.5. The white traps caught the highest number of thrips (297.4) followed by blue traps (227.6). In general, thrips infestation appeared from the first week of the crop, which progressively and significantly increased in successive crop stages up to 6 weeks.

2.6 Effect of thrips on mungbean

Hossain *et al*. (2009) conducted an experiment at Pulses Research Center, Ishurdi, Pabna, Bangladesh during kharif-I to find out the Thrips attacking mungbean crop sowing at different dates to determine the optimum date(s) of sowing. It is seen that the incidence and population fluctuation of various insect pests was very much dependent on the prevailed climatic conditions of the cropping season. The early (February 14 to March 06) and late sown (mid -April to onward) crops received higher thrips infestation than the mid sown (March 13 to April 10) crops.

Mungbean (*Vigna radiata* L) is one of the important pulse crops in Bangladesh. Due to its short lifespan gradually farmers are becoming more interested to cultivate this valuable crop after harvesting of rabi crops (kharif-I season). Several insect pests have been reported to infest mungbean damaging the crops during seedlings, leaves, stems, flowers, buds and pods causing considerable losses. More than twelve species of insect pests were found to infest mungbean in Bangladesh, aphid and whitefly, thrips and pod borers are important (Hossain *et al.*, 2004).

Sucking insects not only reduce the vigor of the plant by sucking the sap but also transmit disease and affect the photosynthetic activity that is the main source of producing more number of pods plant^{-1}. Similar results are reported by Chumder and Singh (1991) and Sethuraman *et al*. (2001).

Some thrips can affect plants by direct feeding, which may leave visible signs of damage such as leaf silvering (Palmer *et al.*, 1989).

The African species, *M. sjostedti* (Trybom) and two of the Asian species, *M. usitatus* (Bagnall) and *M. distalis*, are known as pests of legume crops that sometimes require insecticidal control (Kooner *et al.,* 2007).

Litsinger and Tommew (1983) classified mungbean insect pests into pre- and post-flowering pests. They classified bean fly, thrips, flea beetle and leaf folder as pre-flowering, while pod borer as post- flowering pest.

Ananthakrishnan (1969) had reported *M. distalis* as one of the common flower thrips causing severe damage to the flowers.

Sreekant *et al*. (2004) conducted field experiments in kharif seasons on mungbean cv. K-851 to determine the effect of intercropping on the incidence of thrips. The treatments comprised intercropping mungbean with pigeon pea, maize, sorghum, pearl millet, castor bean and cotton, sole cropping of mungbean. The reduction in thrips was observed with pearl millet intercrop during both the seasons.

Massod *et al*. (2004) reported that the resistance of mungbean varieties (NM-92, NM-98, NM-121-125, M-1, and NCM-209) was investigated against some sucking insect pests of mungbean at the Gram Research Station Kalurkot, Bhakkar. Mungbean varieties, NM-92 and NM-98 showed significantly low mean whitefly population/leaf as compared to the other three tested varieties. Similar trend was also found among the varieties against jassids and thrips; however, the mean population/leaf of jassids and thrips in NM-98 and

NM-121-125 were statistically similar. Yield production of NM-92 and NM-98 was significantly higher than the other tested varieties due to low infestation by sucking insect pests.

Khattak *et al*. (2004) were investigated the resistance of mung bean cultivars (NM-92, NM-98, NM-121-125, M-1 and NCM- 209) against some sucking insect pests was evaluated in Kalurkot, Bhakkar, Pakistan. NM-92 and NM-98 showed significantly low mean whitefly population per leaf than the other cultivars.

A similar trend was observed among the cultivars against jassids (*A. devastans* [*A. biguttula* biguttula]) and thrips, except that the mean populations of jassids and thrips per leaf in NM-98 and NM-121-125 did not significantly vary. The yields of NM-92 and NM-98 were significantly higher than the other cultivars due to low infestation by sucking insect pests.

Hossain *et al*. (2009) conducted an experiment was at Pulses Research Center, Ishurdi, Pabna, Bangladesh during kharif-I to find out the insect pests attacking mungbean crop sowing at different dates to determine the optimum date(s) of sowing. Thrips population in mungbean flower differed significantly depending on sowing dates, ranging from 1.20 thrips/flower/day to 3.98 thrips/flower/day. The highest thrips population (3.98 thrips/flower/day) was observed in February 14 sowing crops followed by February 21 and February 28 sowings. The lowest thrips population (1.20 thrips/flower/day) was observed in March 06 sowing crops which was identical to all the sowings of March. In April sowings crops, thrips population increased than those of March sowings crop. Thrips population was statistically identical in all the sowing dates of April. It is seen that thrips population was higher in early (February14 to March 06) and late (April 13 and onward) sowing crops than mid sowings (March 13 to April 10).

Shah *et al.* (2007) reported that Mungbean is attacked by different species of insect pests but sucking insect pests (whitefly, jassids and thrips) are of the major importance. These insect pests not only reduce the vigor of the plants by sucking the sap but transmit diseases and affect the process of photosynthesis.

Colors and scents are used by flower-dwelling thrips as cues for detection of and orientation to their hosts (Terry, 1997).

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.

Hossain *et al*.(2009) conducted an experiment was at Pulses Research Center, Ishurdi, Pabna, Bangladesh during kharif-I to find out the insect pests attacking mungbean crop sowing at different dates to determine the optimum date(s) of sowing. The highest yield (1548 kg/ha) was obtained from March 27 sowing crop. The second highest yield (1279 kg/ha) was obtained from March 13 sowing which was statistically identical to March 20, April 03 and April 10 sowings crop. Again, the delayed sowings after mid-April to onward provide yield of 717 kg/ha to 178 kg/ha which were very poor. Hence, for ensuring higher yield and less insect pest infestation, mungbean should be sown within the period of March 13 to April 10 and the best date of sowing should be March 27.

The yield reduction due to FTh (flower bud thrips) ranges from 20 to 80% but under severe infestation, grain yield may be almost nil (Singhand Allen, 1980).

Spraying appropriate insecticides can reduce the damage caused by FTh and other insect pests (Afun *et al.*, 1991).

2.7 Effect of chemicals and botanical control on thrips and growth and yield of mungbean

Several investigatiors under took studies on insect control by chemical insecticides and listed mungbean pests (Canapi *et al.*, 1987; Litsinger, 1987; Lal *et al.*, 1980; Brivestava and Singh, 1979; Shetgeor and Puri, 1979; Litsinger *et al.*, 1978 andSingh and Singh, 1977).

Ahmad *et al.* (1998) found that 0.03% dimethoate or 0.04% monocrotophos effectively reduced the insect pest complex of Mungbean when applied 45 and 60 days after sowing.

Latif *et al.* (2001), Mustafa (1996), Tufail *et al.* (1996) and Ahmad and khan (1995) have also evaluated different insecticides against sucking insect pests of cotton common to Mungbean.

Cowpea is an important legume in sub-Sharan Africa where its protein rich grains are consumed. Insect pests constitute a major constraint to cowpea production. Flower bud thrips (FTh) is the first major pest of cowpea at the reproductive stage and if not controlled with insecticides is capable of reducing grain yield significantly. Information on the inheritance of resistance to FTh is required to facilitate breeding of resistant cultivars. The genetics of resistance was studied in crosses of four cowpea lines. Maternal effect was implicated while frequency distributions of the F2 and backcross generations suggest quantitative inheritance. Additive, dominance and epistatic gene effects made large contributions and since improved inbred lines are the desired product, selection should not be too severe in the early generations to allow for desirable gene recombination. This study suggested that some of the genes involved in the control of resistance of FTh are different in TVu1509 and Sanzi. Broad sense heritability ranged from 56% to 73%. Choice of maternal parent in across will be critical to the success of resistance breeding (Omo-Ikerodah, 2010).

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

In the field trials at the experiment station and in a farmer's field at Mbita near the shores of Lake Victoria, Kenya, applications of 2 or 3% neem seed extract (NSE) @ 200 l ha-1 with a knapsack sprayer at 38, 47 and 51 days after emergence (DE) of the cowpea crop or 5, 10 and 20% NSE sprayed @ 10 l ha^{-1} 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 and 20% NSE.

Cowpea grain yield was significantly higher in plots sprayed with 2% 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 cypermethin. Also, grain quality was superior in neem-treated plots than in untreated or cypermethrin-treated plots (Kidiavai, 2009).

Azam *et al*. (2008) conducted a field study which 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 mungbean. The experiment consisted of seven treatments of various management practices. The incidence of this pest was first noticed during vegetative and flowering stage. The infestation rate was highest in reproductive stage. Application of Furadan 5 G as a seed treatment gave the maximum yield (950.05 kg ha^{-1}). 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.

The research also showed that seed yield of mungbean also differs significantly by the different treatments. It is evident from the results that the highest seed yield (950.50 kg/ha) was recorded from T_1 (Seed treatment by @ 4% before sowing) treatment which was statistically similar with T_6 (Spraying of Shobicron 425 EC @ 20 ml l^{-1} of water at20

DAS and at 35 DAS) (915.2 kg ha^{-1}). The lowest seed yield was recorded from the untreated control and it was statistically different from other treatments. The highest rate of increasing seed yield (60.87%) over control was obtained from T_1 (Furadan 5G) treatment followed by T6 (Shobicron 425 EC) (54.91%) treatment. The third and fourth highest increase (38.85% and 35.57 %) was recorded from the application of T_4 (Spraying of Cymbush 10 EC @ 1 ml l^{-1} of water at 20 DAS and at 35 DAS) and T_3 (Neem seed oil @ 10 ml of water + Trix @ 5 ml l^{-1} of water at 20 DAS and following spray at an interval of 10 days and continued up to the maturity of the crop) treatments respectively. There was strong negative linear regression (y= 1219.1 –127.7x) was found between the number of thrips and yield for different treatments, which indicated that higher number of thrips conversely lower the total yield. The correlation coefficient (r) was – 0.91 and the contribution of the regression (R2) were 0.82. Anon. (2001) reported spraying of Cymbush 10 EC provided better yield of mungbean.

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 generalists *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).

In India several insecticides were tested for the control of *M.distalis* and *C. indicus*on various crops (Acharya and Koshiya, 1991; Singh and Singh, 1991; Ghorpade and Thakur, 1989; Koshta *et al.,* 1988; Mundhe, 1980; Awate *et al.,* 1978; Gargav and Vaishampayan, 1978; Awate and Pokharkar, 1977).

A field trial was carried out in the Punjab, India, to determine the effectiveness of several insecticides against insect pests of summer mungbean (*Vigna radiata*), the most serious of which are *Melanagromyza phaseoli* [*Ophiomyia phaseoli*], *Acherontia styx* and *Megalurothrips distalis.* The most effective treatment was a combination of aldicarb at 1 kg a.i. ha^{-1} and 0.04% monocrotophos, which gave a significantly higher yield than no treatment. The avoidable losses in this case were 54.4% (Chhabra and Kooner, 1985).

Prodhan *et al*. (2008) conducted an experiment at the field of Regional Agricultural Research Station (RARS), Bangladesh Agricultural Research Institute (BARI), Ishurdi, Pabna, during March to June 2008 to develop integrated management approaches against insect pest complex of mungbean. The management approaches tested in the study were T_1= Seed treatment with Imidachlorpid (5g kg^{-1} seeds) + Poultry manure (3t ha^{-1}) + Sequential release of bio-control agent (*Trichograma chilonis* + *Bracon habetor*) + Detergent @ 2g l^{-1} of water, T_2= Seed treatment with Imidachlorpid (5g kg^{-1} seeds) +

Poultry manure (3t ha^{-1}) + Sequential release of biocontrol agent (*Trichograma chilonis* + *Bracon habetor*) + Neem seed karnel extract @ 50gm l^{-1} of water, T_3= Seed treatment with Imidachlorpid (5g kg^{-1} seeds) + Poultry manure (3t ha^{-1}) + Spray with Quinalphos @ 1ml l^{-1} of water and T_4= Untreated control. All the treatments significantly reduced insect's infestation (except thrips) and produced higher yield compared to control. It was found that the highest yield was obtained from the treatment T_3 (1316 kg ha^{-1}) which was statistically similar to T_2 (1316 kg ha^{-1}) and T_1 (1283 kg ha^{-1}). In case of Benefit Cost Ratio (BCR), the highest value was obtained from the treatment T_3 (1.84), which was followed by T_1 (1.55) and T_2 (1.31).

Jahangir Shah *et al*. (2007) conducted a field study was undertaken at Arid Zone Research Institute (AZRI), Bahawalpur, during Kharif, 2005 to investigate the efficiency of different insecticides, namely imidacloprid (Confidor 200SL), acetameprid (Mospilan 20SP), buprofezin (Polo), thiomethoxam (Actara 25WG) along with control on the growth and yield of mungbean. The results revealed that pods/plant and seed yield kg ha^{-1} varied significantly among different insecticides. Out of all the insecticides used in this study, imidacloprid treated plots had significantly the highest yield of (1563 kg ha^{-1}) while the lowest seed yield of (1056 kg ha^{-1}) was obtained from the control plots where no insecticide was applied.

Rajnish *et al*. (2006) were investigate on the insecticides *viz.*, dimethoate (0.03%), monocrotophos (0.04%) and carbofuran (0.5 kg a.i. ha^{-1}) gave better response and were found most effective followed by neem based formulations as moderately effective. The neem based insecticides *viz.*, NSKE (3%). achook (0.3%), neem gold (0.3%) and nimbecidine (0.3%) were found comparable to monocrotophos and dimethoate in all respects. All the insecticides were found economical but two sprays of dimethoate were found most effective and economical.

Khattak *et al*. (2004) conducted an experiment at Agriculture Research Station, Kalurkot, Bhakkar to evaluate the efficacy of Mospilan 20SP, Actara 25WG, polo 500EC, Tamaron 60SI and confidor 200 SL against Whitefly, jassids, and Thrips on mungbean. All the tested insecticides reduced the mean percent population of whiteflies even at 240 hours after spray. Similar trend of insecticides efficacy was also noticed against trips, but Atari 25WG lost its efficacy at 240 hours after spray. Against jassids, Misplay 20 SP, Polo 500 EC, and Confider 200SL at 120 hours and 240 hours after spray were completely ineffective. Variation in the mean percent population of the test insects by insecticides, especially, a sudden drop in the efficacy of insecticides at 72 hours after spray almost against the tested insect pests could be because of the special temporary changes in the environmental conditions.

Iqbal *et al.* (2013) conducted a field study to evaluate one combination of seed treatment with imidacloprid (Confidor 70 WS) and spray with detergent and for insecticide sprays: imidacloprid (Confidor 20% SL), acetamiprid (Acelan 20% SL), thiomethoxam (Actara 25 WG) and acephate (Commando 75 SP), against sucking insect pests on mungbean, *Vigna radiata* (L.) at Arid Zone Research Institute (AZRI), Bhakkar during 2012. All the treatments showed a significant difference with one another, regarding their effectiveness. The application of insecticide sprays immediately enhanced the mortality of the pests, whereas, the effect of seed-treatment and detergent did not show distinctive effect on the pests' population. Imidacloprid and thiomethoxam resulted in a maximum mortality of the jassid, followed by acetamiprid. While in case of whitefly, imidacloprid was the most effective and resulted in a minimum population followed by acetamiprid.

Acephate resulted in the maximum control of thrips and was found the most effective insecticide, followed by acetamiprid.

The application of acephate showed the maximum mortality of the thrips and so was the most effective treatment. The present findings are not in accordance with the results of Koeing *et al*. (2001) who found that actara 25WG proved an excellent controlling insecticide against thrips.

In the present study effectiveness of Actara was minimum which supports the finding of Khattak *et al*. (2004) who investigated that Actara 25WG lost its efficacy against thrips 24 hour after spray.

Ullah *et al.*, (2010) found that Confidor was found to be most effective against thrips and the least efficacy was recorded in case of Actara.

Aslam *et al.*, (2004) found that the most effective insecticides for thrips were Confidor and Mospilan.

Shivanna *et al.*, (2011) reported that Dimethoate was most effective on thrips at three days after spraying which were found to be superior over other treatments; and Kooner *et al.*, (2007) reported that Triazophos 40 EC fetched the highest net returns (Rs.2717 ha-1) over controlled by reducing the thrips damage effectively.

Akhilesh and Paras, (2002) reported that Monocrotophos treated plots were superior in net returns and thrips infestation was lowest.

Bhudev *et al.* (2005) concluded that azadirachtin 5 ml lit^{-1} was found least effective for the control of thrips and the maximum yield was obtained in plots treated with dimethoate 0.03%.

Mahalingappa *et al.* (2008) found that Profenofos 0.10 percent was most effective against mites and thrips.

Imai *et al*. (2001) reported that Methyl anthranilate, a common flower volatile component, was found to be a potent attractant for four species of flower thrips, *Thrips hawaiiensis, T. coloratus, T. flavus* and *Megalurothrips distalis,* irrespective of sex. Methyl anthranilate attracted significantly larger numbers of these four species than *p*-anisaldehyde, an already-known attractant for several species of flower thrips. The attractiveness of the related compounds varied between the species: Within 13related compounds; two positional isomers and 11 functional-group-substituted compounds; *o*-anisidine and *o*-aminoacetophenone for *T. hawaiiensis,* and methyl *m*-aminobenzoate, *o*-anisidine, methyl benzoate and methyl *o*-toluate for *T. coloratus*, were almost as attractive as methyl anthranilate. Meanwhile, no compounds except for methyl anthranilate were attractive to *T. flavus* and *M. distalis*.

Floral volatiles that commonly occur in plants have been examined to find chemical attractants for several species of thrips (Teulon *et al.,* 1993; Kirk, 1987, 1985).

Recent research efforts have concentrated on the western flower thrips *Frankliniella occidentalis* and information on other species is still scarce (Koschier *et al.,* 2000; Manjunatha *et al.,* 1998; Pow *et al.,* 1998; Frey *et al.,* 1994; Teulon *et al.,* 1993).

Trapping experiments on scarab beetles revealed that thrips swarm around funnel traps baited with methyl anthranilate. Methyl anthranilate is a floralscent component in several plants (Knudsen *et al.,* 1993) and along with its related compounds is attractive to the soybean beetle (Maekawa *et al*., 1999; Imai *et al*., 1997).

Subsequently, attraction was examined through field trapping experiments using sticky traps in Okayama, Japan. The experiments in Okayama revealed that two species of thrips, *Thrips hawaiiensis* and *T. coloratus*, and their parasitoid wasp *Ceranisus menes* were attracted to this compound and this attractiveness was much higher than the already-known attractants, *p*-anisaldehyde and geraniol (Murai *et al.,* 2000).

A green plastic plate (80 x 200mm, 3 mm thick) with a 30 x 40 mm hole on the top, into which a lure bottle was attached, was used as a sticky trap. This trap color (green) has already been shown to catch fewer flower thrips than several other colors (Kirk, 1984).

The experiments were conducted to develop insecticide (Imidachlorpid, Imitaf 20SL at 0.5 ml l^{-1}) application schedule for the effective management of thrips and pod borer attacking mungbean during kharif-I season of 2010 and 2011 (Hossain, 2013). In both the years, suppression of thrips population and pod borer infestation were higher in double sprayed treatment than single spraying. Single spraying at 35 DAS (100% flowering) and 42 DAS (100% podding stage) suppressed flower infestation by thrips upto 86 and 93%, respectively, during 2010 and 100 &96%, respectively, during 2011. Double spraying at 42 DAS (100% podding) and 49 DAS (seed developing stage) reduced more pod borer infestation as much as 81-83%. In kharif-I 2010, significantly the highest yield (1798 kg/ha) and MBCR (4.67) were obtained from the plots sprayed twice with Imidachlorpid at 42 DAS (100% podding) and 49 DAS (seed developing stage) but in kharif-I 2011, significantly the highest yield (1457 kg/ha) and MBCR (5.75) were obtained from the plots sprayed twice with Imidachlorpid at 35 DAS (100% flowering) and 42 DAS (100% podding stage). The double spray schedule appeared to be more effective than single spraying against pod borer. But single spray at 42 DAS (100% podding stage) appeared as more effective against flower thrips.

Hossain *et al.* (2004) reported that both the single and double spraying of Imidachloprid starting from flowering to seed developing stage significantly reduced flower infestation and thrips population and double spraying reduced more flower thrips in mungbean than single one.

Imidachloprid showed significant performance in reducing flower infestation and thrips population reduction (Hossain, 2013).

Actara 25WG interferes with the nicotinic acetylcholine receptors in the nervous system of the insect (Maienfisch *et al*., 2001).

Actara having broad activity against pests and claimed to have minimal impact on beneficial (predator) insects (Antunes-Kenyon and Kennedy, 2001) used at rates of 1.0, 1.5 and 2 g gallon^{-1} water.

Khattak (2004) conducted an experiment on insecticides of sucking pest of mungbean and reported that the results of the present studies are in accordance with the results of Ahmad *et al.* (1995) who found that Tamaron effectively controlled thrips on cotton.

Wahla *et al.* (1997) investigated that Tamaron and Confidor effectively controlled cotton thrips. The results of the present studies dis-favored the results of Koenig *et al.* (2001) who determined that Actara 25WG proved an excellent controlling agent against thrips.

Shah *et al.* (2007) reported that the lowest seed yield was noted from the control plots. These results are in conformity with those of Ahmad *et al.* (1998), Deka *et al*. (1998) and Ujagir and Chaudhry (1997).

Flower shedding in summer mungbean, *Vigna radiata* (L.) Wilczek, is a common feature caused by thrips, *Megalurothrips distalis* (Karny). Eleven insecticides were tested in field trials for the control of thrips during the period 1982 to 1984. All the treatments were significantly better in controlling the thrips, reducing flower shedding, increasing the pod numbers and grain yield, in comparison with the control. Increases in yield compared with the control during trials ranged from 85 to 89% (1982), 26 to 96% (1983) and 5 to 194% (1984). Dimethoate gave the highest increases in yield and profit followed by monocrotophos and endosulfan (Chhabra and kooner, 1985).

Botanical pesticides are the most cost effective and environmentally safe inputs in integrated pest management (IPM) strategies. There are about 3000 plants and trees with insecticidal and repellant properties in the world, and India is home to about 70% of this floral wealth (Nazrussalam, 2008). The pest control potential demonstrated by various extracts and compounds isolated from the kernels and leaves of the neem plant (*Azadirachta indica*) neem to be of tremendous importance for agriculture in developing countries.

Biorational control of flower thrips with either: a) M-Pede® insecticidal soap mixed with an emulsified crop oil, or b) weekly applications of neem seed oil (NSO) for four straight weeks. He also found that the fungus *Paecilomyces fumosoroseus* (PFR), the predatory mite *Neoseiulus cucumeris*, and an azadirachtin insecticide (neem) could be used alone or in combination for control of WFT in greenhouses (Grossman and Joel, 1997).

Botani Gard™ and Naturalis-O™, both of which use *Beauveria bassiana*, have been effective on a schedule of three to five applications at three to five-day intervals. The addition of Azatin™ (a neem product) may increase effectiveness (Sanderson and John. 1999).

In 1999, Dr. Dan Gilrein of Cornell Extension tested several biopesticides for their effect on Western flower thrips, including Avid (contains abamectin), Conserve (spinosad), Sanmite (the synthetic chemical pyridaben), Botani Gard (*Beauveria bassiana*), a combination of Botani Gard +Azatin (neem) + M-Pede (insecticidal soap), and Alsa (a garlic product).

CHAPTER III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

The details of the materials and methods of this research work were described in this chapter as well as on experimental materials, site, climate and weather, land preparation, experimental design, lay out, data collection on sucking pests and mosaic disease incidence, grain yield etc. within a period. Overall discussion about experiment was carried out to study on management of mungbean thrips (*Megalurothrips distalis*) by using chemical insecticides and neem oil under the following headings and sub-headings:

3.1 Description of the experimental site

3.1.1 Location and time

The present research was conducted at the research field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from March to May, 2014. The experimental area is located at 23.74º N latitude and 90.35º E longitude with an elevation of 8.2 m from the sea level (Khan, 1997).

3.1.2 Soil

The soil of the experimental area was general soil type series of shallow red brown terrace soils under Tejgaon series. Upper level soils were clay loam in texture, olive-gray through common fine to medium distinct dark yellowish brown mottles under the Agro-ecological Zone (AEZ- 28) and belonged to the Madhupur Tract (UNDP, 1988; FAO, 1988). The selected plot was above flood level and sufficient sunshine was available having available irrigation and drainage system during the experimental period. Soil samples from 0-15 cm depths were collected from experimental field. The analyses were done from Soil Resources Development Institute (SRDI), Dhaka. The experimental plot was also high land, fertile, well drained and having pH 5.8. The physicochemical property and nutrient status of soil of the experimental plots are given in Appendix 1.

3.1.3 Climate and weather

The experimental area is situated in the sub-tropical climatic zone and characterized by heavy rainfall during the months of April to September (Kharif Season) and scanty rainfall during the rest period of the year (Biswas, 1987). The Rabi season (October to March) is characterized by comparatively low temperature and plenty of sunshine from November to February. The detailed meteorological data in respect of temperature, relative humidity and total rainfall recorded by the Weather Station of Bangladesh, Sher-e-Bangla Nagar, Dhaka during the period of study have been presented in Appendix II.

3.2 Crop Cultivation

3.2.1 Variety

Mungbean variety BARI mung 6 was used as experimental materials for the study and the seed of the variety of this experiment collected from Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur.

3.2.2 Treatments

The experiment comprised of ten treatments including an untreated control. The details of the treatments are given below:

Table 1. Name of different treatments, their dose and application interval

Treatments	Dose	Application Interval
T_1 = Decis 5EC	1.0 ml l^{-1} of water	7 days
T_2 = Ripcord 10EC	1.0 ml l^{-1} of water	7 days
T_3 = Marshal 20EC	2.0 ml l^{-1} of water	7 days
T_4 =Sevin 85SP	2.0 ml l^{-1} of water	7 days
T_5 =Dursban 20EC	2.0 ml l^{-1} of water	7 days
T_6 = Neem oil	4.0 ml l^{-1} of water + 4 g detergent	7 days
T_7 = Talstar 2WP	0.5 g $l^{-1}$of water	7 days
T_8 =Aktara 25WG	0.4 g l^{-1} of water	7 days
T_9 = Confidor 70WG	0.3 g l^{-1} of water	7 days
T_{10} = Untreated Control	-	-

Common name, trade name and mode of action of different treatments are given below-

Table 2. Common name, trade name and mode of action of different insecticides used in different treatments

Common Name	Trade Name	Mode of action
Deltamethrin	Decis 5EC	Contact and stomach
Cypermethrin	Ripcord 10EC	Contact and stomach
Carbosulfan	Marshal 20EC	Contact and stomach
Carbaryl	Sevin 85SP	Contact and stomach
Chlorpyriphos	Dursban 20EC	Contact and stomach
Bifenthrin	Talstar 2WP	Contact and stomach
Thiamethoxam	Actara 25WG	Contact, stomach and systemic
Imidaclorpid	Confidor 70WG	Systemic and contact

3.3 Experimental design and layout

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications using variety BARI mung 6. Each block was divided into ten equal plots. Thus there were 30 (3 × 10) unit plots altogether in the experiment. The size of each unit plot was 3 m × 2 m. The distance between block to block and that of the plot to plot was 1.0 m and 1.0 m, respectively. The treatments of the experiment randomly allotted into the experimental plot.

3.4 Land preparation

Power tiller was used for the preparation of the experimental field. Then it was exposed to the sunshine for 7 days prior to the next ploughing. Thereafter, the land was ploughed and cross-ploughed to obtain good tilth. Deep ploughing was done to produce a good tilth, which was necessary to get better yield of this crop. Laddering was done in order to break the soil clods into small pieces followed by each ploughing. All the weeds and stubbles were removed from the experimental field.

3.5 Fertilizers

The fertilizers were applied as per fertilizers recommendation guide (BARI, 2006). The applied manures were mixed properly with the soil in the plot using a spade. The dose and method of application of fertilizers are shown in below:

Table 3. Name of fertilizers and their recommended dose

Fertilizers	Dose (kg ha^{-1})
Urea	30
TSP	70
MP	35

3.6 Sowing of seeds

Seeds were sown on 13th March, 2014 at the rate of 45 kg ha^{-1}in the furrow and the furrows are were covered with soils soon after seeding. The line to line (furrow to furrow) distance was maintained treatment arrangements with continuous sowing of seeds in the line. Plant to plant distance was 6 cm.

3.7 Germination of seeds

Seed germination occurred from 3rd day of sowing. On the 4th day the percentage of germination was more than 85% and on the 5th day nearly all the seedlings came out from the soil.

3.8 Intercultural operations

3.8.1 Thinning out

As the seeds were sown continuously into the line, so there were so many seedlings which need thinning. Emergence of seedling was completed within 10 days after sowing. Overcrowded seedlings were thinned out twice. First thinning was done after 15 days of sowing which is done to remove unhealthy and out of line seedlings. The second thinning was done 10 days after first thinning.

3.8.2 Gap filling

Seedlings were transferred to fill in the gaps where seeds failed to germinate. The gaps were filled in within two weeks after germination of seeds.

3.8.3 Weeding

There were some common weeds found in the mungbean field. First weeding was done at 30 DAS and then once a week to keep the plots free from weeds and to keep the soil loose and aerated.

3.8.4 Irrigation and drainage

The irrigation was done at after first weeding. Irrigation was used as and when irrigation needed. Proper drainage system was also developed for draining out excess water.

3.8.5 Insect and pest management

A cover spray was given with Marshal 20EC after 25 DAS. Various chemicals and botanical extract sprayed as water solution for 4 times at 7 days interval as per treatment from germination to harvest to control insect and pest.

3.8.6 Procedure of spray application

The actual amount of each chemical insecticide was taken in knapsack sprayer having pressure of 4-5 kg cm^{-2} and thoroughly mixed with water and sprayed in the respective plot. The required amount of liquid insecticides were taken by measuring cylinder in the sprayer. Each treatment was repeated at 7 days interval and 4 sprays were applied in the field.

3.9 Data collection

3.9.1 Number of thrips and reduction percentage of thrips

Number of thrips was recorded at vegetative and reproductive stage. Five randomly selected plants and five flowers of those plants were considered for the collection of data. Data on number of thrips were recorded at an interval of 7 days commencing from first incidence and continued up to the 4 weeks (4 times).

Reduction percentage was also recorded on the basis of control treated plant where the maximum number of thrips was attack.

The following formula was used for taking the reduction percentage over control:

$$\% \text{ reduction of thrips} = \frac{\text{Number of thrips in control - Number of thrips in treatments}}{\text{Number of thrips in control}} \times 100$$

3.9.2 Number of infested flower and flower infestation percentage

Number of infested flower was recorded reproductive stage. Five randomly selected plants and five flowers of those plants were considered for the collection of data. Data on number of infested flower were recorded at an interval of 7 days commencing from first incidence of Thrips and continued up to the 4 weeks (4 times).

Flower infestation percentage was recorded by using following formula:

$$\% \text{ flower infested by thrips} = \frac{\text{Number of infested flower}}{\text{Total number of flowers}} \times 100$$

3.9.3 Number of total flower and number of flower shedding and flower shedding percentage

Number of total flowers and number of total flower shedding were recorded at reproductive stage. Five randomly selected plants and total flowers and shaded flowers of those plants were considered for the collection of data. Data were recorded at an interval of 7 days commencing from first incidence of Thrips and continued up to the 4 weeks (4 times).

Flower shedding percentage was recorded on the basis of flower shedding from all the experimental plot.

The following formula was used for taking the flower shedding percentage:

$$\% \text{ flower Shedding} = \frac{\text{No. of flower shed}}{\text{No. of total flowers}} \times 100$$

3.9.4 Number of flower shedding and reduction percentage of flower shedding

Number of flower shedding was recorded at reproductive stage. Five randomly plants and shaded flowers (Plate 1) of those plants were selected for the collection of data. Data on flower shedding were recorded at an interval of 7 days commencing from first incidence and continued up to the 4 weeks (4 times).

Plate 1. Flower shedding of mungbean plant

Reduction percentage was also recorded on the basis of control treated plant where the maximum number of thrips attack and maximum number of flower shedding occurred. The following formula were used for taking the reduction percentage:

Reduction (%) of flower shedding over control

$$= \frac{\text{No. of flower shedding in control - No. of flower shedding in treatment}}{\text{No. of flower shedding in control}} \text{ X } 100$$

3.9.5 Number of total flower and increase percentage of flower

Number of total flowers was recorded at reproductive stage. Randomly selected 5 plants and total flowers of those plants were recorded. Data on total number of flowers of five plants from each plot (Plate 2) were recorded at an interval of 7 days commencing from first incidence and continued up to the 4 weeks (4 times).

Increase percentage was also recorded on the basis of treatments of treated plant where the maximum number of flowers was found than the untreated control plant. The following formula was used for taking the increase percentage:

Increase (%) of flower

$$= \frac{\text{No. of total flowers in treatments - No. of total flowers in control}}{\text{No. of flowers in control}} \text{ X } 100$$

3.9.6 Number of total pod and increase percentage of pod

All pods were separated from five sample plants and the total number of pods were counted and recorded. Average number of pods per plant was calculated.

Increase percentage was also recorded on the basis of treatments of treated plant where the maximum number of pod was found than untreated control plant.

The following formula was used for taking the increase percentage:

$$\% \text{ increase of pod} = \frac{\text{No. of total pod in treatments - No. of total pod in control}}{\text{No. of total pod in control}} \times 100$$

3.9.7 Number of total pod

All pods were separated from five sample plants and the total number of pods was counted and data for pods from five plants were recorded.

3.9.8 Number of total seed

Number of seeds pod^{-1} was recorded after harvesting of the crop from the five randomly selected pods from five pre-selected plants was counted.

3.9.9 Yield plot^{-1} (g)

Seed yield were recorded from randomly selected fives pods. After harvesting the plant was sun-dried and threshed by pedal thresher. Seed were properly sun-dried and their weights recorded. Seed yield was then converted to g plot^{-1}.

3.9.10 Yield plot^{-1} (kg)

Seed yield were recorded from all the pods that were harvested from the plots. After harvesting the plant was sun-dried and threshed by pedal thresher. Seed were properly sun-dried and their weights recorded. Seed yield was then converted to kg plot^{-1}.

Plate 2. An Experimental plot

3.10 Statistical analyses

The data obtained from experiment on various parameters were statistically analyzed in MSTAT-C computer program (Russell, 1986). The mean values for all the parameters were calculated and the analysis of variance for the characters was accomplished by Duncan's Multiple Range Test (DMRT) and the significance of difference between pair of means was tested by the Least Significant Differences (LSD) test at 5 % levels of probability (Gomez and Gomez, 1984).

CHAPTER IV

RESULT AND DISCUSSION

CHAPTER IV

RESULT AND DISCUSSION

The results obtained from the present study on the management of mungbean thrips using chemical insecticides and neem oil have been presented and discussed. Besides different crop characters, yields and yield contributing characters have been presented and discussed in this chapter with some tables and figures as follows:

4.1 Incidence of thrips on mungbean under different treatments

The average population of thrips of mungbean under different treatments has been shown in Table 4. The data (Table 4) expressed that the lowest number of thrips (1.25 plant^{-1}) was observed in Talstar 2WP treated plot followed by Confidor 70WG treated plot (1.75 plant-1) having no significant difference between them. Dursban 20EC also showed low number of thrips (1.92 plant^{-1}). However, the highest number of thrips (18.50 plant^{-1}) was found in control plot which was significantly higher than all other treated plots. Neem oil also showed higher thrips population (5.08 plant^{-1}) than other treatments. Other insecticides have intermediate number of thrips and they were- Decis 5EC (3.33 plant^{-1}), Ripcord 10EC (4.42 plant^{-1}), Marshal 20EC (3.00 plant^{-1}), Sevin 85SP (4.00 plant^{-1}) and Aktara 25WG (2.67 plant^{-1}).

Table 4 revealed that Talstar 2WP showed the best performance in reducing of thrips population over control (93.26%) followed by 90.59% and 89.63% by Confidor 70WG and Dursban 20EC, respectively. Neem oil showed poor results (72.55%) in reducing thrips population over control. However, most of the insecticides gave standard level of reduction (80%) of thrips population over control. The results of the study revealed that all the insecticides significantly reduced thrips population infesting mungbean. Table showed that Talstar 2WP was the most effective insecticide against thrips and Confidor 70WG was second effective insecticides, Dursban 20EC was third effective insecticides but Actara 25WG, Marshal 20EC, Decis 5EC, Sevin 85SP were comparatively less effective insecticides than those. Comparatively, Ripcord 10EC and Neem oil extract was poorly effective against thrips infesting mungbean in field condition. The order of effectiveness is Talstar 2WP (93.26%) > Confidor 70WG (90.59%) > Dursban 20EC (89.63%) > Actara25WG (85.54%) >Marshal 20EC (83.74%) > Decis 5EC (81.96%) >Sevin 85SP (78.39%) >Ripcord 10EC (76.05%) > Neem oil (72.55%). The Table 4 showed that Confidor 70WG was more effective than Actara 25WG which supported the findings of Ullah *et al.* (2010) and Aslam *et al.* (2004). Poor effectiveness of neem oil against thrips population also agreed with the findings of Bhudev *et al.* (2005).

Table 4 Average population of thrips under different treatments on mungbean compared to untreated control

Treatments	**No. of thrips**	**% Reduction of thrips over control**
Decis 5EC	3.33 de	81.96 bc
Ripcord 10EC	4.42 bc	76.05 de
Marshal 20EC	3.00 e	83.74 b
Sevin 85SP	4.00 cd	78.39 cd
Dursban 20 EC	1.92 f	89.63 a
Neem oil	5.08 b	72.55 e
Talstar 2WP	1.25 f	93.26 a
Aktara 25WG	2.67 e	85.54 b
Confidor 70WG	1.75 f	90.59 a
Control	18.50 a	-
LSD(0.05)	**0.74**	**3.84**
CV (%)	**9.42**	**2.65**

In a column, means having different letter(s) are significantly different at 5% level of probability by DMRT

4.2 Effect of different treatments on flower infestation by thrips on mungbean

Flower infestation by thrips was significantly affected by the application of chemical insecticides and neem oil (Table 5). Among the treatments, the lowest flower infestation (0.33 infested flower plant^{-1}) was observed in Talstar 2WP treated plot where lowest infestation (%) and highest number of flower recorded and was closely followed by Confidor 70WG (0.42 infested flower plant^{-1}). On the other hand, the highest flower infestation (4.25 infested flower plant^{-1}) was recorded from control plot where the highest infestation and lowest number of flower was recorded and was closely followed by Neem oil (1.25 infested flower plant^{-1}) and Ripcord 10EC (1.25 infested flower plant^{-1}). Other treatments also showed significant variation in flower infestation and they were Decis 5EC (1.00 infested flower plant^{-1}), Marshal 20EC (0.75 infested flower plant^{-1}), Sevin 85SP (1.17 infested flower plant^{-1}), Dursban 20EC (0.58 infested flower plant^{-1}), Aktara 25WG (0.67 infested flower plant^{-1}). The order of effectiveness is Talstar 2WP > Confidor 70WG > Dursban 20EC > Actara 25WG > Marshal 20EC > Decis 5EC >Sevin 85SP > Ripcord 10EC > Neem oil (Table 5).

Table 5 Effect of chemical insecticides and neem oil on flower infestation by thrips on mungbean

Treatments	Number of total flowers	Number of flower infestation by thrips	% Flower infested by thrips
Decis 5EC	11.17 de	1.00 bc	9.02 bcd
Ripcord 10EC	11.08 de	1.25 b	11.22 bc
Marshal 20EC	12.58 bcd	0.75bc	6.09 bcd
Sevin 85SP	11.67 cd	1.17 b	9.93 bcd
Dursban 20EC	13.42 b	0.58 bc	4.24 cd
Neem oil	9.67 e	1.25 b	12.93 b
Talstar 2WP	16.67 a	0.33 c	2.040 d
Aktara 25WG	13.25 bc	0.67 bc	5.22bcd
Confidor 70WG	15.42 a	0.42 c	2.78 d
Control	7.50 f	4.25 a	57.62 a
LSD(0.05)	**1.59**	**0.69**	**8.30**
CV(%)	**7.59**	**4.36**	**9.97**

In a column, means having different letter(s) are significantly different at 5% level of probability by DMRT

The rate of flower infestation was significantly affected by thrips. The Figure 1 illustrated a proportional relationship between number of thrips and flower infestation percentage. There was a positive relationship between number of thrips and flower infestation rate. The result showed that the flower infestation rate increase with the increase of thrips population but pesticide using reduce the thrips population and flower infestation.

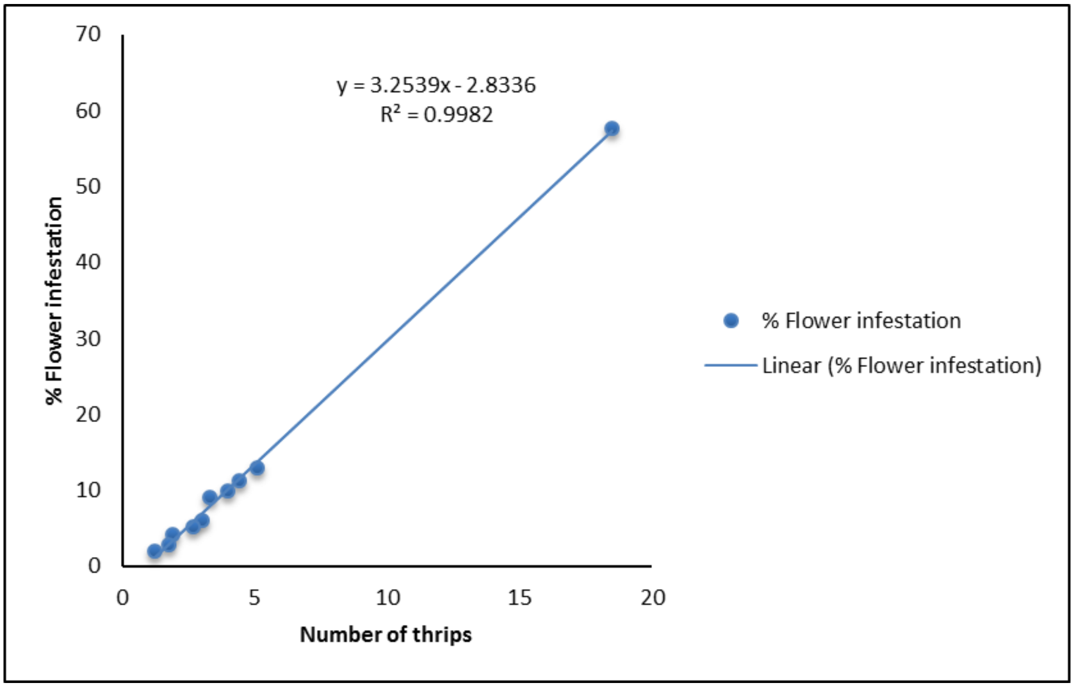

Figure 1. Effect of thrips population on flower infestation percentage (rate)

4.3 Effect of different treatments on flower shedding by thrips on mungbean

Flower shedding by thrips was significantly affected by the application of chemical insecticides and neem oil (Table 6). Among the treatments, the lowest flower shedding (1.00 plant^{-1}) was observed in Talstar 2WP treated plot where lowest shedding rate and highest number of flower (16.67 plant^{-1}) recorded which was followed by Confidor 70WG (1.08 plant^{-1}) and Dursban 20EC (1.08 plant^{-1}). On the other hand, the highest flower shedding (6.8 plant^{-1}) was recorded from untreated control plot where the highest shedding rate and lowest number of flower (7.50 plant^{-1}) recorded and this was closely followed by Neem oil (2.92 plant^{-1}), Ripcord 10EC (2.17 plant^{-1}) and Sevin 85SP (2.17 plant^{-1}). Other treatments also showed significant variation in flower shedding- Marshal 20EC (1.58 plant^{-1}), Decis 5EC (1.92 plant^{-1}) and Aktara 25WG (1.33 plant^{-1}).

Table 6 revealed that Talstar 2WP (85.04%) performed the best performance in reducing of flower shedding over control followed by Confidor 70WG (83.77%) and Dursban 20EC (83.37%). Neem oil showed poor performance (56.35%) in reducing flower shedding over control. However, Talstar 2WP, Confidor 70WG, Dursban 20 EC and Actara 25WG (80.36%) resulted standard level of reduction (80%) of thrips population. The results of the study reveal that all the insecticides significantly reduced flower shedding in mungbean. Table 6 showed that Talstar 2WP, was the most effective insecticide against thrips which cause flower shedding and Confidor 70WG was second effective insecticides, Dursban 20EC was third effective insecticides. Other treatments also showed significant variation in reducing of flower shedding. They were- Decis 5EC (72.22%), Ripcord 10EC (68.33%), Marshal 20EC (77.02%), Sevin 85SP (68.53%), Aktara 25WG (80.36%). Comparatively, Neem oil extract comparatively performed poorly against thrips resulting flower shedding of mungbean in field condition. The order of effectiveness is Talstar 2WP > Confidor 70WG > Dursban 20EC > Actara 25WG > Marshal 20EC > Decis 5EC > Sevin 85SP > Ripcord 10EC > Neem oil.

Table 6. Effect of different treatments on flower shedding by thrips on mungbean

Treatments	Number of total flower	Number of flower shedding	% Flower shedding	% Reduction of flower shedding over control
Decis 5EC	11.67 de	1.92bc	16.48 c	72.22 bc
Ripcord 10EC	11.08 de	2.17 bc	19.69 c	68.33 c
Marshal 20EC	12.58 bcd	1.58 cde	12.47 de	77.02 abc
Sevin 85SP	11.17 cd	2.17cd	19.29 cd	68.53 c
Dursban 20EC	13.42 b	1.08 e	8.10e	83.37 ab
Neem oil	9.67 e	2.92 b	30.02 b	56.35 d
Talstar 2WP	16.67 a	1.00 e	6.02e	85.04 a
Aktara 25WG	13.25 bc	1.33 de	10.08 de	80.36 ab
Confidor 70WG	15.42 a	1.08 e	6.99 e	83.77 a
Control	7.50 f	6.83 a	91.22 a	-
LSD(0.05)	**1.59**	**0.83**	**6.45**	**11.35**
CV (%)	**7.59**	**21.86**	**17.07**	**8.74**

In a column, means having different letter(s) are significantly different at 5% level of probability by DMRT

Rate of flower shedding percentage was significantly affected by thrips. Figure 2 showed a proportional relationship between number of thrips and rate of flower shedding.

There was a positive relationship between number of thrips and rate of flower shedding. The result showed that the flower shedding percentage increase with the increase of thrips population but pesticide reduce the thrips population and flower shedding.

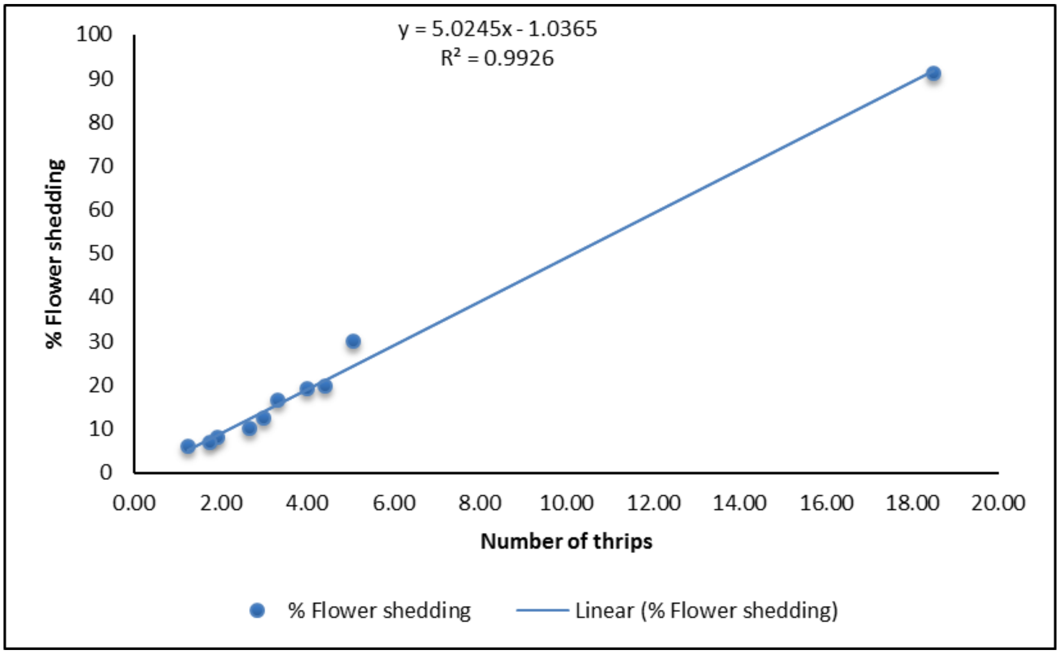

Figure 2. Effect of thrips population on flower shedding percentage

4.4 Effect of chemical insecticides and neem oil on increase of flower of mungbean

The average number of flower of mungbean under different treatments has been shown in Table 7. Table 7 revealed that the highest number of flower (16.67 plant^{-1}) was observed in Talstar 2WP treated plot followed by Confidor 70WG treated plot (15.42 plant^{-1}) having no significant difference between them. Dursban 20EC (13.42 plant^{-1}) and Aktara 25WG (13.25 plant^{-1}) also showed higher number of flower. However, the lowest number of flower (7.50 plant^{-1}) was found in untreated control plot which was significantly lower compared to all other treated plots. Neem oil also showed comparatively lower number of flower (9.67 plant^{-1}) than other treatments. Other insecticides gave the intermediate number of flowers against thrips infestation [Decis 5EC (11.67 plant^{-1}), Ripcord 10EC (11.08 plant^{-1}), Marshal 20EC (12.58 plant^{-1}) and Sevin 85SP (11.17 plant^{-1})].

Table 7 revealed that Talstar 2WPshowed the best performance in increasing of no. of flower over control (123.5%) followed by 108.5% and79.68% by Confidor 70WG and Dursban 20EC, respectively. Neem oil showed poor results (30.82%) in increasing total flower over control. However, most of the insecticides did not give standard level of increasing flower (80%). The results of the study reveal that all the insecticides significantly increase flower in mungbean. Table 7 showed that Talstar 2WP was the most effective insecticide in increasing flower percentage and Confidor 70WG was second effective insecticides, Dursban 20EC was the third effective insecticides. Other treatments also showed significant variation in increasing the flower number and they were- Decis 5EC (57.15%), Ripcord 10EC (49.66%), Marshal 20EC (68.10%), Sevin 85SP (49.86%), Aktara 25WG (77.55%). Comparatively, Neem oil extract was poor in effectiveness in infesting flower shedding of mungbean under field condition. The order of effectiveness is Talstar 2WP > Confidor 70WG >Dursban 20EC > Actara 25WG >Marshal 20EC > Decis 5EC >Sevin 85SP >Ripcord 10EC >Neem oil.

Table 7: Effect of chemical insecticides and neem oil on increase of flower of mungbean

Treatments	Number of total flowers/plant	% Increase of flower number over control
Decis 5EC	11.67 de	57.15 cd
Ripcord 10EC	11.08 de	49.66 de
Marshal 20EC	12.58 bcd	68.10 bcd
Sevin 85 SP	11.17 cd	49.86 de
Dursban 20 EC	13.42 b	79.68 b
Neem oil	9.67 e	30.82 e
Talstar 2 WP	16.67 a	123.5 a
Aktara 25WG	13.25 bc	77.55 bc
Confidor 70 WG	15.42 a	108.5 a
Control	7.50 f	-
LSD(0.05)	**1.59**	**21.62**
CV (%)	**7.59**	**17.43**

In a column, means having different letter(s) are significantly different at 5% level of probability by DMRT

The rate of flower increasing was significantly affected by thrips. Figure 3 showed a negative relationship between number of thrips and the rate of increase of flower. The result showed that the rate of flower increasing enhance with the decrease of thrips population but pesticide use reduced the thrips population.

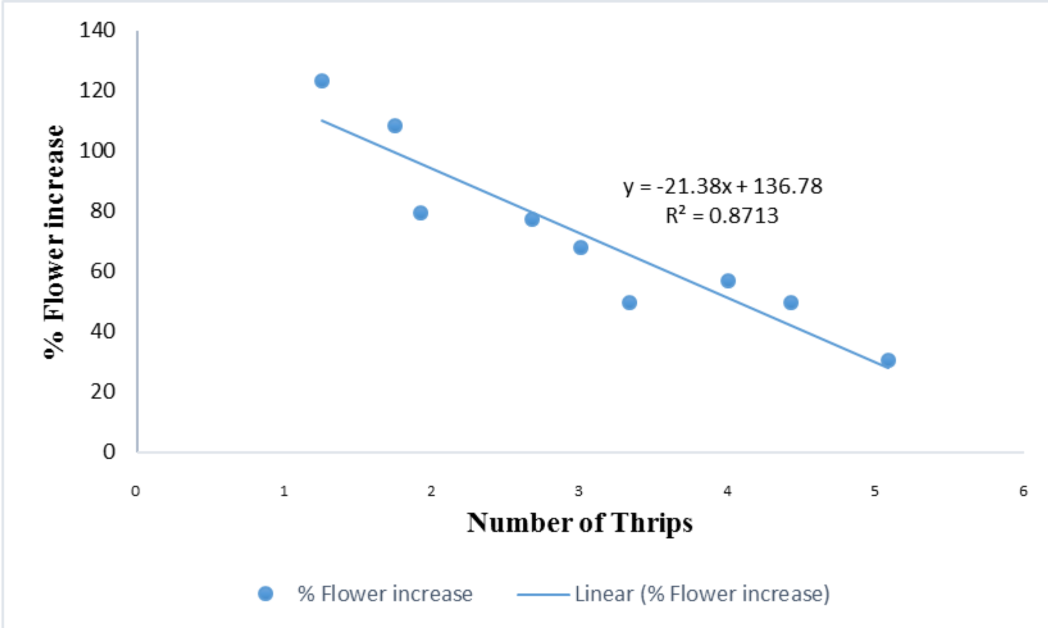

Figure 3. Effect of thrips population on flower increase percentage

4.5 Effect of chemical insecticides and neem oil on increase of pod of mungbean

The average number of pod of mungbean under different treatments has been shown in Table 8. The data highest number of pod (34.27 plant^{-1}) was observed in Talstar 2WP treated plot followed by Confidor 70WG treated plot (29.73 plant^{-1}) having significant difference between them. Dursban 20EC (29.13 plant^{-1}), Actara 25WG (28.73 plant^{-1}) and Marshal 20EC (28.27 plant^{-1}) also showed higher number of pod (Table 8). However, the lowest number of pod (18.73 plant^{-1}) was found in untreated control plot which was significantly lower than all other treated plots. Neem oil also showed lower no. of pod (22.87 plant^{-1}) than other treatments. Other insecticides gave intermediate number of pods [Decis 5EC (27.33 plant^{-1}), Ripcord 10EC (23.60 plant^{-1}) and Sevin 85SP (25.33 plant^{-1})].

Talstar 2WP (83.78%) showed the best performance in increasing of number of pod plant^{-1} over control followed by Confidor 70WG (59.30%) and Dursban 20EC (55.89%). Neem oil showed poor performance (22.57%) in increasing pod over untreated control plot. However, only Talstar 2WP gave standard level of increasing pod (80%) compared to untreated control. The results of the study revealed that all the insecticides significantly increase pod in mungbean. Talstar 2WP was the most effective insecticide in increasing the rate of pod formation and Confidor 70WG was second effective insecticides, Dursban 20EC was third effective insecticides. Other treatments also showed significant variation in increasing pod number and they were- Decis 5EC (46.68%), Ripcord 10EC (26.62%), Marshal 20EC (50.96%), Sevin 85SP (35.71%), Aktara 25WG (54.08%). Comparatively, Neem oil extract was less effective in mungbean in field condition. The order of effectiveness is Talstar 2WP > Confidor 70WG > Dursban 20EC > Actara25WG > Marshal 20EC > Decis 5EC > Sevin 85SP > Ripcord 10EC > Neem oil. These results agree with the report of Jahangir Shah *et al*. (2007) who reported that pods plant^{-1} and seed yield kg ha^{-1} varied significantly among different insecticides.

Table 8. Effect of chemical insecticides and neem oil on increase of pod of mungbean

Treatments	Number of pod/plant	% increase of pod number over control
Decis 5EC	27.33 bc	46.68 bc
Ripcord 10EC	23.60 de	26.62 d
Marshal 20EC	28.27 b	50.96 b
Sevin 85SP	25.33 cd	35.71 cd
Dursban 20 EC	29.13 b	55.89 b
Neem oil	22.87 e	22.57 d
Talstar 2WP	34.27 a	83.78 a
Aktara 25WG	28.73 b	54.08 b
Confidor 70WG	29.73 b	59.30 b
Control	18.73 f	-
LSD (0.05)	**2.42**	**13.49**
CV (%)	**5.27**	**16.11**

In a column, means having different letter(s) are significantly different at 5% level of probability by DMRT

The rate of pod increasing was significantly affected by thrips. Figure 4 showed a negative linear relationship between number of pod and number of thrips. The result showed that the pod number increased with the decreased in thrips population but using pesticide reduces the thrips population.

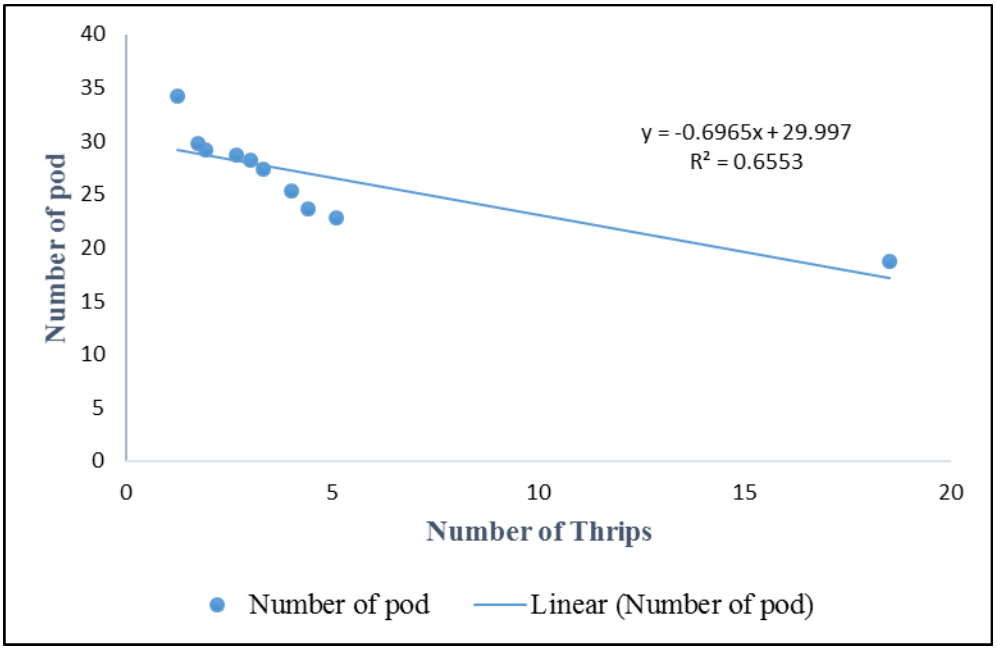

Figure 4. Effect of thrips population on increase of pod number

4.6 Effect of chemical insecticides and neem oil on yield of mungbean

4.6.1 Number of pods plant^{-5}

Number of pods plant^{-5} was significantly influenced by the effect of various chemical insecticides and neem extract where, treatment Talstar 2WP produced the maximum number of pods plant^{-5} (171.3) which resulted maximum reduction of thrips (Table 9). It was followed by Confidor 70WG (148.7 pod), Dursban 20EC (145.7 pod) and Actara 25WG (143.7 pod). Among the other treatments, the minimum number of pods plant^{-5} (93.67 pod) was recorded in untreated control plot (Table 9). Among all the insecticides used in this study, Talstar 2WP treated plots had significantly the highest yield of (2.05 kg plot^{-1}) while the lowest seed yield (1.06 kg ha^{-1}) was obtained from the untreated control plots. Other treatments gave intermediate level of pod and they were- Decis 5 EC (136.7), Ripcord 10EC (118.0), Marshal 20EC (141.3) and Sevin 85SP (128.7).

Comparatively, Neem oil extract (114.3) performed poorly in reducing in thrips infesting mungbean under field condition.

4.6.2 Number of seed (in the pod) plant^{-5}

A significant variation was found in the number of seed (in the pod) plant^{-5} due to the effect of different chemical insecticides and neem oil applied against thrips infesting mungbean. Among the treatment, Talstar 2WP @ 0.5 g l^{-1} produced the maximum number of seeds (in pod) plant^{-5} (885.3) which was closely followed by Confidor 70WG @ 0.3 g l^{-1}of water (881.7). Similarly, the minimum number of seeds (in the pod) plant^{-5} (401.7) was recorded in pods of untreated control plot which was followed by treatment T6, Neem oil @ 4 ml l^{-1}of water (638.3) (Table 9).Other treatments gave intermediate level of seed (in pods) plant^{-5} and they were- Decis 5EC (774.7), Ripcord 10EC (703.0), Marshal 20EC (826.7), Sevin 85SP (718.3), Dursban 20EC (866.0) and Actara 25WG (826.7).

4.6.3 Seed weight (g)

The maximum seed weight (36.19 g) plant^{-5} was recorded in Talstar 2WP treated plot which was followed by Confidor 70WG (33.30). The maximum number of thrips infesting in untreated control plot resulted minimum seed weight (16.57 g). Neem oil provided poor results (25.98 g) in respect of weight of seed. Other treatments resulted intermediate number of seed weight and they were- Decis 5EC (29.67 g), Ripcord 10EC (26.21 g), Marshal 20EC (31.50 g), Sevin 85SP (26.25 g), Dursban 20EC (31.65 g) and Actara 25WG (31.54 g) (Table 9).

Table 9. Effect of chemical insecticides and neem oil to manage the thrips and its impact on yield characteristics of mungbean

Treatments	Number of pod plant^{-5}	Number of seed (in pods) plant^{-5}	Seed weight (g) plant^{-5}
Decis 5EC	136.7 bc	774.7 c	29.67 d
Ripcord 10EC	118.0 de	703.0 d	26.21 e
Marshal 20EC	141.3 bc	826.7 b	31.50 c
Sevin 85SP	128.7 cd	718.3 d	26.25 e
Dursban 20EC	145.7 b	866.0 a	31.65 c
Neem oil	114.3 e	638.3 e	25.98 e
Talstar 2WP	171.3 a	885.3 a	36.19 a
Aktara 25WG	143.7 b	826.7 b	31.54 c
Confidor 70 WG	148.7 b	881.7 a	33.30 b
Control	93.67 f	401.7 f	16.57 f
LSD (0.05)	**12.85**	**21.57**	**0.92**
CV (%)	**5.58**	**1.68**	**1.85**

In a column, means having different letter(s) are significantly different at 5% level of probability by DMRT

4.6.4 Yield plot^{-1} (Kg)

The yield per plot of mungbean was affected by the application of different insecticidal treatments. The highest yield per plot was obtained by the application of Talstar 2WP (2.05 kg) followed by Confidor 70WG (1.96 kg). The lowest yield per plot was obtained in untreated control plot (1.06 kg) followed by Neem oil (1.27 kg). Other treatments gave intermediate levels of yield and they were Decis 5EC (1.68 kg), Ripcord 10EC (1.52 kg), Marshal 20EC (1.83 kg), Sevin 85SP (1.55 kg), Dursban 20EC (1.94 kg) and Actara 25WG (1.91 kg).

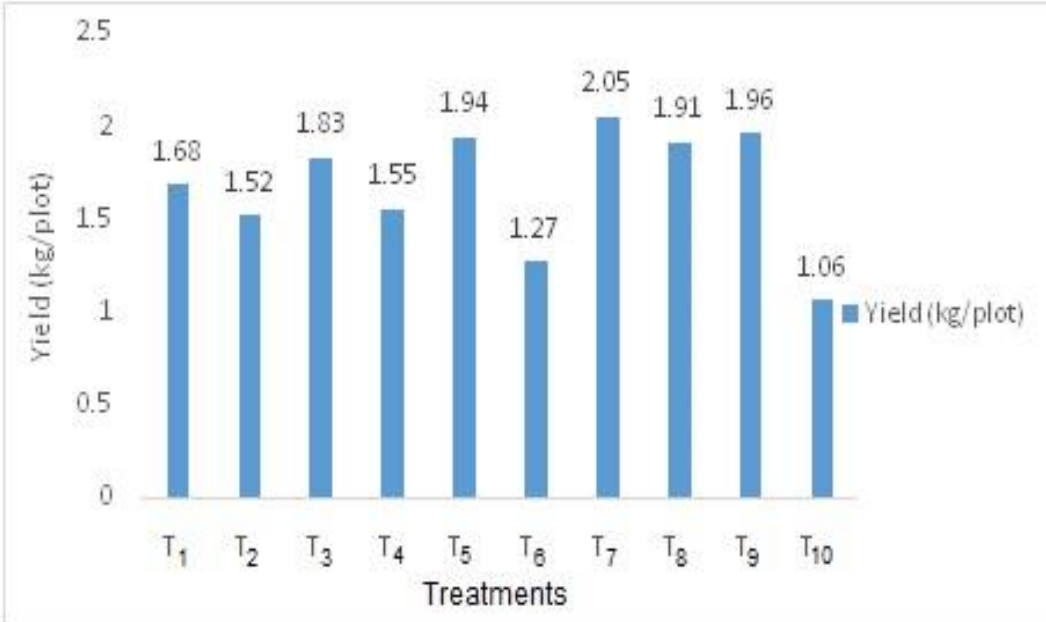

Figure 5. Effect of chemical insecticides and neem oil on yield of mungbean**.**

T_1= Decis 5EC, T_6= Neem oil, T_2= Ripcord 10EC, T_7= Talstar 2WP, T_3= Marshal 20EC, T_8= Aktara 25WG, T_4 = Sevin 85SP, T_9 = Confidor 70WG, T_5 = Dursban 20EC, T_{10} = Control

CHAPTER V

SUMMARY AND CONCLUSION

CHAPTER V

SUMMARY AND CONCLUSION

The present study was conducted at the experimental field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from March to May, 2014 for sustainable management of thrips on mungbean using chemicals and neem oil. The experiment comprised ten treatments viz. T_1= Decis 5EC @ 1.0 ml l^{-1} of water, T_2 = Ripcord 10EC @ 1.0 ml $l^{-1}$of water, T_3= Marshal 20EC @ 2.0 ml $l^{-1}$of water, T_4 = Sevin 85SP @ 2.0 ml l^{-1} of water, T_5= Dursban 20EC @ 2.0 ml $l^{-1}$of water, T_6 = Neem oil @ 4 ml l^{-1} of water + 4 g detergent, T_7= Talstar 2WP @ 0.5 g l^{-1} of water, T_8 = Actara 25WG @ 0.4 g l^{-1} of water, T_9= Confidor 70WG @ 0.3 g l^{-1} of water and T_{10}= untreated control. All insecticides and neem oil were applied at 7 days interval after initiation of Thrips in the mungbean field. Mungbean variety BARI mung 6 was grown in the field to evaluate the treatment effect on thrips. The experiment was laid out in randomized complete block design (RCBD) with three replications.

Thrips population was increased with plant age up to 8^{th} week after germination and then declined with the age of the plant. All the chemical insecticides and neem oil had significant effect on thrips attacking mungbean and reduced their population. Talstar 2WP @ 0.5 g $l^{-1}$of water was more effective against sucking thrips in terms of number of insects and percent reduction of insect pests over control. It reduced 93.26% thrips over control. Confidor 70WG showed almost similar performance in reducing thrips population (90.59%) over control. Neem oil showed only 72.55% reduction of thrips population over untreated control.

Application of treatments has significant impact on reducing the number of infested flower on mungbean. Minimum number of infested flower (0.33/plant) was found in Talstar 2WP treated plot where thrips population was the lowest. On the other hand maximum number of infested flower was found in the untreated control (4.25 $plant^{-1}$) where population of thrips was the highest. Other insecticides and plant products treated plot had significant effect on reducing infested flower.

Application of treatments also has significant impact on reducing flower shedding on mungbean. Minimum number of flower shedding (1.00 $plant^{-1}$) was found in Talstar 2WP treated plot where thrips population was the lowest. On the other hand maximum number of flower shedding was recorded in the untreated control (6.83 $plant^{-1}$) plot where population of thrips was the highest. Other insecticides and plant products treated plot had significant effect on flower shedding.

Spraying of chemical insecticides and neem oil significantly influenced the growth characteristics of mungbean. The highest number of flower (16.67 $plant^{-1}$) and the highest number of pod (34.27 $plant^{-1}$) were found from Talstar 2WP treated plot where the minimum number of thrips was found. Correspondingly, untreated control plot showed minimum number of flower (7.50 $pant^{-1}$) and minimum number of pod (18.73 $plant^{-1}$). Yield and yield contributing characters were also showed significant variation due to the effect of various chemicals and neem oil application. However, Talstar 2WP @ 0.5 g l^{-1} of water provided the higher results yield and yield contributing characteristics viz., number of pods $plant^{-5}$ (171.3), number of seeds $plant^{-5}$ (885.3), seed weight (36.19 g) and yield $plot^{-1}$ (2.05 kg). On the other hand, the minimum number of pods $plant^{-5}$ (93.67), minimum number of seeds plant^{-5} (401.7), lowest seed weight plant^{-5} (16.57g) and the lowest yield plant^{-5} (1.06 kg) were obtained in control treatment.

From the above results, it could be concluded that among all the applied chemicals and neem oil, Talstar 2WP showed the superior performance in managing thrips on mungbean as well as increasing growth and yield characteristics of mungbean. Confidor 70WG showed almost similar performance and neem oil gave poor effect on the management of thrips on mungbean.

However, based on the results of the study the following recommendations may be suggested:

1. Talstar 2WP or Confidor 70WG may be used for the management of thrips on mungbean.

CHAPTER VI

REFERENCES

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APPENDICES

Appendix I. Physical and chemical properties of the initial soil

Characteristics	Value	Critical value
Partical size analysis		
% sand	26	-
% silt	45	-
% clay	29	-
Textural class	Silty clay	-
pH	5.8	Acidic
Organic carbon (%)	0.45	-
Organic matter (%)	0.78	-
Total N (%)	0.03	0.12
Available P (ppm)	20.00	27.12
Exchangeable K (me/100g soil)	0.10	0.12
Available S (ppm)	45	-

Source: SRDI

Appendix II: Monthly record of air temperature, rainfall and relative humidity of the experimental site during the period from March 2014 to June 2014

Month	Temperature (^{0}C)		Relative humidity (%)	Rainfall (mm) (Total)
	Maximum	Minimum		
March	32.1	21.5	57	20
April	33.5	23.2	64	123
May	33.4	24.6	76	235
June	32.6	26.3	80	314

Source: Weather Station, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207.