DEVELOPMENT OF MANAGEMENT PRACTICES AGAINST JASSID (*Amrasca devastans*) IN OKRA

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June, 2014

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A Thesis

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 (MS)

IN

ENTOMOLOGY

SEMESTER: JANUARY-JUNE, 2014

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CERTIFICATE

This is to certify that thesis entitled, **"DEVELOPMENT OF MANAGEMENT PRACTICES AGAINST JASSID (*Amrasca devastans*) IN OKRA"** 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 (MS) IN ENTOMOLOGY**, embodies the result of a piece of bona fide research work carried out by **ANIKA RAHMAN, Registration no. 08-02703** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Date: June, 2014
Place: Dhaka, Bangladesh

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Dedicated to My Beloved Family

DEVELOPMENT OF MANAGEMENT PRACTICES AGAINST JASSID (*Amrasca devastans*) IN OKRA

ABSTRACT

The experiment was conducted at the field laboratory of Sher-e-Bangla Agricultural University, Dhaka during the period from November, 2013 to March, 2014 to find out the efficacy of different management practices against jassid in okra. The treatments comprised two botanical products, two synthetic chemical insecticides along with soap and detergent and one untreated control. These treatments are T_1 = Spray with soap @ 3g/L of Water at 7 days interval; T_2 = Spray with neem oil @ 4ml+Trix (detergent) @ 10 ml/L of water at 7 days interval; T_3 = Spray with neem seed kernel water extract @ 20g/L of water at 7 days interval; T_4 = Spray with (Fenitrothion) Sumithion 50EC@ 1ml/L of Water at 7 days interval; T_5= Spray with Admire 200SL@ 0.5ml/L of water at the 7 days interval and T_6= Untreated Control. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The data were recorded on fruit infestation by number, weight and diameter of individual fruit at early, mid and late fruiting stages; and yield related attributes as well as yield of okra. Among six treatments, T_5 treatment (Admire 200SL) reduced the highest percent (88.46 %) of fruit infestation by number and fruit infestation by weight (85.94 %), followed by T_2 treatment (neem oil + trix) 77.73% and 75.39% respectively, whereas T_1 treatment (soap water) showed the least performance, 32.05% and 30.83% respectively by number and weight. Considering plant and yield related attributes, maximum height of plant (132.97), length of fruits (10.89), and diameter of fruits (1.188) were recorded in T_5 treatment over control followed by T_2. Similarly the highest fruit yield (23.39 ton/ha) was also achieved by the application of Admire 200SL with the increase of 60.21% yield over control whereas soap water showed least yield (15.89 ton/ha), followed by Sumithion 50EC (19.03). Okra yield increased due to increases of fruit length, diameter and plant height; on the other hand fruit yield decreased due to increase of fruit infestation by number and weight. The chemical insecticide Admire 200SL is the most effective in controlling jassid. Among other treatment Neem oil+ trix performed better to control jassid in okra. Considering Benefit Cost Ratio (BCR) and environment aspect, it may be suggested that neem oil+

trix, neem seed kernel water extract and use of soap water may be suitable option than other control.

ACKNOWLEDGEMENT

All praises goes to Allah, the most merciful, gracious and supreme ruler of the universe to complete the research work and thesis successfully. The heartiest gratitude, sincere appreciation and indebtedness to the reverend research supervisor Professor Dr. Md. Serajul Islam Bhuiyan, Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka for his scholastic guidance, innovative suggestions, constant supervision and inspiration, valuable advice and helpful criticism in carrying out the research work and preparation of this manuscript.

A sincere appreciation, respect and immense indebtedness to the respected co-supervisor Dr. Tahmina Akter, Associate Professor, Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka-1207, for extending her generous help, scholastic guidance, constructive criticism, continuous inspiration and valuable scholarly suggestions during the research work and preparation of the manuscript of the thesis.

I would like to express my deepest respect and boundless gratitude to all respected teachers of the Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka-1207 for their sympathetic co-operation and inspirations throughout the course of this study and research work.

The author extends her heartiest thanks and special gratefulness to Mohammad Raihan, y, Nurun Nahar Shahinur and many other well wishers for their inspiration, encouragement, help and active co-operation for carrying out the present study. Cordial thanks are also due to all stuffs of the Dept. of Entomology and field workers of SAU farm for their co-operation to complete the research work in the field.

Dated: June, 2014 **The Author**

SAU, Dhaka

LIST OF ABBREVIATIONS

Full word	Abbreviation
And others	*et al.*
Bnagladesh Agricultural Research Institute	BARI
Bangladesh Burea of Statistics	BBS
Centimeter	cm
Co-efficient of Variation	CV
Degree Celsius (Centigrade)	^{0} C
Degrees of freedom	df
Et cetera	etc
Gram	g
Inch	inch
Journal	J.
Kilogram	kg
Least significant difference	LSD
Litter	L
Mean sum square	MS
Milliliter	ml
Millimeter	mm
Percent	%
Relative Humidity	R.H.
Serial number	SL. No.

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CHAPTER I
INTRODUCTION

Okra, (*Abelmoschus esculentus*) is the only vegetable crop of significance in the Malvaceae family and is widely grown in tropics and subtropics for its tender green fruits (Obeng and Sackey, 2003; Oyelade *et al*., 2003). Though okra is produced mainly in the Kharif season it is cultivated even in dry areas and almost available throughout the year round (Rashid, 1999, Norman, 1992) for favorable climatic conditions (Memon *et al*., 2004). This fruit plays an important role to meet the demand of vegetables of the country when vegetables are scanty in the market (Ahmed, 2011 and Rashid, 1999). About 38,508 metric tons of okra is produced from 9786 hectares of land per year in Bangladesh, (BBS, 2009) and its average yield is about 3.93 ton ha-^{1} (BBS, 2009). The yield is very low as compared to the yield 9.7-10 t ha-^{1} of other developed countries of the world (Thomson and Kelly, 1979).

Okra is a popular nutritious fruit vegetable rich in minerals, carbohydrates fiber, protein, fat and phenols (Alwandai, 1983; Camciuc *et al*., 1998; Oyelade *et al*., 2003; Hung *et al*., 2004). Okra is cultivated mainly for its immature fruits, which are generally cooked as vegetable. When ripe, black or brown white- eyed seeds are sometimes roasted and used as a substitute for coffee. Tender fruits have high mucilage content and are used in soups and gravies. Besides being a vegetable, it acts as clarifying agent (Chauhan, DVS, 1972). The fruits also have some medicinal value. A mucilaginous preparation from the pod can be used for plasma replacement or blood volume expansion (Savello *et al.*, 1980).

In Bangladesh, vegetable production is not uniform round the year. Most of the vegetables are produced in the winter but very few in the summer. Around 30% of the total vegetables are produced in the kharif season and 70 % in rabi season (Anon., 1993) among them okra is very important in both season. In the year 2009-2010, the total production of okra was about 42,000 tons from 10,121 hectors of land with an average yield of 4.15t/ha (BBS, 2011).The yield is very low compared to that of other countries where the yield as high as 7-12 t/ha (Yamaguchi,1998).

The main causes of poor production are the attack of various pests and diseases and lack of knowledge about cultural practices. The crop is more vulnerable to the attack by as many as 13 major insect and non-insect pests during its different growth stages (Dhamdhere *et al*., 1984) includes *Amrasca devastans, Bemisia tabacim, Thrips tabaci, Aphis gossypii, , Earias vittella, Dysdercus koengii, Helicoverpa armigera, Acrocercops bifasciata, Podagrica, Anomisflava, Sylepta derogata, Haritalodes derogata, and Nezara viridula* (Basu, 1995; Lohar, 2001; Mani *et al*., 2005).These insect pests complex damages the crop during their different growth stages, right from germination to harvest (Jagtab *et al.,* 2007) and results in getting lower yields (Kumar and Sherma 1993; Gulati, 2004). The yield losses due to insect pests have been reported up to 69 percent (Mani *et al*., 2005). Insect pests not only reduce the growth and production but also transmit pathogenic diseases (Sheedi, 1980; Dhaliwal *et al*., 1981).

Among all these insect pests, *Amrasca devastans, is* the major pests and cause extensive damage in the early stage of crop (Atwal, 1994; Dubey *et al*., 1999; Lohar, 2001; Mani *et al.,* 2005). These pests are managed by the massive use of insecticides, as it is an immediate solution to control the pests (Mehmood *et al*., 2001) because farmers always desire quick curative action for controlling pests. Since no other control measure against okra sucking pests is available, chemical insecticides have remained as the most powerful tools for controlling this pest. Insecticides are highly effective, rapid in curative action, adaptable to most situations and relatively economical. Insecticides are the only tool for pest management which is reliable for emergency action when insect pest population approach or exceed the economic threshold level (Parkash, 1988). Recently, a large number of chemicals have been reported to have an effective control of insect pests in Okra (Verma *et al*., 2013). It has estimated that 27% of the total insecticides are being used on fruit and vegetables (Hussain *et al*., 2002). Extensive use of insecticides leads to the problems of pest resistance, resurgence, pesticides residues, destruction of beneficial fauna and environmental pollution (Adilakshmi *et al.,* 2008). There is a need to explore alternatives, available pest control techniques to reduce the use of insecticides.

Integrated pest management could be the safe, cheapest and appropriate approach to achieve sustainability in okra (Dhaliwal *et al.*, 1981; Dubey *et al*., 1999; Kumawat *et al*.,

2000; Ahmad *et al*., 2003; Ahmad *et al*., 2011; Khuhro *et al*., 2014). In this regard encouragement of bio-pesticides such as plant extracts occupies a central position in integrated pest management (Akbar *et al*., 2012). Plant extracts have been reported eco-friendly options for management of insect pests of okra (Bindu *et al.*, 2003; Singh and Brar, 2004; Paulraj and Ignacimuthu, 2005). The research have reported the usefulness of plant extracts in controlling different sucking pests of okra including jassid, (Akbar *et al*., 2007) aphid (Akbar *et al*., 2007), whitefly (Akbar *et al*., 2009) and spider mite (Kumar, 1993; Singh, 1999).

Small scale organic growers and home gardeners are utilizing botanical insecticides to manage okra pests. Botanical insecticides are not widely used in commercial agriculture but mixtures of various plant parts such as leaf, bark, seed and vegetable oils are traditionally being practiced in Asia and Africa for the management of this insect pest. Botanicals possess an array of properties including insecticidal activity and insect growth regulatory activity against many insect and mite pests (Prakash *et al*., 1990). Many of the botanicals have broad spectrum activity and may be alternatives to chemical insecticides. Keeping in view the hazardous nature of insecticides the present research work was undertaken to investigate the efficacy of some indigenous botanicals viz. neem oil *(Azadirachta indica),* neem seed kernel water extract, soap water, detergent (Trix) and two insecticides such as Sumithion 50EC and Admire 200SL on the incidence of jassid in okra field aiming to develop suitable management practices against jassid in okra.

Considering the above facts view in mind, the experiment has been undertaken with the following objectives:

- To know the infestation status of okra by jassid (*Amarsaca devastans*).
- To identify the most suitable control tactics for combating jassid.
- To reduce use of chemical pesticide, encouraging use of botanicals.

CHAPTER II:
LITERATURE REVIEW

In Bangladesh limited work of insect pest management of okra (*Abelmoschus esculentus*) in summer or winter has been done. A brief review of the literature available in Bangladesh and elsewhere related to okra and insect pest (jassid) control of okra is discussed below:

2.1. General review of okra (*Abelmoschus esculentus*)

Okra is valued for its edible green fruits, said to be shaped like lady's fingers - one of its common names in British English.

2.1.1.Vernacular names in different nations

The name okra is most often used in the United States and in the Philippines, with a variant pronunciation in Caribbean English of *okro*. The word *okra* is West African in origin, probably from Igbo *ọ́kụ̀rụ̀* (Harper & Mc-Horter, 2000). The plant and its seed fruits are also known as "lady's fingers (Mc-Horter, 2000). In various Bantu languages, okra is called *(ki)ngombo* or a variant,(Okfor *et al.*, 1987) and this is possibly the origin of the name "gumbo", used in different parts of the United States and the English-speaking Caribbean, (Okfor *et al.*, 1987). In much of South Asia, it is called by some variant of *bhindi*, a name also heard in the United Kingdom, but in Bangladesh it is called as *dherosh*.

2.1.2. Structure and physiology

2.1.2.1. Overview: An annual, erect herb up to 5 m (but typically about 2 m) tall. Stems are succulent with scattered, stiff hairs. The whole plant has an aromatic smell resembling cloves.

2.1.2.2. Leaves: Up to 50 cm wide and 35 cm long, deeply lobed, with toothed margins, hairy on both surfaces, especially on the nerves. Each leaf is borne on a petiole (leaf stalk) up to 50 cm long.

2.1.2.3. Flowers: Showy, up to 8 cm in diameter, usually yellow with a dark red, purple or smauve centre, borne on a stout flower stalk (peduncle) up to 4 cm long. Stamens (male parts) united into a white, hairless column up to 2.5 cm long. Stigmas (female parts) dark purple. Calyx (whorl of sepals) and epicalyx (whorl of bracts) both present

Plate 01: Okra flower

2.1.2.4. Fruits: A capsule, 10–20 cm long, roughly circular in cross-section with a pointed end, usually 5-ribbed, borne at the leaf axils. Immature fruit can be purple-red, reddish-green, dark green, pale green or yellow. At maturity, fruits turn brown and split into segments.

2.1.2.5. Seeds: Each fruit has up to 100 spherical or ovoid seeds bearing minute warts in concentric rows. Many cultivars are available, for example 'BARI Dherosh-1' and 'BARI Dherosh-2' (Bangladesh), 'Clemson Spineless', 'Indiana', 'Emerald' (USA) and 'Pusa Sawani' (India) etc.

2.1.2.6. Cultivation: In cultivation, the seeds are soaked overnight prior to planting to a depth of 1–2 cm. Germination occurs between 06 days (soaked seeds) to 21 days. Seedlings require ample water. The seed fruits rapidly become fibrous and woody, and, to be edible, must be harvested within a week of the fruit having been pollinated. The fruits are harvested when immature and eaten as vegetable (ASTG, 2007).

2.1.3. Regional preparations

2.1.3.1. Taxonomy

Kingdom	Plantae – Plantes, Planta, Vegetal, Plants
Subkingdom	Viridiplantae
Infrakingdom	Streptophyta – land plants
Superdivision	Embryophyta
Division	Tracheophyta – vascular plants, tracheophytes
Subdivision	Spermatophytina – spermatophytes, seed plants, phanérogames
Class	Magnoliopsida
Superorder	Rosanae
Order	Malvales
Family	Malvaceae – mallows, mauves
Genus	Abelmoschus Medik. – okra
Species	*Abelmoschus esculentus*

2.1.3.2. About this species

Okra is a cultigens (a plant that has been altered by humans through a process of selective breeding). The exact origin of okra is unknown, but it is thought to have come from Africa, where it has been grown as a crop for centuries. Evidence suggests it was grown in Egypt as long ago as 2,000 BC. Today it is widely cultivated for its edible green fruits, which are harvested when immature (after 3–5 days of development), and are infamous for their slimy mucilage.

Abelmoschus esculentus is also known by the synonym *Hibiscus esculentus* and the common name lady's fingers, thought to be a fanciful reference to the slender, finger-shaped fruits of some cultivars.

The Malvaceae plant family, of which okra is a member, contains many economically important plants. These include cotton (*Gossypium hirsutum*), cocoa (*Theobroma cacao*), ornamental *Hibiscus* species, the genus *Ceiba* (from which kapok fibre is derived), durian fruit (*Durio zibethinus*) and balsawood (*Ochroma pyramidale*).

2.1.3.3. Geography and distribution:

Okra is an allopolyploid of uncertain parentage (proposed parents include *Abelmoschus ficulneus*, *A. tuberculatus* and a reported "diploid" form of okra). Truly wild (as opposed to naturalized) populations are not known with certainty and the species may be a cultigens.

The geographical origin of okra is disputed, with supporters of South Asian, Ethiopian and West African origins. Supporters of a South Asian origin point to the presence of its proposed parents in that region. Supporters of a West African origin point to the greater diversity of okra in that region.

The Egyptians and Moors of the 12th and 13th centuries used the Arabic word for the plant, *bamya*, suggesting it had come from the east. The plant may have entered southwest Asia across the Red Sea or the Bab-el-Mandeb strait to the Arabian Peninsula, rather than north across the Sahara, or from India. One of the earliest accounts is by a Spanish Moor who visited Egypt in 1216 and described the plant under cultivation by the locals who ate the tender, young fruits with meal.

From Arabia, the plant spread around the shores of the Mediterranean Sea and eastward. The plant was introduced to the Americans by ships plying the Atlantic slave trade (Okfar & Farnandes, 1987) by 1658, when its presence was recorded in Brazil. It was further documented in Suriname in 1686. Okra may have been introduced to southeastern North America from Africa in the early 18th century. By 1748, it was being grown as far north as Philadelphia. Thomas Jefferson noted it was well established in Virginia by 1781. It

was commonplace throughout the southern United States by 1800, and the first mention of different cultivars was in 1806 (Okfar & Farnandes, 1987).

2.1.4. Uses: Okra is considered a delicacy in the American Deep South, particularly when breaded with corn meal and deep fried. Several cafe and nationwide restaurant chains serve deep fried okra, typically with a side order of a sauce such as buttermilk (or ranch) dressing. In Syria, Tunisia, Egypt, Albania, Bosnia, Greece, Bulgaria, Republic of Macedonia, Iran, Iraq, Sudan, Jordan, Lebanon, Turkey, and Yemen, and other parts of the eastern Mediterranean, including Palestine, Cyprus and Israel, okra is widely used in a thick stew made with vegetables and meat. In the Turkish cuisine, other than the stew, which can also be made using dried okra, *bamya* is also made as a cold starter or meze dish with the use of olive oil and is eaten sprinkling lemon juice over the plate. In Bosnia and most of West Asia, okra is also known as *bamia* or *bamya*. West Asian cuisine uses young okra fruits, usually cooked whole.

In India, the harvesting is done at a later stage, when the fruits and seeds are larger. Okra is popular in Indian and Pakistani cuisine where chopped pieces are stir-fried with spices, pickled, salted or added to gravy-based preparations such as *bhindi ghosht* and *sambar*. It is also simmered in coconut-based curries or tossed with ground mustard seeds. In India, it is also an ingredient in curries, in which it is used whole after trimming only the excess stalk and keeping the hard conical top, which is discarded at the time of eating. In South India, okra is cut into small circular pieces about 1/4 inch thick and stir-fried in oil with salt and hot pepper powder to make curry. However, when used in sambar, it is cut into pieces which are one inch thick to prevent it from dissolving when the sambar is left to simmer.

In Malaysia okra is commonly a part of *yong tau foo* cuisine, typically stuffed with processed fish paste (surimi) and boiled with a selection of vegetables and tofu, and served in a soup with noodles. In Malawi it is preferred cooked and stirred with sodium bicarbonate to make it more slimy. It is then commonly eaten with nsima made from raw maize flour or maize husks flour. In the Caribbean islands, okra is eaten in soup. In Curaçao the soup is known as *jambo* which primarily is made out of the okra's mucilage.

It is often prepared with fish and *funchi*, a dish made out of cornmeal and boiling water. In Haiti, it is cooked with rice and maize, and also used as a sauce for meat. In Cuba, it is called *quimbombó*, along with a stew using okra as its primary ingredient.

In the Dominican Republic okra is eaten in salad and also cooked with rice. In Trinidad and Tobago okra is used as one of the main ingredients in the thick soup-like melting-pot dish called callaloo. In Trinidad and Tobago and other West Indian territories such as Barbados it is also used as a main ingredient in the cornmeal-based meal called cou-cou that is similar to polenta. Okra became a popular vegetable in Japanese cuisine toward the end of the 19th century, served with soy sauce and *katsuobushi* as tempura and more recently as a nigiri sushi topping.

In the Philippines, okra can be found among traditional dishes like pinakbet, dinengdeng, and sinigang. Because of its mild taste and ubiquity, okra can also be cooked adobo-style, or served steamed or boiled in a salad with tomatoes, onion and bagoong.

Okra forms part of several regional "signature" dishes. *Frango com quiabo* (chicken with okra) is a Brazilian dish especially famous in the region of Minas Gerais, and it is the main ingredient of *caruru*, a Bahian food with *dende* oil. Gumbo, a hearty stew whose key ingredient is okra, is found throughout the Gulf Coast of the United States and in the South Carolina Lowcountry. Deep- or shallow-fried okra coated with cornmeal, flour, etc., is widely eaten in the southern United States. Okra is also eaten in Nigeria, where draw soup is a popular dish, often eaten with *garri* or cassava. In Vietnam, okra is the important ingredient in the dish *canh chua*. Okra slices can also be added to *ratatouille*. A classification of uses are as follows:

2.1.4.1. Food

Okra is widely used in African, Indian, Middle Eastern and Caribbean cuisine and is also popular in southern parts of the USA (where it is the key ingredient in gumbo). Immature fruits are usually boiled, but also fried, steamed, grilled, battered or eaten raw. Fruits are

preserved by pickling, or drying and grinding into powder. They are used to make soups, sauces, stews, curries and even salads. Okra is high in fiber and rich in vitamins and minerals, including calcium and vitamin C.

The fruits have a unique flavor and texture and release slimy mucilage on cooking, which can be used to thicken sauces and add smoothness to soups. Okra mucilage has also been used in confectionery and for clarifying sugar cane juice to make molasses in India. The slimy texture is not to everyone's taste and can be reduced by cooking in salted water.

Okra, raw

Nutritional value per 100 g (3.5 oz)

Energy	138 kJ (33 kcal)
Carbohydrates	7.45 g
Sugars	1.48 g
Dietary fiber	3.1 g
Fat	0.19 g
Protein	2.00 g
Vitamins	
Vitamin A equiv.	(5%) 36 µg
Thiamine (B1)	(17%) 0.2 mg
Riboflavin (B2)	(5%) 0.06 mg
Niacin (B3)	(7%) 1 mg
Vitamin C	(28%) 23 mg
Vitamin E	(2%) 0.27 mg
Vitamin K	(30%) 31.3 µg
Trace metals	
Calcium	(8%) 82 mg
Iron	(5%) 0.61 mg
Magnesium	(16%) 57 mg
Potassium	(6%) 299 mg
Zinc	(6%) 0.58 mg
Other constituents	
Water	90.17 g

- Units
- µg = micrograms • mg = milligrams

- IU = International units

Young leaves are sometimes used as a vegetable, in a similar manner to spinach, particularly in West Africa and Southeast Asia. Okra leaves are sometimes dried and ground into powder for storage. Flower buds and petals are sometimes eaten in times of food shortage (Okfar & Farnandes,1987).

Okra seeds are often used in place of dried peas, beans or lentils in rice dishes and soups. In Nigeria, seeds are prepared into a food known as *dandawan betso*. In India, okra seeds are eaten in curries and chutneys. Roasted okra seeds are ground and used as a substitute for coffee in some areas. Considered by some to be one of the best coffee substitutes known, it was once widely used in Central America, Africa and Malaysia (Okfar & Farnandes,1987).

2.1.4.2. Traditional medicine:

Leaves and immature fruit have long been used in the East in poultices and applied to relieve pain, moisturise skin, induce sweating, prevent scurvy and treat urinary disorders. In Congo-Brazzaville, a leaf decoction is given for heart pains and to promote delivery during childbirth. Okra root has been used to treat syphilis in Malaya. Okra mucilage has been used as a plasma replacement and blood volume expander. To obtain the mucilage, slices of immature fruits are placed in water, which is then boiled. The mucilage is an acidic polysaccharide composed of galacturonic acid, rhamnose and glucose and tends to break down when overheated.

2.1.4.3. Fiber

Okra bark yields silky fiber, which is easy to extract. It is white to yellow in color and strong but rather coarse. It can be spun into yarn, rope and sacking and has been used for

fishing lines, game traps and hammocks in West Tropical Africa. It has also been used in paper and cardboard production.

2.1.4.4. Okra seed oil

Greenish-yellow edible okra oil is pressed from okra seeds; it has a pleasant taste and odor, and is high in unsaturated fats such as oleic acid and linoleic acid (Maya, 1982). The oil content of some varieties of the seed can be quite high, about 40%. Oil yields from okra crops are also high. At 794 kg/ha, the yield was exceeded only by that of sunflower oil in one trial (Martin *et al.*, 1990). A study in 1920 found that a sample contained 15% oil (Jamison *et al.*, 1920). Another study found okra oil suitable for use as a biofuel (Farooq & Anowar, 2010).

2.1.4.5. Other uses

Okra leaves and seed-cake are sometimes used as cattle feed, and the leafy tops are grazed by stock and game. Okra mucilage has been added as size to glaze paper in China.

2.1.5. Known hazards:

The most common disease afflicting the okra plant is verticillium wilt, often causing a yellowing and wilting of the leaves. Other diseases include powdery mildew in dry tropical regions, leaf spots, and root-knot nematodes (DPIF,2007).

Irritating hairs are sometimes present on leaves and stems, and traces of alkaloid have been reported in leaves (Baghman & walter 1920).

2.2. General review of jassid(*Amrasca devastans*)

Jassid is the major insect pest of different vegetables including okra, which causes significant damage to crop every year. The incidence of this pest occurs sporadically or in epidemic from throughout Bangladesh and affecting adversely the quality and yield of the crop.

2.2.1 Nomenclature

Kingdom: Animalia

Phylum: Arthropoda

Sub-phylum: Mandibulata

Class: Insecta

Order: Homoptera

Family: Cicadillidae

Genus: Amrasca

Species: *Amrasca devastans*

2.2.2. Origin and distribution:

Okra Jassid is a versatile and widely distributed insect. It has been recorded in India, China, Pakistan, Iran, Syria, Greece, Spain, Argentina, Brazil and USA. It is distributed widely throughout Eastern, Western, Southern, Central Africa and Australia (Gharami, 1963). This pest is also common in Bangladesh.

2.2.3. Host range:

Apart from feeding on okra, the jassid have a very wide range of the host plants, including herbaceous cultivated plants and weeds, chiefly amongst the Malvaceae, Legunmiosae and Solanaceae.

2.2.4. Status and nature of damage

Okra jassid, *A. devastans* is one of the key insect pests of okra and is the major factor limiting okra yield in Bangladesh (Eltom,1978). This pest can cause more than 50 percent reduction of seed okra yield in some okra genotypes (Bhat *et al*.,1984). The nymphs and adults of this pest can attack okra leaves at all stages of development. Jassid, particularly the older nymphs, feeding on the small veins appear to affect the functioning of the vascular system so that the leaf of edge changes color from dark to pale green, yellow and then red and brown. Adults and nymphs suck plant sap from the under surfaces of leaves. The affected leaves shown hopper burn symptoms. The whole leaf of susceptible okra varieties can desiccate and shed. The edge of leaves curl downwards if attacked leaves have not fully expanded. Growth of young plants may be completely stopped. They also introduce a toxin that impairs photosynthesis of okra plants. Due to attack of the jassid, the okra leaves became yellow and curled upward. Then the leaves finally turned brown at the tips and dried up. The heavily infested plants failed to bear fruits and the less damaged plants were found to produce different types of fruits.

The deformed fruits when cocked were fibrous and become unfit for consumption (Kochhar, 1986). The infested plants remained stunted in the field. The jassid attacked plants are easily identified by presence of globular, translucent, mucilaginous substances. The exudates were present mostly on the under surface of the leaf, a few in the leaf petiole and stem. The jassid damaged the plants at all stages of their growth. The maximum numbers of exudates were found in the younger leaves than in the older ones (Eltom, 1987).

2.2.5: Life history:

2.2.5.1. Egg: Curved, greenish-yellow eggs (0.7-0.9 X 0.15-0.2 mm) are laid deeply embedded in the midrib or a large vein on the either surface of the leaf or in a petiole or young stem but never in the leaf lamina. Depending on species, 29-60 eggs can be laid singly and they hatch in 4-11 days (Sharma, 1997).

2.2.5.2. Nymph: nymphs are pale green, wedge-shaped, 0.5-2.0 mm long, having carb like sideways movement characteristics when disturbed (Kochhar, 1986). They are confined to the under surface of leaves during the daytime, but can be found anywhere on the leaves at night (Evans, 1965). The nypmphal period can vary from 2 to 21 days depending on food supplies and temperature (Hssain *et al*.,1979). A generation likes 3-4 weeks in the summer *Amrasca devastans* is estimated to have 11 generations in a year in India (Iqbal, 2008).

2.2.5.3. Adult: Adults are small, elongate and wedge-shaped, about 2.5 mm long, semi-transparent plae green body, shimmering wings, very active, having a sideways walk like the nymphs, but quick to hop and fly when disturbed.(Singh *et al*., 2003); Kakar and Dobra,1988). They have a life span of up to 2 months (Evans, 1965).

2.2.5.4. Monitoring: Nymphs and adults can be found on the undersides of leaves. Nypmhs tend to move sideways when disturbed, adults can fly readily and both nymphs and adults follow aggregated distribution (Shivalingaswamy *et al.*, 2002).

Sharma and Sharma (1997) observed the biology of jassid (Amrasca) on okra variety; pusa swani revealed that the insect had an incubation period of 6.27 days. The egg hatchability was 91.9 %. The nymphs were observed to pass through five instars and the duration of each instars was 1.5,1.1, 1.2, 1.5 and 2.0 days. Mean pre-mating, pre-observation, oviposition and post-oviposition period were 2.55, 3.45, 16.57 and 3.90 days respectively. The average fecundity was 17.5 eggs per female. The adult life span ranged

from 21 to 30 days. The females dominated over males in numbers in the field. Rearing of nymphs on different cultivars showed poor survival, longer developmental period and smaller size on cv.IC 7194 as compared to days cvs MR 12, MR 10-1 and Pusa Sawami.

2.2.6. Incidence and seasonal distribution of okra jassid

Yadav *et al*,. (2007) studied the population dynamics of jassid (*Amrasca* devastans), on okra cv.Azad bhindi-1 in relation to weather factors, during kharif seasons in 2005 and 2006 at Kanpur, Uttar Pradesh, India. Jassid actively started from first week of \august on 3-week-old crop in 2005. In 2006, jassid infestation on shoots started from the fourth week of July on 7 leaf-stage until the third week of September. The maximum population of jassid was observed in 2005 in the second week of September on 8 week-old plants (Yadav *et al*,. (2005).

The seasonal abundance of jassid, *Amrasca devastans*, on okra was investigated by Inee and Dutta (2000) in Jorhat, Assam, India during1998-99. Result revealed that meteorological parameters played an important role in the population build up of cotton jassid. The jassid population was maximum in the last week of May in 1998 (37.53 nymphs per leaf) and middle of April in 1999 (30.00 nymphs per leaf). High temperature (30-36 degree C), evening relative humidity (bellow 80%) and low rainfall period with bright sunshine hours favored the development of jassid population Yadav *et al*,. (2004).

Kumawat *et al*., (2000) investigated the seasonal incidence of jassid (*Amrasca devastans*) on Okra during kharif 1996 in the semi-arid region of Rajasthan, India. The infestation of jassid started in the fourth week of July and reached in peak in the second and fourth weeks of September, respectively.

Mahmood *at el*., (1990) studied the abundance of the Cicadellidae, *Amrasca devastans* on okra in Pakistan during 1986-1987. The pest appeared in June and remained active until the end of crop season. Among various environmental factors the only significant factor in both years of the study was temperature. A positive correlation was found between maximum and minimum temperature with regarding to density of the pest. Neither relative humidity nor rainfall significantly increased or decreased the pest population.

In another study, Mahmud *at el*., (1988) reported that phonology of the Cicadillidae, *Amrasca devastans* on okra in Pakistan. The population of the pest remained below the economic threshold level for about 5 weeks after germination of the okra crop. The population then crossed over the threshold level in early June and remained at the same level until late August. The population of the pest peaked in late July (27.8 individuals per leaf).

Senapati and Khan (1978) reported that the largest population of okra jassid occurred from November to February. Pawar et al., (1996) showed that the crop sown on 15th May and 1st June had a lower incidence of *Amrasca devastans* with a good yield of marketable fruits (22.9 q/ha). Atwal *et al.*, (1969) reported that the population reached its peak in August and September raged between 28.2-30 C.

Ali and Karim (1991) conducted an experiment in 3 consecutive kharif and rabi seasons in Joydebpur, Bangladesh to investigate the influence of plant age on the abundance of *Amrasca devastans*. Cicadellid populations remained below the economic threshold level of one insect/leaf for up to 35 days of plant age in khraif and 65 days of plant age in rabi. Most of the cicadellids were found in 35 to 75 days old plants in kharif and 65 to 130 days old plants in rabi season. Plants growth in the kharip season was more vulnerable to insect attack than plant grown in the rabi season (Yadav *et al*,. (2008).

Tomar and Rana (1994) reported that among the sowing dates, 20 February and 5 march for spring sow in and 2 April and 5 June for rainy season sowing gave the least incidence of *Amrasca devastans* nymphs Yadav *et al*,. (2001).

2.2.7. Efficacy of indigenous plant materials

Several indigenous plant materials have been used to control these Jassid in our country and others parts of world. Investigations are required to emerge with suitable indigenous plant materials on every crop, especially the vegetables which are consumed daily in large scale. The information on the use of plant materials for the management of okra Jassid is limited.

2.2.8. Efficacy of indigenous plant materials against jassid

Spraying of neem oil, neem seed, neem leaf extract, neem seed kernel extract against jassid, whiteflies, thrips and aphids was very effective. In addition to this many plant products like *Annona squamosa* L., *Chrysanthemum* spp. and *Rotenone* spp were used as insect repellents and antifeedants in managing the pests attacking many crops (Hugar *et al.*, 1990).

Kanvarjibhai (1993) experimented with the extract prepared by using, neem, green chilli and garlic which is mixed with water in the proportion of 1:2 and sprinkled over many crops infested by Jassid and other aphid. He observed the consistent efficacy of the mixture for more than five years.

Thomas (1994) found that hot water extract of highly pungent chilli along with few bits of asafetida (the brownish gum resin of various plants; has strong taste and odor; formerly used as an antispasmodic) to be quite effective against leafhopper and mite pests. Garlic bulbs were (200 g) crushed and soaked in kerosene (200 ml) for 24 h and then mixed with ground chilli (25 g) along with 10 ml of soap solution. When 20 ml of the extract was diluted in one liter of water and sprayed on the crops gave good control of the Jassid (Thomas, 1995).

According to Vijayalakshmi *et al.* (1996), neem and garlic extract alone and in combination with other plant extracts *viz.*, garlic, chilli, ginger, neem, tobacco and even

cow urine was found effective against jassid, aphids and whiteflies and the extract was effective up to 13 days of application. Neem extract alone and Ginger extract alone and in combination with other plant and cow urine was detrimental to jassid, thrips and whitefly (Vijayalakshmi *et al.*, 1997).

Kasyapa (1998) from Medhak district at Andhra Pradesh reported that chilli + garlic solution and neen seed karnel extract (NSKE) spray were the common practices used by local farmers for pest management. Among different botanicals tested by Sridevi (1998), NSKE (5%) proved to be effective in reducing Jassid population in sunflower and all botanicals were found to be safer to natural enemies and pollinators.

Lakshmanan (2001) reported that neem oil & neem seed kernel extract alone or in combination with garlic bulb extract, kerosene, chilli and other extracts effectively managed Jassid, whiteflies, thrips and tetranychid mites infesting several crops. The herbal pesticides were prepared by immersing leaves (possessing bitter taste) in cow urine over a week period. Then the extract was mixed with water and sprayed for the control of Jassid and fruit borer in okra (Krishna, 2001).

2.2 .9 Efficacy of indigenous plant materials against jassid in okra:

Investigations of Patel and Patel (1996) revealed that spraying neem seed kernel suspension (5%) on okra had inhibitory effect on *Amrasca devastans* which resulted in production of abnormal adults and lower emergence of normal adults. Umamaheshwari *et al.* (1999) obtained significantly higher per cent mortality of jassid and others sucking pest on okra with neem oil as compared to achook and nimbecidine. Castor oil was superior to untreated control but was inferior to neem products. However, dicofol (0.2%) proved superior over all the neem products.

Natarajan *et al.*, (2000) studied the efficacy of some botanicals like NSKE, garlic kerosene extract and *Vitex* extract against the jassid, *A. devastans* on okra and found that garlic kerosene extract recorded the lowest number of jassid.

A field trial conducted by Pawar *et al.*,(2000) to assess the bio-efficacy of organic

products against jassid and aphids on okra revealed that cow urine, *Lantana camara* L. and *Azadirachta indica A. Juss* were found to be effective.

The treatments were superior to monocrotophos except in checking jassid incidence. The leaf extract of *Annona, reticulat* and *jatropa* were high in their effectiveness against the jassid of bhendi. The aphid and jassid incidence in okra was minimized by spraying neem oil + garlic extract, garlic extract + chilli extract, garlic extract + cow urine and NSKE + cow urine (Jayakumar, 2002).

The laboratory studies were conducted to test the joint action potential of methanolic extract of NSKE in combination with methanolic extracts of two other botanicals *viz.*, sweet flag and pungum against, *Amrasca devastan* on okra, at 1:1:1, 2:1:1 and 3:1:1 (v/v) ratios. The first combination recorded the lowest settling response and highest mortality of jassids compared to other combinations and NSKE alone. Under field conditions also, the combination at 0.42 per cent concentration gave superior control of the pest after methyl demeton (0.05%) (Srinivasa Rao and Rajendran, 2002). Mani *et al.*, (2005) reported that the botanical pesticides like neem oil, azadirachtin (300 ppm) and (1500 ppm), mahua and pungum oil significantly reduced jassid population on okra.

A field trial was conducted to know the effect of traditional pest control measures against major pests of rice. The results indicated that brown jassid population was suppressed (6.96 hoppers/hill) in plots treated with leaves of asafoetida mixture followed by tobacco leaf waste extract. The treatment applied with rice bran, kerosene recorded lowest jassid population whereas, the least leaf folder damage was registered in plots sprayed with lime + ash and green chilli extract (Bhaskaran, 1995).

Narayanasamy (1999) studied the insecticidal activity of 23 selected traditional pest control practices (plant extracts) against pests of rice *viz.*, jassid and leafhopper under laboratory condition. The most effective practices against jassid was spraying the extract of garlic + kerosene (39.29% mortality) followed by neem oil and rice bran + kerosene.

Reduced jassid population on tea plants was recorded in garlic (21.35/plant) and Margosa (2.94/plant) treated plots followed by Margoeconeem (3.47/plant) (Baisen and Ghosh Hajra, 2001). Rosaiah (2001) reported spraying of monocrotophos in brinjal was superior in reducing jassid incidence. However, neem oil (0.5%) was significantly superior in reducing the jassid and whitefly population and shoot and fruit borer damage followed by NSKE (5%). The leaf extract of Annona, Calotropis and Jatropa were poor in their effectiveness against the pests of brinjal (Rosaiah (2001).

Hanumantappa (2003) studied the efficacy of botanicals against sunflower jassid, *A. devastans* and found that among different botanicals used, NSKE (5%) was the superior treatment over neem oil, pongamia oil and commercial neem formulation.

Deshmukh and Barle (1976) studied the insecticidal activities of suspension and extracts of 20 plant species against jassid. Jassid were much susceptible to plant extracts than *Spodopetra litura* Oriental Leafworm Moth. Some indigenous extracts *viz.*, neem, garlic, tobacco straw wash and a mixture of soap with kerosene were treated as repellents against mustard jassid, *Lipaphis erysimi* K. and all the extracts recorded reduced infestation and increased yield (Kabir and Mia, 1987).

Cold alcoholic extracts of *Calamus*, *Azadirachta indica*, *Butea sp. Calotropis sp. Datura alba* (Nees.), *Ipomea carnea* (Jacq.) and *Parthenium hysterophorous* L. were tested against *Dactynotus carthami* (HRL) and *A. devastans.* Among them, the cold alcoholic extract of *P. hysterophorous* appeared to be comparatively more toxic against both the insects followed by *A. indica* (Patil *et al.*, 1990).

Iyyappa (1994) reported that spraying one per cent lemon juice resulted in reduction of jassid population on okra. The dried tobacco waste soaked in water for two days and the extract mixed with neem oil and cow urine when sprayed against sucking pests like jassid and whitefly was found very effective. A similar observation on the effectiveness of

lemon juice on jassid population in okra was observed by Samanthbhai and Dharmanbhai (1994).

Petroleum ether extract of neem, garlic derivatives, leaves of bullock's heart, Mexican prickly poppy and neem oil (margosa) were tried against okra jassid, *A. devastans* at Tirupathi. All the leaf extracts being at par with each other and gave 88.81 to 90.06 per cent reduction in jassid population. *Annona squamosa* (sugar apple) and Neemguard recorded 84.43 and 82.45 per cent reduction, respectively while garlic extract was the least effective (Chitra *et al.,* 1997).

Drastic reduction in jassid population was observed in plots treated with neem cake (86.92%), *Pongamia pinnata* (Indian Beech or Pongam Oiltree) (85.50%), NSKE (84.48%) and *Lantana* (83.50%). The seed yield was highest in dimethoate treatment followed by *Pongamia* (14.32 q/ha) and *Lantana* (14.14 q/ha). Looking into cost economics and considering ecosystem and environmental factors, it was advised to use botanical extracts like NSKE (5%), neem cake (5%), *Pongamia pinnata* (5%) and *Lantana* (5%) (Mallapur *et al.*, 2001).

Rathod *et al.* (2002) studied the bioefficacy of different herbal products against mustard jassid, *L. erysimi* and observed lower number of jassid population in aripple leaf extract (21.94), sadabahar leaf extract (21.34) and mixture of garlic + green chilli + kerosene (22.50) after 10 days of spraying.

Patel *et al* (2003) studied the efficacy of cow urine and botanicals against sucking pests of okra and revealed that although application of cow urine (20%) alone was found to be effective in reducing the jassid population, the insecticidal effects of cow urine could further be enhanced by enriching it with other botanical products llike 'Nikuchhi', a leaf extract of neem, custard apple, jatropa and lantana.

Patel *et al.* (2003) studied the bioefficacy of leaf extracts (10%) of arni (*Clerodendron multiflorum* F.), lantana (*L. camara*), mint (*Mentha piperata* L.), ardusa (*Alicantehus*

excels R.), naffitia (*Ipomoea fistulosa* M.), kaner (*Nerium indicum* Mill.) against *A. devastans* under laboratory conditions. The results revealed significantly high mortality of *A. devastans* (34.93%) with NSKE followed by neem (32.39%). The plants treated with ardusa leaf extract exhibited 27.39 per cent mortality which was at par with neem, naffatia and lantana. Mint, kaner and axni leaf extracts were more or less equally effective and registered 20 to 22 per cent mortality. Ratanjyot leaf extract failed to check the jassid population. Field evaluation studies also revealed that NSKE was significantly superior over all other treatments by registering lowest jassid population (35.98 jassid/plant). The botanicals were found safe to natural enemies of *A. devastans*.

Nonita Devi *et al.,* (2003) reported that among different plant extracts tested, *Artemesia vulgaris* (Linn.) (@ 0.0645%) showed highest mortality rate of 70.65 per cent against okra jassid.

Balikai and Lingappa (2005) studied the bioefficacy of different botanicals against jassid, *Melanaphis sacchari* (Zhentner) on *rabi* sorghum. Among the plant products tested, *Catheranthes (Vinca) rosea* L. leaves @ 5%, *Pongamia pinnata* (L.) kernels @ 2%, *P. pinnata* leaves @ 5%, *A. indica* kernels @ 5%, *Vitex negundo* L. leaves @ 5% and *Adhatoda vasica* Nees leaves @ 5% possessed as much insecticidal value as endosulfan 35 EC @ 0.07% against jassid. This was reflected in higher grain and fodder yields comparable to endosulfan in the above botanicals, except *V. negundo, and A. vasica.* The plant products *viz., V. rosea, P. pinnata, A. indica, V. negundo* and *A. vasica* can be effectively utilized for its management as an eco-friendly management tactic (Balikai and Lingappa, 2005).

2.2.10. Effect of storage period of plant materials on their efficacy against jassid

Barnby *et al.* (1983) reported that the effect of UV light might probably be the contributing factor for the significant reduction of azadirachtin content and found that neem products are UV sensitive. The degradation of azadirachtin takes place faster in field than in the laboratory, mainly because of the influence of light (Schmutterer, 1988).

Raguraman and Jayaraj (1994) studied the photo stability of neem seed kernel water extract (NSKWE) and its effect on mortality of Ambrasca devastans. The efficacy of NSKWE (5%) was reduced after two days of exposure to sun light and the authors concluded that the efficacy of NSKWE lasted for a shorter time due to the UV radiation of sunlight.

Udaiyan *et al.* (1995) studied the stability of azadirachtin in a neem oil based commercial formulation, nimbecidine during indoor storage in polythene bottles under different agro-climatic regions *viz.*, Coimbatore, Ooty, Madras and Delhi. The azadirachtin content was assessed at six monthly intervals over a period of 30 months from January 1991 to June 1993. The nimbecidine samples were filled in 200 ml polythene bottles and stored in the respective places. Although a gradual reduction in the azadirachtin content was recorded over a period of time, more than required concentration was maintained even after 30 months of storage at all the places.

2.2.11. Impact of indigenous plant materials on natural enemies in different crops

Naseeh (1982) studied the effectiveness of crude extract of garlic at 1.25, 2.5 and 5.00 per cent concentrations on the larvae and pupae of *Chrysoperla carnea* Stephn. And *Coccinella septumpuctata* L. The extracts killed 16-56 and 4-20 per cent of *C. carnea* and *C. septumpunctata*, respectively. Predators of leafhoppers and jassids such as the spider, *Lycosa pseudounnulatai* (Blackwall) was found unharmed by neem oil (2%) in rice ecosystem (Krishnaiah and Kalode, 1984).

Yadav and Patel (1990) evaluated the effect of commercial botanical insecticides like Neemark, Repellin, Welgro, neem seed kernel suspension, nicotine sulphate and Neemrich on oviposition and ovicidal action against *Chrysoperla* under laboratory conditions. All the botanicals repelled *Chrysoperla* from treated cotton field. While, nicotine sulphate was found toxic to adults, it also affected egg hatching.

Kaethner (1991) reported that neem extract and neem oil were harmless to eggs, larvae, adults of *C. carnea* and *C. septumpunctata*. However, under laboratory conditions, when the suspensions were directly sprayed on larvae, morphogenic defects developed leading to higher mortality.

The ether extracts of neem kernel was safer to *C. septumpunctata* as compared to synthetic insecticides. The order of safety was neem kernel extract > endosulfan > quinalphos > malathion > monocrotophos (Guddewar *et al.*, 1994).

Chinniah and Mohanasundaram (1999) studied the possible toxic effect or the safety of the neem derivatives to the predatory mites *Amblysieus* spp. Neem cake extract (10%), NSKE (5%) and neem oil (3%) proved safe by recording lower predator mortality.
Ravikumar *et al.*, (1999) evaluated various botanicals against the natural enemies of safflower aphid under laboratory conditions. The dust formulation of *Bougainvillea spectabilis* (Willd.) and *P. pinnata* at 25 per cent concentration were highly safe to the eggs of *C. carnea* (more than 85% hatching) at 48 hours after application. The dust formulation of *B. spectabilis* (25%) caused 16.66, 11.66 and 10.00 per cent larval mortality of 1st, 2nd and 3rd instars, respectively. Against pupae, the dusts and 2 per cent cooked extract of *V. rosea* were found safe by recording maximum adult emergence. The dust formulation of *B. spectabilis* and cooked extract of *V. negundo* proved safer to the grubs of *C. carnea*.

Kulkarni *et al.* (1999) reported that several botanicals proved safer to *C. carnea* as compared to acephate (0.075%), nicotine sulphate (1%) and cascade (0.5%). The percent egg hatchability and adult emergence were higher in castor leaf extract (5%), garlic bulb extract (2%), neemrich (2%) and cotton seed oil (1%) under laboratory conditions.

Among the predatory population in okra ecosystem, spiders, chrysopids, *Apanteles* sp. and Coccinellids were the most predominant and there was no significant difference among the population of these predators when the plots were treated with plant products (Rosaiah, 2001).

The conventional insecticides like dicofol, propargite and ethion were found to be highly toxic to predatory mite, *Amblysieus* spp. and also to coccinellids. On the contrary, the plant extracts were found to be quite safe (Smitha, 2002).

The plant products *viz.*, *V. rosea* leaves 5%, *P. pinnata* leaves *5%, A. indica* kernels 5%, *V. negundo* leaves 5% and *Adhatoda vasica* Nees leaves 5% were found safe to natural enemies of sorghum aphid (Balikai and Lingappa, 2004).

2.3. 1.Chemical control

Kumar et al. (1989) evaluated the critical time of insecticidal application for control of *Amrasca devastans* on okra was investigated in Karnatak, India. Application of insecticide 21-42 days after germination resulted in the lowest infestation of both pests and the highest benefit-cost ratio.

Babu and Santaram (2000) reported that the effect of imidacloprid 200 SL persisted for 23 days against aphids, 31 days against leafhopper in chilli ecosystem.

Verma (1989) tested Sumithion 50 EC, Lindane, endosulfun (Thiodan 35 EC), methyl-O-demton, monocrotophose (Azodrin 400) and some others chemical against cicadellid *Amrasca devastans* on okra in the field in India. He recommended 50% mortality concentration within 4.0 days.

A schedule of insecticide sprays using sumithion 50 EC and systoate 400 on 35, 45, 55 and 65 days after planting was investigated in Benin to determine the most effective treatment. Application of sumithion 50 EC, malathion 8F, quinalphos 25 EC or monocrotophos or endosulfan 35 EC one at flowering and then at pod setting stage would be highly effective. However, at lower infestation, insecticide application would not be economically advisable (Atachi and Sourkou,1989).

Rana *et al.*,(2006) conducted experiments during kharif 2003 and 2004, in Karnal,

Haryana, India, showed that admire 200SL at 2 ml as well as thiamethoxam and carbosulfan each at 2g/kg seed were quite effective in controlling jassid and whitefly. Okra seed yield was higher in treatments. And it was cost effective and minimized quantity of insecticide in a very significant level.

Gandhi *et al.*, (2006) showed that insecticidal seed treatment is an alternative method to spray and granular applications. Lal and Sinha (2005) carried out investigation to evaluate four (5,9,18, 36, g/kg) doses of Admire (imadacloprid treatments against sucking pests of okra. Studies revealed that seeds yield of all the treatments, except highest dose (36g/kg) of Admire treatment gave excellent results.

Dey *et al*. (2005) conducted filed experiment during the 1998 and 1999 to evaluate the efficacy of imidacloprid 70WS, Admire 200SL, against jassid, *Aphis gossephi* and *Bemisia tabaci* of okra and their natural enemies. Admire 20SL was applied as foliar spray at 20 and 40 days after sowing. It was effective against jassid and others sucking pests

Anoh, (2005) conducted an experiment to control jassid population on lady's finger and found that admire 200 SL had significant effect in controlling jassid.

2.3.2. Efficacy of new promising molecules against okra pests and natural enemy complex:

Kumar *et al.* (1999) studied the bio-efficacy of a new insecticidal compound Admire 200 SP against okra aphid and jassid in comparison with monocrotophos, acephate and oxydemeton methyl. Based on the results obtained from two seasons of testing, acetamiprid at all the tested doses proved superior to the conventional insecticides in controlling the pests. The chemical @ 10 g a.i./ha provided consistent control of the target pests for an extending period of time.

Dhawan and Simwat (2000) studied the effect of indoxacarb on the population of sucking

pests like aphids and jassids during 1997 and 1998. In both the years the population was significantly low in indoxacarb and admire than cypermethrin and untreated control. Ramesh Babu and Santaram (2000) reported that the effect of admire 200 SL persisted for 23 days against jassid, 31 days against sucking pest like jassid in ecosystem.

Katole and Patil (2000) studied the activities of natural enemies in seed treatments and foliar sprays with imidacloprid (70 WS for seed treatment and 17.8 SL for foliar spray). Though non-significant difference on the occurrence of natural enemies (Coccinellids and *Chrysoperla* grubs) was noticed, the plots with seed treatments recorded relatively higher populations of natural enemies as compared to foliar sprays. Acetamiprid 20 SP @ 30 g a.i./ha recorded least number of jassid (0.92/leaf) and aphids (0.65/leaf) after 7 days of application as compared to monocrotophos (1.68 jassid and 11.10 aphids/leaf) in cotton (Patil *et al.,* 2001).

Patil *et al.* (2002) evaluated imidacloprid 17.8% SL for its relative efficacy against sucking pest complex of chilli *viz.,* aphid (*A. gossypii*), thrips (*Scitothrips dorsalis* Hood) and jassids (*A. devastans devastans*) in comparison to conventional insecticides. Imidacloprid 17.8 SL @ 125 and 150 ml/ha was highly effective against the sucking pest complex in chilli and proved better than monocrotophos and dimethoate. The treatment with imidacloprid 17.8 SL @ 150 ml/ha recorded significantly higher yield followed by imidacloprid 17.8 SL @ 125 and m100 ml/ha, monocrotophos 36 WSC (650 ml/ha) and dimethoate 30 EC (750 ml/ha).

Subhadra Acharya *et al.*, (2002) studied the efficacy of newer insecticides *viz.*, acetamiprid, thiamethoxam, imidacloprid and abamectin and, other commonly used insecticides like dicofol, ethion and dimethoate against okra jassid, *A. devastans devastans* and found that acetamiprid @ 20 g a.i./ha and thiamethoxam and imidacloprid (both @ 25 g a.i/ha) proved quite effective followed by abamectin @ 20 g a.i./ha. All the newer insecticides were found safe to lady bird beetle. Isacc and Svetlana (2002) studied the bioefficacy of emamectin benzoate 5 SG against Western flower thrips, *Frankliniella occidentalis* (Pergade) in comparison with abamectin under both laboratory and field conditions. The results revealed that the activity of emamectin benzoate on thrips was

nearly 10 fold greater than that of abamectin.

As reported by Misra (2002), imidacloprid 70 WS and thiomethoxam 20 WG @ 25 g a.i. proved significantly superior in controlling jassids on okra. Imidacloprid was very effective neonecotinoid next best to thiamethoxam against 3rd instar nymphs of the *A. devastans devastans* with a LC50 value of 0.000813 per cent (Ravikumar *et al.*, 2003).

Pawar *et al.,* (2003) evaluated the efficacy of newer molecules *viz.,* imidacloprid 17.8 SL, acetamiprid 20SP and thiamethoxam 20WG against okra sucking pests. The results revealed that imidacloprid and acetamiprid were the effective molecules in reducing the pest population followed by thiamethoxam. A field experiment was conducted by Jayewar *et al.* (2003) to evaluate the bioefficacy of acetamiprid 20SP against sucking pests of chilli. Acetamiprid @ 80 and 40 g a.i./ha was found quite effective in reducing jassids and thrips population and resulted in maximum green chilli yield.

Khedkar and Ukey (2003) studied the efficacy of newer insecticides against jassids on okra and found that acetamiprid was the effective molecule by recording highest reduction in jassid population (to the extent of 92.16 at 10 DAS) and appeared as the most effective treatment against jassids. Emamectin benzoate 5 SG (proclaim) provided competitive control of *Scirtothrips* sp. on beans with 2 applications at 7 days interval in Thailand. In Indonesia also emamectin benzoate provided an effective control of *Thrips palmi* L. on potato at 7 days after spraying. Further, the chemical also gave an effective control of mites on okra (Anon., 2003).

As reported by Siddegowda *et al.* (2003), spinosad 45 SC at higher dosages (50 g a.i./ha) recorded significantly lower pod damage and higher grain yield in pigeonpea. However, the lower dosage (56 g a.i./ha) recorded on par pod damage and higher grain yield compared to endosulfan @ 700 g a.i./ha.

2.4. Effect of Detergent on Plant:

Bokary *et al.*, conducted thesis on 2004 and found that laundry detergent containing anionic surfactants was used to test their effects on plant growth through irrigation water. Lettuce and okra were cultivated in pot experiment and irrigated with distilled water containing domestic detergent at three different concentrations: low concentration (LC) of 0.1 g L-1; normal concentration (NC) of 1.0 g L-1 and high concentration (HC) of 5.0 g L-1 and distilled water (DW) used as control. The experiment was conducted during three months from July to October in a green house in Ouagadougou, Burkina Faso. Lettuce leaves, okra fruits and both crops shoots were measured at harvest period as dry and/or fresh weights. Soil pH and electrical conductivity (EC) were analyzed to evaluate changes caused by watering. Soil pH and EC tended to increase with detergent concentration in irrigation solutions. They were no significant difference in okra's fruit growth (fresh and dry weight) for DW, LC and NC treatments. However plants in HC died 20 days after planting (DAP). Similarly, no significant difference was noticed in lettuce shoots (dry weight) between LC, NC and DW treatments but lettuce in HC died 12 DAP. After harvest, irrigated soils EC for all treatments were significantly increased in contrast to pH where no significant difference was obtained. The study show that more than 1.0 g L-1 of laundry detergent can inhibit plant growth and application of high concentrate greywater on detergent can exacerbate soil salinity.

CHAPTER III
MATERIALS AND METHODS

The present study was conducted to develop a holistic management practice for combating okra jassid and to provide botanical support to the diverse ecosystem by producing healthy and safe environment for human, plants, insects and animals promoting sustainable ecosystem in the experimental farm of Sher-e-Bangla Agricultural University (SAU), Dhaka-1207, during November 2013 to March 2014. The materials and methods adopted in the study are discussed under the following heading and sub-headings:

3.1. Experimental Site

The experimental field was located at 90º 33.5´ E longitude and 23º 77.4´ N latitude at an altitude of 9 meter above the sea level (Anon.,1999). The field experiment was set up on the medium high land of the experimental farm.

3.2. Soil

The soil of the experiment site was a medium high land, clay loam in texture and having P^H 5.47-5.63. The land was located in Agro-ecological Zone of 'Madhupur Tract'(UNDP,1988) corresponding AEZ No. 28.

3.3 Climate

The climate of the experimental site is sub-tropical characterized by Late Autumn and Winter season during November to March and sporadic during the rest of the year.

3.4 Design of the experiment and layout

The study was conducted with six treatments. The experiment was laid out in a Randomized Complete Block Design (RCBD). The entire experimental field was divided into three blocks. Each block was divided into six plots. Two adjacent unit plots and blocks were separated by 0.5m and 1.0m distance respectively. Each experimental plot

comprised of 3m x 2.42m area and the total area covered 19m x 12m. Each treatment was allocated randomly within the block and replicated three times.

3.5 Land preparation:

The main field was first opened with the tractor drawn disc plough. Ploughed soil was then brought into desirable final tilt by four operations of ploughing followed by harrowing and laddering. The stubbles of the crops and uprooted weeds were removed from the field and the land was properly leveled. The field layout was done on accordance to the design, immediately after land preparation. The plots were raised by 10 cm from the soil surface keeping the drain around the plots. The plots were spaded one day before seed sowing and the basal does of fertilizers was incorporated thoroughly with the soil.

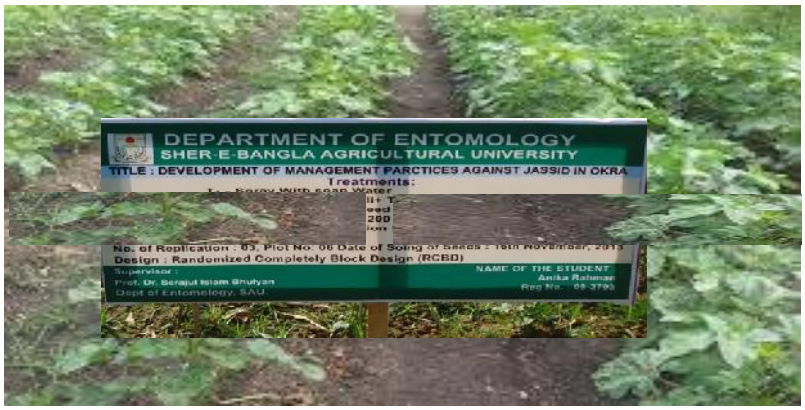


Plate 2: The experimental field of okra laid out in the farm of SAU, Dhaka

3.6. Manures, fertilizer and their methods of application:

Manures and fertilizers with their doses and their methods of application followed in this study were recommended by Haque (1993) and are shown in following:

Manure/Fertilizer	Dose per ha	Basal dose	Top dressing(kg/ha)	
			First*	Second**
Cow dung	10 tons	Entire amount	-	-
Urea	45 kg	-	75	75
TSP	100 kg	Entire amount	-	-
MP	150 kg	Entire amount	-	-

*25 days after sowing, **45 days after sowing

The entire quantity of cowdung (10 ton/ha) was applied just after opening the land. Urea was applied as per treatment in each randomized plots of $6m^2$. Triple Super Phosphate (TSP) and Muriate of Potash (MP) were applied at the rate of 100kg/ha and 150kg/ha

respectively. Full dose of TSP and cowdung were applied to the soil at the final land preparation. Urea and MP were applied as side dressing (ring method) in 3 equal installments at 15, 30 and 45 days after germination.

3.7 Planting materials used for experiment:

The okra variety "BARI Dherosh-1''was used in this study. It was an open pollinated high yielding variety developed by the Vegetable Division of Horticulture Research Center, Bangladesh Agricultural Research Institute (BARI), Gazipur. The variety was released for commercial cultivation in 1996. Seeds were sown in the experimental plots at the rate of 105 seeds/plot (three seeds per pit and 35 pits per plot) having a depth of 2 to 3 cm. Seeds were sown on November 15, 2013. The row to row and plant to plant spacing was maintained at 40 cm x 35 cm respectively.

Plate 03: Seedlings of okra

3.8. Intercultural operations:

The seedlings were always-kept under close observation. Necessary intercultural operations were done throughout the cropping season to obtain proper growth and development of the plants are as follows:

3.8.1 Thinning and propping:

When the seedlings got established, one healthy seedling in each location was kept and other seedlings were removed . Propping of each plant by bamboo sticks was provided to avoid their lodging.

Plate 4: Okra seedling after thinning

3.8.2 Gap filling:

Dead, injured and weak seedlings were replaced by new vigor seedling from the stock on the border line of the experiment.

3.8.3 Weeding:

Weeding was done four times to break the soil crust and to keep the plot free from weeds. Four weeding were done manually at 15, 30, 45 and 60 DAS to keep the plots free from weeds.

3.8.4 Irrigation and drainage:

Light overhead irrigation was provided with a watering can to the plots once immediately after sowing of seed and then it was continued at 3 days interval after seedling emergence for proper growth and development of the seedlings. When the soil moisture level was very low. Wherever the plants of a plot had shown the symptoms of wilting the plots were irrigated on the same day with a hosepipe until the entire plot was properly wet. Stagnant water effectively drained out at the time of heavy rains.

3.9 Treatments:

The comparative effectiveness of the following six treatments against jassid was evaluated on the basis of reduction of this pest and used as treatments after 7 days interval:

T_1 = Spray with soap water @ 3g/L of Water at the 7 days interval

T_2 = Spray with neem oil @ 4ml+Trix (detergent) @10ml/L of Water at the 7 days interval

T_3 = Spray with neem seed kernel water extract @ 20gm/L of Water at the 7 days interval

T_4 = Spray with (Fenitrothion) Sumithion 50EC@ 1ml/L of Water at the 7 days interval

T_5= Spray with Admire 200SL@ 0.5ml/L of Water at the 7 days interval

T_6= Untreated Control

3.10. Preparation of the treatments:

3.10.1 Neem oil

For proper management of okra jassid 4 ml neem oil was poured in 1Liter of water and then 10 ml trix was mixed to obtain fine droplet to spray 3m x 2m area.

Plate 5: Neem oil used as treatment

3.10.2 Neem seed kernel extract

20 gm of neem seed kernel crushed and dissolved in 1Liter of water for 24 hours. The solution had to be filtered through fine gauze (cloth) to remove the bigger particles. The filtered water was sprayed in 3m x 2m area for proper management of the target pest.

Plate 6: Neem seed kernel extract

3.11 Application of the treatments:

Spraying was done at 3.30 pm to avoid scorching sun light. The treatments were applied as per schedule and a total of five spraying were done during the study period. First application was done after 55 days of germination. Treatments were applied at 7 days interval. Spraying was done by knapsack sprayer having a pressure of 4.5 kg/cm^2. To get complete coverage of plant spraying was done uniformly on the entire plant with special care.

3.12 Data collection:

Data on infestation by okra jassid under different management treatments were recorded during both vegetative and reproductive stages. Five plants were randomly selected from each plot by tagging for taking data. The number of healthy and infested leaves/plant were counted and recorded from randomly selected 5 plants at 7 days interval during whole cropping season. The population of jassid was recorded from 5 top leaves at 7 days

interval. The counting was started from the very beginning of jassid infestation. Nymphs on under side of the leaf were removed from the plant on a white paper for recording data. Adults were counted by covering with poly bag. Then data were converted to percent infestation. Yield data were also be recorded. The BCR was calculated using the present market price of okra. The data recorded on different parameters were analyzed statistically by using MSTAT-C software for analysis of variance after transformation as per necessity. ANOVA was made by F- variance test and the differences between treatment's means were compared by LSD test/DMRT.

The data on the following parameters were recorded at 7 days time intervals as given below:

- Number of insect population per plant after different treatments
- Number of Infested fruit per plant and per plot
- Number of healthy fruits per plant and per plot at different time of crop growth
- Healthy Fruit length at different harvesting time
- Healthy Fruit diameter at different harvesting time
- Healthy Fruit weight at different harvesting time
- 1st flowering time
- Plant height at harvesting
- Yield per plot

Plate 07: Vegetative stage of okra plant in the experimental

Plate 08: Reproductive stage of okra plant with flower and fruits

3.13 Method of recording:

3.13.1. Number of fruit

The data on the number of healthy and infested fruits were recorded from 5 tagged plants in each treatment .The percent infested of fruit was calculated with the following formula:

$$\% \text{ Infested of fruit} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits}} \times 100$$

$$\% \text{ Healthy fruit} = \frac{\text{Number of healthy fruits}}{\text{Total number of fruits}} \times 100$$

3.13.3. Yield per hectare:

Total yield of okra per hectare for each treatment was calculated in tons from cumulative fruit production in a plot. Effect of different treatments on the increase and decrease of okra yield over control was also calculated by the following formula:

$$\% \text{ increase of yield over control} = \frac{\text{Yield of treated plot- Yield of untreated plot}}{\text{Yield of untreated plot}} \times 100$$

3.13.4. Number of jassid: The data on the number of jassid were recorded from 5 tagged plants in each treatment .The percent infestation of jassid was calculated with the following formula:

$$\% \text{ reduction of jassid} = \frac{\text{Number of jassid before control- Number of jassid after control}}{\text{Total number of jassid before control}} \times 100$$

$$\% \text{ number of jassid over control} = \frac{\text{Number of jassid of treated plot- Number of jassid of control plot}}{\text{Number of jassid of control plot}} \times 100$$

3. 14. Benefit cost ratio analysis

For benefit cost analysis, records of the costs incurred for labor, inputs, application of inputs in each treatment and that of control without insecticide were maintained. The untreated control (T_6) did not require any pest management cost. The price of the marketable healthy fruit of each treatment and that of control was calculated at market rate. The result of Benefit-Cost analysis was expressed in terms of Benefit-Cost Ratio (BCR).

3.17 Statistical analysis

The recorded data were compiled and tabulated for statistical analysis. Analysis of variance was done with the help of computer package MSTAT program (Gomez and Gomez, 1976). The treatment means were separated by Duncan's Multiple Range Test (DMRT).

CHAPTER IV
RESULT AND DISCUSSION

The results on the effectiveness of various treatments including untreated control for the management of jassid on okra have been described and discussed with following sub headings:

4.1. Effect of various treatments on the incidence of jassid on okra

The population of jassid per plant of okra was studied in relation to different treatments. Significant differences were observed among different treatments in terms of number of jassid per infested leaf (Table 1).

At early fruiting stage the lowest number of jassid per plant (0.07) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval) treated plot which was statistically closely followed by T_2 (0.13) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval). On the other hand, the highest number of jassid per plant (3.47) was recorded in untreated control (T_6) plot

which was statistically different from all other treatments and it was followed by T_1 (2.53) treatment (Spraying soap water @ 3g/litter of water at 7 days interval) (Table 1).

Similar trend of results were also found from at mid fruiting stage and late fruiting stage of okra (Table 1).

In case of the percent reduction of number of jassid over control, the highest reduction percent (96.55 %) was recorded in T_5 treatment (Admire 200SL @ 0.5ml/litter of water at 7 days interval) treated plot which was closely followed by T_2 (90.96%) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval) treated plot. The intermediate level of reduction was recorded (85.01%) in T_4 (Spraying Sumithion 50EC @ 1ml/litter of water at 7 days interval) and (84.75 %) in T_3 treatment (Spraying neem seed karnel water extract @ 20 g/litter of water at 7 days interval) was observed. On the other hand, the lowest percent of reduction over control (25.84 %) was recorded in T_1 treatment (Spraying soap water @ 3 gm/litter of water at 7 days interval) (Table 1).

Table 1. Effect of different pest management on number of jassid on okra

Treatment	Number of Jassid at fruiting stage				
	Early	Mid	Late	Mean Number	% of Reduction Over Control
T_1	2.53 b	3.67 b	2.40 b	2.87 b	25.84 %
T_2	0.13 d	0.47 c	0.46 e	0.35 c	90.96 %
T_3	0.33 c	0.60 c	0.83 c	0.59 c	84.75 %
T_4	0.27 c	0.73 c	0.75d	0.58 c	85.01 %
T_5	0.07 d	0.13 c	0.20 e	0.13 d	96.55 %
T_6	3.47 a	4.33 a	3.80 a	3.87 a	
$LSD_{(0.05)}$	0.073	0.061	0.021		
Level of Significance	0.01	0.01	0.01		
CV(%)	7.68	5.47	6.95		

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

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05level of probability.

T_1: Spray with soap water @ 3 gm/litter of water at 7 days interval

T_2: Spray with neem oil @ 4ml +Trix detergent @ 10 ml/litter of water at 7 days interval

T_3: Spray with neem seed kernel water extract @ 20 gm/litter of water at 7 days interval

T_4: Spray with (Fenitrothion) Sumithion 50EC @ 1ml/litter of water at 7 days interval

T_5: Spray with Admire 200SL @ 0.5ml/litter of water at 7 days interval and

T_6: Untreated Control

However, these findings partially contradict to the findings of Hanumantappa (2003) the efficacy of botanicals against sunflower jassid, *A. devastans* and found that among different botanicals used, NSKE (5%) was the superior treatment over neem oil and commercial neem formulation. It also contradicts with the findings Patel and Patel (1996).

From the results in these experiment neem oil @ 4ml + trix detergent @ 10ml/litter of water at 7 days interval showed the best reduction percent which is similar to Mallapur *et al.*, 2001, drastic reduction in jassid population was observed in plots treated with neem cake (86.92%), *Pongamia* (85.50%), NSKE (84.48%) and *Lantana* (83.50%). Rosaiah (2001b) reported spraying neem oil (0.5%) was significantly superior in reducing the jassid followed by NSKE (5%) and also similar to the findings of Umamaheshwari *et al.* (1999).

4.2. Fruit infestation due to Jassid on okra at early fruiting stage by number basis:

The number of fruit per plant at fruiting stage of okra plant was significantly influenced by the application of different treatments in table 2. The results revealed that at early fruiting stage the highest number of healthy fruit per plant (14.67) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval) which was statistically closely followed by T_2 (14.0) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval). On the other hand, the lowest number of healthy fruit per plant (10.85) was recorded in untreated control plot (T_6 treatment) which was statistically different from all other treatments and it was followed by T_1 (11.33) treatment (Spraying soap water @ 3g/litter of water at 7 days interval) (Table 2).

Similarly, the lowest number of infested fruit per plant (0.34) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval) treated plot which was statistically closely followed by T_2 (0.64) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval). On the other hand, the highest number of infested fruit per plant (2.65) was recorded in untreated control plot (T_6 treatment) which was statistically different from all other treatments and it was followed by T_1 (1.78) treatment (Spraying soap water @ 3g/litter of water at 7 days interval) (Table 2).

Table 4.2. Fruit infestation due to Jassid on okra at early fruiting stage by number basis

Treatment	Fruits in number			
	Healthy	Infested	% Infestation	Reduction over control (%)
T_1	11.33 d	1.78 b	13.58 b	30.83
T_2	14.00 b	0.64 d	4.37 c	77.73
T_3	13.42 c	0.88 c	6.15 c	68.65
T_4	13.92 b	0.84 c	5.69 c	71.01
T_5	14.67 a	0.34 e	2.27 d	88.46

T_6	10.85 e	2.65 a	19.63 a	--
$LSD_{(0.05)}$	0.473	0.231	2.342	--
Level of Significance	0.05	0.01	0.01	--
CV(%)	7.89	5.72	6.05	--

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

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of probability.

T_1: Spray with soap water @ 3 gm/litter of water at 7 days interval

T_2: Spray with neem oil @ 4ml +Trix detergent @ 10 ml/litter of water at 7 days interval

T_3: Spray with neem seed kernel water extract @ 20 gm/litter of water at 7 days interval

T_4: Spray with (Fenitrothion) Sumithion 50EC @ 1ml/litter of water at 7 days interval

T_5: Spray with Admire 200SL @ 0.5ml/litter of water at 7 days interval and

T_6: Untreated Control

In case of the reduction percent of infestation at the early fruiting stage, a significant difference was found among different treatments for the management of jassid on okra plant. The lowest percent of infestation (2.27%) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval @ 0.5ml/litter of water at 7 days interval) treated plot which was statistically closely followed by T_2 (4.37%) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval). On the other hand highest percent of infestation (19.63) was recorded in untreated control plot (T_6 treatment) which was statistically different from all other treatments and it was closely followed by T_1 (13.58) treatment (Spraying soap water @ 3g/litter of water at 7 days interval) (Table 2).

In case of the percent reduction of number of infested fruit over control, the highest percent (88.46 %) reduction was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval) which was statistically closely followed by 77.73% in T_2 treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval) treated plot. The intermediate level percent of reduction was recorded 71.01% in T_4 treatment (Spraying Sumithion 50EC @ 1ml/litter of water at 7 days interval) and 68.65% in T_3 treatment (Spraying neem seed karnel water extract @ 20 g/L of water at 7 days interval). On the other hand, the lowest percent of reduction over control (30.83%) was recorded in T_1 treatment (Spraying soap water @ 3g/litter of water at 7 days interval) (Table 2).

4.3 Fruit infestation due to jassid on okra at early fruiting stage by weight of fruit basis:

The weight of fruit per plant at early fruiting stage of okra plant was significantly influenced by the application of different treatments in table 3. The results revealed that at early fruiting stage the maximum weight of healthy fruit per plant (143.80) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval) and which was statistically closely followed by T_2 (139.55) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval). The intermediary level of weight was recorded 132.65 in T_4 (Spraying Sumithion 50EC @ 1ml/litter of water at 7 days interval) and 131.30 in T_3 treatment (Spraying neem seed karnel water extract @ 20 g/L of water at 7 days interval). On the other hand, The minimum weight of healthy fruit plant (107.45) was recorded in untreated (T_6 treatment) plot which was statistically different from all other treatments (Table 3) and it was followed by T_1 (115.45) treatment (Spraying soap water @ 3g/litter of water at 7 days interval).

Table 3.Fruit infestation by jassid on okra at early fruiting stage by weight of fruit basis:

Treatment	Fruits in weight (g)

	Healthy	Infested	% Infestation	Reduction over control (%)
T_1	115.45 c	18.45 b	13.78 b	32.05
T_2	139.55 a	7.33 c	4.99 c	75.39
T_3	132.65 b	9.56 c	6.72 c	66.85
T_4	131.30 b	8.87 c	6.33 c	68.79
T_5	143.80 a	4.22 d	2.85 d	85.94
T_6	107.45 d	27.33 a	20.28 a	--
$LSD_{(0.05)}$	4.387	2.765	1.893	--
Level of Significance	0.01	0.01	0.01	--
CV(%)	4.56	6.66	5.55	--

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

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05level of probability.

T_1: Spray with soap water @ 3 gm/litter of water at 7 days interval

T_2: Spray with neem oil @ 4ml +Trix detergent @ 10 ml/litter of water at 7 days interval

T_3: Spray with neem seed kernel water extract @ 20 gm/litter of water at 7 days interval

T_4: Spray with (Fenitrothion) Sumithion 50EC @ 1ml/litter of water at 7 days interval

T_5: Spray with Admire 200SL @ 0.5ml/litter of water at 7 days interval and

T_6: Untreated Control.

Again the minimum weight of infested fruit per plant (4.22) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval)treated plot and which was statistically closely followed by T_2 (7.33) treatment (Spraying neem oil @ 4ml + trix

detergent @10ml/litter of water at 7 days interval). On the other hand, The maximum weight of infested fruit plant (27.33) was recorded in untreated (T_6 Treatment) plot which was statistically different from all other treatments (Table 3) and it was followed by T_1 (18.45) treatment (Spraying soap water @ 3g/litter of water at 7 days interval) treated plot.

In case of reduction of weight of infested fruit over control, the highest reduction (85.94 %) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval) treated plot, which was statistically closely followed by T_2 (75.39%) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval) treated plot. The intermediate level of reduction was recorded (68.79 %) in T_4 (Spraying Sumithion 50EC @ 1ml/litter of water at 7 days interval) and 66.85 % in T_3 treatment (Spraying neem seed karnel water extract @ 20 g/L of water at 7 days interval). On the other hand, the lowest reduction over control (32.05 %) was recorded in T_1 treatment (Spraying soap water @ 3g/litter of water at 7 days interval) (Table 3).

4.4.Fruit infestation due to jassid on okra at mid fruiting stage by number basis

The number of fruit per plant at fruiting stage of okra plant was significantly influenced by the application of different treatments in table 4. The results revealed that at mid fruiting stage the highest number of healthy fruit per plant (18.67) was recorded in T_5 treatment (spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval) treated plot and which is statistically closely followed by T_2 (16.95) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval). The lowest number of healthy fruit plant was (12.78) recorded in untreated control (T_6 treatment) plot which was statistically different from all other treatments (Table 4) and it was followed by T_1 (13.56) treatment (Spraying soap water @ 3g/litter of water at 7 days interval). The intermediary level of reduction was recorded 16.34 in T_4 (Spraying Sumithion 50EC @ 1ml/litter of water at 7 days interval) and 15.44 in T_3 treatment (Spraying neem seed karnel water extract @ 20 g/L of water at 7 days interval).

Table 4. Fruit infestation due to Jassid on okra at mid fruiting stage by number basis

Treatment	Fruits in number			
	Healthy	Infested	% Infestation	Reduction over control (%)
T_1	13.56 c	2.84 b	17.32 b	22.22
T_2	16.95 b	0.88 c	5.39 c	75.78
T_3	15.44 b	1.38 c	7.79 c	65.02
T_4	16.34 b	1.22 c	6.71 c	69.84
T_5	18.67 a	0.75 c	3.86 c	82.65
T_6	12.78 c	3.66 a	22.26 a	--
$LSD_{(0.05)}$	1.342	0.583	4.053	--
Level of Significance	0.05	0.01	0.01	--
CV(%)	4.22	6.90	5.78	--

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

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05level of probability

T_1: Spray with soap water @ 3 gm/litter of water at 7 days interval

T_2: Spray with neem oil @ 4ml +Trix detergent @ 10 ml/litter of water at 7 days interval

T_3: Spray with neem seed kernel water extract @ 20 gm/litter of water at 7 days interval

T_4: Spray with (Fenitrothion) Sumithion 50EC @ 1ml/litter of water at 7 days interval

T_5: Spray with Admire 200SL @ 0.5ml/litter of water at 7 days interval and

T_6: Untreated Control

In case of reduction of number of infested fruit over control, the highest percent reduction (82.65 %) was recorded in T_5 (Admire 200SL @ 0.5ml/litter of water at 7 days interval) treated plot which was closely followed by T_2 (75.78%) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval) treated plot. The intermediate level of reduction percent 69.84 % in T_4 (Spraying Sumithion 50EC @ 1ml/litter of water at 7 days interval) and 65.02 % in T_3 treatment (Spraying neem seed karnel water extract @ 20 g/L of water at 7 days interval.) On the other hand, the lowest percent of reduction over control (22.22 %) was recorded in T_1 treatment (Spraying soap water @ 3g/litter of water at 7 days interval) (Table 4).

4.5. Fruit infestation due to Jassid on okra at mid fruiting stage by weight basis.

The weight of fruit per plant at mid fruiting stage of okra plant was significantly influenced by the application of different treatments in table 5. The results revealed that at mid fruiting stage the maximum weight of healthy fruit per plant (178.67) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval) treated plot which was statistically closely followed by T_2 (169.97) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval). On the other hand, The minimum weight of healthy fruit plant was 120.45 recorded in untreated control plot which was statistically different from all other treatments (Table 5) and it was followed by T_1 treatment (Spraying soap water @ 3g/litter of water at 7 days interval)(135.90) treated plot.

At mid fruiting stage highest percent (83.93 %) reduction was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval) treated plot which was statistically closely followed by T_2 (76.23%) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval) treated plot. The intermediate level of reduction 69.95 % in T_4 (Spraying Sumithion 50EC @ 1ml/litter of water at 7 days interval) and 66.29 % in T_3 treatment (Spraying neem seed karnel water extract @ 20 g/L of water at 7 days interval.) On the other hand, the lowest percent of reduction

over control (36.81 %) was recorded in T_1 treatment (Spraying soap water @ 3g/litter of water at 7 days interval) (Table 5).

Table 5. **Fruit infestation due to Jassid on okra at mid fruiting stage by weight basis**

Treatment	Fruits in weight (g)			
	Healthy	Infested	% Infestation	Reduction over control (%)
T_1	135.90 c	22.67 b	14.30 b	36.81
T_2	169.97 a	9.66 c	5.38 c	76.23
T_3	155.55 b	12.68 c	7.54 c	66.69
T_4	156.95 b	11.45 c	6.80 c	69.95
T_5	178.67 a	6.74 c	3.64 c	83.93
T_6	120.45 d	35.22 a	22.62 a	--
$LSD_{(0.05)}$	9.34	6.092	4.782	--
Level of Significance	0.01	0.01	0.01	--
CV(%)	9.05	3.89	5.78	--

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

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05level of probability

T_1: Spray with soap water @ 3 gm/litter of water at 7 days interval

T_2: Spray with neem oil @ 4ml +Trix detergent @ 10 ml/litter of water at 7 days interval

T_3: Spray with neem seed kernel water extract @ 20 gm/litter of water at 7 days interval

T_4: Spray with (Fenitrothion) Sumithion 50EC @ 1ml/litter of water at 7 days interval

T_5: Spray with Admire 200SL @ 0.5ml/litter of water at 7 days interval and

T_6: Untreated Control

4.6. Fruit infestation due to jassid on okra at late fruiting stage by number basis.

The number of fruit per plant at late fruiting stage was significantly influenced by the application of different treatments. The results revealed that at late fruiting stage the

highest number of healthy fruit per plant (16.45) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval) which is statistically closely followed by T_2 (16.32) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval). On the other hand, the lowest number of healthy fruit plant was (11.05) recorded in untreated control plot which was statistically different from all other treatments (Table 6) and it was followed by T_1 (12.85) treatment (Spraying soap water @ 3g/litter of water at 7 days interval)(12.85) treated plot.

In case of the percent reduction of number of infested fruit over control, the highest reduction percent (83.21 %) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval) which was closely followed by T_2 (79.95%) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval) treated plot.

On the other hand, the lowest percent of reduction over control (25.72 %) was recorded in T_1 treatment (Spraying soap water @ 3g/litter of water at 7 days interval).

The intermediate level of reduction 69.12 % in T_4 (Spraying Sumithion 50EC @ 1ml/litter of water at 7 days interval) and 64.87 % in T_3 treatment (Spraying neem seed karnel water extract @ 20 g/L of water at 7 days interval) (Table 6).

Table 6. Fruit infestation due to Jassid on okra at late fruiting stage by number basis

Treatment	Fruits in number			
	Healthy	Infested	% Infestation	Reduction over control (%)
T_1	12.85 b	2.46 b	16.07 b	25.72

T_2	16.32 a	0.74 d	4.34 c	79.95
T_3	15.08 a	1.24 c	7.60 c	64.87
T_4	14.67 a	1.05 c	6.68 c	69.12
T_5	16.45 a	0.62 d	3.63 c	83.21
T_6	11.05 b	3.05 a	21.63 a	--
$LSD_{(0.05)}$	1.873	0.278	4.093	--
Level of Significance	0.01	0.01	0.01	--
CV(%)	5.66	7.09	4.99	--

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

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05level of probability

T_1: Spray with soap water @ 3 gm/litter of water at 7 days interval

T_2: Spray with neem oil @ 4ml +Trix detergent @ 10 ml/litter of water at 7 days interval

T_3: Spray with neem seed kernel water extract @ 20 gm/litter of water at 7 days interval

T_4: Spray with (Fenitrothion) Sumithion 50EC @ 1ml/litter of water at 7 days interval

T_5: Spray with Admire 200SL @ 0.5ml/litter of water at 7 days interval and

T_6: Untreated Control

4.7. Fruit infestation due to Jassid on okra at late fruiting stage by weight basis:

The weight of fruit per plant at late fruiting stage of okra plant was significantly influenced by the application of different treatments. The results revealed that at late fruiting stage the maximum weight of healthy fruit per plant (156.38) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval) treated plot

which was statistically closely followed by T_2 (151.23) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval).

On the other hand, The minimum weight of healthy fruit plant was 109.55 was recorded in untreated control plot which was statistically different from all other treatments (Table 7) and it was closely followed by T_1 (118.45) treatment (Spraying soap water @ 3g/litter of water at 7 days interval) treated plot.

In case of the percent reduction of weight of infested fruit over control, the highest reduction percent (82.64 %) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval)treated plot which was closely followed by T_2 (75.49%) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval) treated plot.

On the other hand, the lowest percent of reduction over control (29.04 %) was recorded in T_1 treatment (Spraying soap water @ 3g/litter of water at 7 days interval).

The intermediate level of reduction 66.65 % was recorded in T_3 (Spraying neem seed karnel water extract @ 20 g/L of water at 7 days interval) and 64.67 % in T_4 (Spraying Sumithion 50EC @ 1ml/litter of water at 7 days interval). (Table 7).

Table 7. Fruit infestation due to Jassid on okra at late fruiting stage by weight basis:

Treatment	Fruits in weight (g)			
	Healthy	Infested	% Infestation	Reduction over control (%)
T_1	118.45 c	18.44 b	13.47 b	29.04
T_2	151.23 a	7.38 c	4.65 c	75.49
T_3	139.65 b	9.44 c	6.33 c	66.65
T_4	134.78 b	9.69 c	6.71 c	64.67
T_5	156.38 a	5.33 d	3.30 c	82.64
T_6	109.55 d	25.67 a	18.98 a	--
$LSD_{(0.05)}$	9.892	2.318	4.092	-

Level of Significance	0.01	0.01	0.01	--
CV(%)	6.03	4.22	5.09	--

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

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05level of probability

T_1: Spray with soap water @ 3 gm/litter of water at 7 days interval

T_2: Spray with neem oil @ 4ml +Trix detergent @ 10 ml/litter of water at 7 days interval

T_3: Spray with neem seed kernel water extract @ 20 gm/litter of water at 7 days interval

T_4: Spray with (Fenitrothion) Sumithion 50EC @ 1ml/litter of water at 7 days interval

T_5: Spray with Admire 200SL @ 0.5ml/litter of water at 7 days interval and

T_6: Untreated Control

4.8. Effect of different pest management practices on yield contributing characters and yield of okra:

4.8.1. Effect of management practices on Plant height at harvest:

The height of plant at harvesting stage of okra was significantly influenced by the application of different treatments. The results revealed that the maximum height of plant (132.97) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval) which was closely followed by T_2 (120.40) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval). The intermediary level was recorded as 116.77 in T4 (Spraying Sumithion 50EC @ 1ml/litter of water at 7 days interval) and 116.30 in T3 treatment (Spraying neem seed karnel water extract @ 20 g/L of water at 7 days interval). On the other hand, the minimum height of plant was (102.93) recorded in T_6 (untreated control) plot which was statistically different from all other treatments (Table 8) and it was followed by T_1 (115.50) treatment (Spraying soap water @ 3g/litter of water at 7 days interval) treated plot.

4.8.2. Effect of management practices on 1st flowering:

The 1st flowering days of okra plant was significantly influenced by the application of different treatments. The results revealed that minimum days for flowering (25.33) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval)treated plot which was statistically closely followed by T_2 (29.43) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval). On the other hand, the maximum time required for flowering was recorded in T_6 (35.87) treatment (untreated) plot which was statistically different from all other treatments (Table 8) and it was followed by T_1 (35.00) treatment (Spraying soap water @ 3g/litter of water at 7 days interval) treated plot.

4.8.3. Effect management practices on pod length:

The length of pod per plant of okra was significantly influenced by the application of different treatments. The results revealed that the longest pod of plant (10.89) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval)treated plot which was statistically closely followed by T_2 (10.21) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval). On the other hand, the minimum length of fruits was 7.43 recorded in untreated control plot which was statistically different from all other treatments (Table 8) and it was followed by T_3 (9.26) treatment (Spraying neem seed karnel water extract @ 20 g/L of water at 7 days interval) treated plot.

4.8.4. Effect management practices on pod diameter:

The diameter of pod per plant of okra was significantly influenced by the application of different treatments. The results revealed that the highest fruit diameter (1.188) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval) which was statistically closely followed by T_2 (1.067) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval). On the other hand, the lowest fruit diameter (0.836) was recorded in untreated control plot which was statistically different from all other treatments (Table 8) and closely followed by T_3

(0.922) treatment (Spraying neem seed karnel water extract @ 20 g/L of water at 7 days interval) treated plot.

4.8.5. Effect management practices on number of fruits per plant:

The number of fruits per plant of okra was significantly influenced by the application of different treatments. The results revealed that the highest numbers of fruits per plant (51.50) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval)treated plot which was closely followed by in T_2 (48.65) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval). On the other hand, the lowest number of fruits (44.04) was recorded inT_6 (untreated) control plot which was statistically different from all other treatments (Table 8) and it was followed by T_1 (44.82) treatment (Spraying soap water @ 3g/litter of water at 7 days interval).

4.8.5. Effect management practices on pod yield per hector:

The yield per hector of okra was significantly influenced by the application of different treatments. The results revealed that the highest yields per hector (23.39) was recorded in T_5 treatment (Spraying Admire 200SL @ 0.5ml/litter of water at 7 days interval)treated plot which was statistically closely followed by T_2 (22.80) treatment (Spraying neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval). On the other hand, the lowest yield was 14.60 recorded in T_6 (untreated) control plot which was statistically different from all other treatments (Table 8) and was closely followed by T_1 (15.89) treatment (Spraying soap water @ 3g/litter of water at 7 days interval).

Table 8. Effect of different pest management practices on yield contributing characters and yield of okra

Treatment	Plant height at harvest	Days for sowing to 1st flowering	Pod length (cm)	Pod Diameter (cm)	Number of fruits/plant	Pod yield/ Hectare
T_1	115.50 b	35.00 b	9.60 b	1.024 ab	44.82 c	15.89 c

T_2	120.40 b	29.43 a	10.21 ab	1.067 ab	48.65 b	22.80 a
T_3	116.30 b	31.00 b	9.26 bc	0.922 bc	48.34 b	20.89 a
T_4	116.77 b	30.30 b	9.47 b	0.955 bc	48.02 b	19.03 cd
T_5	132.97 a	25.33 c	10.89 a	1.188 a	51.50 a	23.39 a
T_6	102.93 c	35.87 a	7.43 d	0.836 c	36.34 c	14.60 c
$LSD_{(0.05)}$	9.764	3.675	0.840	0.163	1.324	2.185
Level of Significance	0.01	0.01	0.01	0.01	0.01	0.01
CV(%)	4.79	6.35	5.97	8.88	7.03	5.72

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

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05level of probability

T_1: Spray with soap water @ 3 gm/litter of water at 7 days interval

T_2: Spray with neem oil @ 4ml +Trix detergent @ 10 ml/litter of water at 7 days interval

T_3: Spray with neem seed kernel water extract @ 20 gm/litter of water at 7 days interval

T_4: Spray with (Fenitrothion) Sumithion 50EC @ 1ml/litter of water at 7 days interval

T_5: Spray with Admire 200SL @ 0.5ml/litter of water at 7 days interval and

T_6: Untreated Control

4.9. Relationship among yield and others yield contributing factors of okra in different management practice:

4.9.1. Correlation between plant height and yield:

Correlation study was done to establish the relationship between height of okra plant among different management practices. From the Figure 1, it was revealed that positive correlation was observed between the parameters. It was evident that the equation y = 2.255x + 73.64 gave a good fit to the data and the co-efficient of determination (R^2 = 0.711) fitted regression line had a significant regression co-efficient. It may be concluded from the figure that the girth of healthy fruit was strongly as well as positively correlated with the yield (ton/ha) of okra.

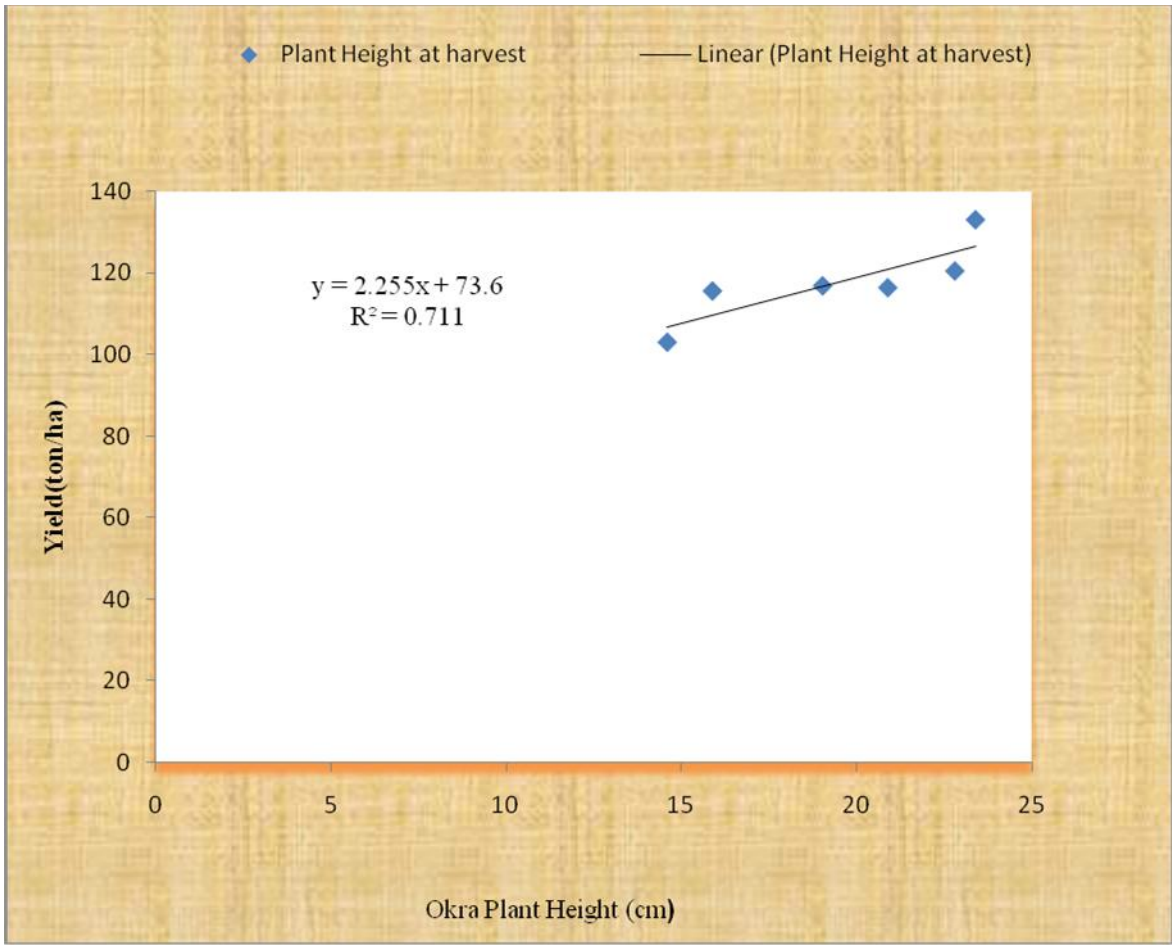


Figure 1: Correlation between Okra Plant Height & Yield (Ton/Ha)

4.9.2. Correlation between fruit length and yield:

Correlation study was done to establish the relationship between yield of okra fruit and length of healthy fruit among different management practices. From the Figure 2, it was revealed that positive correlation was observed between the parameters. It was evident that the equation y = 0.263x + 4.34 gave a good fit to the data and the co-efficient of

determination (R^2 = 0.669) fitted regression line had a significant regression co-efficient. It may be concluded from the figure that the length of healthy fruit was strongly as well as positively correlated with the yield (ton/ha) of okra, i.e., fruit yield increased due to increase of the fruit length.

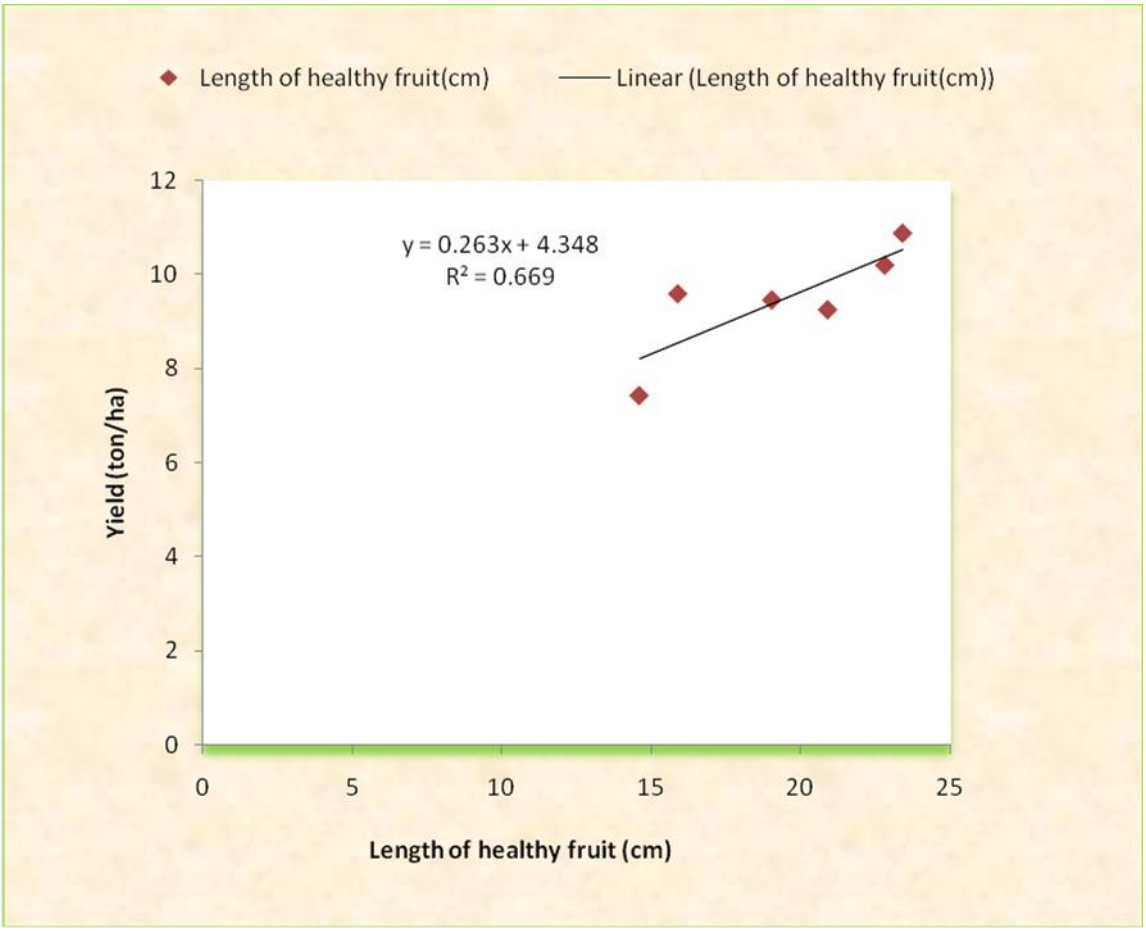


Figure 2: Correlation between Fruit Length and Yield

4.9.3 Correlation between fruit diameter and yield:

Correlation study was done to establish the relationship between yield of okra fruit and diameter (girth) of healthy fruit among different management practices. From the Figure 3, it was revealed that positive correlation was observed between the parameters. It was evident that the equation y = 0.024x + 0.527 gave a good fit to the data and the co-efficient of determination (R^2 = 0.508) fitted regression line had a significant regression

co-efficient. It may be concluded from the figure that the diameter (girth) of healthy fruit was strongly as well as positively correlated with the yield (ton/ha) of okra.

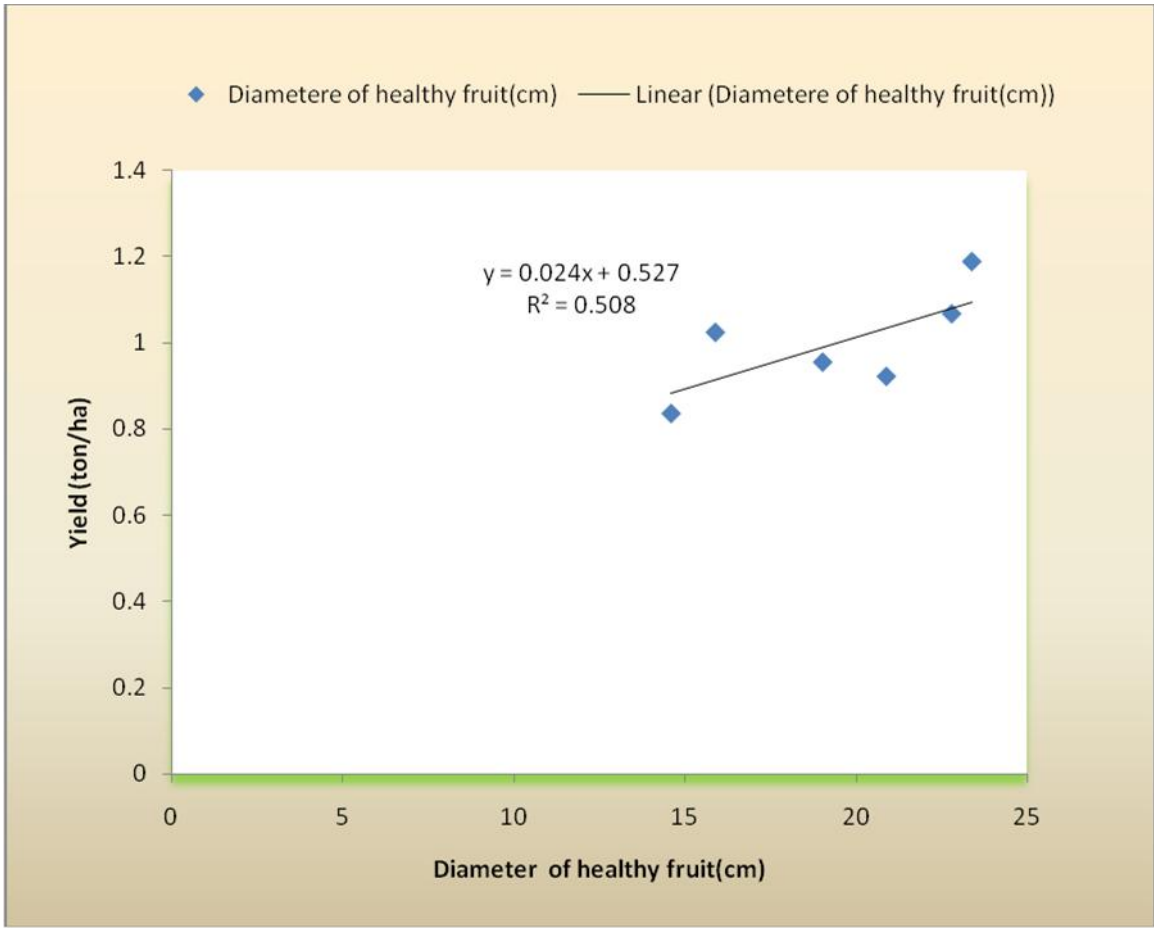


Figure 3: Correlation between Yield and Diameter of Healthy Fruit

4.9.4. Correlation between number of jassid and yield of okra:

Correlation study was done to establish the relationship between yield of okra fruit and by number of jassid among different management practices. From the Figure 4, it was revealed that negative correlation was observed between the parameters. It was evident that the equation y = -0.953X + 49.68 gave a good fit to the data and the co-efficient of determination (R^2 = 0.793) fitted regression line had a significant regression co-efficient. It may be concluded from the figure that the fruit infestation by number of jassid was

strongly as well as negatively correlated with the yield (ton/ha) of okra i.e., fruit yield was decreased due to increase of the fruit infestation by number of jassid.

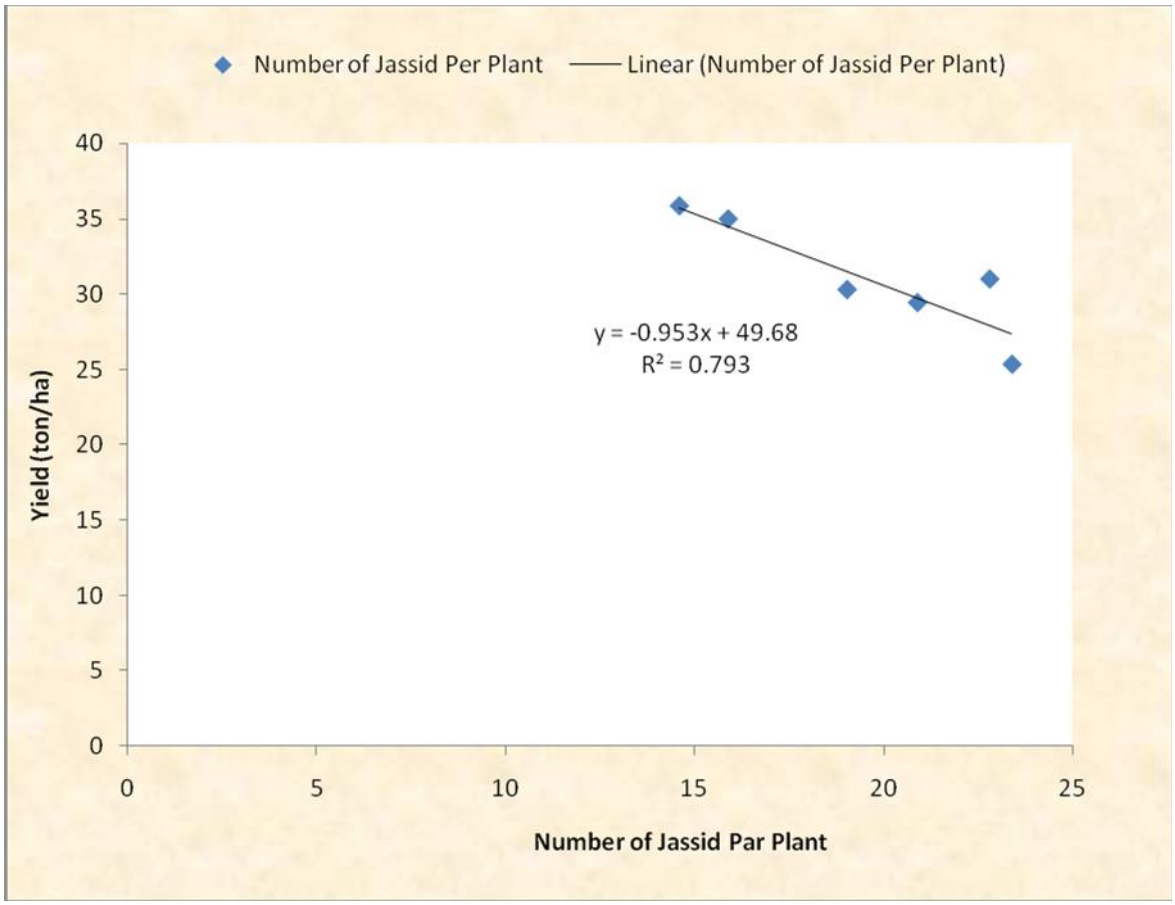


Figure 4: Correlation between Number of Jassid and Yield

4.9.5 **Correlation between number of infested fruit and yield of okra:**

Correlation study was done to establish the relationship between yield of okra fruit and by number of infested fruit among different management practices. From the Figure 5, it was revealed that negative correlation was observed between the parameters. It was evident that the equation y = -0.311 + 7.871 gave a good fit to the data and the co-efficient of determination (R^2 = 0.903) fitted regression line had a significant regression co-efficient. It may be concluded from the figure that the fruit infestation by number of infested fruit was strongly as well as negatively correlated

with the yield (ton/ha) of okra i.e., fruit yield was decreased due to increase of the fruit infestation by number.

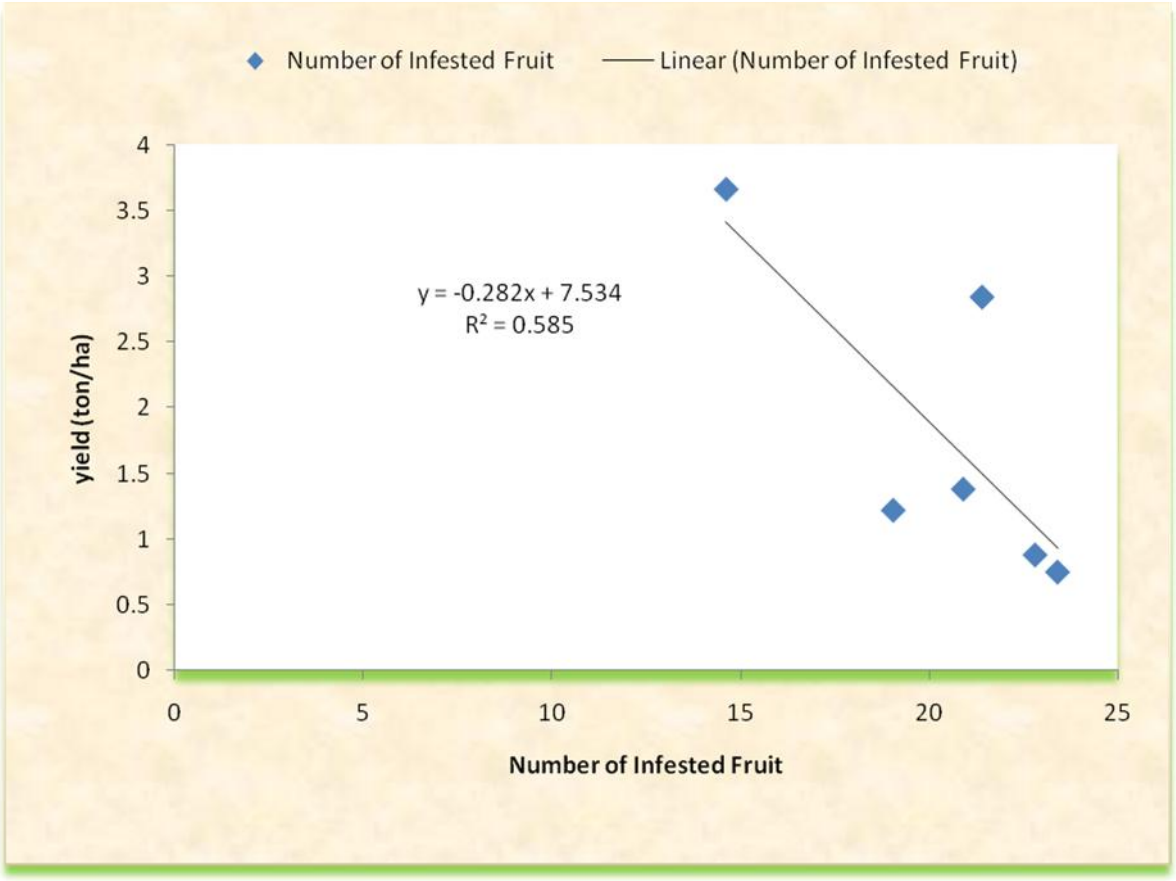


Figure 5: Correlation between Number of Infested Fruit and Yield

4.9.6 Correlation between weight of infested fruit and yield of okra:

Correlation study was done to establish the relationship between yield of okra fruit and by weight of infested fruit among different management practices. From the Figure 6, it was revealed that negative correlation was observed between the parameters. It was evident that the equation y = -2.723x +69.32 gave a good fit to the data and the co-efficient of determination (R^2 = 0.847) fitted regression line had a

significant regression co-efficient. It may be concluded from the figure that the weight of infested fruit was strongly as well as negatively correlated with the yield (ton/ha) of okra i.e., fruit yield was decreased due to increase of the weight of infested fruit.

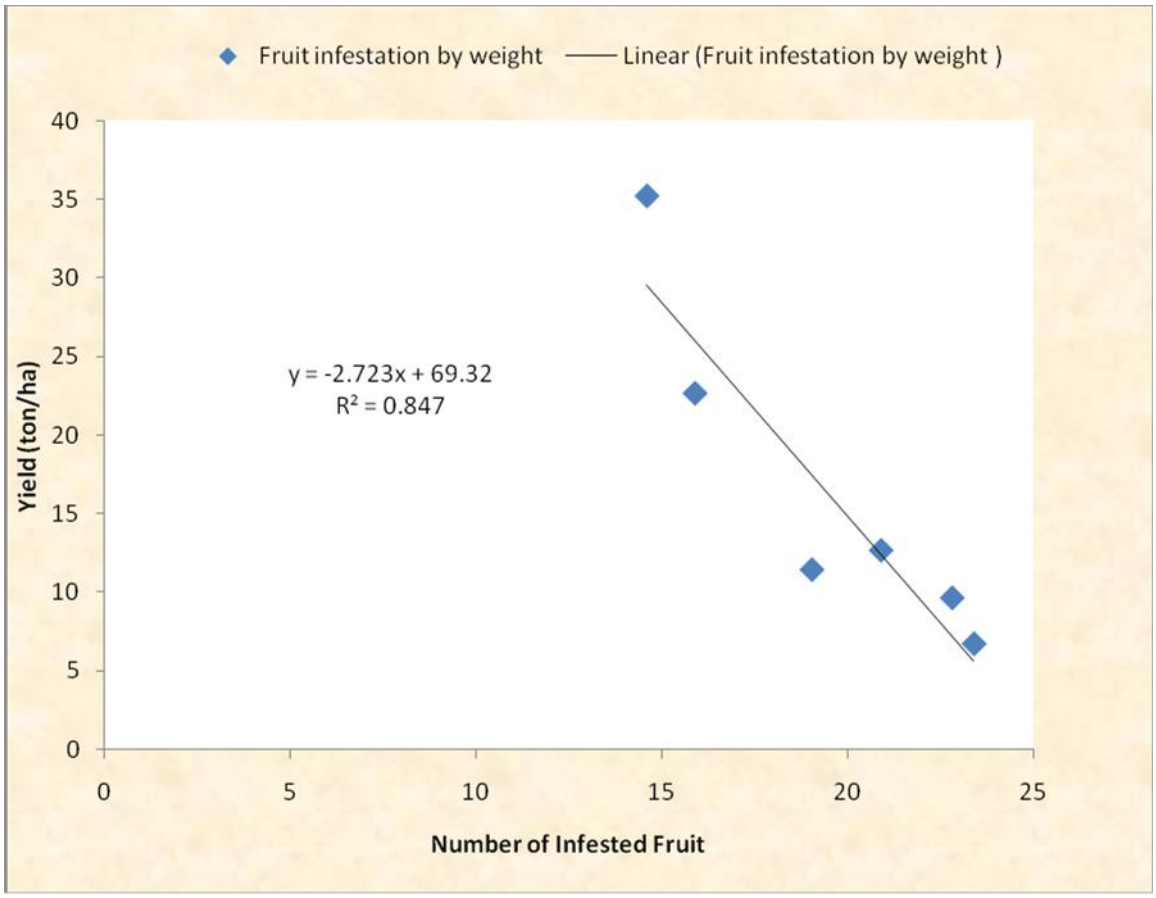


Figure 6: Correlation between Weight of Infested Fruit and Yield of Okra

4.9.7 Correlation between number of fruit and yield of okra:

Correlation study was done to establish the relationship between yield of okra fruit and by number of infested fruit among different management practices. From the Figure 7, it was revealed that positive correlation was observed between the parameters. It was evident that the equation y = 0.660x + 26.73 gave a good fit to the data and the co-efficient of determination (R^2 = 0.437) fitted regression line had a significant regression co-efficient. It may be concluded from the figure that the

number of fruit was strongly as well as positively correlated with the yield (ton/ha) of okra. Yield of okra was increased due to increase of the number of fruit.

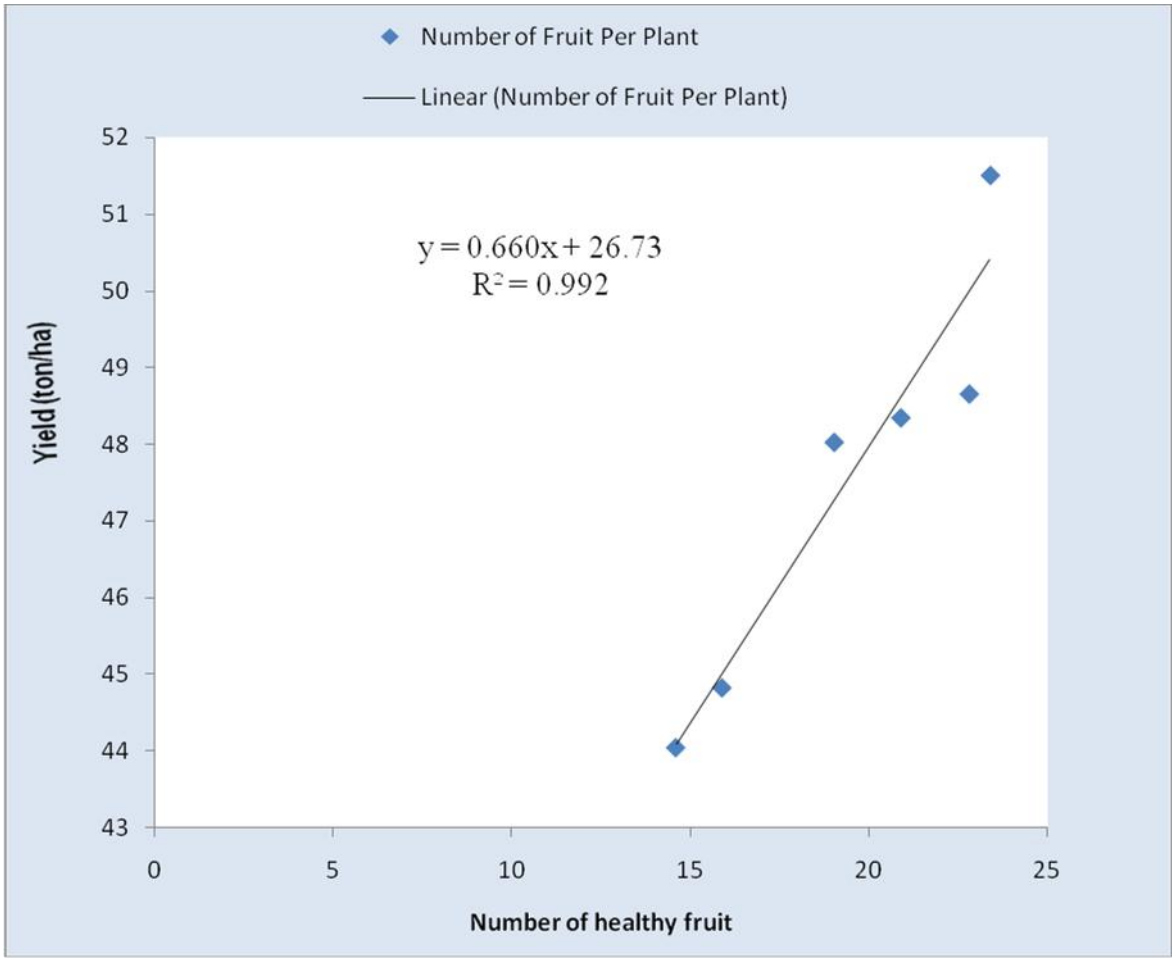


Figure 7: Correlation between Number of Healthy Fruit and Yield

4.9.8. Correlation between 1st flowering days and yield of okra:

Correlation study was done to establish the relationship between yield of okra fruit and by 1st flowering days after sowing among different management practices. From the Figure 8, it was revealed that negative correlation was observed between the parameters. It was evident that the equation y = -0.999x + 50.57 gave a good fit to the data and the co-efficient of determination (R^2 = 0.871) fitted regression line had a significant regression co-efficient. It may be concluded from the figure that the

days of 1st flowering was strongly as well as negatively correlated with the yield (ton/ha) of okra. Yield of okra was increased due to increase of the number of fruit.

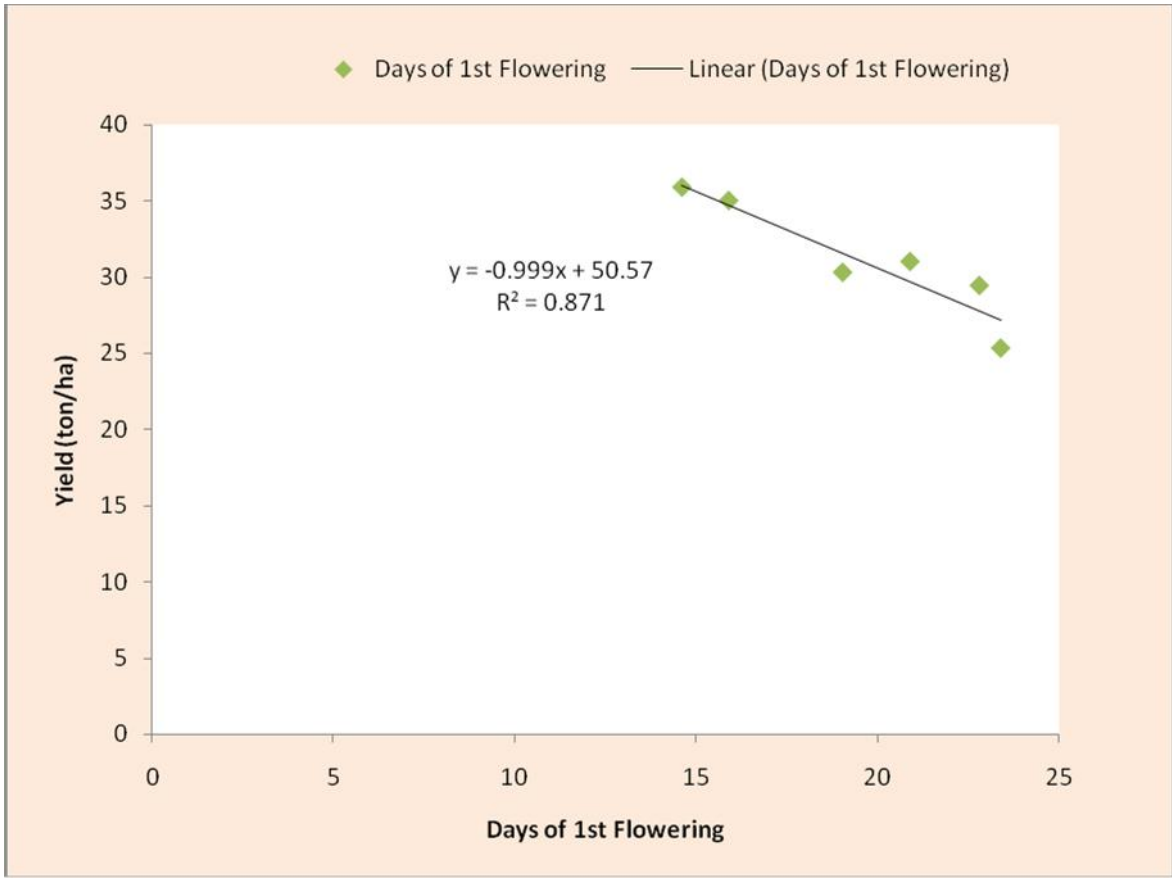


Figure 8: Correlation between 1st Flowering and Yield

4.10. Benefit cost analysis

Benefit cost analysis of different treatments for managing jassid in okra is presented in table 9. The highest benefit cost ratio (BCR) was calculated (23.89) in T_2 Treatment (Spray with neem oil @ 4ml +Trix detergent @ 10 ml/litter of water at 7 days interval) which was closely followed by T_5 (15.20) treatment (Spray with Admire 200SL @ 0.5ml/litter of water at 7 days interval). On the other hand the lowest BCR ws calculated in T_1 (Spray with soap water @ 3 gm/litter of water at 7 days interval) which was statistically closely followed by T_4 (8.51) treatment

(Spray with (Fenitrothion) Sumithion 50EC @ 1ml/litter of water at 7 days interval).

Table: 9 : Benefit/cost analysis of different control measures against jassid in okra

Treatment	Production (ton/ha)	Gross Return from Produce (Tk/ha)	Additional Income due to Treatment	Cost of Treatment (Tk/ha)	Net benefit from Treatment	Benefit –Cost Ratio (B/C)
T_1	15.89	238350	19350	2540	16810	6.62
T_2	22.80	342000	123000	4940	118060	23.89
T_3	20.89	313350	94350	4940	89410	18.10
T_4	19.03	285000	66000	6940	59060	8.51
T_5	23.39	350850	131850	8140	123710	15.20
T_6	14.60	219000	-	-	-	-

T_1: Spray with soap water @ 3 gm/litter of water at 7 days interval

T_2: Spray with neem oil @ 4ml +Trix detergent @ 10 ml/litter of water at 7 days interval

T_3: Spray with neem seed kernel water extract @ 20 gm/litter of water at 7 days interval

T_4: Spray with (Fenitrothion) Sumithion 50EC @ 1ml/litter of water at 7 days interval

T_5: Spray with Admire 200SL @ 0.5ml/litter of water at 7 days interval and

T_6: Untreated Control

Cost of soap (trix) @ Tk 80.0/L; Cost of Neem oil @ Tk 150.0/L; Cost of Neem Seed@ Tk 50.0/Kg; Cost of Sumithion @ Tk 1500.0/L; Cost of Admire @ Tk 7200.0/L; Cost of Sparay: Two labours/ spray/ha @ Tk. 300/Day; Spary volume required:500L/ha;

Farm Gate price of Okra: Tk. 15.00/Kg (During November-March 2013-2014.

CHAPTER V

SUMMARY

The present study was carried out at the experimental farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from November 2013 to March 2014 to evaluate the performance of different management tools for the development of a suitable management of jassid in okra.

Among six treatments, it was observed that, T_5 (Spray with Admire 200SL@ 0.5ml/L of Water at the 7 days interval) was the most effective treatment for reducing jassid infestation over control at different fruiting stages of okra plant. The lowest infestation percent was recorded as 2.27 %, 3.86 % and 3.63 % in T_5 at early fruiting stage, mid fruiting stage and late fruiting stage respectively, followed by T_2 treatment (Spray with neem oil @ 4ml + trix detergent @10ml/litter of water at 7 days interval), T_4 (Spray with (Fenithorion) Sumithion 50 EC @ 1ml/L of Water at the 7 days interval), T_3 (spray with neem seed water extract @ 20gm/L of Water at the 7 days interval). On the other hand, the highest infestation percent 19.63%, 22.26% and 21.63% were recorded in T_6 (untreated control) at early fruiting stage, mid fruiting stage and late fruiting stage respectively, followed by T_1 (Spray with soap water @ 3g/L of Water at the 7 days interval) treatment. It is also observed that T_5 ensured significantly the highest percent of reduction of infestation (88.46%) over the control followed by T_2 and T_4. On the other T_1 is the least performer.

It was also found that T_5 performed as the best treatment in terms of length and girth of healthy fruit and also of infested fruit. In terms of percent increase of fruit length over control, the maximum increase of fruit length (46.57 %) was recorded in T_5 where T_3 - (24.63) was the least performer over control. The maximum increase of fruit girth (42.11 %) was also recorded in T_5 treatment.

Out of six treatments, T_5 performed as the best treatment in terms of percent reduction of jassid population (96.55%) due to application of different management practices followed by T_2 (90.96 %), T_4 (85.01%) and T_3 (84.75%). On the other hand, the lowest percent of reduction of number of jassid was recorded in T_1 (25.84%) over control.

From the above finding, it is revealed that T_5 performed as the best treatment in terms of increasing the yield of okra over control (60.21 %) followed by T_2 (56.16 %), T_1 (46.50) and T_3 (43.02 %). Where the minimum increase of fruit yield over control was recorded in T_4 (30.34 %).

In case of relationship between percent of jassid infestation and yield of okra among different management practices, it was shown that negative correlation was observed

between the parameters i.e., the yield of okra decreased with the increase of incidence of jassid infestation. Same trends were observed in relationship between the weight of infested fruit and yield of okra and also in relationship between the incidence of fruit infestation and yield of okra among different management practices.

It is also revealed that T_2 (23.89) performed as the best treatment in terms of benefit cost ratio followed by T_5 (15.20). On the other hand, the lowest benefit cost ratio was found in T_1 (6.62) treatment. But additional income is highest in T_5 (Tk.1,38,150/-) followed by T_2 (Tk.1,23,000/-). Highest income was observed in T_5 (Tk.350850/-), followed by T_2 (Tk.342000/-). On the other hand lowest gross income is recorded in T_6 (Tk. 219000/-).

T_1 performed best in terms of lowest cost (2540) of treatment, followed by T_2 & T_3 (4940), and the most costly (8140) was in T_5 followed by (6940) T_4. Net benefit is highest in T_1 (123710), followed by (118060) T_2 and (99310) T_1. On the other hand lowest net benefit was recorded (59060) in T_4 treated plot.

CONCLUSION

The present study revealed that the increased yield per hectare of okra with decrease rate of infestation, jassid population, days of 1st flowering, height of okra plant and the reduced weight of infested fruits might be obtained by applying Admire 200SL @ 0.5ml/litter of water at 7 days interval (T_5) and neem oil @ 4ml/Liter of water + trix at 7 days interval (T_2). Treatment T_1 consist of soap @ 3g/L and T_3 consists of neem seed kernel @ 20g/L of water at 7 days interval might be chosen as the alternative approach.

The chemical insecticide Admire 200SL is most effective against jassid. Among other treatment Neem oil+ trix performed better to control jassid in okra. But considering environment concern and BCR, it may be suggested that Admire 200SL may be used for controlling jassid in case of very high population of jassid, otherwise neem oil+ trix, neem seed kernel and use of soap water may be suitable option than other control.

However, further study of this experiment is needed in different locations of Bangladesh for accuracy of the results obtained from the present experiment.

CHAPTER VI
REFERENCE

Adilakshmi, A., Korat, D. M. and Vaishnav, P. R., (2008). Effect of organic manures and inorganic fertilizers on the incidence of insect pests infesting okra. *Karnataka J. agric. Sci.*, **21**:287-289.

Ahmad, F., W. Akram, A. Sajjad and Imran, A., (2011). Management practices against cotton mealybug, *Phenacoccus Solenopsis* (Hemiptera: pseudococcidae). *Int. J. Agric. Biol*., **13**: 547–552.

Ahmad, S., A. Mahmood, A.J. Malik, A. Karim, and Kumbhar, M.B., (2003). Response of okra to water stress. *Sarhad J. Agri.* **19(1)**:73-79.

Ahmad, S., A.J. Malik, A. Mahmood, M.B. Kumbhar and A. Karim. (2004). Inheritance studies in okra under drought conditions. *Sarhad J. Agri*. **20(1)**: 57-65.

Akbar, M. F., Yasmin, N., Khan, M. F., Qureshi, M. H., Naz, F. and Latif, T.A., (2005). Relative toxicity and persistence of different insecticides against jassid, *Amrasca devastans* Dist. on soybean. *Pakistan J. Ent*. Karachi, **20**:1-3.

Akbar, M. F., Yasmin, N., Khan, M. F., Qureshi, M. H., Naz,F., and Latif, T. A., (2006). Effectiveness of profenophos in comparison with endosulfan against *Amrasca devastans* Dist. on okra crop. *Pakistan J. Ent*. Karachi, **21**: 25-27.

Akbar, M. F., Yasmin, N., Naqvi, S. N. H., Khan, M. F. and Naz, F., (2007). Relative efficacy of biopesticide in comparison with conventional pesticides against *Amrasca devastans* Dist.on brinjal crop. *Pakistan J. Ent*. Karachi, **22**:1-3.

Akbar MF, Haq MA, Yasmin N, Naqvi SN, Khan MF., (2012). Management of potato leaf hopper (*Amrasca devastans* Dist.) with biopesticides in comparison with conventional pesticides on autumn potato crop. *Pakistan J. Zool*. **44**:313-320.

Ali, M. I., and Karim, M. A., (1991). Rational insecticide use for the control of the cotton jassid, *Amrasca biguttula* (Shir) (Cicadellidae, Homopters) and the spotted bollworm, *Earias vittella* (F.) (Noctuidae, Lepidoptera) on cotton in Bangledesh. *Trop. Pest Management.* **37** (1):66-70.

Al-Wandawi, H. (1983). Chemical composition of seeds of two okra cultivars. *J. Agric. Food Chem.*, **31**: 1355-1358.

Anonymous, (1985), Annual Reports for 1985-86, Central Institute of Cotton Research, Nagpur,p. 27.

Anonymous, (1999). Annual Weather Report, Meteorological Station, Dhaka, Bangladesh.

Anonymous, (1993).Research and development of vegetable crops. Paper presented in the workshop on importance of okra as summer vegetable on March 9-10, IPSA, Gazipur.pp.1-07.

Anonymous, (2005), Horticultural Information Service, *Monthly Bulletin*, pp. 60-62.

Anonymous, (2005). Development of management approach against jassid infestation on lady's finger (*Abelmoschus esculentus*). Annual Research Report, Entomology Division. Bangladesh Agricultural Research Institute. Gazipur, Bangladesh. pp. 46- 48.

Atachi, P. and Sourokou, B. (1989) Use of Decis and Systoate for the Control of *Maruca testulais* (Geyer) in Cowpea. *Insect Science and Its Application*, **10**: 373-381.

Atwal, S.N.(1994) Agricultural Pests of India and South East Asia. Kalyani Publishers New Delhi, India.529Pp.

Atwal, A. S., Chaudhary, J. P. and Sohi, B. S. (1969). Effect of temperature and humidity on development and population of jassids, *Empoasca devastants* Distant. *J. Res. (PAU)*,**6(1)**: 255-261.

Babu R, K. and Santaram, G., (2000). Persistence toxicity of imidacloprid to aphid and leafhoppers on groundnut. *Pestology,* **24** : 23-25.

Bhat, M.G. Joshi, A.B. and Singh, M. (1984). Relative Losses of Seed Cotton Yield by Jassid and Bollworm in Some Cotton Genotypes(*Gossypium hirsutum* L.), *Idian J. Entomol*.**46(1)**: 169-173.

Bhaskaran, S., (1995), Studies on traditional pest control practices of Tamil Nadu. M. Sc. (Agri.) Thesis, Annamalai University, Annamalainagar, p. 120.

Baisen J. S. and Ghosh Hajra, N., (2001). Bioefficacy of some neem formulations and garlic extract against sucking pests of tea. *Pestology,* **15** : 12-15.

Balikai, R.A. and Lingappa, S., (2005), Management of aphid, *Melanaphis sacchari* (Zehntner) on rabi sorghum through botanicals. In Sustainable Insect Pest Management (Eds. S. Ignacimuthu and S. Jayaraj) Narosa Publishing House, New Delhi, pp. 204-209.

Balikai, R.A. and Lingappa, S., (2004). Effect of natural plant products on predators of aphid *Melanaphis sacchari* (Zehntner) in sorghum. *Indian J.Ent.,* **66**(1):57-59.

Basu, A. N. (1995). Bemisia tabaci Gennadius-Crop pest and principal whitefly vector of plant viruses. Oxford & IBH Pub. Co. Pvt. Ltd. New Delhi. pp. 183.

Baughman, Walter F. J., George S.,: OKRA SEED OIL.1 (1920). S.l.: *American Chemical Society Journal of the American Chemical Society* 42 (1920), S. 166-170.

BBS (Bangladesh Bureau of Statistics). (2009). Ministry of Planning, Government of Peoples Republic of Bangladesh. Yearbook of Agric. Statistics of Bangladesh. Dhaka.

BBS (Bangladesh Bureau of Statistics). (2011). Ministry of Planning, Government of Peoples Republic of Bangladesh. Yearbook of Agric. Statistics of Bangladesh. Dhaka.

Bindu, P., Bharpoda, T.M., Patel, J.R. and Patel, J.J. (2003). Evaluation of various schedules based on botanical and synthetic insecticides in okra ecology. *Indian J. Ent.* **65**: 344-346.

Camciuc, M., Bessifre, J.M., Vilarem, G., and Gaset, A., (1981). Volatile components in okra seed coat. *Phytochem*.**48**:311 – 315.

Camciuc, M., Deplagne, M.,Vilarem, G., Gaset, A., (1998). Okra *Abelmoschus esculentus* L. (Moench.) a crop with economic potential for set aside acreage in France. Industrial *Crops and Products* **7**: 257–264.

Chauhan, D.V.S. (1972). Vegetable production in India. 3rd Edition. Published by Ram Prasad Sons, Agra. Pp. 28-30

Chinniah and Mohanasundaram, M., (1999). Evaluation of neem derivatives for their toxic effect on safety to predatory mites, *Amblyseius* spp. (Acarina : Phytoseidae) in cotton ecosystem. *Pestology*, **123** : 45-48.

Chitra KC, Rao SJ, Rao PK (1997). Efficacy of plant extracts for controlling cotton aphid (*Aphis gossypii). Indian J. Agric. Sci.* **63**:134-135.

Deshmukh, S. D. and Barle, M.N., (1976). Studies on the insecticidal property of indigenous

plant extracts. *Indian J. Entomol*. **3** : 11-18.

Dey, R., Pal, K.K., Bhatt, D.M., Chauhan, S.M., 2005. Growth promotion and yield enhancement of peanut okra by application of plant growth. *Microbiol*. Res. **159**, 371–394.

Dhaliwal, J.S., Sidhu, M.S. and Singh, G., (1981). Effect of different dates of sowing on sorghum and the incidence of red leaf spot disease and major insect pests in Punjab. *J. Res. Agric*. Univ. Ludhiana, **18**: 400-405

Dhamdhereet, S.V., Bhadur, I. and Mishra, U.S. (1984). Studies on occurrence and succession of pests of okra at Gwalior. *Indian J. Plant Prot*. **12**: 9-12.

Dhawan, A. K. and Simwat, G.S., (2000). Evaluation of indoxacarb for the control of bollworm complex and its impact on population of sucking pests. *Pestology*, **15** : 20- 25.

Dubey, V.K., Bhagat, K. and Yadu, Y.K.,(1999). Insect pest succession studies on okra. *J. appl. Zool. Res*.,**10**: 144-145.

DPIF, (2004). Mark Traynor, Senior Technical Officer, DPIFM Darwin, Volume 2 Department of Primary Industry, Fisheries and Mines Crops, Forestry and Horticulture Division.

El-Tom, H.A. (1987). Integrated Pest Management for Cotton in Bangladesh (Terminal Report). FAO/UNDP Cotton Improvement Program. Cotton research Station, Rangpur, Bangladesh. 4p.

Evans, D.E. (1965). The coffee berry borer in Kenya. Kenya Coffee **30**: 335–337.

Farooq, Anwar; Umer Rashid; Muhammad Ashraf; Muhammad Nadeem (March 2010). "Okra (*Hibiscus esculentus*) seed oil for biodiesel production". *Applied Energy* **87 (3)**: 779–785. doi:10.1016/j.apenergy.2009.09.020.

Gandhi, V.P., & Namboodiri, N.V. (2006). *The adoption and economics of Bt cotton in India: Preliminary results from a study* (Working paper number 2006-09-04). Ahmedabad, India: Indian Institute of Management.

Ghauri,M.S.K.(1963).Distinctive features and geographical distridution of two closely similar pests of cotton,*Empoasca devastans* (Dist.) and *E.terraerejinal*(Paoli). Bull. *Entomol.* Res. **53**:653-656

Guddewar, M. B., Shukla, A., Chandra, R., Pandey, S. and Saini, M.L., (1994). *Tabenaemontana coronaria* B. Br. Apocynaceae, a potential source of botanical insecticides. *Plant Protection Bulletin*, **46** : 1-5.

Gulati, R., (2004). Incidence of *Tetranychus cinnabarinus* (Boisd.) Infestation in different varieties of *Abelmoschus esculentus* L. *Annals of Pl. Protn. Sci*.,**12** : 45-47

Hanumantappa, M., (2003). Bioecology and management of leafhopper, *Amrasca biguttula biguttula* (Ishida) (Homoptera : Cicadellidae) on sunflower. M. Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad.

Harper, Douglas. "okra". Online Etymology Dictionary.

Hugar,P.,Nandihalli, B.S. and Patil, B.V., (1990).Botanical insecticides : A gift. Krishi Munnade, **3**: 7-9.

Hung, H.C., K.J. Joshipura, R., Jiang, F.B., Hung, D., Hunter, S.A. Smith-Warner, G.A., Colditz, B., Rosner, D. Spiegelman, and Willett, W.C., (2004). Fruit and vegetable intake and risk of major chronic disease. *Journal of the National Cancer Institute*. **96(21)**:1577- 1584.

Hussain, S., Masud, T. and Ahad, K., (2002). Determination of pesticide residues in selected varieties of mango. *Pak. J. Nutr.*, **1**: 41-42.

Hussain, N., Khan, S, and Mian, L.S. ,(1979). Biology of cotton jassid (*Amrasca devastans*) in relation to different host plants. *J. Sci. Techn*. **3(1-2)**: 21-24.

Inee-Gogoi, B. C., Dutta and Gogoi,I., (2000). Seasonal abundance of cotton jassid, (*Amrasca biguttula biguttula*) Ishida. On okra.*J.Agric.Sci.,Society-of-North-East-India.*,**13(1)**:22-26.

Isacc, I. and Svetlana, K.A., (2002). Emamectin a novel insecticide for the control of field crop pests. *Pest Management Science*, **58** : 1091-1098.

Iyyappa, V.R., (1994), Plant Protection Practices. Honey Bee, **1**: 13.

Iqbal, J., Mansoor , H., Muhammad, A., Shahbaz, T. and Amjad, A., (2008). Screening of Okra genotypes against Jassid, *Amrasca biguttula biguttula* (Ishida) (Homoptera: Cicadellidae). *Pakistan Journal Agricultural Science*. **45(4)**:448 - 451.

Jagtap P, Szabo C (2005).Poly(ADP-ribose) polymerase and the therapeutic effects of its inhibitors. *Nat Rev Drug Discov* **4**: 421-440.

Jagtap, P., Soriano, F.G., Virag, L., Liaudet, L., Mabley, J., Szabo, E., Hasko, G., Marton, A., Lorigados, C.B., Gallyas Jr., F., Sumegi, B., Hoyt, D.G., Baloglu, E., VanDuzer, J., Salzman, A.L., Southan, G.J., Szabo, C., (2002). Novel phenanthridinone inhibitors of poly (adenosine 5_-diphosphate-ribose) synthetase: potent cytoprotective and antishock agents.Crit. Care Med.**30**: 1071–1082.

Jamieson, George S.; Baughman, Walter F. (1920). "Okra Seed Oil.1". *Journal of the American Chemical Society* **42**: 166. doi:10.1021/ja01446a023

Jayakumar, R., (2002). Survey of indigenous practices for the management of pests in Raichur district and evaluation of few practices against okra. M. Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad.

Kabir, K. H. and Mia, M.D., (1987). Effectiveness of some indigenous materials as repellent against the mustard aphid. *Bangladesh J. Zoo*., **15** : 87-88

Kaethner, M., (1991). No side effect of neem extract on the aphidophagous predators, *Chrysoperla carnea* (Steph.) and *Coccinella septumpunctata* L. *Anzeigertus schadlingarkunde Flanzeneschutz Unweltschutz*, **64** : 97-99.

Kakar, K.L. and G.S. Dobra., (1988). Insect-pests of okra, *Abelmoschus esculentus* (Linn.) Monech. and their control under mid-hill conditions. *J. Insect. Sci.* **1(2)**: 195-198

Kanvarjibhai, N. T., (1993). Insect pest control : Aphid Control. Honey Bee, **4**: 16.

Kasyapa, S., (1998). Innovative pest management : Gram pod borer. Honey Bee, **9**: 4-8.

Katole, S. R. and Patil, P.J., (2000), Biosafety of imidacloprid and thiamethoxam as seed treatment and foliar sprays to some predators. *Pestology*, **24**: 11-13.

Khedkar, J. R. and Ukey, S.P., (2003), Efficacy of newer insecticide against jassids, *Amrasca devastans* State Level Seminar on Pest Management for Sustainable Agriculture, February 6-7, 2003, MAU, Parbhani, pp. 199-192.

Khuhro, R. D., Nizamani,S.M., Abbasi, Q.D.,Solangi,G.S., and Jiskani,M.M., (2005). Mango tree mortality due to Asian Ambrosia Beetle, *Xylosandrus crassiusculus* Mot. (Coleoptera: Scolytidae*). Pak. J. Agri.Engg. Vet. Sci*. **21 (1)**:39-42.

Khuhro, R. D., Nizamani,S.M., Abbasi, Q.D.,Solangi,G.S., and Jiskani,M.M., (2005). New host records of Asian Ambrosia Beetle in Sindh Pakistan. *Pak. J. Agri.Engg. Vet. Sci.* **21 (1)**:43.

Khuhro, S.N., Kalroo, A.M., Rustamani, M.A., and Khuhro,R.D., (2014). Lab. Studies on biology of cotton mealy bug, *Phenacoccus solenopsis* at CCRI-Sakrand. *The Pakistan Cotton* **54(14)**: 38-40.

Kochar, S.L.,(1986). Tropical Crops. A text book of economic botany. p.263-264. Macmillan Indian Ltd.

Krishna Prasad, G., (2001), Krishiranga : Golden seed. Prajavani Daily, July 18, p. 9.

Krishnaiah, N. V. and Kalode, M.B., (1984), Evaluation of neem cake and other nonedible cakes against rice pests. *Indian J. Plant Prot.*, **12**: 101-107.

Kulkarni, K. A., Udikeri, S., Hegde, R. and Lingeri, M., (1999), Toxicity of botanicals to the green lace wing, *Chrysoperla carnea* (S.). In : *Biopesticides in Insect Pest Management*, Parbhani, pp. 156-158.

Kumawat, R. L.,B. L. Pareek and B. L. Meena, (2000). Seasonal incidence of jassid and whitefly on okra and their correlation with abiotic factors. *Annals of Biology*. **16 (2)**: 167-169.

Kumar, K., (1998). Studies on bioefficacy and determination of residues of imidacloprid applied against sucking pests on cotton. Ph.D. thesis, Tamil Nadu. Agricultural university Coimbatore.

Kumar, K., (1993). Studies on bioefficacy and determination of residues of imidacloprid applied against sucking pests on cotton. Ph.D. thesis, Tamil Nadu Agricultural University, Coimbatore.

Kumar, V. D.V.N.H., Subramanian, R. and Natarajan, P., (1999). Evaluation of acetamiprid a new chemical insecticidal compound against cotton aphids, *Aphis gossypii* and jassids, *Amrasca biguttula biguttula. Pestology*, **23** : 28-33

Lakshmanan, K. K.,(2001), Garlic a natural pesticide. The Hindu, March-1, p. 8.

Lal, O.P., (1996). Bio-efficacy of some neem formulations against mustard aphid, *Lipaphis erysimi* Kalt. on cabbage plants, In: National symposium Towards Green and Sustainable Pesticides held on 4-6, December 1996 at IARI, New Delhi, pp 20-21.

Lal, O.P.; Sinha, S.R. and Srivastava, Y.N. ,(2005). Evaluation of some promising insecticides against mustard aphid, *Lipaphis erysimi* Kalt. on cabbage under field condition. *J. ent. Res.*,**26(2)** : 169-173.

Lohar, M.K., (2001). Biological control. In: Applied entomology Published by Dr. Kashif Raza under Kashif Publication, Hyderabad. pp.147-167.

Mahal, M.S. and B. Singh., (1979). Population build-up of cotton jassid and index of its injury as a measure of resistance in okra. *Indian J. Ecol*. **6**: 71-81.

Mahal, M.S., H. Lal and R. Singh.,(1991). Standardisation of technique for screening okra germplasm for resistance against cotton jassid, *Amrasca biguttula biguttula* (Ishida) I. Development and survival of nymphs. *J. Insect Sci*. **4(2)**: 135-137.

Mahmood, T., K.M. Khokar, M. Banaras and M. Ashraf.,(1990). Effect of environmental factors on the density of leafhopper, *Amrasca devastans* (Distant) on okra. *Crop Pest Manag*. **36**:279-284.

Mahmood, T., Mahmood, K. and Niazi, Z.M.(1988). Density variation of leafhopper on okra at Islamabad. *Pakistan J. Agril.Res*.**9(2)**:195-197.

Mallapur, C. P, Hulihalli, U.K. and Kubsad, V.S.,(2001). Safflower aphid management through botanical insecticides. *Karnataka J. Agric. Sci.*, **14** : 321-325.

Mallapur, C. P. and Lingappa, S. (2005), Management of chilli pests through indigenous materials. *Karnataka J. Agric. Sci.*, **18**: 389-392.

Mani, M., Krishnamoorthy, A. and Gopalakrishnan, C. (2005). Biological control of lepidopterous pests of Horticultural crops in India. A. Review. Agric. Res. **26**(1): 39-49.

Martin, Franklin W. (1982). "Okra, Potential Multiple-Purpose Crop for the Temperate Zones and Tropics". *Economic Botany* **36 (3)**: 340–345.

Mc-Whorter, John H. (2000). The Missing Spanish Creoles: Recovering the Birth of Plantation Contact Languages. University of California Press. p. 77. ISBN 0-520-21999-6. Retrieved 2008-11-29.

Mehmood, K.; Afzal, M. and Amjad, M., (2001). Non-traditional insecticides: A new approach for the control of okra jassid. *J. Biol. Sci*., **1**:36-37.

Memon, A.J., Abro, G.H. and Syed, T.S. (2004). Varietal resistance of okra against *Earias* spp. *J. Ent.* **1**: 1-5.

Misra, H. P., (2002). Field evaluation of some newer insecticides against aphids (*Aphis gossypii*) and jassids (*Amrasca biguttula biguttula*) on okra. *Indian J. Entomol.*, **64** : 80-84.

Naseeh, M. U., (1982), The effect of garlic extract on *Syrphus corollae* F., *Chrysoperla carneas* S., and *Coccinella septumpuctata* L. Zeitschruft for Angewandte Emtologie, **94** : 123-126.

Natarajan, K., Prasad, R. and Sundaramurthy, V.T., (1986). Effect of neem oil on cotton whitefly (*Bemisia tabaci*). *Indian J. Agric. Sci*., **60** : 290- 291.

Natarajan, R., Subramanian, P. and Santaram, G., (2000). Efficacy of some botanicals against okra leafhopper, *Amrasca biguttula biguttula* (Ishida). *Annals of Plant Protection Sci*., **8** :18-21.

Narayansamy, P. (1999). Traditional pest management for sustainable agriculture. Proceeding of Biopesticides in Insect Pest Management, Rajmundry. pp.225-231.

Nonita Devi, M., Singh, T.K. and Chitradevi, L., (2003). Efficacy of certain botanical insecticides against cotton aphid, *Aphis gossypii* Glover on brinjal. *Pestology,* **27** : 6-9.

Norman, J.C.,(1992). Tropical Vegetable Crops. Arthur H. Stockwell Limited. Elms Court Ilfracomb Devon.

Obeng Ofri D., Sacky, J. (2003). Filed evaluation of non-synthetic insecticides for the management of insect pest on okra *Abelmoschas esculentous* (L.) Monech in Ghana *Ethupian J . Sci.***26***:*145-150.

Okafor J. C. & Fernandes, E. C. M., (1987). "Compound farms of southeastern Nigeria: a predominant agroforestry homegarden system with crops and small livestock". *Agroforestry Systems*. **5 (2)**: 153–168. doi:10.1007/BF00047519

Oyelade, O.J, Ade-Omowaye, B.I.O., and, Adeomi, V.F., (2003). Influence of variety on protein, at contents and some physical characteristics of okra seeds. *J. Food Eng*.**57(2)**:111-114.

Patel, M. S., Yadav, D.N. and Rai, A.B., (1994). Neemark (*Azadirachtin*) as ovipositional deterrent against cotton pests. *Pestology,* **18** : 17-19.

Patel, P. S., Shukla, N.P. and Patel, G.M., (2003). Enhancing insecticidal properties of cow urine against sucking pests of cotton. *In : Proceedings of the National Symposium on Frontier Areas of Entomol. Res., November 5-7, 2003, p. 471.*

Patel, Z. P. And Patel, Z.R., (1996). Effect of botanicals on behavioural response and growth of jassids*, Amrasca biguttula biguttula. Indian J. Plant Prot.,* **24** : 28-32.

Patil, A. S., Patil, P.D. and Patil, R.S., (2002). Efficacy of different schedule doses of imidacloprid against sucking pest complex of chilli (*Capsicum annum L.). Pestology,* **26***:* 31-33.

Patil, B. V., Bhemanna, M. Badriprasad, P.R., Gowdar, S.B. and Kuamr, N.H., (2001). Bioefficacy of acetamiprid 20SP against early sucking pests in irrigated cotton. *Pestology*, **25**: 29-33.

Patil, K. S., Deshkar, M.M., Rane, A.E. and Nimbalkar, S.A., (1990). Some indigenous plant materials against *A. gossypii* and Dactynotus carthami H. R. L. In: Botanical Pesticides in Integrated Pest Management 1993, Ed. Chari M. S. and Ram Prasad G. *Indian Soc*. *Toba. Sci., Rajamundri*, p. 238- 241.

Patil, S. R., (2003), Evaluation of indigenous products for the management of chilli mite, *Polyphagotarsonemus latus* (Bank) (Acari : Tarsonemidae). M. Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad.

Paulraj, M.G. and Ignacimuthu, T. (2005). Predatory insect fauna in mixed cropping agro ecosystems in Northeastern Tamil Nadu. *Insect Environ*. **11**: 79-82.

Parkash S. and Chopra V.L. (1988). Interrogation of resistance to shuttering in *Brassica napus* from *Brassica juncia* through non homologous recombination. *Plant breeding*.**101**: 167-168.

Pawar, D.B., Lawande, D.E., Warade, S.D., (1996). Effects of different sowing dates on the incidence of leafhopper, mite and fruit borer of okra. *J. Mahrashtra Agril. Univ*. **21(3)**: 375-377.

Pawar, D. R., Warad, S.D., Patil, S.K. and Barve, H.S., (2000). Preliminary studies on the efficacy of organic product on aphid, *Aphis gossypii* Glover (Aphididae: Homoptera) and leafhopper, *Amrasca devastans* Dis (Cicadellidae : Homoptera) of okra. *Insect Environment*, **6** : 111-112.

Pawar, S. A., Walunj, A.R., Mote, U.N. and Charan, A.P., (2003). Efficacy of PI-0111 a new molecule for control of sucking pests of cotton. *In : Proceedings of the National Symposium on Frontier Areas of Entomol. Res.*, November 5- 7, 2003, p. 170.

Prakash, A., Rao, J., Pasalu, I.C. and Mathur, K.C. (1987). Rice Storage and Insect Management. B.R. Publishing Corporation, New Delhi. p.337.

Prakash, A., Rao, J., Jevari, S.N. and Gupta, S.P. (1990). Rice agro ecosystem management by pesticides and its consequences Nat con. Publ. in Growth Development and Natural Resources Conservations. pp. 131-137.

Raguraman, S. and Jayaraj, S., (1994). Photostability of neem seed kernel water extract and its effect on mortality of rice brown plant hopper, *Nilaparvata lugens* (Stal) nymphs. *Indian J. Entomol*., **56** : 443-446.

Rana, J.,(2006). Response of *Coccinella septempunctata* and *Menochilus sexmaculatus* (Coleoptera: Coccinellidae) to their aphid prey, *Lipaphis erysimi* (Hemiptera: Aphididae) in Rapeseed-mustard. *European. J. Ent*. **103**: 81-84.

Rana, J.S., (2005). Performance of *Lipaphis erysimi* (Homoptera: Aphididae) on different Brassic species in a tropical environment. *J. Pest Sci.,* **78**: 155-160.

Rashid, M. M. (1999). Shabjibiggayan (In Bengali). Rashid Publishing House, 94 Old DOHS, Dhaka-1206. P. 49.

Rathod, A. T., Tandale, M.B., Aherkar, S.K. and Lande, G.K., (2002). Bioefficacy of herbal products against mustard aphid, *Lipaphis erysimi* (Kalt) and its parasite, *Diaeretiella rapae*. *Pestology*, **26** : 17-19.

Ravikumar, S. S., Chillar, B.S. and Rohilla, H.R., (2003) Toxicity of Nitroguanidines/ Neonicotinoids and conventional insecticides against leaf hoppers,*Amrasca biguttula* on okra under screen house. *Indian J.Entomol.* **65** : 268-272.

Ravikumar, S. S., Kulkarni, G.G., Basavan Gowda, K. and Mallapur, C.P., (1999). Insecticidal property of some indigenous plant extracts against Lepidopterous pests of safflower. *Annals of Agro-Bio Res.*, **4** : 49-52.

Rashid, M. M. (1999). Shabjibiggayan (In Bengali). Rashid Publishing House, 94 Old DOHS, Dhaka-1206. P. 49.

Rehman, M.H. and Ali, H. (1983). Biology of spotted bollworm of cotton *Earias vittella* (F). *Pakistan J. Biol.* **13**(1-2): 105-110.

Rosaiah, R., (2001a). Performance of different botanicals against the pests complex in bhendi. *Pestology*, **25** : 17-19.

Rosaiah, R., (2001b). Evaluation of different botanicals against the pest complex of brinjal. *Pestology*, **25** : 14-16.

Samanthabhai and Dharmanbhai, D., (1994). Lemon juice for aphid control. Honey Bee, **1**: 17.

Savello, P.A., Mortin, F.W. and Hill, J.M. (1980). Nutritional composition of okra seed meal. Agricultural and Food Chemistry. **28**: 1163-1166.

Schmutterer, H., (1988). Potential of azadiractin containing pesticides for integrated pest control in developing and industrialized countries. *J. Ins. Phy.*, **34**: 713-719.

Senapati, B. and Khan, S.R., (1978). A note on population fluctuation of *Amarasca biguthula biguthula* (Ishida) on okra at Bubaneshwar. *Indian J. Agric. Res*., **12**:97-98

Sharma, S.S., (1993) Efficacy of some insecticides for Jassid control in Okra. *Haryana J. Horti. Sci.,* **22***:* 247-249.

Sharma, G.N. and P.D. Sharma. (1997). Ovipositional behavior of cotton leafhopper, *Amrasca biguttula biguttula* (Ishida) vis-à-vis morphological Characters of cotton cultivars. *Ann. Pl. Prot. Sci*. **5**:15-17.

Sharma,G.N. and P.D. Sharma., (1997). Biology and development of cotton leafhopper, *Amrasca biguttula biguttula* (Ishida) on different genotype of okra (*Abelmoschus esculentus* (L.) Monech). *Crop Research Hisar* ,**14(3)**: 487-492

Sheedi, M.A., (1980). Arthropods associated with okra *Hibiscus esculentus* L. crop. M.Sc.thesis, Sindh Agricultural University, Tandojam. pp. 58

Siddegowda, D. K., Suhas Yelshetty and Patil, B.V., (2003), Spinosad 45 SC : An effective insecticide against pigeon pea pod borer, *Helicoverpa armigera* (Hub.). *Pestology*, **17** : 21-22.

Singh, J. and Brar, K.S., (2004). Mass production and biological control potential of coccinellids in India. In: Indian insect predators in biological control (ed. K. Sahayaraj) Daya Publishing House, Delhi, India. pp. 204-260.

Singh, A.K. and Kumar, M., (2003). Efficacy and economics of neem based products against cotton jassid, *Amrasca biguttulla* Ishida in okra. *Crop.Res.Hisar.*,**26:**271-274.

Shivalingaswamy, T.M., Satpathy, S. Singh, B. and Kumar, A., (2002). Predator-prey interaction between jassid (*Amrasca biguttula biguttula*, Ishida) and a staphylinid in okra. *Veget. Sci*., **29**: 167-169.

Smitha, M. S., (2002). Management of yellow mite, *Polyphagotarsonemus latus* Banks (Acari :Tarsonemidae) on chilli. *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad.

Sridevi, (1998). Evaluation of certain botanicals against pests of sunflower. M. Sc. (Agri.) Thesis, Acharya N. G. Ranga Agricultural University, Rajendranagar, Hyderabad, p. 126.

Srinivasa Murthy, K. and Sharma, D.P., (1997). Traditional pest management in cotton. *Insect Environment*, **3** : 73-74.

Srinivasa Rao, N. and Rajendran, R., (2002). Joint action potential of neem with other plant extracts against the leaf hoppers, *Amrasca devastans* (Distant) on okra. *Pest Management and Eco.Zoo.,* **10** : 131-136.

Srinivasan, G. and Sundara Babu, P.C., (1997). Management of brinjal shoot and fruit borer, *Leucinodes orbonalis* Guene (Pyralidae: Lepidoptera) using neem products and insecticides. Proceedings of 1st National Symposium on Pest Management in Horticulture Crops, Bangalore, p. 54.

Srinivasan G, Babu P.C.S., (2000). Effect of Neem products on predatory green lacewing, *Chrysoperla carnea*. *Pest Res J.* **12**:123–126

Srivastava, L.S. and Verma, R.N., (1989). Fungicidal control of white rust of mustard in Sikkim. *Indian Phytopath.* **42**(1): 84-86.

Tomar, S. K.; Rana, O. S., (1994). Incidence of jassid in relation to variety and time of sowing in cotton (*Gossypium* Species) *Ind. J. Agric. Sci*., **64 (11)**: 10-37.

Thomas, K. T., (1994). Indigenous method of plant protection. The Hindu, Daily, October-5 p. 8.

Thomas, M. S., (1995). A few traditional practices in rice farmer in Kerala. In : Key Note Paper and Extended abstract of 2nd Congress on Traditional Sciences and Technology of India, Anna University, Annamalinagar, December 27-31, 1995.

Thomson, H.C. and Kelly, W.C.,(1979). (3rd ed.) Vegetable crops. McGraw Hill Co. New York. P. 562.

Udaiyan, K., Murugan, K., Viswanathan, S.R. and Murugesan, N.V., (1995). Stability of *azadirachtin* in nimbecidine during storage under different agroclimatic conditions. *Pestology*, **19** : 33-40.

Umamaheshwari, T., Sharmila, Bharathi, C., Kanagarajan, R., Arvindainambi, S. and Selvanarayana, V., (1999). Neem formulation and castor oil – A safe way to manage okra red spider mite. *J. Aca.,* **14** : 77-79.

UNDP. (1988). Land Resource Appraisal of Bangladesh for Agricultural Development Report 2:Agro-ecological regions of Bangladesh, FAO, Rome, Italy,pp.577.

Van Den Bosch, R., (1972). *The cost of poison. Environ*., **14**: 8-13.

Verma, I.M. and B.R. Batra., (2001). Effect of irrigation and nitrogen on growth and yield in okra. Changing scenario in the production systems of horticultural crops. Proceedings of a National Seminar, Coimbatore, Tamil Nadu, India, 28-30 August 2001. *J. South-Indian-Horticulture*, **49**:386-388.

Verma S., Ajuvendra S, Aastik J, Mishra V.K. (2013). Population dynamics of sucking insect pests and its natural enemies on okra agro-ecosystem in Chitrakoot region. Mahatama Gandhi Chitrokoot Gramodya Vishwvidyalay, Satna (M.P.) India.Indian Institute of Vegetable Research, Varanasi (U.P.) India.

Vijayalakshmi, K., Subhashini, B. and Shivani, V.K., (1996). Plant in Pest Control : Garlic and Onion. Centre for Indian Knowledge System, Chennai, pp. 1-20.

Vijayalakshmi, K., Subhashini, B. and Shivani, V.K., (1997). Plant in Pest Control : Turmeric and Ginger. Centre for Indian Knowledge System, Chennai, pp. 1-32.

Vijayalakshmi, K., Subhashini. B. and Shivani, V. Koul, (1998). Plant in Pest Control, Custard Apple, Vitex, Sweet Flag and Position Nut. Centre for Indian Knowledge System, Chennai, pp. **1**-30.

Yamaguchi, M. (1998). World Vegetables Principles, Production and Nutritive Values. Van Nostrand Reiduction. New York, USA. pp. 415.

Yadav, D. N. and Patel, R., (1990). Effect of some botanicals on oviposition of *Chrysoperla scelestes* and their ovicidal action. In: Proceedings of Symposium on Botanical Pesticide in Integrated Pest Management, Rajamundrai, pp. 166-169.

Yadav, P., Singh, P.,Yadav, R. L. and Lal, R.,(2004). Ameliorative organic manures and nitrogen levels on okra. *Haryana J. Hort.Sci.,* **33** : 124-126.

Yadav, S.K., B.S. Dhankhar, D.P. Deswal and R.P.S. Tomer, (2001). Effect of sowing date and plant geometry on seed production and quality of okra, *Abelmoschus esculentus* L. (Moench) cv. Varsha Uphar. *Seed Res*., **30**: 240-243.

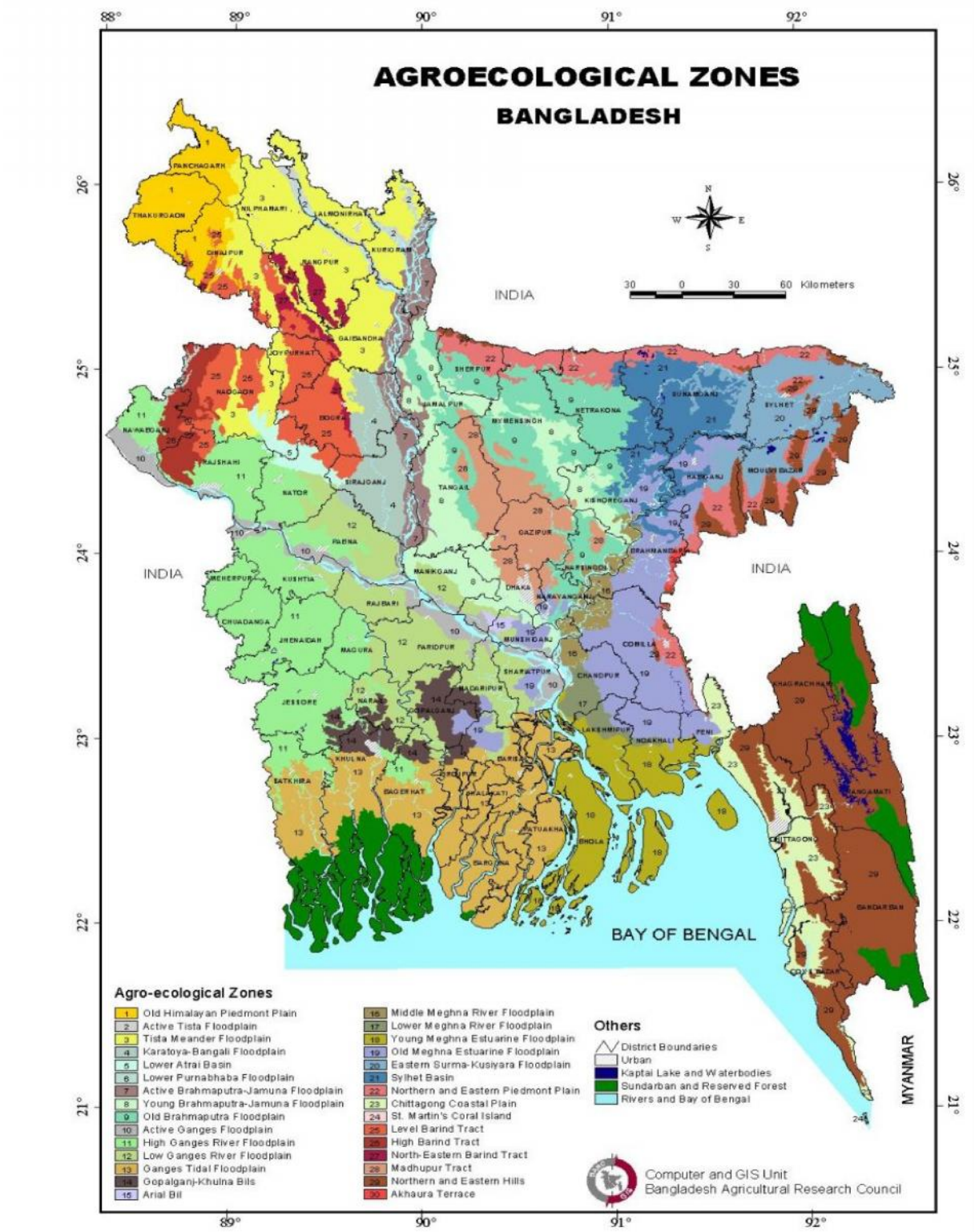
Yadav,J.B., Singh, R.S. and Tripathi, R.A.(2008). Evaluation of biopesticides against pest complex of okra.*Ann.Pl.Protec.Sci*.**16**:58-61.

Yadav, S.K., Dhankhar, B.S., Deswal, D.P. and Tomer, R.P.S.(2005). Effect of sowing date and plant geometry on seed production and quality of okra, *Abelmoschus esculentus* L. (Moench) cv. Varsha Uphar. *Seed Res*, **29**: 149-152.

Yadav, J.B., Singh, R.S. and Tripathi, R.A. (2007). Effect of weather parameters on the incidence of pest complex of okra. *Annal Plants Protec.Sci.*,**15(2)**:477-478.

APPENDICES

Appendix I. Agro-Ecological Zone of Bangladesh



Appendix II. Monthly record of air temperature, rainfall, relative humidity, soil temperature and Sunshine of the experimental site during the period from October 2013 to March 2014

Month	Average air temperature (°C)			Average relative humidity (%)	Total rainfall (mm)	Total Sunshine per day (hrs)
	Maximum	Minimum	Mean			
October, 2013	34.8	18.0	26.4	77	227	5.8
November, 2013	29.7	20.1	24.9	65	5	6.4
December, 2013	26.9	15.8	21.35	68	0	7.0
January, 2014	24.6	12.5	18.7	66	0	5.5
February, 2014	33.7	23.8	28.81	69	185	7.8
March, 2014	36.7	20.3	28.5	70	205	7.7

Source: Bangladesh Meteorological Department (Climate & weather division), Agargoan. Dhaka – 1212

Appendix III. Characteristics of Horticulture Farm soil is analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

C. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Central Ferm, SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon

Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping Pattern	Fallow- Tomato

D. Physical and chemical properties of the initial soil

Characteristics	Value
%Sand	27
%Silt	43
%clay	30
Textural class	Silty-clay
pH	6.1
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.077
Available P (ppm)	20.00
Exchangeable K (mel 1 00 g soil)	0.10
Available S (ppm)	45

Source : SRDI, 2013

Appendix IV. Analysis of variance of the data on effect of different pest management on number of jassid on okra

Source of variation	Degrees of freedom	Mean square		
		Number of Jassid		
		Early	Mid	Late
Replication	2	0.0003	0.0001	0.00001
Treatment	5	1.261**	1.312**	1.056**
Error	10	0.0016	0.0012	0.00013

Appendix V. Analysis of variance of the data on fruit infestation due to Jassid on okra at early fruiting stage by number basis

Treatment	Degrees of freedom	Pods in number		
		Healthy	Infested	% Infestation

Replication	2	0.045	0.011	0.451
Treatment	5	0.123*	0.367**	5.783**
Error	10	0.068	0.016	1.659

Appendix VI Analysis of variance of the data on fruit infestation due to Jassid on okra at early fruiting stage by number basis

Treatment	Degrees of freedom	Pods in weight (g)		
		Healthy	Infested	% Infestation
Replication	2	1.342	0.562	0.786
Treatment	5	18.986**	9.805**	7.893**
Error	10	5.816	2.311	1.083

Appendix VII. Analysis of variance of the data on fruit infestation due to Jassid on okra at mid fruiting stage by number basis.

Treatment	Degrees of freedom	Pods in number		
		Healthy	Infested	% Infestation
Replication	2	0.134	0.023	1.672
Treatment	5	2.092*	3.453**	16.098**
Error	10	0.544	0.103	4.963

Appendix VIII. Analysis of variance of the data on effect fruit infestation due to Jassid on okra at mid fruiting stage by weight basis

Treatment	Degrees of freedom	Pods in weight (g)		
		Healthy	Infested	% Infestation
Replication	2	3.453	6.091	2.345
Treatment	5	118.678**	87.785**	56.892**
Error	10	26.35	11.21	6.911

Appendix IX. Analysis of variance of the data on fruit infestation due to jassid on okra at late fruiting stage by number basis

Treatment	Degrees of freedom	Pods in number		
		Healthy	Infested	% Infestation
Replication	2	0.892	0.012	1.234
Treatment	5	5,684**	0.434**	18.905**
Error	10	1.059	0.0231	5.090

Appendix X. Analysis of variance of the data on fruit infestation due to Jassid on okra at late fruiting stage by weight basis

Treatment	Degrees of freedom	Pods in weight (g)		
		Healthy	Infested	% Infestation
Replication	2	12.892	1.092	1.233
Treatment	5	143.903**	6.908**	67.895**
Error	10	27.44	1.543	5.088

Appendix XI. Analysis of variance of the data on effect of different pest management practices on yield contributing characters and yield of okra

Treatment	Degrees of freedom	Plant height at harvest	Days for sowing to 1st flowering	Pod length (cm)	Pod Diameter (cm)	Number of pods/plant	Pod yield/ hectare
Replication	2	11.902	0.987	0.123	0.001	0.123	0.045
Treatment	5	188.097***	15.908**	2.894**	0.234**	8.675**	11.234**
Error	10	29.05	3.786	0.213	0.008	0.537	1.423