EFFECTIVENESS OF SOME INSECTICIDES IN CONTROLLING MAJOR INSECT PESTS OF POTATO

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EFFECTIVENESS OF SOME INSECTICIDES IN CONTROLLING MAJOR INSECT PESTS OF POTATO

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CERTIFICATE

This is to certify that thesis entitled, "**EFFECTIVENESS OF SOME INSECTICIDES IN CONTROLLING MAJOR INSECT PESTS OF POTATO**" 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 **NAZIA ISLAM, Registration No. 090-3399** under my supervision and guidance. No part of the thesis has been submitted for any other degree of 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.

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DEDICATED TO

MY

BELOVED PARENTS

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EFFECTIVENESS OF SOME INSECTICIDES IN CONTROLLING MAJOR INSECT PESTS OF POTATO

ABSTRACT

The experiment was conducted at the research field of Sher-e-Bangla Agricultural University, Dhaka; during the period from November, 2014 to March 2015 to study the effect of different insecticides on controlling the major insect pests of potato. The potato variety cardinal was used as the test crop. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. The experiment consists of seven treatments viz. T_1 (Admire 200 SL @ 0.5ml/L of water); T_2 (Diazinon10G with Emamectin Benzoate @ 0.5 g/L); T_3 (Ascend 3G with cartap @ 1g/L); T_4 (Acetamiprid 0.5g/L); T_5 (Furadan 5G with Actara @ 0.5g/L); T_6 (Chlorpyriphos @ 2ml/L+Cypermethrin @ 1.0ml/L) and T_7 (untreated control). The experiment revealed that T_4 treatment showed the best performance to control aphid infestation (92.51%) and lowest infestation reduction was observed on T_1 treatment (73.69%). In case of jassid infestation 94.83% significant highest infestation reduction was observed on T_4 treatment and lowest on T_1 and T_3 treatment (87.09%). In controlling cutworm, T_2 treatment showed best performance (82.22%) followed by T_1 (77.78%) and the lowest in T_5 (46.77% reduction). Highest yield (30t/ha) was observed on T_2 treatment.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

Potato is one of the important crop in Bangladesh and plays a significant role in the human diet as a vegetable and supplementary food crop. It is a prominent crop in consideration ofits production and its internal demand inBangladesh.Total potato production has been estimated8,950,024 metric tonsin2013-2014(BBS,2014) and92.54 million tons of potato in 2015(BBS,2015).The potato (*Solanumtuberosum*L.) is a starchy, tuberous crop. It is the world's fourth-largest food crop, following maize, wheat and rice(International year ofthe potato, 2008). The potato was first domesticated in the region of modern-day southern Peruand extreme northwestern Bolivia (Spooner*et al*., 2005). It has since spread around the world and become a staple crop in many countries. Potato due to its high yield, crop safety, low price, diversified use and high nutritive value can playan important role in reducing the dependence on the cereals likerice and wheat.

Potato is rich in water content(78%) and vitamin C (1.7 mg/100g) and its biological value of protein (73mg/100g) is superior to rice or wheat(Rashid and Hossin,1985). The Food and Agriculture Organization of the UnitedNations (UN) reports that the world production of potatoes in 2013 wasabout368 million tones due to perishability, only about 5% of the world's potato cropis traded internationally; its minimal presence in world financial markets contributed to its stable pricing during the 2007-2008 world food price crisis. Thus, the UN officially declared 2008 as the International Year of the potato raise its profile in developing nations, calling the crop a ‘hidden treasure’.

One of the major problem in potato production is the insect pests causing severe damage of tubers every year under both field and storage condition. Potato crop is attacked and damage by a number of insect pests.Potato is attacked by more than 100 arthropod pests. Of the various insect-pests; white grubs, epilachna beetles, defoliating caterpillars and potato tuber moths are serious and responsible for considerable damage. The importance of aphids and jassid are mainly due to their role in the spread of viruses and mycoplasma, respectively.Cutworms and potato aphids are the two devastating insect pest in the spring crop (Sing, 2002).The larvae of the cutworm damage the plant by cutting the stem at the base or leaflets in the early stage of the crop growth before tuber formation. The amount of damage by cutting the plants exceeds the amount by gradual eating.The larvae usually hide in cracks and crevices in the soil or under the clods or debris around the plants during the day time and come out of these places of hiding at night and cut the young plants at ground level and eat only the tender parts (Butani and Jotwani, 1984). The major damage occurs when the larvae feed on the tubers under the soil soon after the tuber formation to harvest of tubers in the field (DasheveskiiandRybakov, 1979). Attuberization period, the larvae bore into the tubers and consume the inner contents of tubers reducing the yield and market value of potato to a great extent. Cutworm damage to the tubers varied from 5 to 75% inIndia(Lal, 1990; Saxena, 1974). Several different aphids can be found in potato fields. Aphids of themselves can cause wilting damage by sucking out nutrients from foliage and stem tissues and this may be a problem especially in nursery crops. But, the real problem caused by aphids in commercial fields is their ability to carry pathogenic viruses. In potato fields, the common viruses are potato leaf roll virus (PLRV), the mosaic viruses (e.g., PVA, PVY) and alfalfa mosaic virus (AMV, "calico virus"). The peach potato or green peach aphid, *Myzuspersicae* Sulzer is the most important as a potential vector of potato viruses (Verma and Misra, 1975).

Pradhan (1969) has reported that the use of pesticides to control pest and maximize the production of potato may be essential, but these toxic chemicals should be applied carefully and judiciously. The aim is to control the variety of pests for a longer period with the minimum use of pesticides. Other potent and recommended methods of cultural, mechanical, physical and biological control should be given equal importance in controlling pests and developing an effective and economicinstructionmanagementprogramme (IPMP) against potato pests.

Under the above consideration, the present study was undertaken to fulfil the following objectives-

- To find out the effectiveness of some promising insecticides against the major potato insect pests.
- To know the impact of insecticides on potato yield.

CHAPTER II

REVIEW OF LITERATURE

The potato is one of the world's most important food crops. The potato plant develops through four clearly defined growth stages: (1) vegetativegrowth, (2) tuber initiation, (3) tuber growth and (4) plant maturation (Johnson, 2008). Eachstage is affected by different groups of insect pests. The degree of the damage will depend on the timing of events, cultivar characteristics, and the intrinsic characteristics of each pest.

Potato is attracted by a number of insect pests. Commonly the major potatoinsects are cutworm, aphid, jassidetc seen in Bangladesh. The relevant literature of these insets is shown on below-

2.1 Potato aphid (Homoptera: Aphididae)

Although many insects can vector viruses, aphids are the most important vectors for potatoes. The green peach aphid, *Myzuspersicae*, is the most common aphid species in potatoes and the most efficient at transmitting potato viruses (Radcliffe and Ragsdale, 2002). Other aphid species such as the potato aphid, *Macrosiphum euphorbiae*, cuckthorn aphid, *Aulacorthumsolani*, and melon aphid,*Aphis gossypii*are also of concern (Radcliffe and Ragsdale, 2002). Viruses can be divided into two groups - persistent and non-persistent viruses. Distinguishing the virus transmission process between persistent and non-persistent viruses is crucial in order to evaluate potential vector controls. When an aphid feeds on a plant infected by a persistent virus (e.g. potato leaf roll virus), it can take hours of probing and incubation before the aphid acquires the virus and has the potential to transmit to another plant. For these viruses, contact insecticides are a good tool to prevent aphids from infecting healthy plants (Radcliffe and Ragsdale, 2002). Consequently, aphids carrying non-persistent viruses have the potential to infect other plants very quickly. For non-persistent viruses, most insecticides do not prevent virus transmission because they do not act fast enough to prevent aphids from inserting their mouthparts into plants (Perring *et al.*,1999).

The aphid population in western North America, north of Mexico, is comprised of 1,020 species in 178 genera in 15 subfamilies (Pike *et al*., 2003). Several aphid species are known to be pests of potatoes, but the green peach aphid, *Myzuspersicae* (Sulzer), and potato aphid, *Macrosiphum euphorbiae* (Thomas), are two of the most important vectors of diseases in the Pacific Northwest. Aphids are important due to their ability to transmit viruses. According to Hoy *et al*. (2008) there are six commonly found potato viruses transmitted by aphids which arepotato leafroll virus (PLRV), multiple strains of potato virus Y (PVY), potato virus A (PVA), potato virus S (PVS), potato virus M (PVM), and alfalfa mosaic virus (AMV). PLRV and PVY are transmitted by several species of aphids.

2.1.1 Pest description

Green peach aphids are small, usually less than 0.3 cm long. The body varies in color from pink to green with three darker stripes down the back. The head has long antennae which have an inward pointing projection or tubercle at its base. Potato aphids are larger than green peach aphids with a body somewhat elongated and wedge-shaped(Branson *et al.*, 1966).

2.1.2 Damage

In general, aphids injure plants directly by removing sap juices from phloem tissues. They also reduce the aesthetic quality of infested plants by secreting a sugary liquid called "honeydew" on which a black-colored fungus called "sooty mold". The “sooty mold” reduces the photosynthetic potential of the plant. Most importantly, aphids transmit plant diseases, particularly viruses. Aphids on potato are serious pests because of their ability to transmit several plant diseases such as PLRV (transmitted mainly by green peach aphid) and PVY (transmitted by several species of aphids). PLRV causes necrosis while strains of PVY can cause internal brown lesions in the tubers. Srinivasan and Alvarez (2007) reported that mixed viral infections of heterologous viruses occur regularly in potatoes.

2.1.3 Hosts

The green peach aphid, also known as tobacco or spinach aphid, survives the winter in the egg stage on peach trees. Besides potatoes and peaches, other hosts include lettuce, spinach, tomatoes, other vegetables and ornamentals (Tamaki *et al.,* 1980).

2.1.4 Biology

Green peach aphid migrates to potatoes in the spring from weeds and various crops where it has overwintered as nymphs and adults, or from peach and related trees where it overwinters as eggs. Most aphids reproduce sexually and develop through gradual metamorphosis (overwintering diapause egg, nymphs and winged or wingless adults) but also through a process called 'parthenogenesis' in which the production of offspring occurs without mating (Jensen *et al*., 2011). Potato aphids also overwinter as active nymphs, adults or eggs; eggs are laid on roses and sometimes other plants. Throughout the growing season aphids produce live young, all of which are female and can be either winged or wingless. In some instances, aphids undergo sexual, oviparous reproduction as a response of a change in photoperiod and temperature, or perhaps a lower food quantity or quality, where females produce sexual females and males. In the fall, winged males are produced which fly to overwintering hosts and mate with the egg-laying females produced on that host. Aphids found in the region undergo multiple overlapping generations per year (Jensen *et al*., 2011, Schreiber *et al*., 2010).

2.1.5 Monitoring

Fields should be checked for aphids at least once a week starting after emergence. The most effective scouting method is beating sheets, trays, buckets or white paper. There are no well-established treatment thresholds for aphids in potatoes in the Pacific Northwest but since aphids transmit viruses, producers are encouraged to control aphids early in the season, especially in seed potato producing areas. Schreiber *et al.*(2010) recommend a minimum sample size of ten locations per 100 acre field. For potatoes that are not to be stored, application of foliar aphidicide should begin when 5 aphids per 100 leaves or 5 aphids/plant are detected. Hoy *et al*. (2008) suggests some sampling methods and action thresholds for colonizing aphids on processing potatoes, table stock, and seed potato in different productions thresholds.

2.1.6 Control

Weed control and elimination of secondary hosts are critical. Early aphid infestations commonly occur on a number of weeds including species of mustards and nightshade; therefore, those weeds should be kept under control. Research in Idaho indicates that hairy nightshade is an excellent aphid and virus host (Srinivasan and Alvarez, 2007), thus, control of this weed is highly recommended. In some instances, the number of insects available to infest crops in the spring depends upon winter survival. Thus, the elimination of overwintering sites is commended if possible. Peach trees are the most common winter hosts, although apricots and several species ofrunus are sometimes infested (Schreiber *et al.*, 2010). A large numbers of generalist predators feed on aphidsincluding the minute pirate bugs, big-eyed bugs, damsel bugs, lady bird beetles and their larvae, lacewings, flower fly larvae, and aphid-specific parasitoid wasps. If aphids are present, use of insecticides in commercial fields should occur as soon as non-winged aphids are detected. In seed producing areas, preventive methods are recommended. Application of foliar aphidicide should begin just prior to the decline in performance of seed-treatment insecticides applied at planting. (Schreiber *et al.*, 2010) indicated that complete insect control from planting until aphid flights have ceased is the only means to manage diseases in full season potatoes.

2.2Jassid(Homoptera: Cicadellidae)

2.2.1 Pest description

The leaf hoppers or jassids are also important pests of the potato crop. Several species have been recorded. They include*Alebroidesnigroscutulatus*Dist, *Amrascabiguttuta*Ishida, *Balclutha* Spp., *Exitianuscoronatus*, *E. indicus*, *E.*

nanus, *Ophiolabicolour* Pruthi,*Phyronomorphus*spp., *Psammotettisprovinciatis*Rib.,*P. Striatus*(L.), *Serianaequata* and *Subhimalusmelanus.*

2.2.2 Damage

The nymphs and adults suck sap from the mesophyll and cause direct damage to potato foliage. The adults and nymphs of *Empoascadevastans*, *E. Fabae* and *Amrascabiguttulabiguttula*Ishida cause hopper burn (Saxena*etal.,* 1974). Late nymph stages cause higher yield reductions than adults. The average reduction in potato yield caused by nymphs was about 2-6 times more than that caused by adults (Prasad, 1961). Some leafhoppers are vectors of mycoplasmal diseases such as Witch's broom, purple top roll (PTR) and marginal flavescence (MF). The losses were estimated at 40-70 and 70-80% respectively (Nagaich, 1974). The females of *E. Devastans*lay about 300 eggs in the leaf veins. These eggs hatch in 4-10 days. The nymphs become adults between 17-21 days and 11 generations have been reported in one year (Pruthi, 1969). Chemical should be used alone but this will give insect pests a chance to develop resistant against a specific group of insecticides so the combination of insecticide can give good results.

2.3 Cutworm, armyworm and loopers

2.3.1 Cutworm, armyworm and loopers infestation

These are several species of moth larvae that affect potato crops. Cutworms, armyworms and loopers are the immature stages of lepidopteran moths. Moths' typically have four defined life stages: egg, larva, pupa and adult. Cutworms

*(Agrotis*spp.) are cosmopolitan and polyphagous (Pruthi, 1969). Five species: *Agrotisipsilon, A. interacta,A. Flammatra*Schiff, *A. spinnifera* and*A. Segetum.* have been reported damaging the potato crop in India (Rataul and Misra, 1979). Two, *A. ipsilon*and*A. segetum,* are the main cause of damage. The former is common in the plains while the latter is more prevalent in the hilly tracts. The other three are of minor importance. Cutworm larvae cut off the stalks of young potato plants.They are nocturnal in habit, living 5 to 8 cm below ground level and cut potato stalks at their base or a few centimeters above the ground level. They spoil more than they consume. The infested fields sometimes look as if it has been grazed. In grown crops they usually damage tender shoots and branches. After tuberization their damage is confined to the tubers, reducing the market value. In badly infested fields, damage has been reported from 12-40% (Verma and Handla, 1977; Saxena and Misra,1980).

Cutworms are active from October to April in the plains and during Summer in the mountains, and have been reported from almost all the potato growing areas of north India, forming a continuous belt from the Punjab to Bengal. There may be a migration of adults to and from the hills. Moths are generally not found in the north Indian plains from May to September (Narayanan, 1954), but appear during October and remain active until March or April. The life-history of *A. ipslon*has been studied in detail (Saxena and Rizvi, 1974). It feeds on potato, barley, maize, mustard, linseed, cabbage, peas, gram and tobacco but gram is the preferred host (Srivastava, 1958), Chandra (1962) reported that larval development is faster on Cutworms feed on potato seeds, cut stems, and foliage; armyworms and loopers feed on foliage throughout the season.

Cutworms and armyworms have three pairs of true legs and five pairs of prolegs behind; loopers have only three pair of true legs and three pair of prolegs behind. At planting insecticides protect potato seed from cutworms; however, after the residual effect is gone, the crop is unprotected; in some years, a foliar chemical application may be needed. Potatoes can tolerate some worm defoliation without loss in marketable yield. The period of full bloom is the most sensitive plant growth stage, but even then defoliation on the order of 10% appears to cause little if any yield loss. Applications should be targeted to control small larvae (1st and 2nd instars), rather than larger larvae (Schreiber *et al*., 2010; Jensen *et al*., 2011).

The cutwormisnocturnal in habit. The larvae remain hiding in the clods or cracks of the soil during the day time and cause damage to the crops in the night. The larvae may be observed if the soil is dug within 30 cm area of the cut plants (Rai *et al*., 1988). In India, the losses in yield due to the attack of *A. ipsilon* ranged from 35-40% (Chaudhuri, 1953; Rai *et al*., 1988).Several researchers reported the feeding behaviour of the cutworm in potato field. Butani and Jotwani (1984) reported that the larvae damage the plants by cutting the stem at the base or the leaflets in the early stage of the crop growth before tuber formation. The larvae usually hide in cracks and crevices in the soil or under the clods or debris around the plants during day time and come out of these places of during at night and cut the young plants at ground level and eat only the tender parts.

Panchabhavi*et al.* (1972) reported that cutworm is a polyphagous noctuid and a severe pest of potato in the field. During night the larvae become active and come out of their place, cut the growing plants at the surface of the ground, feed on the leaves leading to the retardation in the growth of the plants ultimately reduce the tuber yields. Nasir*et al*. (1974) and Butani and Verma (1976) also reported similar observations. Nessa*et al.* (1990) andIslam*et al.* (1991) reported that Basudin and Pyrifos were effective in reducing the cutworm damage.

Das *et al.*(1996) showed that tuber damage by number and weight and yield of cutworm infested tuber was 73.6%, 77.9% and 24.4 t/ha, respectively in the untreated control plots. The untreated plots showed significantly higher rates of infestation compared with insecticide treated plots. Among the insecticides tested Dursban gave the best result.

Kareem (1981) observed 25% mortality in*Plutellaxylostella*larvae fed on leaves treated with 3%neemoil. High mortality was induced at higher concentrations.

Salem (1990) showed that the 100 ppm concentration of neemseed oil was the most effective against larval feeding of potato tuber moth, *Phthorimaeaoperculella* Zell. The antifeedant properties of neem oil against several insect pests was also reported by Islam (1984).

2.3.2 Monitoring

Trapping should start early, especially in areas with history of cutworm problems. In the Pacific Northwest trapping starts mid to late March until April to May. Horton (2006) modeled the relationship between bait trap counts and crop damage by *L. canus*in Wapato, WA. Horton's model predicts tuber damage based on number of wireworms collected.

Cutworm presence or absence in a field should be determined before using control measures. Unfortunately, current monitoring methods are time consuming, laborious and often do not accurately reflect field populations of this pest. Historically, wireworms have been monitored by extracting and sifting through soil cores to locate larvae.

Since the distribution of wireworms in a field tends to be patchy and unpredictable, large numbers of samples are required to accurately estimate population size. Baits have largely replaced random soil sampling, since they are less labor intensive and may detect low wireworm populations. Baited traps can be constructed by placing 3-4 tablespoons of a mixed of wheat and corn seeds or rolled oats inside a fine mesh bag or nylon. Dig a hole about 20-25 cm deep and 3.5-4 cm wide at the soil surface (Horton, 2006). Bury the mixture at the bottom of the hole. Fill the hole and mound a "soil dome" over the covered bait to serve as a solar collector and to prevent standing water. Cover each mound with a sheet of black plastic and cover the edges with soil to hold the plastic sheet down. The plastic collects solar radiation and speeds germination of the mixture. The germinating seeds attract cutworms. A few days later, remove the plastic and soil covering the bait and count the number of cutworm larvae found at each station. There are not specific recommendations as to how many traps per field should be placed. However, placement of the bait stations should represent different areas of a field(Horton, 2006).

2.3.3 Control

There are no effective natural enemies for cutworm. If one suspect wireworms are present in a field based on rapping, chemical control is the best management option. Fumigants are effective on cutworms that are present at the time of fumigation and within the zone of fumigation (Schreiber *et al*., 2010). Fumigants are sensitive to soil temperatures. In furrow applications are also effective; however, some operational restrictions may apply. Use of contemporary chemicals in other crops suggests that stand protection and wireworm reduction are not covered with current chemicals available (Schreiber *et al.*, 2010).

2.4 Potato tuberworm

The potato tuberworm, *Phthorimaeaoperculella,* is one of the most economically significant insect pestso cultivated potatoes worldwide. The first significant economic damage to potato crops in the Columbia Basin region occurred in 2002 (Rondon, 2010).

2.4.1 Damage

Tuberworm larvae behave as leaf miners. They can also live inside stems or within groups of leaves tied together it silk. The most important damage is to tubers, also a food source for the larvae, especially exposed tubers, or those within centimetres of the soil surface. Larvae can infest tubers when foliage is vine killed or desiccated right before harvest (Clough *et al.,* 2010).

2.4.2 Hosts

Although the potato tuberworm host range includes a wide array of Solanaceous crops such as tomatoes, peppers, eggplants, tobacco, and weeds such as nightshade, the pest has been found only on potatoes in the Pacific Northwest region (Rondon, 2010).

2.4.3 Control

Control efforts should be directed toward tuberwormpopulations right before or at harvest. The greatest risk for tuber infestation occurs between desiccation and harvest (Clough *et al*., 2010; Rondon, 2010). Most chemical products aim to reduce larva population in foliage but that technique does not provide 100% protection for the tuber. Eexperiment was conducted at Agriculture Research Institute, Tarnab Peshawar during2009 for the evaluation of some chemical against Aphids, jassids and Whiteflies in Potato. Six insecticides were applied against these insect/pests of potato. All the insecticides showed above 85 percent mortalityagainst these pests of potato. Tender 10EC and Sharp 25WP caused the highest 96.4 % mortality inAphids. The efficacy of Tender 10EC against jassid was higher than other insecticide that was about 88.7 percent followed by Sharp 25WP. In case of white flies the highest mortality wascaused Sharp 20SL, whichwas about 86.6 percent and the lowest mortality was caused by Talent which was 85.3 percent. Tender10EC and Sharp 25WP should be used for controlling aphids, jassid and whiteflies in potato crops.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted to study the effect of different insecticides in controlling potato insects during the period from November, 2014 to March, 2015. This chapter includes materials and methods i.e. experimental site, climatic condition and characteristics of soil of the experimental plot, materials used, design of the experiment, data collection, procedure of data analysis and these are presented below under the following headings and sub headings-

3.1 Experimental site

The experimental area was situated at $23^0 77'$ N latitude and $90^0 33'$ E longitude at an altitude of 8.6 meter above the sea level (Anon., 2004).

3.2 Climatic condition

The climate of experimental site is subtropical characterized by three distinct seasons, the winter from November to February and the pre-monsoon period or hot season from March to April and the monsoon period from May to October.The monthly average temperature, humidity and rainfall during the crop growing period were collected from Weather Yard, Bangladesh meteorological Department(Climate Division), Agargaon, Dhaka and that are presented in Appendix I.

3.3 Characteristics of soil

The experimental plot belongs to the Modhupur Tract which was under the Agro Ecological Zone-28. The analytical data of the soil, collected from the experimental area were determined in SRDI, Soil Testing Laboratory, Khamarbari, Dhaka and presented in Appendix II. The soil of the experimental site was clay loam in texture having pH 5.47-5.6.

3.4 Design of the experiment and layout

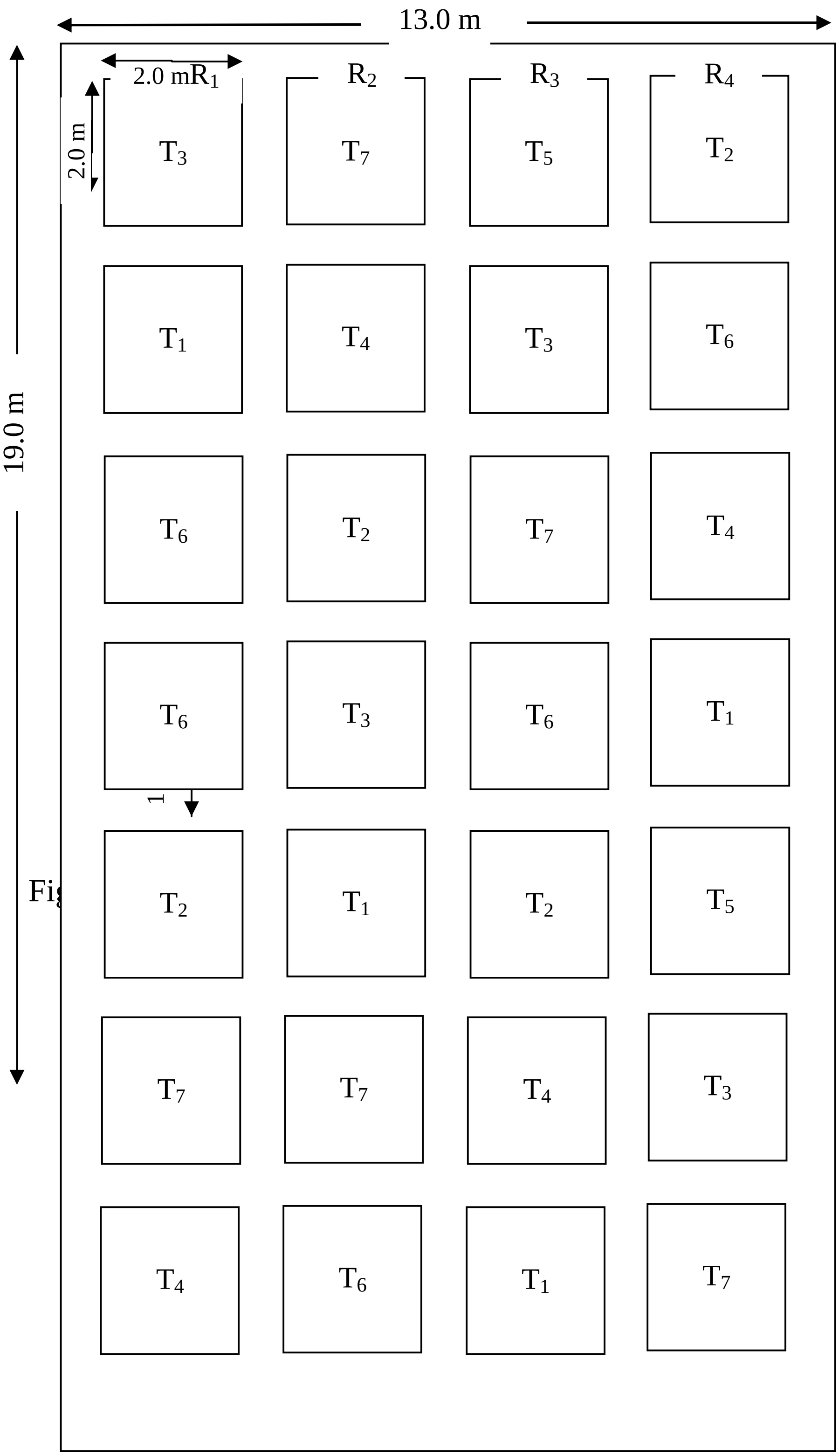
The study was conducted considering six insecticidal treatments along with a control for controlling cutworm, aphid, jassid etc. the important harmful insect pests of potato. The experiment was laid out in a Randomized Complete Block design(RCBD).The entire experimental field was divided into four blocks. Every block contains six plotfor insecticidal treatment and one for control. The each block wasseparately 1.0 m apart from each other. Each experiment plot comprised the area about 4 m^2. So the total area was covered by the experiment was 247m^2. Each treatment plots were allocated randomly.

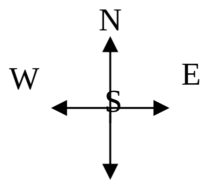
3.5 Land preparation

The experimental land was first openedwith a country plough. Ploughed soil was then brought into desirable final tilth by four operations of ploughing followed by laddering. The stubbles of the crops uprooted weeds were removed from the field. Then the land was properly levelled. The field layout was properly done on accordance to the design, immediately after land preparation. The plots were raised byfurrow-ridge method and contained four lines.

3.6 Manures,fertilizer and their methods of application

Manures and fertilizers with their doses and their methods of application followed by the study, well decomposed cow dung was applied to the plots at the rate of 10 tons/ha and incorporated to the soil during final land preparation. In addition, Muriatic of potash (MoP) and Triple super phosphate (TSP) were applied to the experimental plot @ 175 and 150 kg/ha, respectively. The total





Plot size: 2.0 m × 2.0 m

Plot spacing: 50 cm

Between replication: 1.0 m

Treatments

T_1= Admire 200g/L @ 0.5 ml/L of water

T_2= Diazinon 10G (soil application) + Emamectin Benzoate @ 0.5 g/L of water

T_3= Ascend 3GR (soil application) + Cartap @ 1.0 g/L of water

T_4= Acetamiprid (Tundra 20 SP) @ 0.5 g/L of water

T_5= Furadan 5G (soil application) + Actara @ 0.5 g/L of water

T_6= Chlorpyriphos (2.0 ml/L) + Cypermethrin (1.0 ml/L) of water

T_7= Control

amount of urea (as per treatment) was applied as top dressing around the base of the plant. Top dressing of one third of urea was applied at 15 days after sowing and remaining urea was top dressed in two equal instalments at 30 and 45 days after transplanting (DAT). MoP was applied as basal dose and top dressing at 45 DAT in equal split. TSP was applied as basal dose in the plots. Gypsum and boric acid was applied as small amount as per requirement.

3.7 Collection and sowing of seeds

Seeds are collected from the BARI, Joydebpur, Gazipurand sown in the experimental plots at the rate 28 seeds/plot (four seed per line). Seeds were sown on 23 November, 2014.

3.8 Treatments of the experiment

Treatments

Therefore, seven treatment combinations were tested in this experiment

T_1= Admire 200 SL @ 0.5ml/L of water

T_2= Diazinon 10G (soil application) + Emamectin Benzoate (Wonder 5 WG) @ 0.5g/L of water

T_3= Ascend 3GR (soil application) + Cartap 50 SP @ 1.0 g/L of water

T_4= Acetamiprid (Tundra 20 SP) @ 0.5 g/Lof water

T_5= Furadan 5G (soil application) + Actara 25WG@ 0.5 g/L of water

T_6= Chlorpyriphos 20EC (2.0 ml/L) + Cypermethrin or Ripcord 10EC (1.0 ml/L) of water

T_7= Control

Application of insecticides

First application of insecticides was sprayed on the potato plant just after one week of germination. Data was counted before spraying, 1 day after the spraying, 3 days after the spraying and last data was counted 5 days after the spraying. Insecticides were sprayed on the potato plant on three times at 15 days interval.

3.9 Cultural Operation

Irrigation, Weeding, Draining and fertilizer application and other intercultural operations will be done properly during whole cropping season.

3.10 Data Collection

The data on the following parameters were recorded at different time intervals as given below:

- Total number of infested plants per plot
- Total number of aphid/plant in each plot
- Total number of jassid/plant in each plot
- Total number of cutworm/plant in each plot
- Total potato tuberweight/plot
- Total infested potato tuber weight/plot
- Total number of potato tuber/plot

3.10.1 Number of aphid per plot

Number of aphid were counted from the sampling potato plant from each plot and mean number expressed as number of aphid per treatment. Data on developed aphids/plant were recorded as the average of 5 plant selected randomly from each plot.

3.10.2 Number of jassid per plot

Number of jassid was counted from the sampling potato plant from each plot and mean number expressed as number of jassid per treatment. Data on developed jassid/plant were recorded as the average of 5 plant selected randomly from each plot.

3.10.3 Number of cutworm

Number of cutworm were counted from each plot of the field during harvesting time where cutworm seen on the experimental plot and mean number expressed as number of cutworm per treatment.

3.10.4. Number of other insect

Many other insect such as thrips, potato beetle, white fly, wire worm, tuber worm and beneficial insect lady bird beetle were also counted when seen on the field.

Harvesting of the yield

The potato was harvested on 7 March, 2015.

3.10.5 Number of potato per plot

Total number of potato was recorded on each plot and mean number expressed as number of potato per treatment.

3.10.6 Yield per plot

Potato yield was recorded on kilogram (kg). Mean number expressed as weight of potato per treatment.

3.10.7 Yield per hectare

Yield per hectare was calculated out from per plot yield data and their average was taken. It was measured by the following formula,

$$\text{Yield per hectare (ton)} = \frac{\text{Yield per plot (kg)} \times 10000}{\text{Area of plot in square meter} \times 1000}$$

3.11 Statistical analysis

Collected data were statistically analysed using MSTAT-C computer package programme. Mean for every treatments were calculated and analysis of variance for each one of characters was performed by F–test (Variance Ratio). Difference between treatments was assessed by Duncan's Multiple Range Test (DMRT) at 5% level of significance (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was conducted to study the effect of different insecticides on controlling major insect pestsof potato. Data on parameters such as number of insects, number of seed tubers and yields were recorded in this experiment. The findings of the experiment have been presented and discussed with the help of table and possible interpretations with supporting relevant reference were given under the following headings.

4.1 Effect of insecticides on aphid population

The comparative effectiveness of various treatments on aphid infestation by the aphid population has been evaluated in terms of their efficacy in reducing the potato infestation over control expressed in percent as presented in Table1-3. The population incidence of potato aphid under different treatments has been shown in Table 1. Treatment T_4showed the better performance to reduce the aphid population than all the insecticidal treatment plotwhere as 90% significant highest infestation reduction observed, followed by the T_6 (89.13%) treatments.

The data shows that lowest number of aphid (0.5/plant) was observed in T_4 after spraying where as the number of aphid (5.00) was observed before first spraying. T_1 (75%), T_2(80%), T_6 (76%)showed intermediate results in reducing aphid population. The results of the present study was in accordance with the findings of other scientist like Hussain and Rahman (2000) showed significant results in controlling aphids as compared to the check plot by using 6 insecticides. The percent mortality of all insecticides was above 95% and the maximum mortality was found in Tundra 10EC and Sharp 25WP, which was 96.4%.

Table 1. Efficacy of insecticides in controlling the potato aphids after first spraying

Treatments	No. of aphid/plant before spraying	No. of aphid/plant at 3 DAS	Percent (%) aphid reduction over control
T_1	4.50 bc	1.50 b	75.00 b
T_2	5.00 a	1.00c	80.00 b
T_3	4.30 bcd	1.00 c	76.00 b
T_4	5.00 a	0.50d	90.00 a
T_5	4.10cd	1.50 b	63.00 c
T_6	4.60 ab	0.50d	89.13 a
T_7	4.00d	4.10 a	--
$LSD_{0.05}$	**0.40**	**0.35**	**4.78**
SE (±)	**0.13**	**0.11**	**1.55**
Level of significance	**0.05**	**0.05**	**0.05**
CV (%)	**4.99**	**13.44**	**3.98**

In a column, means having different letters are significantly different at 5% level of probability by DMRT.

[**T_1**= Admire 200SL @ 0.5ml/L, **T_2**= Diazinon 10G (soil application) + Emamectin Benzoate @ 0.5g/L, **T_3**= Ascend 3GR (soil application) + Cartap @ 1.0 g/L, **T_4**= Acetamiprid (Tundra 20 SP) @ 0.5 g/L, **T_5**= Furadan 5G (soil application) + Actara@ 0.5 g/L, **T_6**= Chlorpyriphos (2.0 ml/L) + Cypermethrin (1.0 ml/L) and
T_7= Control].

The lowest infestation reduction showed by the T_5 treated with Furadan 5G (soil application) and Actarawhere only 63% infestation reduction observed where (4.1) and (1.5) were mean number of aphid before and after spraying respectively.All these treatments differed most significantly from untreated control plotT_7.

Table 2 showed the results of second spraying. Highest level of infestation reduction observed in T_4 (88.88%) and T_6 (88.88%), which was statistically similar followed by T_2 and T_3 where 75.00% and 73.33% significant reduction of infestation observed respectively. Lowest level of infestation reduction observed in T_5 (66.66%).The experiment results are in compatibility with Foster *et al.*, (2000) that the insecticides can control the potato aphids effectively. The results are also in similarity with the results of Hussain and Rahman (2000). They managed the aphid population by using different chemicals.

Statistically significant variation was recorded for number of aphid per plant due to different management practices (Table 3). Highest of infestation reduction observed in T_5 (93.33%) followed by T_3(92.85)and T_4 (92.85%), which was statistically similar. Lowest level of infestation reduction observed in T_5 (66.66%). All these treatments differed most significantly from untreated control plotT_7 where as the number of aphid/plant (4.75) was highest than all the other insecticides treated plot.

Radcliffe and Ragsdale(2002) reported that Actara 25WG (thiamethoxam), Fulfill 50WG (pymetrozine) andProvado 1.6F (imidacloprid) all the insecticides provided excellent control of an extremely high aphid infestation.

Table 2. Efficacy of insecticides in controlling the potato aphids after second spraying

Treatments	No. of aphid/ plant before spraying	No. of aphid/ plant at 3 DAS	Percent (%) aphid reduction over control
T_1	3.00 c	1.00 c	66.66c
T_2	2.00 e	0.50 d	75.00 b
T_3	3.75 b	1.00 c	73.33 b
T_4	2.25 de	0.25 d	88.88 a
T_5	3.00 c	1.00 c	66.66 c
T_6	2.50 d	1.50 b	88.00 a
T_7	4.30 a	4.40 a	--
$LSD_{0.05}$	**0.45**	**0.28**	**2.91**
SE (±)	**0.15**	**0.09**	**0.95**
Level of significance	**0.05**	**0.05**	**0.05**
CV (%)	**8.48**	**11.41**	**2.51**

In a column, means having different letters are significantly different at 5% level of probability by DMRT.

[$\mathbf{T_1}$= Admire 200SL @ 0.5ml/L, $\mathbf{T_2}$= Diazinon 10G (soil application) + Emamectin Benzoate @ 0.5g/L, $\mathbf{T_3}$= Ascend 3GR (soil application) + Cartap @ 1.0 g/L, $\mathbf{T_4}$= Acetamiprid (Tundra 20 SP) @ 0.5 g/L, $\mathbf{T_5}$= Furadan 5G (soil application) + Actara@ 0.5 g/L, $\mathbf{T_6}$= Chlorpyriphos (2.0 ml/L) + Cypermethrin (1.0 ml/L) and
$\mathbf{T_7}$= Control].

Table3. Efficacy of insecticides in controlling the potato aphids after third spraying

Treatments	**No. of aphid/ plant before spraying**	**No. of aphid plant at 3 DAS**	**Percent(%) aphid reduction over control**
T_1	3.50 bc	1.00 b	87.50 b
T_2	3.00 c	0.50 d	83.33 c
T_3	3.50 bc	0.25 e	92.85 a
T_4	3.50 bc	0.25 e	92.85 a
T_5	3.75 b	0.25 e	93.3 a
T_6	3.45 bc	0.75 c	78.26 d
T_7	4.50 a	4.75 a	--
$LSD_{0.05}$	**0.61**	**0.21**	**2.91**
SE (±)	**0.20**	**0.07**	**0.95**
Level of significance	**0.05**	**0.05**	**0.05**
CV (%)	**9.58**	**10.64**	**2.17**

In a column, means having different letters are significantly different at 5% level of probability by DMRT.

[**T_1**= Admire 200SL @ 0.5ml/L, **T_2**= Diazinon 10G (soil application) + Emamectin Benzoate @ 0.5g/L, **T_3**= Ascend 3GR (soil application) + Cartap @ 1.0 g/L, **T_4**= Acetamiprid (Tundra 20 SP) @ 0.5 g/L, **T_5**= Furadan 5G (soil application) + Actara@ 0.5 g/L, **T_6**= Chlorpyriphos (2.0 ml/L) + Cypermethrin (1.0 ml/L) and
T_7= Control].

4.2 Effect of insecticides on jassid population

The population incidence of jassid at potato plant under different treatment has been shown in (Table4).In T_6 treatment, the mean number of jassid was recorded 3.5 and 2.0 before spraying and after spraying respectively. Treatment T_6 showed better performance to reduce the jassid population which was combined treated with chlorpyriphos and cypermethrin where 94.28% significant highest infestation reduction was observed followed byT_1 (90.00%)and T_5 (90.00%)treatment there were no significant difference between T_1 and T_5 treatment.

Moreover, 86.00% infestation reduction was observed on T_2 (Diazinon10G withEmamectin Benzoate), T_3(Ascend 3G with cartap), T_4(Acetamiprid) those were statistically similar. Statistically significant variation was recorded for number of jassid per plant due to different management practices (Table4).

Results of the Table 6 indicate that significant highest infestation reduction observed in T_4 (95.00%), followed by T_5 (85.00%). In T_4 treatment, the number of jassid (1.00) was observed before spraying and lowest number (0.05) was observed after spraying Acetamipred @ 0.5g/L. Lowest level of infestation reduction was observed in T_5 (66.66%) treatment treated with Furadan 5G with Actara @ 0.5 g/L where asthe number of jassid (1.00) was observed before spraying and (0.15) was observed after spraying. All these treatments differed most significantly from untreated control plot, T_7 that recorded the highest jassid infestation (3.2) by the number of jassid population.

Table 4. Efficacy of insecticides in controlling the potato jassid after first spraying

Treatments	No. of jassid/ plant before spraying	Mean no.of jassid/plant at 3 DAS	Percent(%) jassid reductionover control
T_1	2.00 d	0.20 c	90.00 ab
T_2	3.00 b	0.40 b	86.60 b
T_3	3.00 b	0.40 b	86.60 b
T_4	3.00 b	0.40 b	86.6 b
T_5	3.50 a	0.35 b	90.00 ab
T_6	3.50 a	0.20 c	94.28 a
T_7	2.50 c	2.60 a	--
$LSD_{0.05}$	**0.22**	**0.08**	**4.74**
SE (±)	**0.07**	**0.03**	**1.54**
Level of significance	**0.05**	**0.05**	**0.05**
CV (%)	**4.15**	**7.32**	**3.50**

In a column, means having different letters are significantly different at 5% level of probability by DMRT.

[**T_1**= Admire 200SL @ 0.5ml/L, **T_2**= Diazinon 10G (soil application) + Emamectin Benzoate @ 0.5g/L, **T_3**= Ascend 3GR (soil application) + Cartap @ 1.0 g/L, **T_4**= Acetamiprid (Tundra 20 SP) @ 0.5 g/L, **T_5**= Furadan 5G (soil application) + Actara@ 0.5 g/L, **T_6**= Chlorpyriphos (2.0 ml/L) + Cypermethrin (1.0 ml/L) and
T_7= Control].

Table 5. Efficacy of insecticides in controlling the potato jassid after second spraying

Treatments	No. of jassid/ plant before spraying	No. of jassid/ plant at 3 DAS	Percent (%) jassid reductionover control
T_1	2.00 b	0.50 b	75.00 d
T_2	1.00 d	0.10 c	90.00 b
T_3	1.50 c	0.50 b	66.66 e
T_4	1.00 d	0.05 c	95.00 a
T_5	1.00 d	0.15 c	85.00 c
T_6	1.30 cd	0.20 c	84.61 c
T_7	3.00 a	3.20 a	--
$LSD_{0.05}$	**0.29**	**0.16**	**3.37**
SE (±)	**0.09**	**0.05**	**1.09**
Level of significance	**0.05**	**0.05**	**0.05**
CV (%)	**10.58**	**13.00**	**2.67**

In a column, means having different letters are significantly different at 5% level of probability by DMRT.

[**T_1**= Admire 200SL @ 0.5ml/L, **T_2**= Diazinon 10G (soil application) + Emamectin Benzoate @ 0.5g/L, **T_3**= Ascend 3GR (soil application) + Cartap @ 1.0 g/L, **T_4**= Acetamiprid (Tundra 20 SP) @ 0.5 g/L, **T_5**= Furadan 5G (soil application) + Actara@ 0.5 g/L, **T_6**= Chlorpyriphos (2.0 ml/L) + Cypermethrin (1.0 ml/L) and
T_7= Control].

The data of Table 6 expressed that significantly highest infestation reduction observed in T_4 (95.83%), followed by T_2 (90.00%). On T_4 treatment the number of jassid (1.20) was observed before spraying and lowest number(0.05) was observed after spraying Acetamiprid @ 0.5g/L. Lowest level of infestation reduction was observed in T_6(85.71%) treatment where asthe number of jassid (1.40) was observed before spraying and (0.20) was observed after spraying. From the findings it is revealed Acetamiprid was more effective among all the insecticides. All these treatments differed most significantly from untreated control plot, T_7 that recorded the highest jassid infestation (3.2) by the number of jassid population.

Results in Table 7 demonstrated that T_4 treatment showed better performance to reduce jassid infestation where 94.83% significant infestation reduction was observed over control, followed by T_6(93.54%).T_1showed lowest infestation reduction (87.09%) over control.

The result of the present study was in accordence with the findings of other scientists like Mohammed (2007). He state that the efficacy of Actara and Marshall was evaluated for two consecutive seasons (2005/06 and 2006/07) at shambat research station farm for the control of aphid and jassid, while Phychlorex was evaluated for one season (2006/07) against aphid on potato. The three insecticides, Actara, Marshall, Phychlorex significantly reduced aphid population compared to the untreted control.

Table 6. Efficacy of insecticides in controlling the potato jassid after third spraying

Treatments	**No. of jassid /plant before spraying**	**No. of jassid /plant at 3 DAS**	**Percent(%) jassid reduction at 3 DASover control**
T_1	1.80 b	0.50b	72.22 e
T_2	1.00d	0.10 de	90.00 b
T_3	1.30 c	0.30 c	76.92 d
T_4	1.20cd	0.05 e	95.83 a
T_5	1.20 cd	0.30 c	75.00 d
T_6	1.40 c	0.20 cd	85.71c
T_7	3.40a	3.50 a	--
$LSD_{0.05}$	**0.21**	**0.11**	**2.47**
SE (±)	**0.07**	**0.03**	**0.81**
Level of significance	**0.05**	**0.05**	**0.05**
CV (%)	**7.40**	**8.45**	**1.97**

In a column, means having different letters are significantly different at 5% level of probability by DMRT.

[**T_1**= Admire 200SL @ 0.5ml/L, **T_2**= Diazinon 10G (soil application) + Emamectin Benzoate @ 0.5g/L, **T_3**= Ascend 3GR (soil application) + Cartap @ 1.0 g/L, **T_4**= Acetamiprid (Tundra 20 SP) @ 0.5 g/L, **T_5**= Furadan 5G (soil application) + Actara@ 0.5 g/L, **T_6**= Chlorpyriphos (2.0 ml/L) + Cypermethrin (1.0 ml/L) and
T_7= Control].

Table 7. Efficacy of insecticides in controlling the potato jassid

Treatments	No. of jassid reduction/plant	Percent(%) jassid reduction over control
T_1	0.40 b	87.09 b
T_2	0.20 c	93.54 a
T_3	0.40 b	87.09 b
T_4	0.16 c	94.83 a
T_5	0.26 c	91.61 a
T_6	0.20 c	93.54 a
T_7	3.10 a	--
$LSD_{0.05}$	**0.10**	**3.41**
SE (±)	**0.03**	**1.11**
Level of significance	**0.05**	**0.05**
CV (%)	**8.30**	**2.46**

In a column, means having different letters are significantly different at 5% level of probability by DMRT.

[$\mathbf{T_1}$= Admire 200SL @ 0.5ml/L, $\mathbf{T_2}$= Diazinon 10G (soil application) + Emamectin Benzoate @ 0.5g/L, $\mathbf{T_3}$= Ascend 3GR (soil application) + Cartap @ 1.0 g/L, $\mathbf{T_4}$= Acetamiprid (Tundra 20 SP) @ 0.5 g/L, $\mathbf{T_5}$= Furadan 5G (soil application) + Actara@ 0.5 g/L, $\mathbf{T_6}$= Chlorpyriphos (2.0 ml/L) + Cypermethrin (1.0 ml/L) and
$\mathbf{T_7}$= Control].

4.3 Efficacy of insecticides on cutworm and yield of potato tubers

Various insecticide treatments showed significant reduction in loss of potato tubers by weight due to the cutworm damage, showed in Table 8. Among the treatments, T_2 (Diazinon 10G and spraying Emamection Benzoate @ (0.5g/L of water) showed better performance to reduce the damage potato tuber and reduced 82.22% potato tuber damage over controlfollowed by T_1 treatment where 77.78% tuber reduction was observed over control having significant difference between them.

The total yield of potato (12.00 kg) was highest on T_2 treatment than the other insecticides treatment. T_3 showed 51.11% significantly lowest reduction of damaged potato tuber over control and the number of cutworm (16.07) was observed. 13.69% significant loss of damaged potato tuber found on T_6 (Chlorpyriphos @ 2ml/L of water and Cypermethrin @ 0.5ml/L of water) treatment where as 10.96 kg yield of potato recorded. The number of cutworm (21.43) was observed on T_6 treatment. Significantly 18.65% loss of damaged potato tuber found on T_4 treatment where 10.57 kg yield of potato was recorded. The highest number of cutworm (24.11) was observed on T_6 treatment. The lambdacyhalothrin, dimethoate were evaluated during potato growing seasons against potato cutworm. All the lambdacyhalothrin treatments significantly reduced cutworm infestation. All tested insecticide treatments, with the exception of pychlorex in season 2005/06 and the lowest dosage rate of zork, significantly increases compared to the untreated control.

Table 8. Effect of insecticides on cutwormdamage and yield of potato

Treatments	Number of cutworm	Damaged potato tuber	Percent (%) damage potato tuber	Total Wt. (kg)	Total Wt. (t/ha)
T_1	8.925 c	1.0	8.74	11.44 a	28.6
T_2	13.40 b	0.8	6.66	12.00 a	30.0
T_3	16.07 b	2.2	19.35	11.37 a	28.4
T_4	21.33 a	3.0	28.38	10.57 a	26.4
T_5	20.32 a	2.0	18.65	10.72 a	26.8
T_6	21.43 a	1.5	13.69	10.96 a	27.4
T_7	24.11 a	4.5	73.41	6.130 b	15.4
$LSD_{0.05}$	3.36	-	-	1.85	
SE(±)	1.13			0.62	
Level of significance	0.05			0.05	
CV(%)	12.40			12.12	

Mean value of 4 replications; each replication is derived from 28 plants per treatment. In a column, means having different letters are significantly different at 5% level of probability by DMRT.

[**T_1**= Admire 200SL @ 0.5ml/L, **T_2**= Diazinon 10G (soil application) + Emamectin Benzoate @ 0.5g/L, **T_3**= Ascend 3GR (soil application) + Cartap @ 1.0 g/L, **T_4**= Acetamiprid (Tundra 20 SP) @ 0.5 g/L, **T_5**= Furadan 5G (soil application) + Actara@ 0.5 g/L, **T_6**= Chlorpyriphos (2.0 ml/L) + Cypermethrin (1.0 ml/L) and
T_7= Control].

CHAPTER V

SUMMARY AND CONCLUSION

In a field experiment conducted during the rabi season 2014-2015 at Sher-E-Bangla agricultural university, Dhaka to study the effect of different insecticides on controlling the major insect pests of potato. The potato variety cardinal was used as the test crop.The experiment consists of six insecticidal treatments that the Admire@ 0.5ml/ L of water (T_1), Diazinon10G with EmamectinBenzoate@ 0.5g/L of water (T_2), Ascend 3G with Cartap@ 1.0 g/L of waer (T_3),Acetamiprid@, 0.5g/L fo water (T_4), Furadan with Actara@ 0.5g/L of water (T_5), Chlorpyripho @ 2.0 ml/L + Cypermethrin @ 1.0 ml/L of water (T_6) along with an untreated control treatment (T_7) to evaluate the efficiency of these insecticides against the major potato insect pests viz. cutworm, aphid andjassid. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications.

The experiment revealed 90% significant highest infestation reduction was observed on T_4 treatment and lowest in T_5(Furadan 5G with Actara)treatment (63%) during first spraying. At second spraying 88.88% significant highest infestation reduction was recorded in T_4 treatment and lowest in T_5 treatment (66.66%). At third spraying 93.33% highest in T_5treatment and lowest in T_6 (77.26% reduction).

In case of controlling jassid population, 94.28% highest infestation reduction was recorded from T_6 treatment and lowest in T_2 treatment (86.60%) at first spraying. At second spraying 95% highest infestation reduction was recorded in T_4 treatment and lowest in T_5 treatment (66.66%). At third spraying 95.83%

highest in T_5 treatment and lowest in T_1 (72.22% reduction). T_4 (Acetamiprid) showed best performance where as 94.83% significant highest infestation reduction over control and 87.09% lowest infestation reduction in T_3 (Accent 3G with Cartap).

In controlling cutworm T_2 treatment showed best performance (82.22%) followed by T_1 (77.78%) and the lowest in T_5 (46.77% reduction). Highest yield (30t/ha) was observed in T_2 treatment.T_1 and T_2 performed best, where lowest number of cutworm was recorded .8.74% and 6.66% infested potato tuber were recorded from T_1 and T_2 respectively. Among all the insecticides highest loss of potato tuber on T_4 (28.38%). Highest number of cutworm(24.11) were recorded from untreated control plot which showed significant damage (73.4% damaged tuber) and the lowest yield of potato (15.325 t/ha) was recorded than all the treatment plots.

Conclusion:

From the above findings it was revealed that, Acetamiprid @ 0.5g/L was more realiable to control aphid and jassid population among all other insecticides and Diazinon 10G as soil application with spraying Emamectin Benzoate @ 0.5g/L showed best performance to control cutworm infestation.

Recommendations:

Based on the above findings following recommendations may be suggested:

1. Such study may be conducted in different agro-ecological zones (AEZ) and seasons of Bangladesh for exploitation of regional adaptability and other performances;

2. Some different insecticides may be included in future program for more confirmation of the results.

3. Integrated pest management practices may be introduced to get effectiveness of insecticides by changing the use of insecticides formulation and their active ingredient days after days and maintain the general rules of spraying insecticides, use of such insecticides which are not affected as long term on soil and environment, timely used of insecticides on the target pests and sometimes natural and biological control may be added with chemical insecticides for controlling aphid, jassid and cutworm.

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APPENDICES

Appendix I. Monthly average record of air temperature, rainfall, relative humidity and Sunshine of the experimental site during the period from October 2014 to April 2015

Month	Air temperature (ºc)		Relative humidity (%)	Total rainfall (mm)	Sunshine (hr)
	Maximum	Minimum			
October, 2014	31.6	23.8	78	172.3	5.2
November, 2014	29.6	19.2	77	34.4	5.7
December, 2014	26.4	14.1	69	12.8	5.5
January, 2015	25.4	12.7	68	7.7	5.6
February, 2015	28.1	15.5	68	28.9	5.5
March, 2015	32.5	20.4	64	65.8	5.2
April, 2015	33.7	23.6	69	165.3	4.9

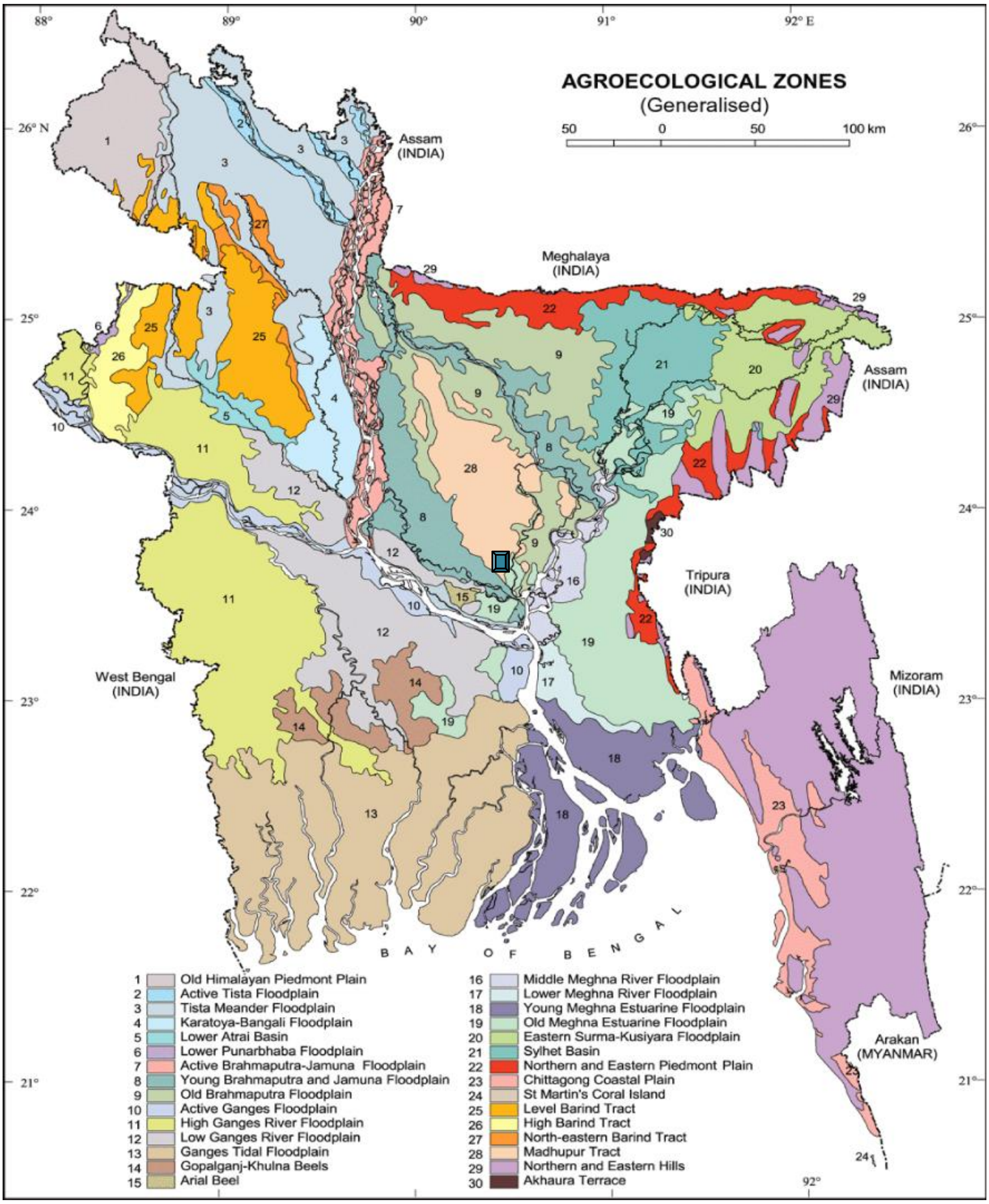
Source: Bangladesh Meteorological Department (Climate & Weather Division) Agargoan, Dhaka - 1212

Appendix II. Physical characteristics and chemical composition of soil of the experimental plot

Soil characteristics	Analytical results
Agrological Zone	Madhupur Tract
P^H	6.00 – 6.63
Organic matter	0.84
Total N (%)	0.46
Available phosphorous	21 ppm
Exchangeable K	0.41 meq / 100 g soil

Source: Soil Resource and Development Institute (SRDI), Dhaka

Appendix III. Map showing the experimental site under the study



The experimental site under study

Appendix iv. Effect of Insecticides on major potato insects

Treatments	4/01/2015		08/01/2015
	Aphid	Jassid	Aphid
T_1	11.61 a	0.890 b	4.46 b
T_2	11.61 a	1.79 a	6.25 a
T_3	4.46 d	1.79 a	4.46 b
T_4	8.92 b	0.890 b	5.355 ab
T_5	7.14 c	1.79 a	6.247 a
T_6	5.36 d	1.790 a	2.680 c
T_7	8.04 bc	1.790 a	5.360 ab
$LSD_{0.05}$	1.38	0.133	0.993
SE (±)	0.465	0.046	0.335
Level of significance	**	**	**
CV (%)	11.39	5.94	13.45

** = Significant at 1% level of probability

Appendix iv. Effect of Insecticides on major potato insects

Treatments	20/01/2015		20/01/2015
	Aphid	Aphid	3.570 c
T_1	10.71 b	10.71 b	4.460 bc
T_2	6.250 c	6.250 c	5.360 b
T_3	13.39 a	13.39 a	4.460 bc
T_4	6.248 c	6.248 c	3.570 c
T_5	5.355 c	5.355 c	8.040 a
T_6	8.931 b	8.931 b	8.932 a
T_7	9.823 b	9.823 b	0.923
$LSD_{0.05}$	1.77	1.77	0.311
SE (±)	0.595	0.595	**
Level of significance	**	**	11.32
CV (%)	13.72	13.72	

** = Significant at 1% level of probability

Appendix iv. Effect of Insecticides on major potato insects

Treatments	04/02/2015		08/02/2015		13/02/2015	
	Aphid	Jassid	Aphid	Jassid	Aphid	Jassid
T_1	3.570 c	0.8900 d	4.460 c	3.570 b	2.680 de	3.570 c
T_2	4.460 bc	2.680 b	0.8900 e	0.8900 e	5.362 c	0.8900 e
T_3	5.360 b	6.250 a	7.140 b	2.680 c	1.790 e	4.460 b
T_4	4.460 bc	0.8900 d	2.680 d	0.000 f	9.822 a	4.460 b
T_5	3.570 c	6.250 a	4.460 c	2.680 c	3.570 d	0.8900 e
T_6	8.040 a	6.250 a	6.250 b	1.790 d	8.042 b	2.680 d
T_7	8.932 a	1.790 c	8.931 a	5.360 a	10.71 a	6.250 a
$LSD_{0.05}$	0.923	0.220	0.979	0.535	1.15	0.831
SE (±)	0.311	0.074	0.330	0.180	0.387	0.280
Level of significance	**	**	**	**	**	**
CV (%)	11.32	4.15	13.25	14.87	12.92	16.88

** = Significant at 1% level of probability

Analysis of variance of the data for

Source of variation	df	4/01/2015		08/01/2015	20/01/2015	
		Aphid	Jassid	Aphid	Aphid	Jassid
Replication	3	1.890	0.016	0.294	0.953	0.012
Treatment	6	31.316**	0.771**	6.222**	33.714**	6.223**
Error	18	0.864	0.008	0.447	1.416	0.036

** = Significant at 1% level of probability

Analysis of variance of the data for

Source of variation	04/02/2015		08/02/2015		13/02/2015	
	Aphid	Jassid	Aphid	Jassid	Aphid	Jassid
Replication	0.270	0.027	0.464	0.147	0.529	0.267
Treatment	18.577**	26.584**	29.630**	12.463**	50.697**	15.644**
Error	0.386	0.022	0.434	0.130	0.600	0.313

** = Significant at 1% level of probability

Appendix v. Effect of Insecticides on major potato insects

Treatments	Number of cutworm	Total wt. (kg)
T_1	8.925 c	11.44 a
T_2	13.40 b	12.00 a
T_3	16.07 b	11.37 a
T_4	21.43 a	10.57 a
T_5	22.32 a	10.72 a
T_6	21.43 a	10.96 a
T_7	24.11 a	6.130 b
$LSD_{0.05}$	3.36	1.85
SE (±)	1.13	0.623
Level of significance	**	**
CV (%)	12.40	12.12

** = Significant at 1% level of probability

Analysis of variance of the data for

Source of variation	df	Number of cutworm	Total wt. (kg)
Replication	3	15.046	1.846
Treatment	6	124.265**	13.815**
Error	18	5.113	1.551

** = Significant at 1% level of probability