EFFECT OF SOWING TIMES ON INCIDENCE AND DAMAGE SEVERITY OF THRIPS, *MEGALUROTHRIPS DISTALIS* (KARNY) IN MUNGBEAN

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CERTIFICATE

This is to certify that the thesis entitled, **"EFFECT OF SOWING TIMES ON INCIDENCE AND DAMAGE SEVERITY OF THRIPS, *MEGALUROTHRIPS DISTALIS* (KARNY) IN MUNGBEAN "** Submitted to Department of Entomology, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE in ENTOMOLOGY,** embodies the result of a piece of bona fide research work carried out by **TAMANNA SULTANA, Registration No. 09-03295** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated: June, 2015

Prof. Dr. Md. Abdul Latif
Department of Entomology
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The Author
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EFFECT OF SOWING TIMES ON INCIDENCE AND DAMAGE SEVERITY OF THRIPS, *MEGALUROTHRIPS DISTALIS* (KARNY) IN MUNGBEAN

ABSTRACT

The effect of sowing times on incidence and damage severity of mungbean thrips was studied during the period from January to June 2015 at the experimental field of Sher-e-Bangla Agricultural University (SAU). The experiment comprised of seven treatments viz., T_1= sowing on 31 January 2015, T_2= sowing on 10 February 2015, T_3= sowing on 20 February 2015, T_4= sowing on 2 March 2015, T_5= sowing on 12 March 2015, T_6= sowing on 22 March 2015 and T_7 = sowing on 1 April 2015. The variety, BARI mungbean 6 was used as planting material. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Data on different crop parameters, incidence and infestation of mungbean thrips, flower shedding were recorded and analyzed statistically. Different sowing dates had significant effect on growth and yield parameters, incidence of thrips and flower shedding of mungbean crop. It was found that the highest number of healthy plants (61.33), number of flowers plant^{-1} (12.22), number of total pods plant^{-1} (12.00), number of seeds pod^{-1} (11.33) and weight of seeds plant^{-1} (16.83 g) was obtained from T_6 (sowing on 22 March 2015). Again, the lowest number of mungbean thrips flower^{-1} (1.00, 2.00, 2.20, 2.50, 3.00,1.50, 2.00 and 1.20 at 25, 30, 35, 40, 45, 50, 55 and 60 DAS, respectively), infested plants (18.67), infested flower plant^{-1} (2.20) and flower shedding plant^{-1} (3.0) was recorded form the same treatment T_6 (sowing on 22 March) followed by T_7 (sowing on 1 April). Considering thrips infestation and flower shedding 22 March was the best time for sowing mungbean.

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

CHAPTER I
INTRODUCTION

Mungbean, *Vigna radiata* (L.) Wilczek belongs to the family Leguminosae and sub-family Papilionaceae, is one of the most important pulse crops in tropical and sub-tropical regions. The area under pulse crops in Bangladesh is 2,65,587 hectares with a production of 2,40,000 metric tons where mungbean is cultivated in the area of 35,312 hectares with production of 24,764 metric tons (BBS, 2013). It ranks fifth both in acreage and production and contributes 6.5% of the total pulse production in Bangladesh (Anonymous, 1998). It is considered as a quality pulse in the country but production per unit area is very low (901kg/ha) as compared to other countries of the world (BBS, 2013). The global mungbean growing area has increased during the last 20 years at an annual growth rate of 2.5% (Green and King, 1992).

The crop has many advantages in cropping system because of its rapid growth and early maturation. It can also fix atmospheric nitrogen through symbiotic relationship with soil bacteria and improve the soil fertility (Yadav *et al*., 1994). Mungbean plays an important role to supplement protein in the cereal-based low-protein diet of the people of Bangladesh but the acreage production of mungbean is gradually declining. Mungbean is considered as a poor man's meat because it is a good source of protein (Mian, 1976). It contains 51% carbohydrate, 26% protein, 10% water, 4% minerals and 3% vitamins. It is a popular crop in Bangladesh not only as a food crop but also as a fodder crop.

Mungbean is attacked by a number of insect pests which cause a heavy loss to crop. Several insect pests have been reported to infest mungbean damaging the crops during seedlings, leaves, stems, flowers, buds and pods causing considerable losses (Husain, 1993; Karim and Rahman, 1991). More than twelve species of insect pests were found to infest mungbean in Bangladesh (Anonymous, 1998), among them stemfly (Rahman, 1987), jassid (Baldev *et al*., 1988), aphid and whitefly (Rahman *et al*., 1981), thrips (Hossain *et al*., 2004), hairy caterpillar (Rahman *et al*., 1981) and pod borers (Hossain *et al*., 2004) are important. Thrips associated mostly with the damage of tender buds and flowers of mungbean (Lai, 1985). Chhabra and kooner (1985) have reported extensive damage to the mungbean due to flower shedding caused by thrips. Thrips alone cause 35-41% yield loss of cowpea (Kyamanywa, 2009).

Mungbean 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). Despite its importance, mungbean yields are greatly depressed by a complex of biotic and abiotic factors of which insect pests are the most important. Pest appearance, population fluctuation, infestation rate and crop yield are very much dependent on sowing time. Most of the farmer's usually sown mungbean just after harvesting the rabi crops without considering optimum sowing dates (Hossain *et al*., 2000). If they get free land early then they sown early or if it is late they sown late. As a result crops growth affected by unfavourable prevailing climatic condition and also crop received higher pest infestation and accordingly yields become reduced. Sowing time is one of the major non-monetary input affecting the growth and yield of field crops as well as pest incidence. It affects the duration of vegetative, reproductive and maturity periods. Dhanjal *et al*. (2000) reported that early sown mungbean (on 15 March) had a higher seed than crops sown on the other dates (31^{st} March or 16^{th} April). Ram and Dixit (2000) reported from their field trails in Faizabad (India) that early sown mungbean (30 March) produced better results in terms of growth, yield and its contributing characters. Sowing dates significantly affected aphid infestation in mungbean. Percentage of plant infestation by aphid in different dates of sowing ranged from 8.57% to 57.37% (Hossain *et al*., 2000).

Information regarding thrips incidence, infestation and its severity of damage in relation to sowing time is not available in Bangladesh especially for mungbean crops. Therefore, the present study was undertaken to fulfill the following objectives-

1. To investigate the degree attack by the thrips of mungbean, their severity of damage and its effect on grain yield in relation to variation of sowing times.

2. To find out the optimum sowing times of mungbean for low level of thrips infestation in relation with climatic factor.

CHAPTER II

REVIEW OF LITERATURE

Mungbean, *Vigna radiata* (L.) Wilczek is one of the important pulse crops in Bangladesh. It grows without less care or management practices. For that a very few studies regarding growth, development, insect pest influence and management and yield of mungbean have been carried out in our country as well as many other countries of the world. 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, among them stemfly, jassid, aphid and whitefly, thrips, hairy caterpillar and pod borers are important. Thrips associated mostly with the damage of tender buds and flowers of mungbean (Lai, 1985). For better understanding efforts have been made to review the available literature related to this pest distribution, pest status and host range, and its biology is necessary. However, some of the important and informative works regarding the incidence of mungbean thrips on different sowing times so far been done at home and abroad on this crop and their findings regarding the growth and yield of this crop have been reviewed in this chapter under the following headings and subheadings-

2.1 Thrips

Thrips, *Megalurothrips distalis* (Karny), are important pests in mungbean. They are small, slim-bodied insects with rasping-sucking mouthparts that puncture plant cells and suck out their contents. Thrips feed on flowers, petioles and stigmas causing deformity of the inflorescence and premature flower shedding (Karim and Rahman, 1991). Sachan (1986) has reported widespread thrips damage to mungbean flowers. In most seasons, damage by thrips to newly emerging pulse crops or field bean crops occurs to a greater or lesser degree. Attacks are more severe during periods of slow growth and in particular on hard soils.

2.2.1Biology

Thrips hatch from an egg and develop through two actively feeding larval stages and two non feeding stages before becoming an adult. Female, most of them are plant feeding lay eggs on leaves, buds and other locations,where larvae feeds.Thrips have several generations (upto eight) in a year. When weather is warm, life cycle completed in as short a time as two weeks (Bethke *et al*., 2014).

2.2.2 Nature of damage

Thrips are tiny, narrow bodied, black insects of the type known as thunder flies. Many generations of thrips are wingless and spend most of the year in the soil, feeding on a wide range of non-legume crops including Brassicae, linseed and sugar beet. As pulse or beans begin to emerge in the spring thrips feed inside the tightly rolled leaves of the growing point. Because feeding causes damage to the leaf surface, young leaflets appear pale and slightly distorted and if held to the light, small translucent markings are obvious. On pulse or beans, leaves may appear shiny and speckled with sooty black markings. The underside of pulse or bean leaves develop a rusty discoloration. By carefully unfolding the leaflets of affected seedlings, thrips may be found in varying numbers. In severe attacks the thrips are too numerous to count (Bethke *et al*., 2014).

Leaf damage shows blotching, expanding leaves at their worst in when cold and dry. Cosmetic damage to pods causes silvering effect. Only a problem if selling spotted peas. Also gives the leaves a ‘leathery’ look. Feeding by thrips causes tiny scars on leaves and fruit, called stippling, and can stunt growth. Damaged leaves may become papery and distorted. Infested terminals may discolour, become rolled, and drop leaves prematurely. Petals may exhibit “color break,” which is pale or dark discolouring of petal tissue that was killed by thrips feeding before buds opened. Avocado, citrus, and greenhouse thrips cause silvery to brownish, scabby scarring on the avocado and citrus fruit surface, but this cosmetic damage does not harm the internal fruit quality. Faeces may remain on leaves or fruit long after thrips have left. Where thrips lay eggs on grapes, dark scars surrounded by lighter “halos” may be found on the fruit. Thrips feeding on raspberries, apples, and nectarines can deform or scar developing fruit; sugar pea pods may be scarred or deformed (Bethke *et al*., 2014).

2.2.3 Damage of thrips on pulse and other crops

Hossain *et al*. (2009) conducted an experiment 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. It was 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 pest infestation than mid sown (March 13 to April 10) crops. The highest yield (1548 kg/ha) was obtained from March 17 sowing crop. The second highest yield (1279 kg/ha) was obtained from March 6 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's infestation, mungbean should be sown within the period of March 13 to April 10 and the best date of sowing should be March 27.

Thrips associated mostly with the damage of tender buds and flowers of mungbean (Lai, 1985). Chhabra and kooner (1985) have reported extensive damage to the mungbean due to flower shedding caused by thrips.

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

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

Islam (2009) reported that tolerance as a mechanism of resistance to the melon thrips, *Thrips palmi* Karny (Thysanoptera: Thripidae), in common beans, *Phaseolus vulgaris* L., was evaluated under field and greenhouse conditions. Seven resistant (Brunca, BH-5, BH-60, BH-130, BH-144, EMP 486, and FEB 115) and five susceptible (PVA 773, EMP 514, BAT 477, APN 18, and RAZ 136) bean genotypes were assessed according to adult and larval populations, visual damage and reproductive adaptation scores, and yield components in field trials. From these genotypes, four resistant (Brunca, BH-130, EMP 486, and FEB 115) and two susceptible (APN 18 and RAZ 136) genotypes were selected for quantification of proportional plant weight and height increase changes due to thrips infestation in greenhouse tests. Under medium to high thrips infestation in the field, most resistant genotypes tended to have higher reproductive adaptation and lower yield losses, though they did not always suffer less damage, as compared to susceptible genotypes. In the greenhouse, resistant genotypes showed less reduction in plant dry weight and height increase than did some susceptible ones under the same infestation pressure. Results from both field trials and greenhouse tests suggest the possible expression of tolerance as a mechanism of resistance to *T. palmi* in the resistant genotype EMP 486, and confirm the existence of antixenosis in FEB 115, whereas tolerance might be combined with other resistance mechanisms in Brunca .

Atakan (2008) investigated thrips (*Thysanoptera*) and their predators from 2005–2007 on a wide range of vegetables grown mostly in the winter period in Cukurova 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 Melonthrips.

Several insect pests have been reported to infest mungbean damaging the crops during seedlings, leaves, stems, flowers, buds and pods causing considerable losses (Hossain, 1993; Karim and Rahman, 1991). More than twelve species of insect pests were found to infest mungbean in Bangladesh (Anonymous, 1998), among them stemfly (Rahman 1987), jassid (Baldev *et al*., 1988), aphid and whitefly (Rahman *et al*., 1981), thrips (Hossain *et al*., 2004), hairy caterpillar (Rahman *et al*., 1981) and pod borers (Hossain *et al*., 2004) were important.

2.2.4 Individual effect of sowing times on growth and yield

Sowing time is one of the major non-monetary input affecting the growth and yield of field crops. It affects the duration of vegetative, reproductive and maturity periods. Dhanjal *et al*. (2000) reported that early sown mungbean (on 15 March) had a higher seed than crops sown on the other dates (31st March or 16th April). Ram and Dixit (2000) reported from their field trails in Faizabad (India) that early sown mungbean (30 March) produced better results in terms of growth, yield and its contributing characters.

Sangakkara (1998) reperted from Sri Lanka that late sowing of mungbean produced the lowest yields of low quality seeds. Chaudhry *et al*. (1994) found in a field experiment sown during kharif using urdbean cultivars in Uttar Pardesh

(India) that delay in sowing decreased seed yield. Similar findings were reported by Bhingarde and Dumbre (1994).

Bhoit and Nimbalkar (1997) tested different kharif season crops including greengram, that were sown on 18-25th June (early), 25th June-01st July (normal or 2nd-8th July (late). Grain yield and monetary returns were highest with the earliest sowing date and lowest with latest sowing date for all the crops.

Gobologlu *et al*. (1997) sown mungbean cultivars on 1 or 15 May or 1 or 15 June and reported that plant height was greatest with sowing on June 15 and lowest with May 15 sowing, pods/plant were highest with May 1 or June 15 sowing, seeds/ pod were higher with June than May sowing, while 1000-seeds weight and yield were highest with May 15 or June 15 sowing.

Sowing time is a major factor to influence the crop yield, earlier sowing times usually result in greater crop biomass, higher risk of lodging at the end of the season and increased risk of frost damage during flowering and pod setting. However, these risks can be outweighed by a longer growing season and subsequently higher yield potential. The optimum sowing time for maximizing yield varies with location. They also reported significant effects on crop biomass and grain yield due sowing on different dates (Hossain *et al*., 2009).

Crowder *et al*. (2010) reported that early flowering and podding cultivars had significantly higher green yields. Fresh yield measured at 75 days after sowing was far below those expected for late maturing chickpea crops. They also recommended 15 November to 15 December at a proper sowing time for chickpea.

The chickpea sown on 30th November may yield 10-20 percent higher than the crop sown on 15^{th} November or 15^{th} December.

2.2.5 Incidence of different insect pest on different sowing times

Kethran *et al*. (2014) conduct an experiment to observe the activity of insect pests of chilli crop using variety P-777 with four sowing dates, January 15^{th} (SD_1), January 30^{th} (SD_2), February 15^{th} (SD_3) and February 28^{th} (SD_4). The observation of insect pests was recorded at weekly intervals from first week of transplanting up to maturity. The results showed that the maximum mean aphids, thrips, jassids whitefly and fruit borer population of 0.527, 3.68, 0.46, 5.49 and 0.427 $leaf^{-1}$ were found in SD_4 and minimum of 0.36, 1.83, 0.01, 3.41 and 0.27 $leaf^{-1}$ were present in SD_1. However, the maximum bud mites population (0.381 $leaf^{-1}$) was observed in SD_1 followed by 0.26 mites $leaf^{-1}$ in SD_2 and minimum was found in SD_3 and SD_4 respectively. As regards to green pod yield, the finding of this study showed that maximum pod yield of 2.71t ha^{-1} was produced in SD_1 followed by 2.50 t ha^{-1} in SD_2 and minimum yield of 1.72 $leaf^{-1}$ was achieved in SD_4. It is inferred that early sowing (January 15^{th} or January 30^{th}) resulted in lower incidence of aphids, thrips, whitefly and fruit borer except mites. Such low level of insect pest caused less crop injury which resulted in enhancing the green pod yield of chilli. So, it is suggested that for early sowing the appropriate planting time can be January 15^{th} and January 30^{th}.

Mohamed (2011) studied during two successive seasons (2009 and 2010) considering the effect of four planting dates of squash seeds (March 15^{th}, April 1^{st}, April 15th and May 1st) on levels of infestation with three pests, aphid (*Aphis gossypii*), whitefly (*Bemisia tabaci*) and thrips (*Thrips tabaci*) and on yield of this plant. The degree of infestation by these pests increased significantly by delaying planting date, as squash plants cultivated in the earliest planting date (March, 15th) were attacked by the fewest numbers with highest weight of squash fruits, while the plants of the latest planting date (May, 1st) were more liable to insects infestation with lowest weight of squash fruits. The results showed that, the mean rate of infestation with *A. gossypii* were (2.82, 4.07, 17.27 and 30.78 individuals/leaf) during 2009 season, (0.28, 3.35, 9.04 and 13.27 individuals/leaf) during 2010 season for the four dates, respectively. So, the earliest date (March 15th) led to plants harboured the lowest population of A. gossypii (2.82 and 0.28 individuals/leaf in the two seasons, respectively), also, the highest weight of squash fruits (9.39 and 10.89 kg/plot in the two seasons, respectively) was obtained. The same trend were recorded for the populations of *B. tabaci* and *T. tabaci* on squash plants during the two seasons. Therefore, it was concluded that, the plant date was effective on the rate of infestation with pests, pest population and yield of squash plants and can be avoided by planting it as early as March 15th. Sowing dates significantly affected aphid infestation in mungbean. Percentage of plant infestation by aphid in different dates of sowing ranged from 8.57% to 57.37%. The highest percentage (57.37%) of plant infestation was observed in February 21 sowing crops followed by February 14 and February 28. Aphid infestation was lower in those crops sown in March than those of February sowings. The lowest percentage (8.57%) of plant infestation was observed in April 03 sowing crop which was statistically identical to March 20, April 10, April 17, April 24 and May 01. Generally, it is seen that aphid infestation was higher in February sowings crops followed by March, April and May sowings. This might be due to lower temperature in early sowings crops which favoured population increase to higher infestation.

Hossain *et al*. (2000) reported that aphid infestation in lentil varied significantly depending on sowing time. The relative abundance of lentil aphid was investigated at different sowing dates (21 November, 28 November, 5 December and 12 December) during rabi seasons in Ishurdi. Lentil aphid appeared in the field in the first week of January. The crop sown in November received less aphid infestation and consequently produced higher yield than the crop sown in December and found that to protection measures taken against aphids and this was also dependent on the different dates of sowing.

Sowing time is a major factor to influence the crop yields, earlier sowing times usually result in greater crop biomass, higher risk of lodging at the end of the season and increased risk of frost damage during flowering and pod setting. However, these risks can be outweighed by a longer growing season and subsequently higher yield potential. The optimum sowing time for maximizing yield varies with location (Hashmi and Hassal, 1988). The early sown crops can suffer from lodging due to excessive vegetative growth. This was particularly evident in the early May sown crops; and the taller cultivars Howzat and Jimbour were more susceptible to lodging; this would be of concern on better soil types such as the grey clay in seasons of higher yield potential (Amer *et al*., 2009).

Pod damaged by pod borer varied significantly due to different sowing dates. The lowest pod damage (9.25%) was observed in March 27 sowing crops which was statistically identical to February 14, February 21 and March 13 sowing crop. The highest pod damage (38.54%) was observed in May 01 sowing crops which was statistically identical to April 17 and April 24 sowing crops. It is seen that in February and March sowing crop pod borer damage was comparatively low than that of April and May sowing crops. This might be due to higher rainfall in April-May sowings favouring pod borer population increase caused higher pod infestation. Jayaramiah and Babu (1990) reported rainfall as the influencing factor of pod borer moth emergence as well as higher pod borer infestation.

Relative abundance of lentil aphid, *Aphis craccivora* Koch were investigated and yield loss assessment at different sowing dates during rabi season of 1999-2000 and 2000-2001 at Ishurdi Bangladesh. Lentil aphid appeared in field in the first week of January. The maximum aphid population (15.82/twig) was recorded in the first week of February 2000-2001, but the population reached to the peak was in the last week of January in 1999-2000, subsequently rainfall caused a sudden reduction of aphid population in latter dates. Aphid population and infestation increased with the delayed dates of sowing. The crop sown in November received less aphid infestation and consequently produced higher yield than the crop sown in December. During 1999-2000, the avoidable yield loss due to aphid infestation was recorded 0.90 to 6.78% and in 2000-2001 it was 2.65 to 9.00% depending on the different dates of sowing. Avoidable yield loss was less in November sowing crop than the crop sown in December. On the other hand, yield increased by 0.91 to 7.27% and 2.72 to 9.89% in 1999- 2000 and 2000-2001 respectively, due to protection measures taken against aphids and this was also depend on different dates of sowing (Hossain *et al*., 2006).

Timely sown rapeseed and mustard crops were less infested with aphids than late planted crops (Prasad and Lal, 2001), and yields were higher due to low aphid attack (Khattak and Hamed, 1993). Delay in sowing of rapeseed and mustard exposed the crops to higher levels of aphids reducing the yield harvests. Therefore, early and timely sowing was recommended to escape aphid severity (Saljoqi *et al*., 2006).

Early sown mustard crops from mid-October to early November yielded higher by avoiding aphid populations on these crops in Bangladesh (Rahman *et al*., 1989) and in Indian states i.e., Madhya Pradesh and Maharashtra (Bhadauria *et al*., 1992). Similarly, in Assam, early sown toria crop (*Brassica campestris*) from 25th October to 15th November gave higher yields by escaping the aphid invasion (Yein, 1985).

Research work from different parts of Pakistan (Saljoqi *et al*., 2006) on time of sowing in relation to insect pest attack has little value in southern Punjab. From southern Punjab, no work was cited on planting dates, however, Aslam *et* *al*.,(2007) studied raya crop (*Brassica juncea*) and they used two sowing dates in two different crop years (mid October in year 2002 and early November in year 2003). They did not report any other insect pest except two aphid species, ie., cabbage aphids and turnip aphids. Research on other *Brassica* crops has rarely been examined the effect of sowing date within a season on pest abundance.

Dhurve and Borle (1986) cited that the pod damage in mungbean by *H. armigera* was the lowest when the crop was sown between 30 October and 4 December. The yield was significantly higher in 30 October and 27 November sowings.

The optimum sowing date results in flowering occurring when the risk of cold temperatures is low, and it is especially important to avoid frost during flowering, which can kill chickpea plants (Hashmi and Hassal, 1988). Earlier sowing can expose the crop to more rain events which can increase the disease risk (Amer *et al*., 2009).

Sandhu *et al*. (2007) reported that early flowering and podding cultivars had significantly higher green yields. Fresh yield measured at 75 days after sowing was far below those expected for late maturing chickpea crops. Singh *et al*. (2011) recommended 15 November to 15 December at a proper sowing time for chickpea. The chickpea sown on 30th November may yield 10-20 percent higher than the crop sown on 15th November or 15th December.

Bashir *et al*. (2008) also reported varied performance of chickpea varieties under similar input and management conditions.

Sowing time is a major factor to influence the crop yields; earlier sowing times usually result in greater crop biomass, higher risk of lodging at the end of the season and increased risk of frost damage during flowering and pod setting. However, these risks can be outweighed by a longer growing season and subsequently higher yield potential. The optimum sowing time for maximizing yield varies with location (Hossain *et al*., 2009). They also reported significant effects on crop biomass and grain yield due sowing on different dates. Crowder *et al*. (2010) reported that early flowering and podding cultivars had significantly higher green yields. Fresh yield measured at 75 days after sowing was far below those expected for late maturing chickpea crops. They also recommended 15 November to 15 December at a proper sowing time for chickpea. The chickpea sown on 30th November may yield 10-20 percent higher than the crop sown on 15^{th} November or 15^{th} December.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted to study the effect of sowing time on incidence and damage severity of mungbean thrips during the period from January to June 2015. A brief description of the experimental site, soil, climate, experimental design, treatments, cultural operations, data collection and analysis of different parameters under the following headings are presented below-

3.1 Experimental site

The experiment was conducted at the central farm of SAU Sher e Bangla Nagar, Dhaka, Bangladesh, which is situated in $23^0 74'$ N latitude and $90^0 35'$ E longitude (Anonymous, 1989) (Plate 1).

Plate 1. Experimental Field

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 1.

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 2.

3.4 Planting material

BARI Mung-6 was used as the test crop of this experiment. The seeds were collected from Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur.

.**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. During land preparation 10 t ha^{-1} decomposed cowdung were mixed with soil.

3.6 Manures and fertilizers application

Urea, Triple super phosphate (TSP) and Muriate of Potash (MoP) were used as a source of nitrogen, phosphorous and potassium, respectively. Urea, phosphate and potash were applied at the rate of 40, 40 and 50 kg per hectare, respectively following the BARI recommendation. The entire amount of TSP and MP was applied as basal dose at the time of land preparation. Urea was applied as top dressing in three equal splits at vegetative stage and early and mid fruiting stage.

3.7 Sowing of seeds in the field

The seeds of mungbean were sown as per treatment. Before sowing seeds were treated with fungicide Bavistin to control the seed borne disease. The seeds were sown in furrows having a depth of 2-3 cm. Row to row distance was 30 cm. Light irrigation was applied for proper germination of seeds.

3.8 Treatments of the experiment

Seven planting times were considered as the treatments of the present study. The treatments are as follows –

T_1	=	Sowing on 31 January	T_5	=	Sowing on12 March
T_2	=	Sowing on10 February	T_6	=	Sowing on 22 March

T_3 = Sowing on 20 February T_4 = Sowing on 2 March	T_7 = Sowing on 1 April

3.9 Layout and design of experiment

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The whole experimental field was divided into three equal blocks and each block was divided into seven plots. Thus there were 21 (7×3) unit plots altogether in the experiment. The size of each unit plot was 6.0 m^2 (3.0 m × 2.0) m. The distance between Block to Block and plot to plot was 1.0 m. The treatments of the experiment were randomly distributed among the experimental plots of each block. Randomization was done separately for each block. The layout of the experimental plot has been presented in Figure 1.

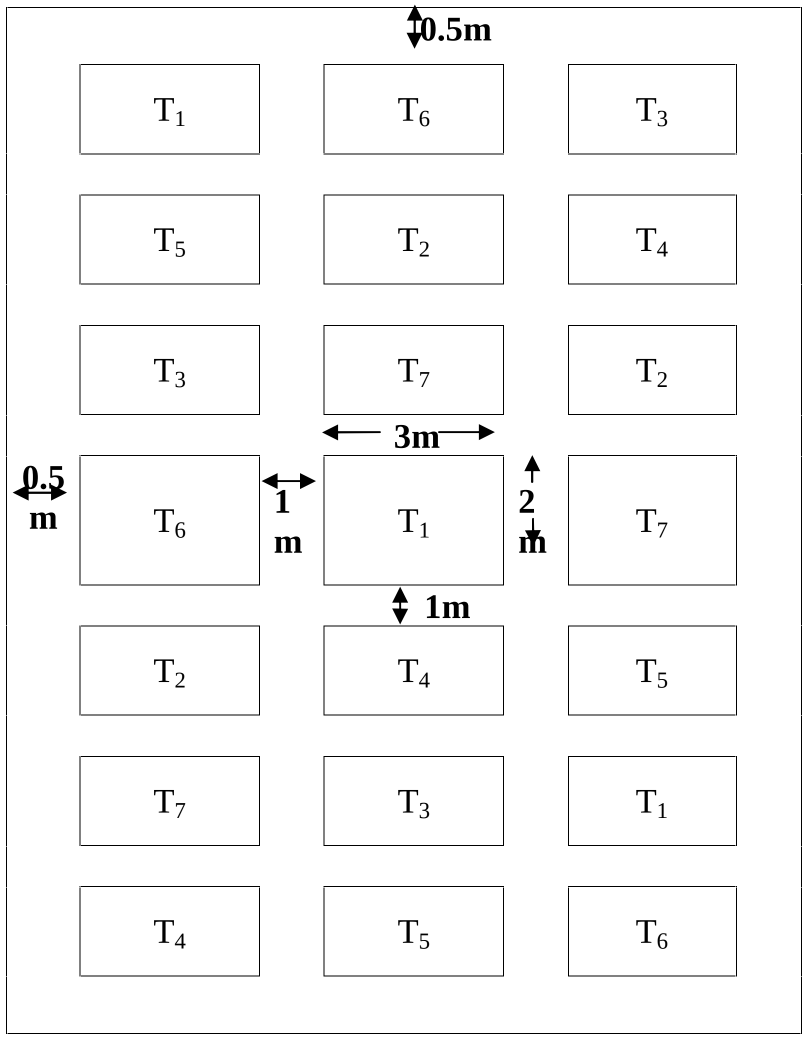
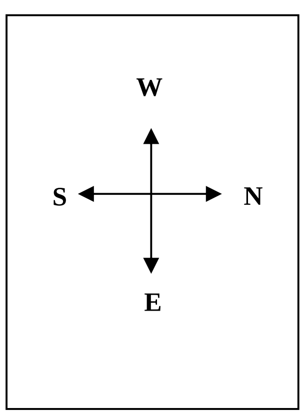


Figure 1: Layout of experiment



T_1 = sowing on 31 January	
T_2 = sowing on 10 February	
T_3 = sowing on 20 February	
T_4 = sowing on 2 March	
T_5 = sowing on 12 March	
T_6 = sowing on 22 March	
T_7 = sowing on 1 April	

3.10 Intercultural operations

3.10.1 Thinning out

Emergence of seedling was completed within 10 days after sowing. Over crowded seedlings were thinned out two times. First thinning was done after 15 days of sowing which was done to remove unhealthy and lineless seedlings. The second thinning was done 10 days after first thinning.

3.10.2 Weeding

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

3.10.3 Irrigation and drainage

First irrigation was done at after first weeding. Subsequent irrigation was applied as when irrigation needed. Proper drainage system was also developed for draining out excess water.

3.11 Crop sampling and data collection

Ten plants from each treatment were selected randomly inside the central row of each plot and marked with the help of sample card for data collection on different parameters.

3.12 Monitoring and data collection

The mungbean plants of different treatments were closely examined at regular intervals commencing from germination to harvest. The following parameters were considered during data collection –

1. Number of flowers plant^{-1}
2. Number of infested flowers plant^{-1}
3. Number of healthy plant
4. Number of infested plant
5. Number of shedding flower plant^{-1}
6. Number of thrips flower^{-1}
7. Number of total pods plant^{-1}
8. Number of seeds pod^{-1}
9. Weight of seeds plant^{-1}

3.12.1 Number of flowers plant^{-1}

Number of total flowers of selected plants from each plot was counted and the mean number was expressed on plant^{-1} basis. Data were recorded as the average of 10 plants selected at random from the inner rows of each plot.

3.12.2 Number of infested flowers plant^{-1}

Total number of infested flowers of selected plants from each plot was counted and the mean number was expressed on plant^{-1} basis. Data were recorded as the average of 10 plants selected at random from the inner rows of each plot.

3.12.3 Number of healthy plant

Mungbean plants free from thrips infested flowers were considered as healthy plants. Number of healthy plants was identified and was counted from each plot. Then average number of healthy plants were calculated from these date.

3.12.4 Number of infested plant

Number of infested plants was identified and was counted from each plot. Then average number of infested plants were calculated from these date.

3.12.5 Number of flower shedding plant^{-1}

Total number of flower shedding from 10 selected plants of each plot was counted and the mean number was expressed on plant^{-1} basis.

Plate 2. Flower shedding of mungbean

3.12.6 Number of thrips flower^{-1}

Total number of thrips was recorded from total flowers of randomly selected 10 plants. Then average number of thrips flower^{-1} was calculated.

3.12.7 Number of total pods plant^{-1}

All pods were separated from 10 sample plants and the total number of pods were counted and recorded. Average number of pods per plant was calculated.

3.12.8 Number of seeds pod^{-1}

Number of seeds pod^{-1} was recorded after harvesting of the crop from the 10 randomly selected pods. The seed plant^{-1} was calculated from their mean values.

3.12.9 Weight of seeds plant^{-1}

At first total number of seeds was collected from 10 randomly selected plants from each plot. Seeds were properly sun-dried and their weights recorded. Weight of seeds was then converted to g plant^{-1}.

3.12.10 Percent flower infestation

Percent number of infested flowers plant^{-1} was calculated using the following formula- .

$$\%\text{ flower infestation plant}^{-1} = \frac{\text{Number of infested flowers plant}^{-1}}{\text{Total number of flowers plant}^{-1}} \times 100$$

3.12.11 Percent plant infestation

Percent plant infestation was calculated using the following formula:

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

3.12.12 Percent flower shedding plant^{-1}

Percent number of flower shedding plant^{-1} was calculated using the following formula:

$$\% \text{ flower shedding plant}^{-1} = \frac{\text{Number of flower shedding plant}^{-1}}{\text{Total number of flowers plant}^{-1}} \times 100$$

3.13 Statistical analyses

The data on different parameters as well as incidence of thrips were statistically analyzed to find out the significant differences among the effects of different treatments. The mean values of all the characters were calculated and analyses of variance were performed by the ‘F’ (variance ratio) test using computer based MSTAT-C program. 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

The study was conducted to evaluate the effect of sowing time on incidence and damage severity of mungbean thrips at the farm of SAU, Sher-e-Bangla Nagar, Dhaka during the period from January to June 2015. The analyses of variance (ANOVA) of the data on different parameters with thrips infestation considering different sowing date are given in Appendix 3-8. The results have been presented and discussed, and possible interpretations have been given under the following headings:

4.1 Number of flowers plant^{-1}

Significant variation was found on number of flowers plant^{-1} in respect of different sowing dates (Table 1). The results showed that the highest number of flowers plant^{-1} (12.22) was found in T_6 (sowing on 22 March) followed by 11.00 in T_2 (sowing on 10 February) having significant difference between them. But T_2 (sowing on 10 February), T_4 (sowing on 2 March) and T_7 (sowing on 1 April) had no significant difference among them. On the other hand, the lowest number of flowers plant^{-1} (9.28) was found in T_1 (sowing on 31 January) followed by 10.22 in T_3 (sowing on 20 February) having significant difference between them. But T_3 (sowing on 20 February) and T_5 (sowing on 12 March) had no significant difference between them. The data also indicate that comparatively higher number of flowers plant^{-1} was observed with late sown crops than early sown crops.

4.2 Number of infested flowers plant^{-1}

Number of infested flowers plant^{-1} caused by mungbean thrips varied significantly variation at different sowing dates (Table 1). The data demonstrate that the lowest number infested of flowers plant^{-1} (2.20) was found in T_6 (sowing on 22 March) which was statistically identical with 2.30 in T_7 (sowing on 1 April) having no significant difference between them. In contrast the highest number infested flowers plant^{-1} (4.22) was observed in T_2 (sowing on 10 February) followed by 4.00 in T_1 (sowing on 31 January) without any significance difference between them. Moreover no significant difference was found between T_3 (sowing 20 February) and T_4 (sowing on 2 March) but significantly varied with others. It was also revealed that late sown crops (sowing after 12 March) had lower level of flower infestation than early sown crops.

4.3 Percent flower infestation

Significant effect was observed by different sowing time on percent flowers infestation plant^{-1} caused by mungbean thrips (Table 1). The data revealed that the lowest percent flower infestation plant^{-1} (18.00) was found in T_6 (sowing on 22 March) which was statistically similar with T_7 (sowing 1 April) having 20.50% flower infestation and no significant difference was observed between them. On the other hand, the highest percent flower infestation plant^{-1} (43.10%) was recorded in T_1 (sowing on 31 January) followed by 38.36% in T_2 (sowing 10 February) having significant difference between them.

The above result indicates that mungbean sowing on 22 March (T_6) had low level flower infestation followed by T_7. In contrast early sowing mungbean crops [sowing on 31 January (T_1) and sowing on 10 February (T_2)] had high level flower infestation. This result agrees with findings of Sachan (1986) who reported that widespread thrips damage to mungbean flowers. It also support the findings of Mohamed (2011) who studied the damage of thrips on squash in four planting dates (March 15, April 1, April 15, May 1) and reported that planting after 15 March had less infestation than planting on other dates. The results may vary with others due to climatic variations and other factors.

Table 1. Flower infestation caused by mungbean thrips at different sowing times

Treatments	Number of flowers plant^{-1}	Number of infested flowers plant^{-1}	% flower infestation
T_1	9.28 d	4.00 a	43.10 a
T_2	11.00 b	4.22 a	38.36 b
T_3	10.22 c	3.50 b	34.25 c
T_4	11.22 b	3.50 b	31.19 d
T_5	10.00 c	3.00 c	30.00 d
T_6	12.22 a	2.20 d	18.00 e
T_7	11.22 b	2.30 d	20.50 e
LSD $_{(0.05)}$	**0.28**	**0.31**	**2.53**
Level of significance	**0.05**	**0.05**	**0.05**
CV (%)	**4.71**	**5.43**	**5.25**

Data are the average of seven observations and three replications. In a column, means having same letter(s) statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability by DMRT.

T_1 = Sowing on 31 January
T_2 = Sowing on 10 February
T_3 = Sowing on 20 February
T_4 = Sowing on 2 March
T_5 = Sowing on 12 March
T_6 = Sowing on 22 March
T_7 = Sowing on 1 April

4.4 Number of healthy plant

Mungbean plant free from infested flower was considered as healthy plant in this study. Effect of different sowing dates on plant infestation caused by mungbean thrips had significant effect (Table 2) in terms of number of healthy plants plot^{-1}. The result revealed that among total of 80 plants plot^{-1}, the highest healthy plants (61.33) was found in T_6 (sowing on 22 March) which was followed by 59.33 in T_5 (sowing on 12 March) having significant difference between them. But T_5 (sowing on 12 March) and T_7 (sowing on 1 April) had no significant difference between them. On the contrary, the lowest healthy plant (47.00) was found in T_1 (sowing on 31 January) which was followed by 49.00 in T_2 (sowing on 10 February) having significant difference between them. But T_2 (sowing on 10 February) and T_3 (sowing on 20 February) had no significant difference between them. Thus comparatively higher number of healthy plants was observed with late sown mungbean than early sown mungbean.

4.5 Number of infested plant

Mungbean plant having infested flower was considered as infested plant in this study. Significant variation was found on number of infested plant caused by mungbean thrips in respect of different sowing dates (Table 2). The result revealed that out of 80 plants plot^{-1}, the lowest number of infested plants (18.67) was found in T_6 (sowing on 22 March) which was followed by 20.67 in T_5 (sowing on 12 March) and 20.67 in T_7 (sowing on 1 April) having significant difference among them. Again, the highest number of infested plants (33.00) was found in T_1 (sowing on 31 January) which was followed by 31.00 in T_2 (sowing on 10

February) having significant difference between them. However, no significant difference was observed between T_2 (sowing on 10 February) and T_3 (sowing on 20 February). Thus comparatively higher number of infested plants was observed with early sown mungbean than late sown mungbean.

4.6 Plant infestation

Percent (%) plant infestation caused by mungbean thrips was significantly varied in different sowing dates (Table 2). The result demonstrated that the lowest percent plant infestation (23.33%) was found in T_6 (sowing on 22 March) which was followed by 25.83% in T_5 (sowing on 12 March) and T_7 (sowing on 1 April) having significant variation among them. On the contrary, the highest percent plant infestation (41.25%) was found in T_1 (sowing on 31 January) which was followed by 38.25% in T_2 (sowing on 10 February) having significant variation between them. However no significant variation was found between T_2(sowing on 10 February) and T_3 (sowing on 20 February).

The above result indicates that mungbean sowing on 22 March (T_6) had low level of thrips infestation (23.33%) followed by sowing on 1 April (T_7) and 12 March (T_5). The result agrees with the findings of Hossain *et al*. (2009) who reported that mungbean sowing on early (February 14 to March 6) and late sown (mid April to onward) had higher pest infestation than mid sown (March 13 to April 10).

Table 2. Plant infestation caused by mungbean thrips at different sowing times

Treatments	Total number observed plants plot^{-1}	Number of healthy plants plot^{-1}	Number of infested plants plot^{-1}	Percent plant infestation
T_1	80	47.00 e	33.00 a	41.25 a
T_2	80	49.00 d	31.00 b	38.25 b
T_3	80	49.75 d	30.25 b	37.81 b
T_4	80	57.33 c	22.67 c	28.33 c
T_5	80	59.33 b	20.67 d	25.83 d
T_6	80	61.33 a	18.67 e	23.33 e
T_7	80	59.33 b	20.67 d	25.83 d
LSD $_{(0.05)}$	**--**	**3.93**	**4.93**	**2.69**
Level of significance	**--**	**0.05**	**0.05**	**0.05**
CV (%)	**--**	**5.81**	**8.55**	**7.67**

Data are the average of seven observations and three replications. In a column, means having same letter(s) statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability by DMRT.

T_1	=	Sowing on 31 January	T_5	=	Sowing on 12 March
T_2	=	Sowing on 10 February	T_6	=	Sowing on 22 March
T_3	=	Sowing on 20 February	T_7	=	Sowing on 1 April
T_4	=	Sowing on 2 March			

4.7 Number of flower shedding plant^{-1}

Effect of different sowing time on number of shedding flowers plant^{-1} had significant effect (Table 3). It was observed that comparatively higher number of flowers shedding plant^{-1} was observed with early sown mungbean where lower number flowers shedding plant^{-1} were found in late sown mungbean. Under the present study, result revealed that the lowest number flowers shedding plant^{-1} (3.00) was found in T_6 (sowing on 22 March) and T_7 (sowing on 1 April) followed by 3.28 in T_5 (sowing on 12 March) having significant difference among them . On the other hand, the highest number of flower shedding plant^{-1} (5.00) was found in T_2 (sowing on 10 February) followed by 4.50 in T_4 (sowing on 2 March) having significant difference among them.

4.8 Percent flower shedding plant^{-1}

Effect of different sowing time had significant effect on percent flower shedding plant^{-1} caused by mungbean thrips (Table 3). The result revealed that the lowest percent flower shedding plant^{-1} (24.55) was found in T_6 (sowing on 22 March) followed by 26.74% in T_7 (sowing on 1 April) having significant difference between them. In contrast, the highest percent of flower shedding plant^{-1} (45.45%) was found in T_2 (sowing on 10 February) followed by 43.10% in T_1 (sowing on

31 January) and 41.29% in T_3 (sowing on 20 February) having significant difference among them . The results obtained from T_4 (sowing on 2 March) and T_5 (sowing on 12 March) showed intermediate results.

The above result indicates that mungbean sowing on 22 March (T_6) had low level flower shedding followed by 1 April (T_7). Mungbean sowing on 10 February (T_2) had high level flower shedding followed by 31 January (T_1). This result agrees with findings of Chhabra and Kooner (1985) who reported extensive damage to the mungbean due to flower shedding caused by thrips.

Table 3. Flower shedding plant^{-1} caused by mungbean thrips at different times

Treatments	Number of flowers plant^{-1}	Number of flower shedding plant^{-1}	Percent flower shedding plant^{-1}
T_1	9.28 d	4.00 d	43.10 b
T_2	11.00 b	5.00 a	45.45 a
T_3	10.22 c	4.22 c	41.29 c
T_4	11.22 b	4.50 b	40.11 c
T_5	10.00 c	3.28 e	32.80 d
T_6	12.22 a	3.00 f	24.55 f
T_7	11.22 b	3.00 f	26.74 e
LSD $_{(0.05)}$	**0.28**	**0.18**	**1.86**
Level of significance	**0.05**	**0.05**	**0.05**
CV (%)	**4.71**	**7.25**	**6.32**

Data are the average of seven observations and three replications. In a column, means having same letter(s) statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability by DMRT.

T_1	=	Sowing on 31 January	T_5	=	Sowing on 12 March
T_2	=	Sowing on 10	T_6	=	Sowing on 22 March

		February			
T_3	=	Sowing on 20 February	T_7	=	Sowing on 1 April
T_4	=	Sowing on 2 March			

4.9 Trend of thrips population incidence at different sowing times

The trends of thrips population incidence at different sowing times have presented graphically from Figure 2-8.

4.9.1 Thrips population trend in mungbean sowing on 31 January

The trend of population incidence of mungbean thrips sowing on 31 January has shown in Figure 2. The graph shows that population of thrips gradually increased with the age of mungbean and reached at peak 40 days after sowing (DAS) then declined rapidly at 50 DAS. Again it was increased and then declined with the age of the crops. The cause of population decline at 50 DAS was rainfall.

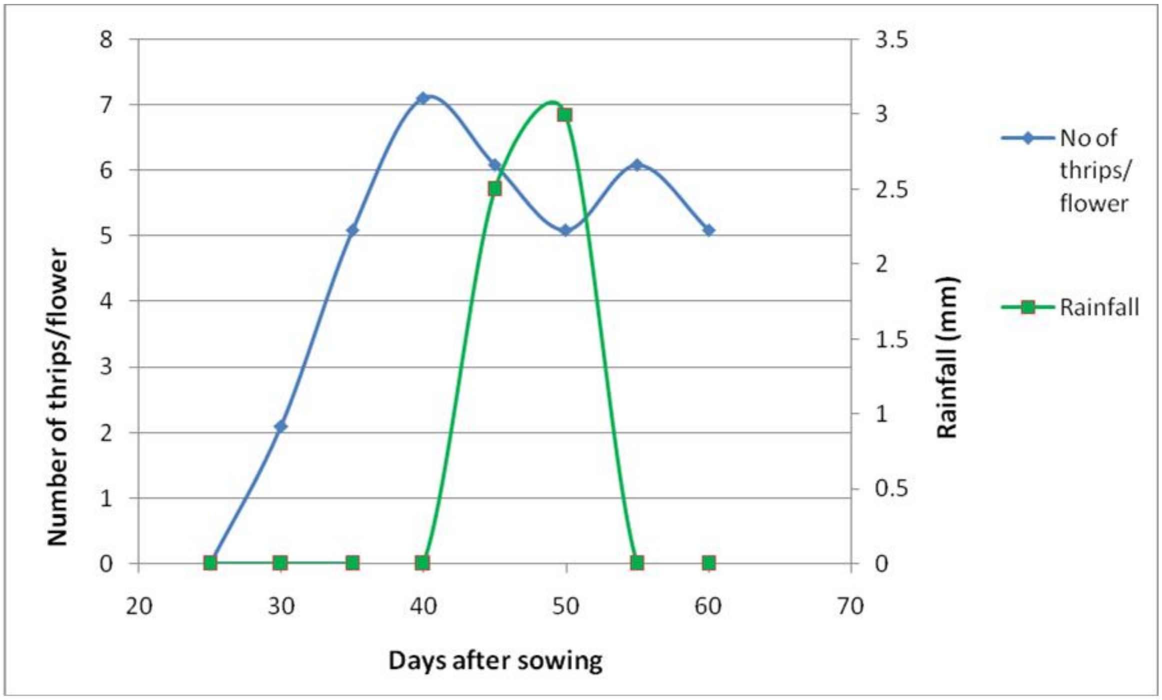


Figure 2. Trend of thrips population on mungbean flower sowing on 31 January.

4.9.2 Thrips population trend in mungbean sowing on 10 February

The trend of population incidence of mungbean thrips sowing on 10 February has shown in Figure 3. The graph shows that population of thrips gradually increased with the age of mungbean and reached at peak 45 DAS then declined rapidly at 50 DAS. Again it was increased and then declined with the age of the crops. The cause of population decline at 50 DAS was rainfall.

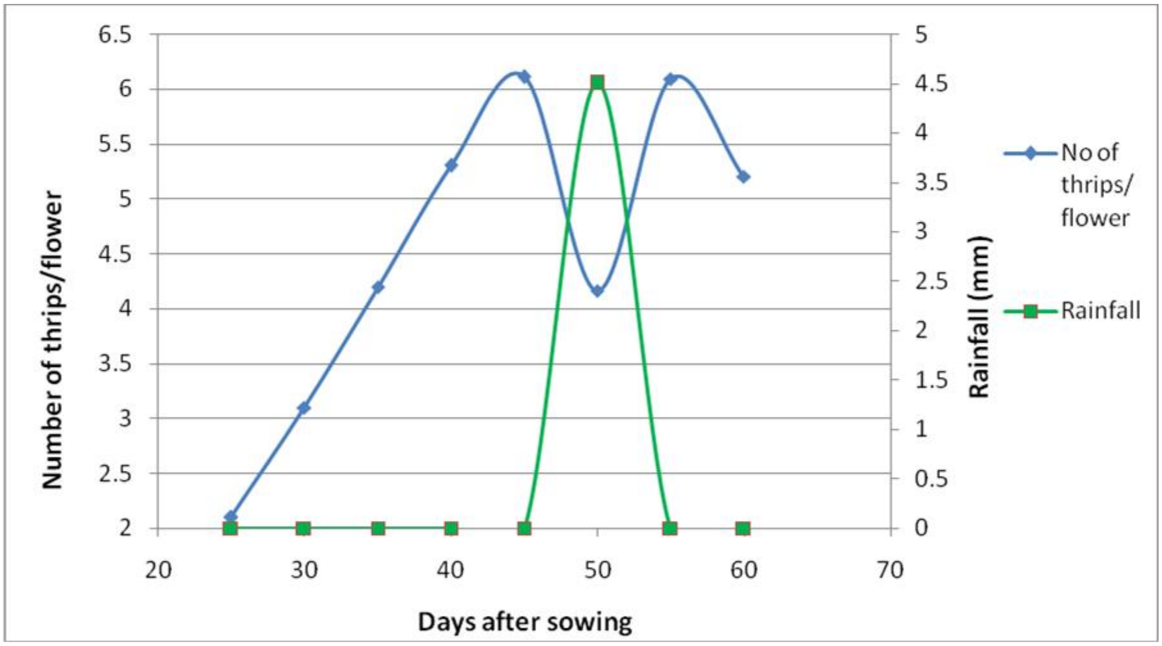


Figure 3. Trend of thrips population on mungbean flower sowing on 10 February .

4.9.3 Thrips population trend in mungbean sowing on 20 February

The trend of population incidence of mungbean thrips sowing on 20 February has shown in Figure 4. The graph shows that population of thrips gradually increased with the age of mungbean and reached at peak 50 DAS then declined rapidly at 60 DAS.

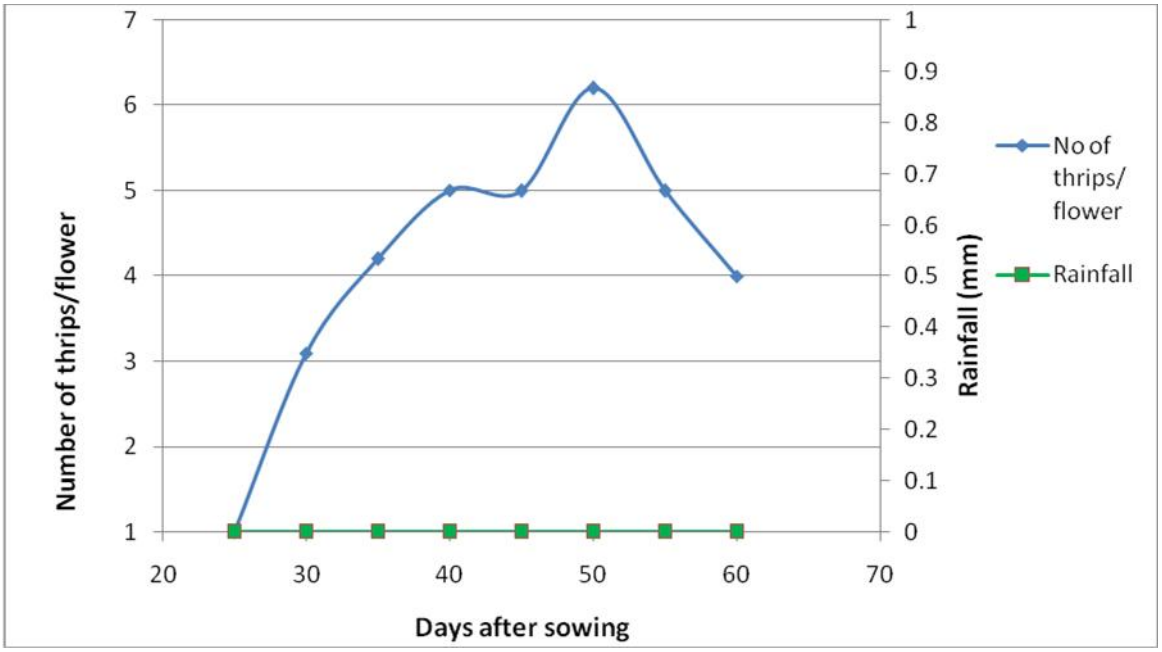


Figure 4. Trend of thrips population on mungbean flower sowing on 20 February.

4.9.4 Thrips population trend in mungbean sowing on 2 March

The trend of population incidence of mungbean thrips sowing on 2 March has shown in Figure 5. The graph shows that population of thrips gradually increased with the age of mungbean and reached at peak 45 DAS then declined rapidly at 60 DAS.

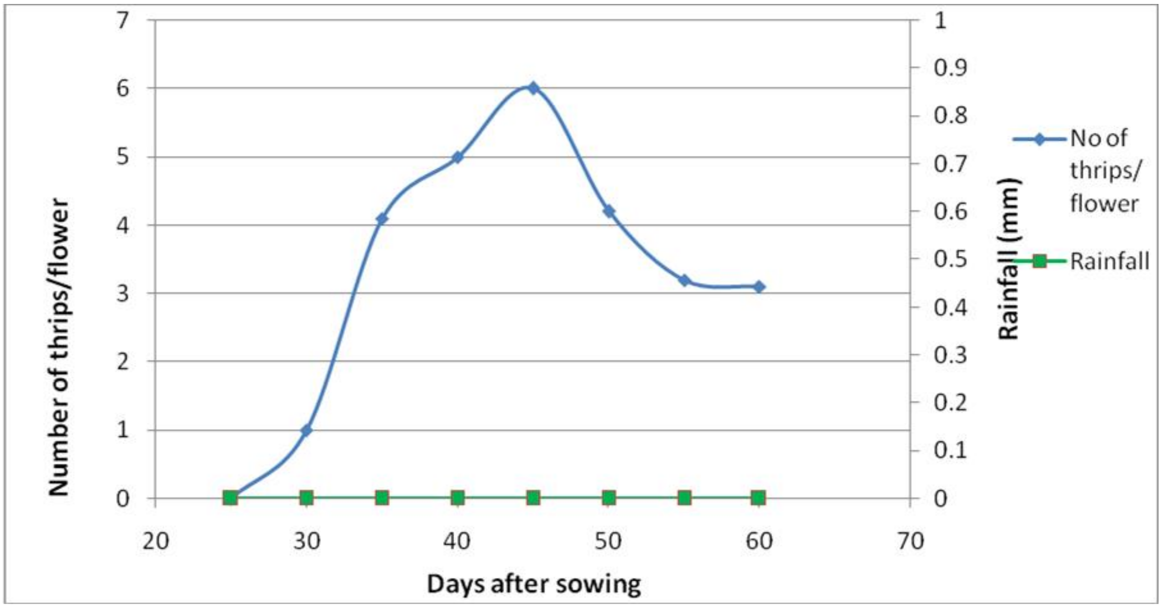


Figure 5. Trend of thrips population on mungbean flower sowing on 2 March.

4.9.5 Thrips population trend in mungbean sowing on 12 March

The trend of population incidence of mungbean thrips sowing on 12 March has shown in Figure 6. The graph shows that population of thrips gradually increased with the age of mungbean and reached at peak 50 DAS then declined rapidly at 60 DAS.

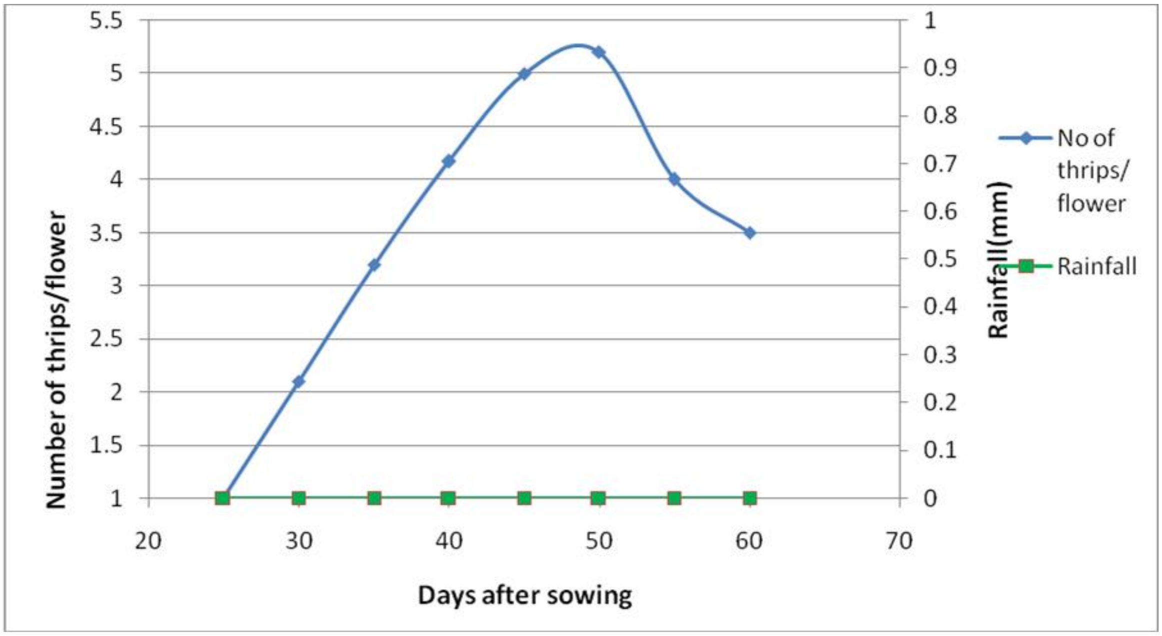


Figure 6. Trend of thrips population on flower sowing on 12 March.

4.9.6 Thrips population trend in mungbean sowing on 22 March

The trend of population incidence of mungbean thrips sowing on 22 March has shown in Figure 7. The graph shows that population of thrips gradually increased with the age of mungbean and reached at peak 45 DAS then declined rapidly at 50 DAS. Again it was increased and then declined with the age of the crops. The cause of population decline at 50 DAS was rainfall.

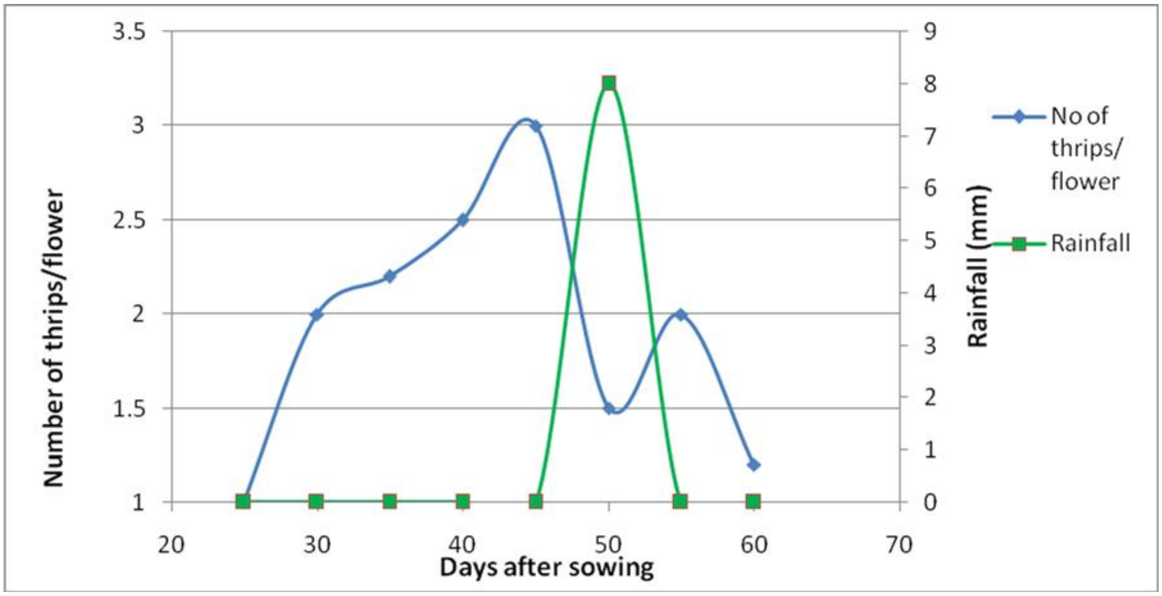


Figure 7. Trend of thrips population on flower sowing on 22 March.

4.9.7 Thrips population trend in mungbean sowing on 1 April

The trend of population incidence of mungbean thrips sowing on 1 April has shown in Figure 8. The graph shows that population of thrips gradually increased with the age of mungbean and reached at peak 40 DAS then declined rapidly at 50 DAS. Again it was increased and then declined with the age of the crops. The cause of population decline at 50 DAS was rainfall.

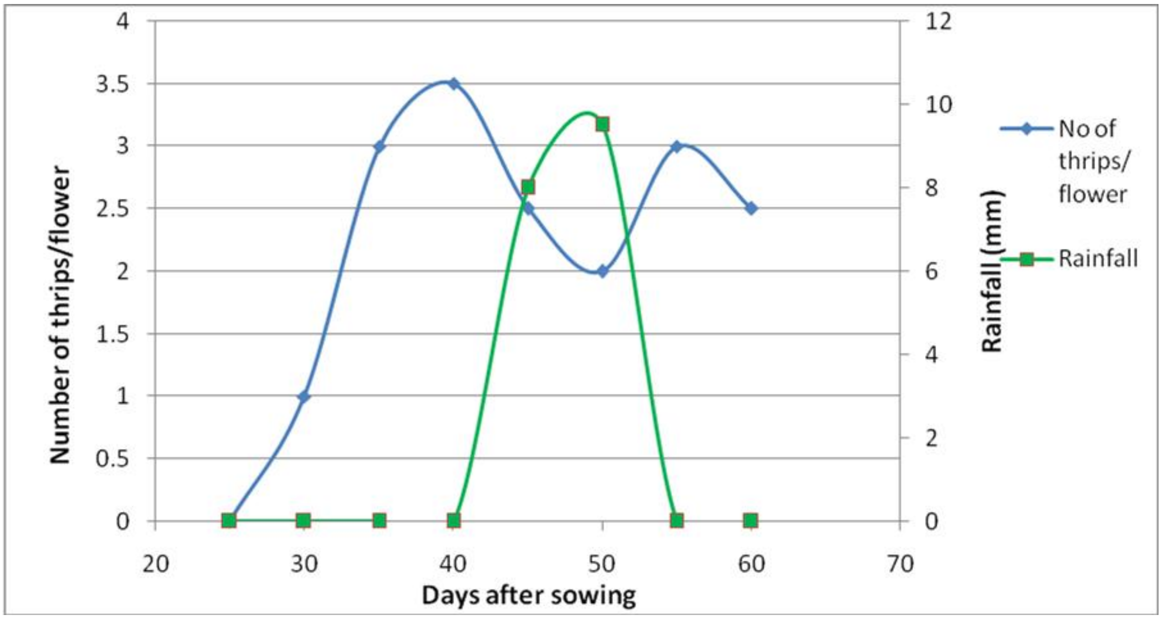


Figure 8. Trend of thrips population on flower sowing on 1 April.

From the above result it revealed that thrips population decreases with the age of mungbean and rainfall had important role for thrips population reduction. It supports the findings of Mohamed (2011) who reported that thrips population increase or decrease depending on sowing time.

4.9.8 Average number of thrips flower^{-1} on different sowing times

For the average incidence of mungbean thrips flower^{-1} on different sowing times has shown in Figure 9.The highest results (5.1) was found from T_1 (sowing on 31

January) followed by 4.5 in T_2 (sowing on 10 February) having significant difference between them. But T_2 (sowing on 10 February) and T_3 (sowing on 20 February) having no significant difference between them. Where the lowest average incidence of mungbean thrips flower^{-1} (1.8) was observed from T_6 (sowing on 22 March) followed by 2.2 in T_7 (sowing on 1 April) having significant difference between them. But there no significant difference between T_4 (sowing on 2 March) and T_5 (sowing on 12 March).The result support the findings of Atakan (2008) most of the thrips was found on flower early spring (early and mid February).

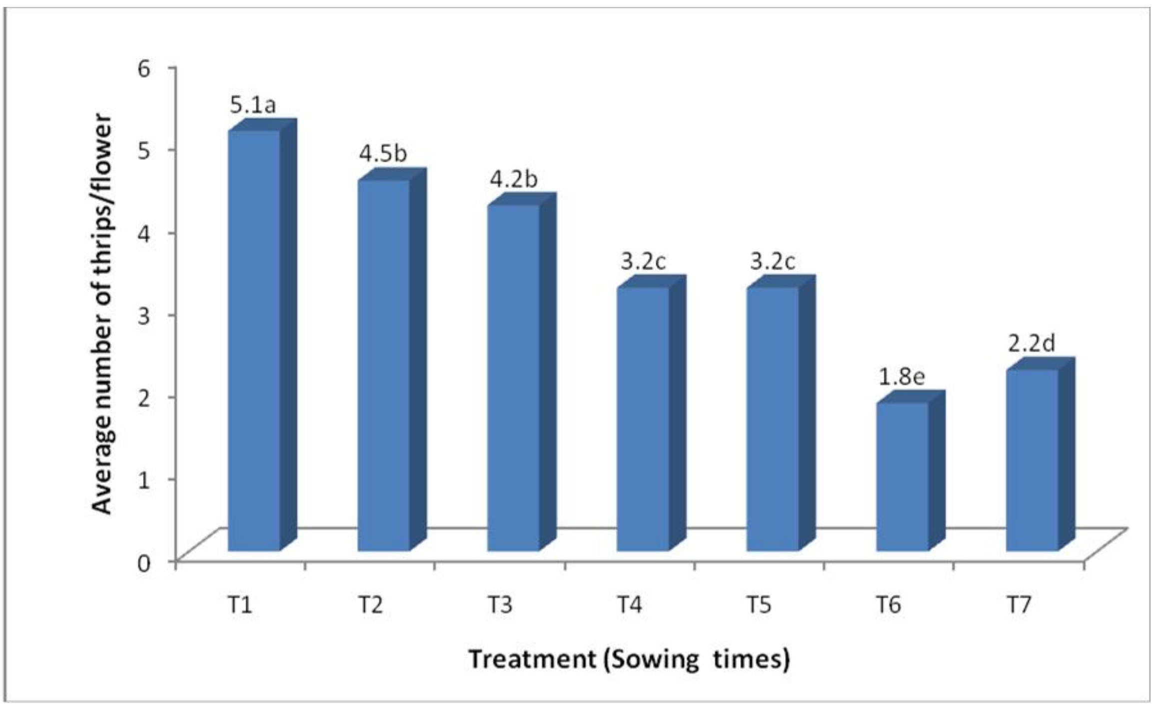


Figure 9. Average number thrips flower^{-1} on different sowing times.

T_1	=	Sowing on 31 January	T_5	=	Sowing on 12 March

T_2	=	Sowing on 10 February	T_6	=	Sowing on 22 March
T_3	=	Sowing on 20 February	T_7	=	Sowing on 1 April
T_4	=	Sowing on 2 March			

4.10 Total number pods plant^{-1} on different sowing times

Total number pods plant^{-1} on different sowing times has shown in Figure 10. The highest number of pod (12.00) was found in T_6 (sowing on 22 March) followed by 11.5 in T_7 (sowing 1 April) having significant difference between them. But T_7 (sowing 1 April) and T_5 (sowing on 12 March) had no significant difference between them. In contrast the lowest number of pod plant^{-1} (8.00) was found in T_1 (sowing on 31 January) followed by 9.00 in T_2 (sowing on 10 February) having significance difference between them. But T_3 (sowing on 20 February) and T_2 (sowing on 10 February) had no significant difference between them.

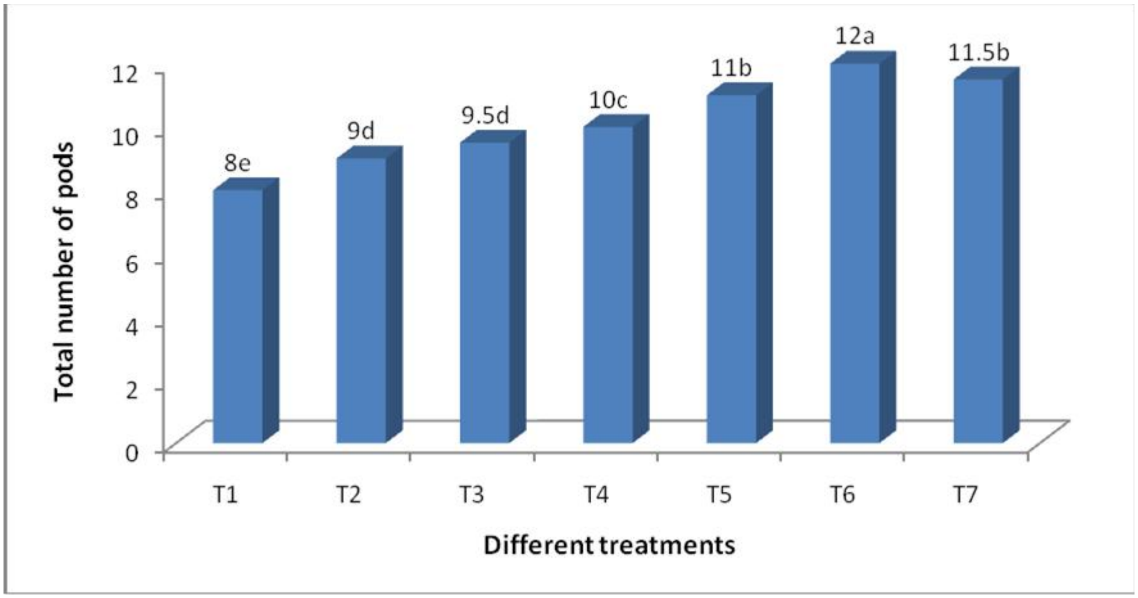


Figure 10. Total number pods plant^{-1} on different sowing times.

T_1	=	Sowing on 31 January	T_5	=	Sowing on 12 March
T_2	=	Sowing on 10 February	T_6	=	Sowing on 22 March
T_3	=	Sowing on 20 February	T_7	=	Sowing on 1 April
T_4	=	Sowing on 2 March			

The above result indicates that mungbean sowing on 22 March (T_6) had highest pod followed by 1 April (T_7). Lowest pod was found 31 January (T_1) followed by 10 February (T_2) . This result agree with findings of Ram and Dixit (2000) who reported that sown mungbean (30 March) produced better result in terms of growth, yield and other contributing characters.

4.11 Number of seeds pod^{-1}

Number of seeds pod^{-1} was significantly influenced by different sowing time regarding mungbean thrips infestation (Table 4). Under the present study, it was observed that the highest number of seeds pod^{-1} (11.33) was found in T_6 (sowing on 22 March) which was statistically identical with T_5 (sowing on 12 February) and T_7 (sowing on 1 April). The lowest number of seeds pod^{-1} (6.00) was found in T_3 (sowing on 20 February) which was statistically identical with T_1 (sowing on 31 January), T_2 (sowing on 10 February) and T_4 (sowing on 2 March).

4.12 Weight of seeds plant^{-1} (g)

Effect of different sowing time had significant effect on weight of seeds plant^{-1} (g) as regards mungbean thrips infestation (Table 4). It was observed that with the advancement of sowing date, weight of seeds plant^{-1} (g) was increased to a certain level. Results indicated that the highest weight of seeds plant^{-1} (16.83 g) was found in T_6 (sowing on 22 March) which was statistically identical with T_7 (sowing on 1 April). Again, the lowest weight of seeds plant^{-1} (11.00 g) was found in T_1 (sowing on 31 January) which was statistically identical with T_2 (sowing on 10February), T_3 (sowing on 20 February) and T_4 (sowing on 2 March).

The result supports the findings of Dhanjal *et al*.(2000) mungbean sown on (15 March) had higher seed weight than other dates (16 April). But the result contradicts with the findings of Gobologlu *et al*.(1992) who reported that seeds/pod and weight of seed highest in 15 May. The results may be vary with the geographic location, various crops and environment.

Table 4. Effect of different sowing dates on yield performance caused by mungbean thrips

Treatments	Number of seeds pod^{-1}	Weight of seeds $plant^{-1}$ (g)
T_1	6.67 b	11.00 c
T_2	6.67 b	11.67 c
T_3	6.00 b	12.33 c
T_4	7.67 b	11.53 c
T_5	10.00 a	13.23 b
T_6	11.33 a	16.83 a
T_7	10.00 a	16.00 a
$LSD_{(0.05)}$	**1.56**	**1.01**
Level of significance	**0.01**	**0.01**
CV (%)	**10.47**	**12.78**

Data are the average of seven observations and three replications. In a column, means having same letter(s) statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability by DMRT.

T_1	=	Sowing on 31January	T_5	=	Sowing on 12 March
T_2	=	Sowing on 10 February	T_6	=	Sowing on 22 March
T_3	=	Sowing on 20 February	T_7	=	Sowing on 1 April
T_4	=	Sowing on 2 March			

4.13 Relationship between average number of thrips $flower^{-1}$ and flower infestation ,% plant infestation, number of flower shedding, $yieldplant^{-1}$

4.13.1 Relationship between average number of thrips $flower^{-1}$ and number of flower infestation

Average number of thrips flower^{-1} with number of flower infestation has shown in Figure 11. Positively relationship was found between average number of thrips flower^{-1} with number of infested flower. Positive trend line was observed with the equation of $y = 0.6091x + 1.14$ and $R^2 = 0.8849$. It explained that flower infestation was increased with the increase of number of thripsflower^{-1}.

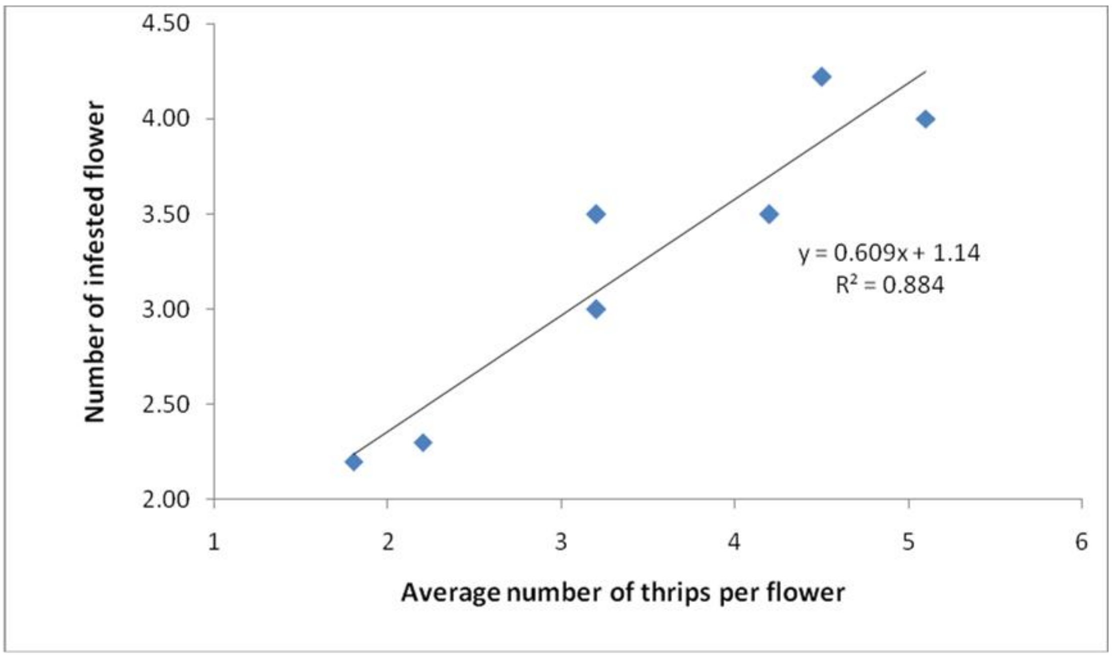


Figure 11. Relationship between average number of thrips flower^{-1} and number of flower infestation.

4.13.2 Relationship between average number of thrips flower^{-1} and number of plant infestation

Average number of thrips flower^{-1} with number of plant infestation has shown Figure 12. There was positive relationship with average number of thrips flower^{-1} and number plant infestation. Positive trend line was observed with the equation of $y = 4.6557x + 9.18$ and $R^2 = 0.9074$. It explained that percent plant infestation was increased with the increase of average number of thrips flower^{-1}.

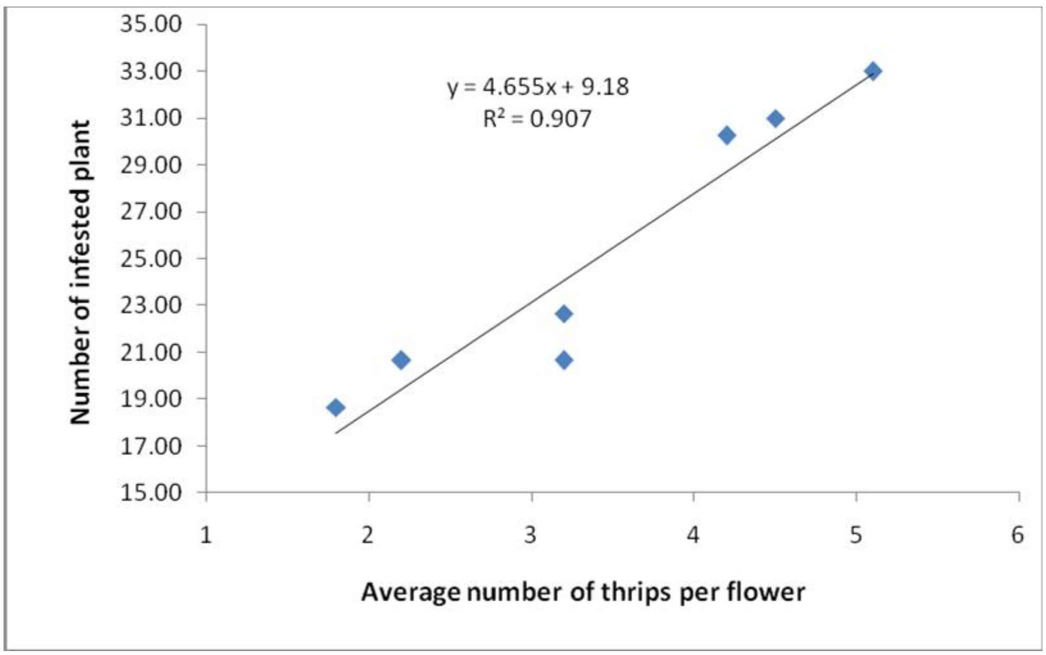


Figure 12. Relationship between average number of thrips flower^{-1} and number of plant infestation.

4.13.3 Relationship between number of thrips flower^{-1} and number of flower shedding

Average number of thrips flower^{-1} with number of flower shedding has shown Figure 13. Average number of thrips flower^{-1} was positively related with number of flower shedding. Positive trend line was observed with the equation of y = 0.4737x+ 2.22 and R^2 = 0.5399. It explained that number of flower shedding was increased with the increase of number of thripsflower^{-1}.

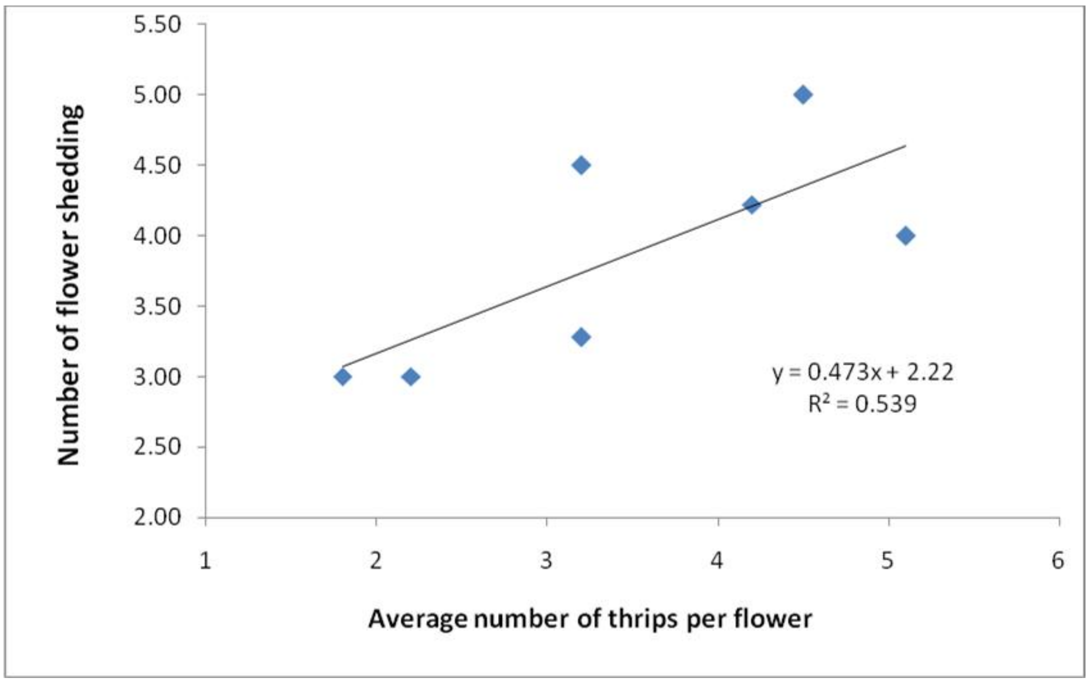


Figure 13. Relationship between average number of thrips flower^{-1} and number of flower shedding.

4.13.4 Relationship between number of thrips flower^{-1} and yield plant^{-1}

Average number of thrips flower^{-1} with yield plant^{-1} has shown in Figure 14. Average number of thrips flower^{-1} was negatively related with yield plant^{-1}. Negative trend line was observed with the equation of $y = -1.7017x + 19.11$ and $R^2 = 0.8026$. It explained that yield plant^{-1} was decreased with the increase of number of thripsflower^{-1}.

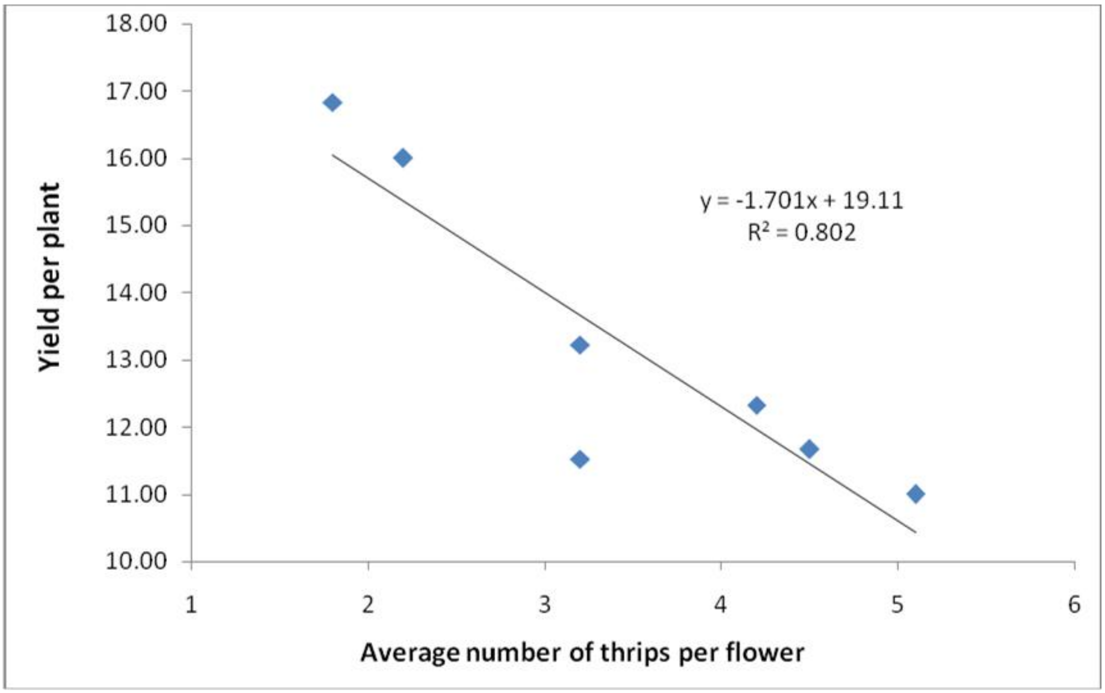


Figure 14. Relationship between number of thrips flower^{-1} and yield plant^{-1}.

From above result it revealed that less number of thrips reduces flower infestation, plant infestation and flower shedding but increases yield. It supports the findings of Hossain *et al*.(2009) who reported that mungbean sowing on early (February 14 to March 6) and late sown (mid April to onward) had higher thrips infestation than mid sown (March 13 to April 10) and mungbean yield became more or less due to number of thrips.

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the Farm of SAU, Sher-e-Bangla Nagar, Dhaka, Bangladesh to study the effect of sowing time on incidence and damage severity of mungbean thrips during the period from January to June 2015. The experiment comprised of seven treatments viz., T_1= sowing on 31 January 2015, T_2= sowing on 10 February 2015, T_3= sowing on 20 February 2015, T_4= sowing on 2 March 2015, T_5= sowing on 12 March 2015, T_6= sowing on 22 March 2015 and T_7 = sowing on 1 April 2015. The variety, BARI mungbean 6 was used as planting material. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Data on different crop parameters, incidence and infestation of mungbean thrips were recorded and the collected data were analyzed statistically and the mean differences were adjusted by Duncan's Multiple Range Test (DMRT).

Different sowing time showed significant effect on thrips infestation of mugbean. Results revealed that the highest percent of healthy plants (61.33%), number of flowers plant^{-1} (12.22), number of total pods plant^{-1} (12.00), number of seeds pod^{-1} (11.33) and weight of seeds plant^{-1} (16.83 g) were found in T_6 (22 March). But the lowest number of mungbean thrips flower^{-1} (1.00, 2.00, 2.20, 2.50, 3.00,1.50,2.00 and 1.20 at 25, 30, 35, 40, 45, 50, 55 and 60 DAS respectively), number of infested plants (18.67) and number of flower shedding plant^{-1} (3.00), number of infested flower plant^{-1} (2.20) was obtained from T_6 (sowing on 22 March) . Again, lowest plant infestation (23.33%), infested flowers plant^{-1} (18.00%) and flower shedding plant^{-1} (24.55%) were found in T_6 (sowing on 22 March 2015).

On the other hand highest number of infested plant (33.00), highest percent of infested flowers plant^{-1} (43.10%), highest percent plant infestation (41.25%), highest number of mungbean thrips flower^{-1} (0.00, 2.00, 5.00, 7.00, 6.00, 5.10, 6.20 and 5.10 at 25, 30, 35, 40, 45, 50, 55 and 60 DAS, respectively) was obtained from T_1 (sowing on 31 January). But the highest percentage of flower shedding plant^{-1} (45.45%) was found from T_2 (sowing on 10 February).

T_6 considerably justified in respect of different growth and yield parameters. It was found that the sowing date of T_6 (22 March) had excellent performance on number of healthy plant, number of infested plant, number of flowers plant^{-1}, number of shedding flower plant^{-1}, number of infested flowers plant^{-1}, number of thrips flower^{-1} number of total pods plant^{-1}, number of seeds pod^{-1} and weight of seeds plant^{-1}. The sowing date of T_7 (1 April) had also better effect on the same parameters.

On the other hand, the sowing date of T_1 (31 January) and T_2 (10 February) showed the lower performance on different parameters. The sowing date of T_3 (20 February), T_4 (2 March) and T_5 (12 March) were not considered as promising responses of achieved results on different parameters.

From the above discussion it can be concluded that mungbean sowing on 22 March showed the best performance against thrips infestation followed by sowing on 1 April. Thus the appropriate sowing times might be on 22 March and on 1 April in case of thrips infestation on mungbean crops but it needs further trial at different locations and Khrif 2 season.

CHAPTER VI

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APPENDICES

Appendix 1. The mechanical and chemical characteristics of soil of the experimental site as observed prior to experimentation

Particle size constitution:

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

Chemical composition:

Constituents	:	0-15 cm depth
P^H	:	6.4
Total N (%)	:	0.07
Available P (µ g/g)	:	18.49
Exchangeable K (meq)	:	0.07
Available S (µ g/g)	:	20.82
Available Fe (µ g/g)	:	229
Available Zn (µ g/g)	:	4.48
Available Mg (µ g/g)	:	0.825
Available Na (µ g/g)	:	0.32
Available B (µ g/g)	:	0.94
Organic matter (%)	:	1.4

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

Appendix 2. Monthly records of Temperature, Rainfall, and Relative humidity of the experiment site during the period from January 2015 to March 2015

Year	Month	Air Temperature (^{0}c)			Relative humidity (%)	Rainfall (mm)	Sunshine (hr)
		Maximum	Minimum	Mean			
2015	January	28.50	17.90	23.20	68.50	0.00	233.20
2015	February	24.60	13.50	19.10	66.50	3.00	194.10
2015	March	27.50	18.60	23.10	60.00	2.00	221.50

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212.

Appendix 3. Effect of different sowing dates on number of healthy plant, number of infested plant and % plant infestation caused by mungbean thrips

Source of variation	Degrees of freedom	Mean square		
		Number of healthy plant	Number of infested plant	% plant infestation
Replication	2	0.172	0.268	0.265
Factor (sowing time)	6	6.358*	5.784*	5.688*
Error	12	2.385	2.883	2.878

Appendix 4. Effect of different sowing time on number of flowers plant^{-1} and number of shedding flower plant^{-1} caused by mungbean thrips

Source of variation	Degrees of freedom	Mean square		
		Number of flowers plant^{-1}	Number of shedding flower plant^{-1}	% number of shedding flower plant^{-1}
Replication	2	0.112	0.087	0.088
Factor (sowing time)	6	5.348*	4.872*	4.868*
Error	12	2.352	1.783	1.764

Appendix 5. Effect of different sowing dates on flower infestation caused by mungbean thrips

Source of variation	Degrees of freedom	Mean square		
		Number of flowers plant^{-1}	Number of infested flowers plant^{-1}	% number of infested flowers plant^{-1}
Replication	2	0.137	0.089	0.087
Factor (sowing time)	6	4.752*	3.477*	3.468*
Error	12	1.118	1.089	1.078

Appendix 6. Effect of different sowing dates on flower infestation caused by mungbean thrips

Source of variation	Degrees of freedom	Mean square of number of thrips flower^{-1} at different days after sowing (DAS)				
		40 DAS	45 DAS	50 DAS	55 DAS	60 DAS
Replication	2	0.034	0.083	0.044	0.053	0.061
Factor (sowing time)	6	2.647*	3.248*	3.114*	2.711**	2.653**
Error	12	0.347	0.416	0.385	0.287	0.362

Appendix 7. Effect of different sowing dates on pod infestation caused by mungbean thrips

Source of variation	Degrees of freedom	Mean square				
		Number of total pods plant^{-1}	Number of healthy pods plant^{-1}	Number of infested pods plant^{-1}	% number of healthy pods plant^{-1}	% number of infested pods plant^{-1}
Replication	2	0.048	0.857	0.048	0.854	0.051
Factor (sowing time)	6	5.634*	7.488*	4.368**	7.469*	4.359**
Error	12	1.256	0.847	0.685	0.838	0.673

Appendix 8. Effect of different sowing dates on yield performance caused by mungbean thrips

Source of variation	Degrees of freedom	Mean square	
		Number of seeds pod^{-1}	Weight of seeds plant^{-1} (g)
Replication	2	0.72	0.147
Factor (sowing time)	6	13.00*	15.878**
Error	12	0.762	2.857