USE OF PLANT MATERIALS FOR THE MANAGEMENT OF SUCKING INSECT PESTS OF OKRA

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USE OF PLANT MATERIALS FOR THE MANAGEMENT OF SUCKING INSECT PESTS OF OKRA

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CERTIFICATE

This is to certify that thesis entitled, **"USE OF PLANT MATERIALS FOR THE MANAGEMENT OF SUCKING INSECT PESTS OF 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 **SAUTAM KUMAR SHIL, Registration no. 10-04225** 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: December, 2012
Place: Dhaka, Bangladesh

(Prof. Dr. Md. Abdul Latif)
Research Supervisor


DEDICATED TO
MY BELOVED
PARENTS AND
FAMILY
MEMBERS

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Dated: December, 2012 **The Author**

SAU, Dhaka

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Abstract

The present experiment was conducted at the field laboratory of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from April to August, 2011 to find out the efficacy of different plant materials against sucking pest of okra. The treatments comprised seven botanical products, one synthetic chemical insecticide and one untreated control and these were T_1 = Ripcord 10EC @ 1 ml/L of water, T_2 = Tamarind fruit juice @ 100 g/4L of water, T_3 = Neem leaf extract @ 0.5 kg/4L of water, T_4 = Bullock's heart leaf extract @ 0.5 kg/4L of water, T_5 = Dodder extract @ 0.5 kg/4L of water, T_6 = Oleander leaf extract @ 0.5 kg/4L of water, T_7= Dhutra leaf extract @ 0.5 kg/4L of water, T_8 = Dholkolmi leaf extract @ 0.5 kg/4L of water, T_9 = Control. Plant extracts and insecticide were applied at 7 days interval. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Among the treatments, oleander leaf extract gave the highest percent reduction of aphid infestation (21.69%) over control. Dhutra leaf extract gave the highest percent reduction of jassid infestation (35.42%) over control. Ripcord showed the best efficacy by reducing 66.35% and 31.31% population of mealybug and whitefly, respectively over control. Considering plant and yield related attributes, dholkolmi leaf extract increased the highest percent of plant height (18.21%), leaf per plant (19.81%) and number of branch per plant (39.17%), where neem leaf extract and bullock's heart leaf extract respectively showed the least performance. Similarly, highest number of fruit per plant, fruit weight, fruit length and fruit diameter (9.83 g, 29.33 g, 15.06 cm and 6.60 cm, respectively) was obtained by application of dhutra leaf extract, tamarind fruit juice and neem leaf extract respectively with the increase of 40.85%, 28.58%, 17.18 % and 30.09 % over control, whereas neem leaf extract (9.73%), dodder extract (11.45%), bullock's heart leaf extract (23.20%) and dhutra leaf extract (18.07%) showed the least performance. Finaly, the highest yield increase over control was achieved in bullock's heart leaf extract (40.35%), whereas the lowest increase showed in ripcord (24.34%). All plant materials have great impact on okra yield attributing character and better impact on aphid and jassid and moderate effect on other sucking pests.

CHAPTER I

INTRODUCTION

Okra or lady's finger, *Abelmoschus esculentus* L., locally known as bhendi, or dheros is a popular and most common vegetable crop in Bangladesh and in other tropical and sub-tropical parts of the world. It belongs to the family Malvaceae and originated in tropical Africa. Okra is an upright annual, herbaceous 3 to 6 feet tall plant with a hibiscus-like flower. It is a tropical direct sown vegetable with duration of 90-100 days. Though okra is produced mainly in the kharif season (Feb-July), it can be grown in year-round. It occupies an area of 3.70 lakh ha with an annual production of 36.57 lakh ton and average yield of 9.88 ton/ha during 2005-06 (Anon., 2005).

Okra is a popular nutritious fruit vegetable. It contains large amount of Vitamin A, B & C and also contains Ca++ & protein. Okra is cultivated mainly for its immature fruits, which are generally cooked as vegetable. Tender fruits have high mucilage content and are used in soups and gravies. The fruits also have some medicinal value. A mucilaginous preparation from the pod can be used for plasma replacement or blood volume expansion. Besides being a vegetable, it acts as clarifying agent in jaggery preparation (Chauhan, 1972). Crude fiber derived from the stem of okra plant is used for rope making. Okra is said to be very useful against genitourinary disorders, spermatorrhoea and chronic dysentery (Nadkarni, 1927).

Okra production in Bangladesh is affected by many factors, among them insect pest attack is the major one. Since okra belongs to the family Malvaceae, nineteen insect pests and

four mites have been reported on okra of which the sucking pest complex create havoc by causing both quantitative and qualitative loss to the crop (Anon., 1993).

Leaves are mainly infested by sucking insect pests. There are four main sucking insect pests of okra in Bangladesh.

Aphid, *Myzus persicae,* Sulzer*;* soft-bodied, pear-shaped insects with a pair of dark cornicles and a cauda protruding from the abdomen; yellow-green nymph, may be winged or wingless but later is most common. These are known to feed in colonies. Aphids can attain very high densities on young plant tissue, causing water stress, wilting, and reduced growth rate of the plant (Pawar *et al.* 2000).

Jassid, *Amrasca biguttula biguttula,* Ishida *;* the adults are wedge shaped (2 mm) pale green with a black spot on posterior half of each of the fore wings. The female inserts about 15 yellow eggs into leaf veins on the underside. Nymphs and adults suck sap usually from the under surface of the leaves and inject toxins causing curling of leaf edges and leaves turn red or brown called as 'Hopper Burn' (Patel and Patel 1996). The leaves dry up and shed. On transformations into winged adults, they feed constantly on the plant juice.

Whitefly, *Bemisia tabaci*, Gennadius*;* the insect breeds throughout the year and the female lays stalked yellow spindle shaped eggs singly on the lower surface of the leaf. Nymphs and adults suck the sap usually from the under surface of the leaves and excrete honeydew. Leaves appear sickly and get coated with sooty mold (Jayaraj *et al.* 1986). The whitefly serves as the vector for the spread of yellow vein mosaic disease causing damage to okra crop.

Mealybug, *Pseudococcus hirsutus,* Green*;* they have sucking mouthparts to extract large amount of sap from the host plant. These insects extract a large amount of sap in order to obtain enough proteins; the excess sap is excreted as honeydew. The excreted honeydew attracts ants and act as a medium for the growth of sooty mould which inhibits the plants ability to manufacture food. Ants in turn protect the mealybug for a continued supply of honeydew, which in turn can damage or kill plants (Gopali 1992). In Bangladesh okra sucking pests severely attack the leaves of okra and reduce the yield of okra.

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). But this is not environment friendly. This is also harmful for human consumption.

The management of sucking pest of okra through various plant materials was limited throughout the world. Management practices of aphid on okra in Bangladesh and other countries are still limited to frequent spray of toxic chemical pesticides (Deshmukh and Barle 1976, Patil *et al.,* 1990, Iyyappa 1994, Patel *et al.,* 1996, Chitra *et al.,* 1997, Rathod *et al.* 2002). Beside the chemical product; plant product also mixed with animal product to reduce the aphid (Ukey *et al.* 1999). Jassid population including adult and nymph may also be reduced through use of plant materials (Natarajan *et al,*. 2000, Rosaiah (2001a). Whitefly and mealybug population was also reduced through chemical insecticide as well as plant materials (Jayaraj *et al.* 1986, Gopali 1992, Nandihalli *et al.* 1990, Ahmad *et al.*

1995, Chandrashekharappa 1995, Tatagar 2002). The use of insecticide is a burning issue in respect of agro socio economic and environmental aspect. For that reason, we should use botanicals for effective management of insect pests. At present situation in Bangladesh, there is a great need of information about appropriate management of sucking insect pests of okra using botanicals.

Objectives

Considering the above situation the present study was, therefore, undertaken with the following objectives:

- To know the infestation status of sucking insect pests on okra.
- To evaluate the efficacy of some plant extracts against the sucking insect pests of okra
- To identify the effective plant extracts for the management of sucking insect pests of okra.

CHAPTER II

REVIEW OF LITERATURE

Sucking pests of okra such as aphid (*Myzus persicae*), jassid (*Amrasca biguttula biguttula*), mealybug (*Pseudococcus hirsutus*) and whitefly (*Bemisia tabaci*) are 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 form throughout Bangladesh and affecting adversely the quality and yield of the crop. Several indigenous plant materials have been used to control these sucking pests in our country and the world. Investigations are required to emerge with suitable indigenous plant materials on every crop, especially the vegetables which are consumed daily (raw or cooked) in large scale. The information on the use of plant materials for the management of okra sucking pests is limited. However, an effort has been made to collect the information on the use of plant materials on okra as well as other crops which are presented below.

2.1 Efficacy of indigenous plant materials against sucking pests

Spraying of tobacco leaf extract (with lime) against 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 green chilli and garlic which is mixed with water in the proportion of 1:2 and sprinkled over many crops infested by aphid and other sucking pests. 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 asafoetida 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 litre of water and sprayed on the crops gave good control of the sucking pests (Thomas, 1995).

According to Vijayalakshmi *et al.* (1996), garlic extract alone and in combination with other plant extracts *viz.,* chilli, ginger, neem, tobacco and even cow urine was found effective against sucking pests like aphids, whiteflies, thrips and mites and the extract was effective up to 13 days of application. Ginger extract alone and in combination with other plant products and cow urine was detrimental to aphids, thrips and whitefly (Vijayalakshmi *et al.*, 1997).

Kasyapa (1998) from Medhak district at Andhra Pradesh reported that chilli + garlic solution and 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 sucking pests population in sunflower and all botanicals were found to be safer to natural enemies and pollinators.

Lakshmanan (2001) reported that garlic bulb extract alone or in combination with kerosene, neem oil, chilli and other extracts effectively managed sucking pests like aphids, 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 sucking pests and fruit borer in okra (Krishna Prasad, 2001).

2.2 Efficacy of indigenous plant materials against sucking pests of okra

Investigations of Patel and Patel (1996) revealed that spraying neem seed kernel suspension (5%) on okra had inhibitory effect on *Amrasca biguttula* which resulted in production of abnormal adults and lower emergence of normal adults. Umamaheshwari *et al.* (1999) obtained significantly higher per cent mortality of tetranychid mites 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. biguttula biguttula* on okra and found that garlic kerosene extract recorded the lowest number of jassids.

A field trial conducted by Pawar *et al.* (2000) to assess the bioefficacy of organic products against aphids and jassids on okra revealed that cow urine, *Lantana camara* L. and *Azadirachta indica* A. Juss were found to be effective.

Rosaiah (2001a) reported that neem oil 0.5% was significantly superior in reducing the whitefly population and shoot and fruit borer damage on okra followed by NSKE (5%). The treatments were superior to monocrotophos except in checking jassid incidence. The leaf extract of *Annona reticulata* and Jatropa were high in their effectiveness against the aphid 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 devastans* (Distant) 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.* (2003) reported that the botanical pesticides like neem oil, azadirachtin (300 ppm) and (1500 ppm), mahua and pungum oil significantly reduced two spotted mite population on okra.

2.3 Efficacy of indigenous plant materials against sucking pests on other crops

2.3.1 Aphids

Deshmukh and Barle (1976) studied the insecticidal activities of suspension and extracts of 20 plant species against larvae of *Spodoptera litura* (Fab.) and adults of *Uroleucon carthami* (H.R.L). Aphids were much susceptible to plant extracts than *S. litura*. Some indigenous extracts *viz.*, neem, garlic, tobacco straw wash and a mixture of soap with kerosene were treated as repellents against mustard aphid, *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. gossypii.* 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 aphid population on cotton. 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 whitefly and aphid was found very effective. A similar observation on the effectiveness of lemon juice on aphid population in cotton was observed by Samanthbhai and Dharmanbhai (1994).

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

As reported by Ukey *et al.* (1999), spraying of cow urine + asafoetida and green chilli + garlic extract + asafoetida were effective against aphids. Tobacco decoction at one per cent was found equally effective as that of monocrotophos against aphids on cowpea (Anon., 1998). Garlic and green chilli extracts in equal proportion was effective against aphids infesting many crops (Anon., 2000).

Drastic reduction in aphid population was observed in plots treated with neem cake (86.92%), *Pongamia* (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* (5%) and *Lantana* (5%) (Mallapur *et al*., 2001).

Rathod *et al.* (2002) studied the bioefficacy of different herbal products against mustard aphid, *L. erysimi* and observed lower number of aphid 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 cotton and revealed that although application of cow urine (20%) alone was found to be effective in reducing the aphid 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.), naner (*Nerium indicum* Mill.) against *A. gossypii* under laboratory conditions. The results revealed significantly high mortality of *A. gossypii* (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 aphid population. Field evaluation studies also revealed that NSKE was significantly superior over all other treatments by registering lowest aphid population (35.98 aphids/plant). The botanicals were found safe to natural enemies of *A. gossypii*.

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 cotton aphid.

Balikai and Lingappa (2005) studied the bioefficacy of different botanicals against aphids, *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 aphids. 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).

2.3.2 Jassid

The extracts prepared by grinding green chilli and garlic bulb together with water in the proportion of 1:200 and sprinkled over the crops infested by jassids and aphids cleared off the pests (Kunvarjibhai, 1993). The raw cotton seed oil (@ 2 and 3%) along with monocrotophos (0.06%) caused significantly higher per cent reduction of sucking pests *viz.*, jassid, aphids, thrips and mites as compared to monocrotophos (0.06%) alone in cotton ecosystem (Tadas *et al.,* 1994).

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 (2001b) reported spraying of monocrotophos in brinjal was superior in reducing jassid incidence. However, neem oil (0.5%) was significantly superior in reducing the 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.

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

2.3.3 Mealybug

Gopali (1992) studied the effect of cotton seed oil at various concentrations against

Pseudococcus hirsutus (Baker and Pritchard) under laboratory conditions. The results revealed significantly higher mortality (>95%) at 1 to 10 per cent concentrations. These treatments differed significantly from dicofol up to three days of spraying indicating that cotton seed oil at 5 per cent and 10 per cent concentrations recorded more than 93.7 per cent reduction followed by 4.0, 3.0, 2.0, 1.5 and 1.0 per cent concentrations.

Chandrashekharappa (1995) reported that NSKE was effective against mealybug and was safe to predators while, the other plant products such as mahua oil, castor oil, honge oil and neem oil were not safe to the predatory mites although they were effective against mealybug. Alternate spray of NSKE and triazophos were found very effective in reducing the *Pseudococcus hirsutus* population resulting in reduced leaf curl incidence in chilli (Venkatesh *et al.,* 1998).

Tatagar (2002) conducted an experiment to study the efficacy of different plant extracts against leaf curl caused by thrips and mealybug in chilli. The least leaf curl index was found in *Vitex* leaf extract which was at par with the recommended package. The pod yield obtained from *Vitex* leaf extract (5%), neem oil (5 ml/l) and recommended package were on par with each other.

Mallapur and Lingappa (2005) evaluated indigenous materials against chilli pests and the results revealed that the least leaf curl index (LCI) against both thrips (0.4 LCI) and mealybug (0.8 LCI) was observed in garlic chilli kerosene extract (0.5%) + nimbecidine. The next best treatments included turmeric + cow urine (2.5%) and GCK (1%) alone. The highest yield was obtained in GCK + nimbecidine treatment followed by insecticide application and GCK alone.

2.3.4 Whiteflies

Jayaraj *et al.* (1986) reported that NSKE (5%) and neem oil (5%) caused 93.7 and 90.3 per cent mortality of nymphal stage of *B. tabaci* at seven days after spraying, respectively. Similarly as reported by Natarajan *et al.* (1986), *B. tabaci* population was suppressed effectively by neem oil (0.5%) when the pest population was 5 to 10 per leaf.

According to Nandihalli *et al.* (1990) two neem products, Neemax and Neemguard (3 ml/l) when combined with sub-lethal dose of monocrotophos (0.086%) gave effective control of nymphal and adult population of *B. tabaci* on cotton followed by application of NSKE (5%) and neem seed oil (5%). The efficacy was on par with insecticides like monocrotophos (0.1%) and phosphamidon (0.1%).

The effectiveness of a neem based product, Neemax as ovipositional deterrent was tested in the lab against *B. tabaci* on cotton in Gujarat. Only 30.39 eggs/plant were deposited on plants treated with (0.5%) Neemax as against 62.61 eggs/plant in case of control plants (Patel *et al.,* 1994). Similarly, in a field trial, Ahmad *et al.* (1995) observed the ovipositional deterrence of neem oil against *B. tabaci* on cotton.

Srinivasamurthy and Sharma (1997) reported some of the traditional pest management practices followed by farmers to manage whiteflies infesting cotton. Neem oil (2%), castor seed oil (5%), *Madhuca latifolia* (J. F. Gmel.) oil (0.5%), tobacco leaf extract (0.5%), fish oil rosin soap (0.2%) and nicotine sulphate (0.2%) helped to reduce the pesticide dumping in cotton ecosystem. As reported by Singh *et al.* (1999), spraying neem seed extract (5%) and neem oil (5%) resulted in considerable reduction of whitefly

population on cotton.

2.4 Effect of storage period of plant materials on their efficacy against sucking pests

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 rice brown leaf hopper, *Nilaparvata lugens* (Stal) nymphs. 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.

2.5 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).

Evaluation of naturally occuring wild and medicinal plant extracts in the field for their safety to *Chysoperla* in cotton ecosystem revealed that all the extracts were safe to *Chrysoperla* (Anon., 1985).

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. The neem products *viz.*, neem cake extract (10%), neem seed kernel extract (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 per cent 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, 2001a).

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).

2.6 Efficacy of new promising molecules against okra pests and natural enemy complex

Eger *et al.* (1998) reported higher efficacy of spinosad against thrips (*Frankliniella* sp.) in groundnut. Kumar *et al.* (1999) studied the bioefficacy of a new insecticidal compound acetamiprid 20 SP against cotton 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.

Fenazaquin (Magister 10 EC) provided effective control (80%) of *P. latus* on chilli when applied @ 125 to 150 g a.i./ha with significant increase in yield. The same chemical @ 150 g a.i/ha was found superior (96.98% mortality) over dicofol @ 225 g a.i./ha (92.67% mortality). All the dosages of fenazaquin were superior to ethion tested @ 625 g a.i./ha m (73.99%) (Somachoudhary *et al.*, 2000). 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 than cypermethrin and untreated control. 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.

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) in cotton. 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). Spinosad was the most effective new molecule which recorded least number of western flower thrips, *Frankliniella* spp. as compared to conventional insecticides (Roy, 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. biguttula biguttula*) 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. biguttula biguttula* 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 aphids and jassids on okra. Imidacloprid was the very effective neonecotinoid next best to thiamethoxam against 3rd instar nymphs of the leafhopper, *A. biguttula biguttula* 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 20 SP and thiamethoxam 20 WG against cotton 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 20 SP against sucking pests of chilli. Acetamiprid @ 80 and 40 g a.i./ha was found quite effective in reducing aphids, 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 cotton and some vegetables (Anon., 2003).

Nachane *et al* (2003) studied the ovicidal action of newer insecticides against okra fruit borer in the laboratory and the results indicated that indoxacarb (14.5 SC) @ 0.0087 percent recorded maximum egg mortality (86.66 to 73.33%) followed by spinosad (45 SC) @ 0.012 per cent which was at par with abamectin (1.8 EC) @ 0.0027 per cent and acetamiprid (20 SP) @ 0.002 per cent.

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.

Udikeri *et al.* (2004) conducted field trails to assess the bioefficacy of microbial origin insecticide *i.e.,* emamectin benzoate 5 SG against cotton bollworms and its safety to natural enemies. Significantly lowest larval population (0.10/plant) was noticed in emamectin benzoate used @ 11 g a.i./ha and the treatment was found on par with spinosad 48 SC @ 50 g a.i./ha and indoxacarb 15 SC @ 75 g a.i./ha. The least bollworm

damage was recorded in emamectin benzoate (4.19%) which resulted in higher seed cotton yield (15.93 q/ha). Further, the activity of predators (Chrysoperla and Coccinellids) in emamectin benzoate and spinosad treated with was as good as untreated control indicating the safety of these molecules to predominant natural enemies in cotton ecosystem. Emamectin benzoate @ 8.5 g a.i./ha recorded lower fruit borer damage in okra (4.4%) with a higher good fruit yield (41.92 q/ha) (Bheemanna *et al.,* 2005).

Kadam *et al*. (2005) studied the impact of insecticide sequence on natural enemies in brinjal ecosystem and revealed that among different sequences, the treatment with imidacloprid – NSKE – imidacloprid sequence recorded significantly lower populations of coccinellids (9.0/plot) as compared to spinosad – NSKE – spinosad (12.6 coccinellids/plot) and untreated control (13.00 coccinellids/plot).

Suganya Kanna *et al.* (2005) evaluated emamectin benzoate 5 SG against tomato fruit borer, *H. armigera*. The insecticide formulation at 10 g a.i./ha and 8.75 g a.i./ha was more effective against the fruit borer when compared to profenofos 50 EC (750 g a.i./ha) and lambda cyhalothrin 5 EC (30 g a.i./ha).

CHAPTER III

METERIELS AND METHODS

This chapter deals with the materials and methods that were used in conducting the experiment.

3.1 location of the experimental plot

The experiment was conducted at the Farm of Sher-e-Bangla Agricultural University, Dhaka during the period from April to September 2011. The site is 23^0 46' N and $90^0$24 ' E Latitude and at Altitude of 9m from the sea level.

3.2 Characteristics of soil

The soil of the experimental site is a medium high land belonging to the Modhupur Tract under the Agro Ecological Zone (AEZ) 28. The soil texture was silty loam with a pH 6.7. Soil samples of the experimental plot was collected from a depth of 0 to 30 cm before conducting the experiment and analyzed in the Soil Resources Development Institute (SRDI), Farmgate, Dhaka. Details of the mechanical analysis of soil sample are shown in Appendix I. The experimental site was a medium high land. The morphological characters of soil of the experimental plots as indicated by UNDP (1998).

3.3 Climate

The weather condition of the experimental site was under the sub-tropical monsoon climate, which is characterized by heavy rainfall during kharif season (April to September, 2011) and scantly in the Rabi season (October to March, 2011). There was no rain fall during the month of December, January and February. The average maximum temperature during the period of experiment was 35.10°C and the average minimum temperature was 30.40°C. Details of the meteorological data in respect of temperature, rainfall and relative humidity the period of the experiment were collected from Bangladesh Meteorological Department, Agargoan, Dhaka- 1207, Dhaka and have been presented in (Appendix II).

3.4 Planting materials used for experiment

The okra variety “BARI Dherosh-1’’was used in this study which was resistant to yellow vein mosaic virus, a severe disease of okra. 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.

3.5 Treatments of the Experiment

Nine treatments were considered in this experiment. These are as follows:

T_1 = Ripcord 10EC @ 1ml/L of water at 7 days interval.

T_2 = Tamarind (*Tamarindus indica)* fruit juice @ 100 g/4L of water at 7 days interval.

T_3 = Neem (*Azadirachta indica)* leaf extract @ 0.5 kg/4L of water at 7 days interval.

T_4 = Bullock’s heart (*Annona reticulate)* leaf extract @ 0.5 kg/4L of water at 7 days interval.

T_5 = Dodder *(Cascuta reflexa)* extract @ 0.5 kg/4L of water at 7 days interval.

T_6 = Oleander *(Nerium oleander)* leaf extract @ 0.5 kg/4L of water at 7 days interval.

T_7= Dhutra *(Datura metel)* leaf extract @ 0.5 kg/4L of water at 7 days interval.

T_8 = Dholkolmi *(Ipomoea carnea)* leaf extract @ 0.5 kg/4L of water at 7 days interval.

T_9 = Control.

3.6 Preparation of plant extracts

Tamarind fruit juice: 100g ripe tamarind socked in 4L of water through over night and before application it was mixed properly. The solid materials separated from mixture by sieve.

Neem leaf extract: 0.5 kg fresh neem leaf blended by electric blender then it mixed with 4L of water. The solid materials separated from mixture by sieve.

Bullock's heart leaf extract: 0.5 kg fresh bullock's heart leaf blended by electric blender then it mixed with 4L of water. The solid materials separated from mixture by sieve.

Dodder extract: 0.5 kg fresh dodder blended by electric blender then it mixed with 4L of water. The solid materials separated from mixture by sieve.

Oleander leaf extract: 0.5 kg fresh olender leaf blended by electric blender then it mixed with 4L of water. The solid materials separated from mixture by sieve.

Dhutora leaf extract: 0.5 kg fresh dhutora leaf blended by electric blender then it mixed with 4L of water. The solid materials separated from mixture by sieve.

Dholkolmi leaf extract: 0.5 kg fresh dholkolmi leaf blended by electric blender then it mixed with 4L of water. The solid materials separated from mixture by sieve.

3.7 Layout and design of experiment

The experiment comprised 9 treatments combination and laid out in RCBD with three replications. The whole field was divided into three blocks and each block consisted of 9 plots. Altogether there were 27 unit plots in each experiment and required 432m^2 lands. Each plot was 9m^2 (3m ×3m) in size. The distance between plots was 1.00m, distance between plant to plant was 50cm and that of row to row was 50cm.

3.8 Cultivation of okra

3.8.1 Land preparation

The selected land for the experiment was first opened on 27 March 2011 by power tiller and expose to the sun for a week. After one week the land was ploughed and cross-ploughed several times with a power tiller and laddering to obtain good tilth followed each ploughing. Weeds and stubble's were removed and the large clods were broken into smaller pieces to obtain a desirable tilth of soil for sowing of seeds. After

removal of the weeds, stubble's and dead roots, the land was leveled and the experimental plot was partitioned in to the unit plots in accordance with the design, and the edge around each unit plot was raised to check run out of the nutrients. All types of manures were applied during final land preparation as basal dose.

3.8.2 Manure and fertilizer application

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 $9m^2$. 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 (Anon, 2005).

3.8.3 Sowing of seeds

Seeds were sown on 28 April, 2011. In each plot, seeds were sown in rows and there were three rows in each plot. In the rows, plant to plant distance was 50 cm and row to row distance was 50 cm. the seeds were covered with fine soil by hand. The field was irrigated lightly immediately after sowing. In each plot there were 36 okra plants.

3.8.4. Intercultural operations

The seedlings were always-kept under close observation. Necessary intercultural operations were done through out the cropping season to obtain proper growth and development of the plants.

3.8.4.1 Thinning

When the seedlings got established, one healthy seedling in each location was kept and other seedlings were removed.

3.8.4.2 Gap filling

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

3.8.4.3 Weeding

Four weeding were done manually at 15, 30, 45 and 60 DAS to keep the plots free from weeds.

3.8.4.4 Irrigation

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.

3.8.4.5 Drainage

Stagnant water effectively drained out at the time of heavy rains.

3.9 Harvesting

As the seeds were sown in the field at times, the crops were harvested at different times. Green pods were harvested at four days interval when they attained edible stage. Green pod harvesting was started from 10 May and was continued up to 17 August, 2011.

3.10 Collection of data on yield and yield contributing character:

Infestation of okra shoot & fruit by okra shoot and fruit borer was monitored during both vegetative and reproductive stages. Infested shoots and fruits were counted and recorded at 7 days intervals after observing the bores and excreta in both vegetative and reproductive stage.

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

- Number of insect population (aphid, jassid, mealybug, whitefly) per plant after different treatments. Insect population data was collected early in the morning from three leaves (upper, middle and lower) of each plant and three plants from each plot. Then average value was recorded.
- Plant height at 20, 30, 40 and 50 days after transplant
- Number of leaves per plant at 20, 30, 40 and 50 days after transplant
- Number of branch per plant at 20, 30, 40 and 50 days after transplant
- Number of fruits per plant at each harvesting time
- Fruit length at different each harvesting time
- Fruit diameter at each harvesting time
- Fruit weight at different each harvesting time

Percent reduction of pest population over control

The percent reduction of pest population was calculated by using the following formula:

$$\% \text{ Reduction of population} = \frac{\text{No. in treated plot} - \text{No. in control plot}}{\text{No. in control plot}} \times 100$$

Percent increase of plant character over control

The percent reduction of pest population was calculated by using the following formula:

$$\% \text{ Increase of plant character} = \frac{\text{Value of treated plot} - \text{value of control plot}}{\text{Value of treated plot}} \times 100$$

3.10 Statistical analysis

The collected data on various parameters were statistically analyzed MSTATC package program. The mean for all the treatments were calculated and analyzed of variance for all the characters were performed by F-variance test. The significance of difference between the pairs of treatment mean was calculated by the Duncan Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

CHAPTER IV
RESULT AND DISCUSSION

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

4.1. Effect of various treatments on incidence of aphid on okra

The incidence of aphid on infested leaf of okra under different treatments has been shown in Table 1. The data indicate that the lowest number of aphid (9.41) was observed in oleander leaf extract treated plot followed by 9.73, 9.77 and 9.80 in bullock's heart leaf extract, ripcord and dhutra leaf extract treated plots respectively having no significant

difference among them. On the other hand, the highest number of aphid per infested leaf (12.45) was recorded as in untreated control plot which was statistically different from all other treatments (Table 1) and it was followed by tamarind fruit juice (10.29) and dholkolmi leaf extract (10.27) treated plots.

In case of the percent reduction of number of aphid over control, the highest reduction percent (24.23 %) was recorded in oleander leaf extract treated plot and followed by Bullock's heart leaf extract (21.79 %), ripcord 10EC (21.59 %) and dhutra (21.11 %) treated plot. On the other hand, the lowest percent of reduction over control (17.23 %) was recorded in tamarind fruit juice treated plot (Table 1) followed by dholkolmi leaf extract (17.53 %), dodder extract (19.43 %) and neem leaf extract (20.82 %) treated plot which was statistically similar with other treatments in terms of reduction of number of aphid over control.

Considering the percent reduction of number of aphid over control, the best effect (24.23 %) was observed in oleander leaf extract treated plot and the lowest reduction (17.23 %) was observed in tamarind fruit juice treated plot (Table 1).

This result agrees with findings of Kabir and Mia (1987) who observed that extracts of neem, garlic, tobacco straw wash and a mixture of soap with kerosene reduced mustard aphid infestation and increased yield. Jayakumar (2002) also reported that aphid and leafhopper incidence on okra was minimized by spraying neem oil + garlic extract, garlic extract + chilli extract, garlic extract + cow urine and NSKE + cow urine. Most of the findings showed that neem products have best result but in the present study oleander leaf extract showed the best performance against aphid and other botanicals including neem leaf extract also showed better result over control. This difference is logical because of

different ecological condition. In the experiment bullock's heart (*Annona reticulate)* also showed the best result which supported the findings Rosaiah (2001a) who reported that the leaf extract of *Annona reticulat* and Jatropa showed high effectiveness against the aphid of bhendi, petroleum ether extract of bullock's heart leave was tried against cotton aphid, *A. gossypii* at Tirupathi. These leaf extracts gave 88.81 to 90.06 per cent reduction in aphid population (Chitra *et al.,* 1997).

4.2. Effect of various treatments on incidence of jassid on okra

The population of jassid per infested leaf of okra under different treatments has been shown in Table 2. The data reveal that significant differences were observed among different treatments in terms of number of jassid per infested leaf. The lowest number of jassid per infested leaf (5.62) was recorded in dhutra leaf extract treated plot followed by 5.77 in oleander leaf extract, 5.93 in bullock's heart leaf extract and 6.08 in ripcord 10EC. On the other hand, the highest number of jassid per infested leaf was 8.21 recorded in untreated control plot which was statistically different from all other treatments (Table 2) and followed by neem leaf extract (6.47) treated plot. In table 2, 6.18 in dodder extract, 6.22 in Tamarind fruit juice and 6.35 in dholkolmi leaf extract treated plot were significantly lower than control plot but statistically similar with other treatments.

In case of the percent reduction of number of jassid over control, the highest percent reduction (35.42 %) was recorded in dhutra leaf extract treated plot and followed by 29.45 % in oleander leaf extract treated plot. On the other hand, the lowest percent of reduction over control (21.30 %) was recorded in neem leaf extract (Table 2) and it was followed by dholkolmi leaf extract (22.71 %). Ripcord 10EC (26.10 %), dodder extract

(23.88 %) and tamarind fruit juice (23.86 %) were significantly lower than dhutra leaf extract treated plot but statistically similar with other treatments in terms of percent reduction of jassid over control.

The above result indicates that dhutra leaf extract was the best plant materials against jassid attacking okra.

This result could not compare with other due to lack of appropriate reference. However, these results contradict with the findings of Jayakumar (2002), who reported that spraying neem oil + garlic extract minimized the incidence of aphid and jassid.

4.3. Effect of various treatments on incidence of mealybug on okra

The incidence of mealybug on okra under different treatments has been shown in Table 3. The data indicate that the lowest number of mealybug (0.3767) was recorded in ripcord 10EC treated plot followed by 0.4000 in dholkolmi leaf extract and 0.4033 in dhutra leaf extract treated plot having no significant difference among them. On the other hand, the highest number of mealybug per leaf 1.123 was recorded in untreated control plot (Table 3) followed by (0.6367) dodder extract treated plot having significant difference between them. However, no significant difference was found in bullock's heart leaf extract (0.5300), tamarind fruit juice (0.4461), oleander leaf extract (0.4467) and neem leaf extract (0.4233) treated plot.

In case of the percent reduction of number of mealybug over control, the highest percent reduction (66.35 %) was recorded in ripcord 10EC treated plot followed by dholkolmi leaf extract (63.91 %), dhutra leaf extract (63.29 %) and neem leaf extract (61.60 %) treated plot having significant difference between them. On the other hand, the lowest percent of reduction over control (44.39 %) was recorded in dodder extract treated plot

was statistically different from all other treatments (Table 3) followed by bullock's heart leaf extract (53.09 %) treated plot having significant difference between them. Oleander leaf extract (59.83 %) and tamarind fruit juice (60.04 %) treated plot were significantly lower than ripcord 10EC treated plot.

The above result indicates that ripcord 10EC was the best plant materials against mealybug attacking okra.

This result contradicts with Chandrashekharappa (1995) who reported that neem seed carnal extract was effective against mealybug. In this experiment beside Ripcord 10EC others plant materials showed better performance over control. In terms of percent reduction it also contradict to Gopali (1992) who reported that cotton seed oil at various concentrations gave the higher mortality (>95%) of *Pseudococcus hirsutus.* The difference in result may be due to different ecological condition and different application procedure.

Table 1. Incidence of aphid on infested leaf of okra under different treatments

Treatments	**Dose**	**Number of aphid per leaf**	**Percent reduction of number of aphid over control**
Ripcord 10EC	1 ml/L	9.77 cd	21.59 ab
Tamarind fruit juice	100 g/4L	10.29 b	17.23 d
Neem leaf extract	0.5 kg/4L	9.86 bcd	20.82 abcd

Bullock's heart leaf extract	0.5 kg/4L	9.73 cd	21.79 ab
Dodder extract	0.5 kg/4L	10.01 bc	19.43 bcd
Oleander leaf extract	0.5 kg/4L	9.41 d	24.32 a
Dhutra leaf extract	0.5 kg/4L	9.80 cd	21.11 abc
Dholkolmi leaf extract	0.5 kg/4L	10.27 b	17.53 cd
Control		12.45 a	--
LSD		**0.42**	**3.38**
CV (%)		**2.40 %**	**9.44 %**

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

Table 2. Incidence of jassid on infested leaf of okra under different treatments

Treatments	**Dose**	**Number of jassid per leaf**	**Percent reduction number of jassid over control**
Ripcord 10EC	1 ml/L	6.08 bc	26.10 bcd
Tamarind fruit juice	100 g/4L	6.22 bc	23.86 bcd
Neem leaf extract	0.5 kg/4L	6.47 b	21.30 d
Bullock's heart leaf extract	0.5 kg/4L	5.93 bc	27.53 bc
Dodder extract	0.5 kg/4L	6.18 bc	23.88 bcd
Oleander leaf extract	0.5 kg/4L	5.77 bc	29.45 b

Dhutra leaf extract	0.5 kg/4L	5.62 c	35.42 a
Dholkolmi leaf extract	0.5 kg/4L	6.35 bc	22.71 cd
Control		8.21 a	--
LSD		**0.69**	**5.22**
CV (%)		**6.40 %**	**11.34 %**

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

Table 3. Incidence of mealybug on infested leaf of okra under different treatments

Treatments	**Dose**	**Number of mealybug per leaf**	**Percent reduction number of mealybug over control**
Ripcord 10EC	1 ml/L	0.3767 c	66.35 a
Tamarind fruit juice	100 g/4L	0.4467 bc	60.04 b
Neem leaf extract	0.5 kg/4L	0.4233 bc	61.60 ab
Bullock's heart leaf extract	0.5 kg/4L	0.5300 bc	53.09 c
Dodder extract	0.5 kg/4L	0.6367 b	44.39 d
Oleander leaf extract	0.5 kg/4L	0.4467 bc	59.83 b
Dhutra leaf extract	0.5 kg/4L	0.4033 c	63.29 ab

Dholkolmi leaf extract	0.5 kg/4L	0.4000 c	63.91 ab
Control		1.123 a	--
LSD		**0.2048**	**4.62**
CV (%)		**22.35 %**	**4.47 %**

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

4.4. Effect of various treatments on incidence of whitefly on okra

The population of whitefly per infested leaf of okra was studied in relation to different treatments. Significant differences were observed among different treatments in terms of number of whitefly per infested leaf (Table 4). The data indicate that the lowest number of whitefly per infested leaf (4.07) was recorded in ripcord 10EC treated plot which was statistically insignificant with tamarind fruit juice (4.20), bullock's heart leaf extract (4.28), dodder extract (4.30) and dhutra leaf extract (4.35) treated plot. On the other hand, the highest number of whitefly per infested leaf (5.98) was recorded in untreated control plot which was statistically different from all other treatments (Table 4). In terms of number of whitefly per infested leaf no significant difference was observe in

dholkolmi leaf extract (4.82), neem leaf extract (4.73) and oleander leaf extract (4.60) treated plot.

In case of the percent reduction of number of whitefly over control, the highest percent reduction (31.31 %) was recorded in ripcord 10EC treated plot which was statistically insignificant with tamarind fruit juice (29.50 %), bullock's heart leaf extract (28.35 %) and dodder extract (27.77 %) treated plot respectively. On the other hand, The lowest percent of reduction over control (19.43 %) was recorded in dholkolmi leaf extract treated plot was statistically significant from ripcord 10EC, tamarind fruit juice, bullock's heart leaf extract, dodder extract, dhutra leaf extract treated plot (Table 4) and it was statistically non-significant to neem leaf extract (21.10 %) and oleander leaf extract (22.85 %) treated plot.

The above result indicates that ripcord 10EC was the best plant materials against whitefly attacking okra (Table 4).

However, these results contradict with the findings of Nandihalli *et al.* (1990) who reported two neem products, Neemax and Neemguard (3 ml/l) when combined with sub-lethal dose of monocrotophos (0.086%) gave effective control of nymphal and adult population of *B. tabaci* on cotton. It also contradict to the findings of Singh *et al.* (1999), spraying neem seed extract (5%) and neem oil (5%) resulted in considerable reduction of whitefly population on cotton and Ahmad *et al.* (1995) observed the ovipositional deterrence of neem oil against *B. tabaci* on cotton. In this experiment ripcord 10EC showed the best and neem leaf extract showed poor result in case of percent reduction which is contradict to findings of Jayaraj *et al.* (1986) reported that NSKE (5%) and neem oil (5%) caused 93.7 and 90.3 per cent mortality of nymphal stage of *B. tabaci* at

seven days after spraying, respectively. Similarly as reported by Natarajan *et al.* (1986), *B. tabaci* population was suppressed effectively by neem oil. The difference in result may be due to different ecological condition, different application procedure and combination of treatments.

Table 4. Incidence of whitefly on infested leaf of okra under different treatments

Treatments	**Dose**	**Number of whitefly per leaf**	**Percent reduction number of whitefly over control**
Ripcord 10EC	1 ml/L	4.07 d	31.31 a
Tamarind fruit juice	100 g/4L	4.20 d	29.50 ab
Neem leaf extract	0.5 kg/4L	4.73 b	21.10 c
Bullock's heart leaf extract	0.5 kg/4L	4.28 d	28.35 ab
Dodder extract	0.5 kg/4L	4.30 d	27.77 ab
Oleander leaf extract	0.5 kg/4L	4.60 bc	22.85 c
Dhutra leaf extract	0.5 kg/4L	4.35 cd	26.93 b
Dholkolmi leaf extract	0.5 kg/4L	4.82 b	19.43 c
Control		5.98 a	--

LSD		**0.28**	**3.61**
CV (%)		**3.56 %**	**7.97 %**

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

4.5. Effect of various treatments on plant height (cm) of okra against sucking pest infestation

A remarkable variation was observed in plant height in different treatments that was shown in Table 5. The data shown that the highest plant height (79.45 cm) was recorded in dholkolmi leaf extract followed by dodder extract (78.00 cm) and dhutra leaf extract (77.78 cm) treated plot respectively having no significant difference among them (table 5). On the other hand, the lowest plant height was recorder as (64.89 cm) in untreated control plot, which was statistically different from all other treatments (Table 5) followed by neem leaf extract(73.00 cm) and bullock's heart leaf extract having no significant difference between them.

In terms of percent increase of plant height over control, all treatments shown better result because all treatments reduce considerable amount of sucking pest infestation. The highest increase percent of plant height (18.21 %) was recorded in dholkolmi leaf extract treated plot followed by oleander leaf extract (16.79 %), dodder extract (16.58 %), dhutra leaf extract (16.18 %) and ripcord 10EC (16.14 %) treated plot having no significant difference between them. On the other hand, The lowest percent of increase over control (11.09 %) was recorded in neem leaf extract treated plot was statistically significant from all treatments and it was statistically non-significant to bullock's heart leaf extract (12.55 %) and oleander leaf extract (22.85 %) treated plot (Table 5).

The above result indicates that the best plant materials for increasing plant height against sucking pests was dholkolmi leaf extract (Table 5).

Table 5. Effect of different treatments on plant height of okra against sucking pest infestation

Treatments	**Dose**	**Plant height (cm)**	**Percent increase of plant height over control**
Ripcord 10EC	1 ml/L	77.44 bc	16.14 ab
Tamarind fruit juice	100 g/4L	76.00 c	14.68 b
Neem leaf extract	0.5 kg/4L	73.00 d	11.09 c
Bullock's heart leaf extract	0.5 kg/4L	74.23 d	12.55 c
Dodder extract	0.5 kg/4L	77.78 abc	16.58 ab
Oleander leaf extract	0.5 kg/4L	78.00 ab	16.79 a
Dhutra leaf extract	0.5 kg/4L	77.48 bc	16.18 ab
Dholkolmi leaf extract	0.5 kg/4L	79.45 a	18.21 a

Control		64.89 e	--
LSD		**1.74**	**1.92**
CV (%)		**1.33 %**	**7.19 %**

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

4.6. Effect of different treatments on number leaves/plant of okra against sucking pest infestation

The results on the effect of different treatments on leaf infestation caused by the sucking pests have been studied. A remarkable variation was observed in number of leaf per plant in different treatments showed in Table 6. The data shown that the height number of leaf per plant (50.56) was recorded in dholkolmi leaf extract treated plot, which was statistically significant from all treatments followed by ripcord 10EC (47.89), dhutra leaf extract (47.78) and bullock's heart leaf (47.60), respectively having no significant different among them (table 6). On the other hand, the lowest number of leaf per plant was recorder as (40.55) in untreated control plot, which was statistically different from all other treatments (Table 6) followed by neem leaf extract (43.41), tamarind fruit juice (45.59) and oleander leaf extract (46.45) treated plot having significant difference among them.

In terms of percent increase of number of leaf per plant over control the highest percent increase of number of leaf per plant (19.18 %) was recorded in dholkolmi leaf extract treated plot, which was statistically significant from all treatments followed by ripcord 10EC (15.40 %), dhutra leaf extract (15.21 %) and bullock's heart leaf extract (14.75 %) having no significant difference among them. On the other hand, the lowest percent of increase over control (6.67 %) was recorded in neem leaf extract treated plot which was statistically significant from all treatments followed by oleander leaf extract (12.06 %), tamarind fruit juice (12.45 %) and dodder extract (12.87 %) treated plots having no significant difference between them (Table 6). For percent increase of plant height over control, dholkolmi leaf extract was the best plant materials and neem leaf extract shown the least performance (Table 6).

The result can not be compare with others due to lack of reference.

Table 6. Effect of different treatments on leaf per plant of okra against sucking pest infestation

Treatments	**Dose**	**Leaf per plant**	**Percent increase of leaf per plant over control**
Ripcord 10EC	1 ml/L	47.89 b	15.40 b
Tamarind fruit juice	100 g/4L	45.59 e	12.45 d
Neem leaf extract	0.5 kg/4L	43.41 f	6.67 e
Bullock's heart leaf extract	0.5 kg/4L	47.60 bcd	14.75 bc
Dodder extract	0.5 kg/4L	46.56 cde	12.78 cd
Oleander leaf extract	0.5 kg/4L	46.45 de	12.06 d
Dhutra leaf extract	0.5 kg/4L	47.78 bc	15.21 b
Dholkolmi leaf extract	0.5 kg/4L	50.56 a	19.81 a

Control		40.55 g	--
LSD		**1.16**	**2.06**
CV (%)		**1.46 %**	**8.62 %**

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

4.7. Effect of different treatments on number branch/plant of okra against sucking pest infestation

The number of branch per plant at different stage of okra plant was significantly influenced by the application of different treatments. The results revealed that the height number of branch per plant (4.17) was recorded in dholkolmi leaf extract treated plot which was statistically significant from all treatments followed by ripcord 10EC (3.74) having significant difference between them (table 7). However no significant difference was found in tamarind fruit juice (3.35), oleander leaf extract (3.35) and dodder extract (3.34) treated plot. On the other hand, the lowest number of branch per plant was recorder as (2.55) in untreated control plot, which was statistically different from all other

treatments (Table 7) followed by bullock's heart leaf extract (3.10) having significant difference between them.

In terms of percent increase of number of branch per plant over control, the highest percent increase of number of branch per plant (39.17 %) was recorded in dholkolmi leaf extract treated plot which was statistically significant from all treatments followed by ripcord 10EC (31.91 %) having significant difference between them. However no significant difference was found in tamarind fruit juice (23.96 %), oleander leaf extract (23.96 %) and dodder extract (23.52 %) treated plot.. On the other hand, the lowest percent of increase over control (17.66 %) was recorded in Bullock's heart leaf extract treated plot which was statistically non-significant to dhutra leaf extract (17.87) and significantly lower from all treatments (Table 7).

Considering the percent increase of number of branch per plant over control, dholkolmi leaf extract shown the best result among the all plant materials and bullock's heart leaf extract shown the least performance (Table 7).

The result can not be compare with others due to lack of reference.

Table 7. Effect of different treatments on branch per plant of okra against sucking pest infestation

Treatments	**Dose**	**Branch per plant**	**Percent increase of branch per plant over control**
Ripcord 10EC	1 ml/L	3.74 b	31.91 b
Tamarind fruit juice	100 g/4L	3.35 c	23.96 c
Neem leaf extract	0.5 kg/4L	3.20 d	20.08 d
Bullock's heart leaf extract	0.5 kg/4L	3.10 d	17.66 e
Dodder extract	0.5 kg/4L	3.34 c	23.52 c
Oleander leaf extract	0.5 kg/4L	3.35 c	23.96 c

Dhutra leaf extract	0.5 kg/4L	3.11 d	17.87 e
Dholkolmi leaf extract	0.5 kg/4L	4.17 a	39.17 a
Control		2.55 e	--
LSD		**0.12**	**1.95**
CV (%)		**2.20 %**	**4.50 %**

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

4.8. Effect of different treatments on number of fruit per plant of okra against sucking pest infestation

The number of fruit per plant at fruiting stage of okra plant was significantly influenced by the application of different treatments. The results revealed that the height number of fruit per plant (9.83) was recorded in dhutra leaf extract treated plot, which was statistically significant from all treatments followed by bullock's heart leaf extract (8.40) and oleander leaf extract (7.83) treated plot having significant different with dhutra leaf and other treatments (table 8). On the other hand, the lowest number of fruit per plant was recorder as (5.83) in untreated control plot, which was statistically different from all other

treatments (Table 8). However no significant difference was found in neem leaf extract (6.46) and dholkolmi leaf extract (6.66) treated plot.

In terms of percent increase of number of fruit per plant over control, the highest increase percent of number of fruit per plant (40.85 %) was recorded in dhutra leaf extract treated plot which was statistically significant from all treatments followed by bullock's heart leaf extract (30.70 %) having significant difference between them. On the other hand, the lowest percent of increase over control (9.73 %) was recorded in neem leaf extract treated plot which was statistically non-significant to all treatments followed by dholkolmi leaf extract (12.57 %) having no significant difference between them (Table 8).

Above results indicate that dhutra leaf extract was the best plant materials for increasing number of fruit against sucking insect pests attacking okra.

The result can not be compare with others due to lack of reference.

Table 8. Effect of different treatments on fruit per plant of okra against sucking pest infestation

Treatments	**Dose**	**Fruit per plant**	**Percent increase of fruit per plant over control**
Ripcord 10EC	1 ml/L	6.83 de	14.67 de
Tamarind fruit juice	100 g/4L	7.00 d	16.58 d
Neem leaf extract	0.5 kg/4L	6.46 f	9.73 f
Bullock's heart leaf extract	0.5 kg/4L	8.40 b	30.70 b
Dodder extract	0.5 kg/4L	7.08 d	17.60 d
Oleander leaf extract	0.5 kg/4L	7.83 c	25.29 c
Dhutra leaf extract	0.5 kg/4L	9.83 a	40.85 a

Dholkolmi leaf extract	0.5 kg/4L	6.66 ef	12.57 ef
Control		5.83 g	--
LSD		**0.28**	**3.33**
CV (%)		**2.24 %**	**9.08 %**

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

4.9. Effect of different treatments on fruit length (cm) of okra against sucking pest infestation

The effect of different treatments on okra fruit length against sucking insect pests infestation has been presented in (table 9). The result reveals that the highest fruit length (15.06 cm) was observed in tamarind fruit juice treated plots followed by (14.80 cm) and (14.58 cm) in neem leaf extract and dholkolmi leaf extract, respectively with no significant difference among them. Next to them, ripcord 10EC (14.53 cm), oleander leaf extract (14.25 cm), bullock's heart leaf extract (14.19 cm), dhutra leaf extract (14.17 cm), and dodder extract (14.08 cm) having no significant difference between them. The lowest fruit length of okra (12.46 cm) was recorded from control plots, which was significantly

lower than all other treated plots. In terms of increase of fruit length over control, tamarind fruit juice treated plots showed the best performance by increasing (17.18 %) fruit length followed by neem leaf extract and dholkolmi leaf extract (15.79 and 14.49 % respectively). On the other hand, dodder extract (11.45 %) and dhutra leaf extract (12.01 %) showed the least effectiveness in increasing length of fruit (table 9).

The result can not be compare with others due to lack of reference.

Table 9. Effect of different treatments on fruit length (cm) per plant of okra against sucking pest infestation

Treatments	**Dose**	**Fruit length (c.m.) per plant**	**Percent increase of fruit length over control**
Ripcord 10EC	1 ml/L	14.53 bc	14.22 ab
Tamarind fruit juice	100 g/4L	15.06 a	17.18 a
Neem leaf extract	0.5 kg/4L	14.80 ab	15.79 ab
Bullock's heart leaf extract	0.5 kg/4L	14.19 c	14.18 ab
Dodder extract	0.5 kg/4L	14.08 c	11.45 b
Oleander leaf extract	0.5 kg/4L	14.25 c	12.52 ab
Dhutra leaf extract	0.5 kg/4L	14.17 c	12.01 b
Dholkolmi leaf extract	0.5 kg/4L	14.58 abc	14.49 ab
Control		12.46 d	--
LSD		**0.47**	**4.02**
CV (%)		**1.92 %**	**17.19 %**

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

4.10. Effect of different treatments on fruit diameter (cm) of okra against sucking pest infestation

The effect of different treatments on okra fruit diameter against sucking pest infestation has been presented in (table 10). The data shown that the highest fruit diameter (6.60 cm) was observed in neem leaf extract treated plots followed by (6.47 cm) and (6.38 cm) in ripcord 10EC and bullock's heart leaf extract respectively with no significant difference among them. Next to them, tamarind fruit juice (6.13 cm), oleander leaf extract (6.06 cm), dodder extract (6.05cm) having no significant difference between them. The lowest fruit diameter of okra (4.61 cm) was recorded from control plots, which was significantly lower than all other treated plots and followed by dholkolmi leaf extract (5.82) and dhutra

leaf extract (5.63). In terms of increase of fruit diameter over control, neem leaf extract treated plots showed the best performance by increasing (30.09 %) fruit length followed by ripcord 10EC and bullock's heart leaf extract (28.73 % and 27.77 % respectively) having no significant difference between them. On the other hand, dhutra leaf extract (18.07 %) showed the least effectiveness in increasing diameter of fruit (table 10). Dholkolmi leaf extract (25.11 %), Tamarind fruit juice (24.66 %), Oleander leaf extract (23.89 %) and Dodder extract (23.74%) was non significant to each other but significant to highest and lowest value.

The result can not be compare with others due to lack of reference.

Table 10. Effect of different treatments on fruit diameter (cm) per plant of okra against sucking pest infestation

Treatments	**Dose**	**Fruit diameter (cm)**	**Percent increase of fruit diameter over control**
Ripcord 10EC	1 ml/L	6.47 ab	28.73 a
Tamarind fruit juice	100 g/4L	6.13 bcd	24.66 b
Neem leaf extract	0.5 kg/4L	6.60 a	30.09 a
Bullock's heart leaf extract	0.5 kg/4L	6.38 abc	27.77 a
Dodder extract	0.5 kg/4L	6.05 cd	23.74 b

Oleander leaf extract	0.5 kg/4L	6.06 cd	23.89 b
Dhutra leaf extract	0.5 kg/4L	5.63 e	18.07 c
Dholkolmi leaf extract	0.5 kg/4L	5.82 de	25.11 b
Control		4.61 f	--
LSD		**0.37**	**2.36**
CV (%)		**3.60 %**	**5.36 %**

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

4.11. Effect of various plant materials on fruit weight (g) of okra against sucking pest infestation

The effect of different treatments on okra fruit weight against sucking pest infestation has been presented in (table 11). The data raveled that the highest fruit weight (29.33 g) was observed in tamarind fruit juice treated plots followed by (28.92 g), (28.76 g) and (28.25 g) in oleander leaf extract, dholkolmi leaf extract and ripcord 10EC, respectively with no significant difference among them. Next to them, dodder extract (27.58 g), neem leaf extract (27.41), dhutra leaf extract (27.32 g) having no significant difference between them. The lowest fruit weight of okra (20.95) was recorded from control plots, which was

significantly lower than all other treated plots followed bullock's heart leaf (27.24 g) and dhutra leaf extract (27.32 g) having no significant difference between them. In terms of percent increase of fruit weight over control, tamarind fruit juice treated plots showed the best performance by increasing (28.58 %) fruit weight followed by oleander leaf extract, dholkolmi leaf extract and ripcord 10EC (27.48 %, 27.22 % and 25.60 % respectively) having no significant difference between them. On the other hand, bullock's heart leaf extract (23.20 %) showed the least effectiveness in increasing weight of fruit (table 11) was significant to dhutra leaf extract (23.29 %).

The result can not be compare with others due to lack of reference.

Table 11. Effect of different treatments on fruit weight (g) per plant of okra against sucking pest infestation

Treatments	**Dose**	**Fruit weight (g)**	**Percent increase of fruit weight over control**
Ripcord 10EC	1 ml/L	28.25 abcd	25.60 abcd
Tamarind fruit juice	100 g/4L	29.33 a	28.58 a
Neem leaf extract	0.5 kg/4L	27.41 cd	23.79 cd
Bullock's heart leaf extract	0.5 kg/4L	27.24 d	23.20 d
Dodder extract	0.5 kg/4L	27.58 bcd	24.18 bcd
Oleander leaf extract	0.5 kg/4L	28.92 ab	27.48 ab

Dhutra leaf extract	0.5 kg/4L	27.32 d	23.29 d
Dholkolmi leaf extract	0.5 kg/4L	28.76 abc	27.22 abc
Control		20.95 e	--
LSD		**1.29**	**3.35**
CV (%)		**2.74 %**	**7.54 %**

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

4.12. Effect of various plant materials on yield (g) per plot of okra against sucking pest infestation

The yield per plot of okra plant was significantly influenced by the application of different treatments. The results revealed that the height yield per plot (577.7 g) was recorded in bullock's heart leaf treated plot followed by dodder extract (505.6 g), tamarind fruit juice (504.2 g), dhutra leaf extract (502.8 g) and dholkolmi leaf extract (502.0 g) treated plot (table 12) having no significant difference between them. However no significant difference was found in oleander leaf extract (473.6 g), ripcord 10EC (445.8 g) and neem leaf extract (440.0 g) treated plot. On the other hand, the lowest yield

per plot was recorder as (410.0 g) in untreated control plot, which was statistically different from all other treatments (Table 12).

In terms of percent increase of yield per plot over control, all treatments increase considerable amount of yield. The highest increase percent of yield per plot (40.35 %) was recorded in bullock's heart leaf treated plot, which was statistically significant from all treatments. However no significant difference was found in dodder extract (32.09 %), tamarind fruit juice (31.76 %), dhutra leaf extract (31.61 %) and dholkolmi leaf extract (30.92 %) treated plot. On the other hand, the lowest percent of increase over control (24.34 %) was recorded in ripcord 10EC treated plot which was statistically non-significant to neem leaf extract (24.98 %), oleander leaf extract (28.37 %) and significantly lower from all treatments (Table 12).

Considering the percent increase of yield over control, among the all treatments bullock's heart leaf extract was the best plant materials (Table 12).

The result can not be compare with others due to lack of reference.

Table 12. Effect of different treatments on yield per plot (g) of okra against sucking pest infestation

Treatments	**Dose**	**Yield per plot (g)**	**Percent increase of yield per plot over control**
Ripcord 10EC	1 ml/L	445.8 bc	24.34 d
Tamarind fruit juice	100 g/4L	504.2 ab	31.76 b
Neem leaf extract	0.5 kg/4L	440.0 bc	24.98 cd
Bullock's heart leaf extract	0.5 kg/4L	577.7 a	40.35 a
Dodder extract	0.5 kg/4L	505.6 ab	32.09 b
Oleander leaf extract	0.5 kg/4L	473.6 bc	28.37 bcd

Dhutra leaf extract	0.5 kg/4L	502.8 ab	31.61 b
Dholkolmi leaf extract	0.5 kg/4L	502.0 ab	30.92 bc
Control		410.0 c	--
LSD		**77.48**	**5.86**
CV (%)		**9.24 %**	**10.96 %**

In a column, means followed by the same letter(s) are not significantly different at 5% level of probability by Duncan's Multiple Range Test (DMRT).

CHAPTER V

SUMMARY AND CONCLUSION

The present experiment was conducted at the field laboratory of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period from April to August, 2011 to find out the efficacy of different plant materials against sucking pest of okra. The treatments are comprised with seven botanical product, one synthetic chemical insecticides and one untreated control and these are T_1 = Ripcord 10EC @ 1ml/L of water at 7 days interval, T_2 = Tamarind fruit juice @ 100g/4L of water at 7 days interval,

T_3 = Neem leaf extract @ 0.5kg/4L of water at 7 days interval, T_4 = Bullock's heart leaf extract @ 0.5kg/4L of water at 7 days interval, T_5 = Dodder extract @ 0.5kg/4L of water at 7 days interval, T_6 = Oleander leaf extract @ 0.5kg/4L of water at 7 days interval, T_7 = Dhutra leaf extract @ 0.5kg/4L of water at 7 days interval, T_8 = Dholkolmi leaf extract @ 0.5kg/4L of water at 7 days interval, T_9 = Control. The experiment was laid out in single factor Randomized Complete Block Design (RCBD) with three replications.

The lowest number of aphid per infested leaf was recorded in oleander leaf extract (9.41) treated plot followed by bullock's heart leaf extract (9.73), ripcord 10EC (9.77) and dhutra leaf extract (9.80) treated plot having no significant difference among them. The highest number of aphid per leaf (12.45) was recorded in control plot. Considering the percent reduction of number of aphid over control, oleander leaf extract gave the best result by reducing (24.23 %) aphid over control followed by bullock's heart leaf extract (21.79 %) and ripcord 10EC (21.59 %) and dhutra leaf extract (21.11 %) treated plot having no significant difference among them and tamarind fruit juice treated plot gave the lowest result by reducing (17.23 %).

The lowest number of jassid per infested leaf was recorded in dhutra leaf extract (5.62) treated plot followed by oleander leaf extract (5.77), bullock's heart leaf extract (5.93) and ripcord 10EC (6.08) treated plot having no significant difference among them. The highest number of jassid per leaf (8.21) was recorded in untreated control which was statistically different from all other treatments. In case of the percent reduction of number of jassid over control, dhutra leaf extract gave the best result by reducing (35.42 %) jassid over control and neem leaf extract treated plot shown least performance by reducing (21.30 %).

The lowest number of mealybug per infested leaf was recorded in ripcord 10EC (0.3767) treated plot and followed by dholkolmi leaf extract (0.4000), dhutra leaf extract (0.4033) treated plot having no significant difference among them. The highest number of mealybug per leaf was recorded in control (1.123). Considering the percent reduction of number of mealybug over control, ripcord 10EC shown the best performance by reducing (66.35 %) and the lowest percent reduction (44.39 %) was observed in dodder extract treated plot.

The lowest number of whitefly per infested leaf was recorded in ripcord 10EC (4.07) treated plot and the highest number of whitefly per leaf (5.98) was recorded in untreated control. In terms of percent reduction over control, ripcord 10EC treated plot gave the best result by reducing (31.31 %) whitefly over control and the lowest percent reduction (19.43 %) was recorded in dholkolmi leaf extract treated plot.

The highest plant height was recorded in dholkolmi leaf extract (79.45 cm) treated plot and the lowest plant height was recorder as (64.89 cm) in untreated control plot. In terms of percent increase of plant height over control, the highest percent increase (18.21 %) was observed in dholkolmi leaf extract and the lowest percent increase (11.09 %) was recorded in neem leaf extract treated plot.

The height number of leaf per plant was recorded in dholkolmi leaf extract (50.56) treated plot, which was statistically significant from all treatments and the lowest number of leaf per plant was recorder as (40.55) in untreated control plot, which was statistically different from all other treatments. Considering the percent increase of leaf per plant over control, dholkolmi leaf extract gave the best result by increasing (19.81 %) and the lowest percent increase (6.67 %) was recorded in neem leaf extract treated plot.

The height number of branch per plant was recorded in dholkolmi leaf extract (4.17) treated plot, which was statistically significant from all treatments and the lowest number of branch per plant was recorder as (2.55) in untreated control plot. Considering the percent increase of branch per plant over control, dholkolmi leaf extract shown the best performance by increasing (39.17 %) and bullock's heart leaf extract shown the least performance by increasing the lowest percent increase (17.66 %).

The highest number of fruit per plant was recorded in dhutra leaf extract (9.83) treated plot and the lowest number of fruit per plant was recorder as (5.83) in untreated control plot. Considering the percent increase of fruit per plant over control, the highest percent increase was observed in dhutra leaf extract (40.85 %) and the lowest percent increase shown in neem leaf extract (9.73 %) treated plot.

The highest fruit length was observed in tamarind fruit juice (15.06 cm) treated plots and the lowest fruit length of okra (12.46 cm) was recorded from control plots. In percent increase of fruit length per plant over control, tamarind fruit juice treated plots showed the best performance by increasing (17.18 %) fruit length. On the other hand, dodder extract (11.45 %) and dhutra leaf extract (12.01 %) showed the least effectiveness in terms of increasing length of fruit.

The highest fruit diameter was observed in neem leaf extract (6.60 cm) treated plots and the lowest fruit diameter of okra (4.61 cm) was recorded from control plots. In percent increase of fruit diameter per plant over control, the best performance by neem leaf extract by increasing (30.09 %) fruit length and dhutra leaf extract (18.07 %) showed the least effectiveness in increasing diameter of fruit.

The highest fruit weight was observed in tamarind fruit juice (29.33 g) treated plot and the lowest fruit weight of okra (20.95) was recorded from control plots, which was significantly lower than all other treated plots. Considering the percent increase of fruit weight per plant over control, tamarind fruit juice treated plots showed the best performance by increasing (28.58 %) fruit weight and bullock's heart leaf extract (23.20 %) showed the least effectiveness in increasing weight of fruit.

The highest yield per plot was recorded in bullock's heart leaf extract (577.7 g) treated plot, which was followed by dodder extract (505.6 g), tamarind fruit juice (504.2 g), dhutra leaf extract (502.8 g) and dholkolmi leaf extract (502.0 g) treated plot having no significant difference among them and the lowest yield per plot was recorder as (410.0 g) in untreated control plot. Considering the percent increase of yield per plot over control, bullock's heart leaf extract gave the best result by increasing (40.35 %) over control and the lowest percent of increase over control (24.34 %) was recorded in ripcord 10EC treated plot.

CONCLUSION

Based on the above findings of the study it can be concluded that oleander leaf extract was the best plant material for the management of aphid population. Dhutra leaf extract

showed the best performance against jassid population. Whitefly and mealybug population were minimized by using ripcord 10EC. In case of plant yield attributing character, plant height, leaf per plant, branch per can be increased by using dholkolmi leaf extract. Dhutra leaf extract was the best plant materials for increasing number of fruit per plant. Tamarind fruit juice can be used for maximization of fruit weight and fruit length. For maximum fruit diameter per plant neem leaf extract showed the best result. Finally bullock's heart leaf extract showed the best result in terms of increasing yield per plot among the all plant materials.

RECOMMENDATIONS

Considering the findings of the study the following recommendations can be drawn:

1. Oleander and dhutra leaf extract may be used for the management of sucking insect pests of okra.
2. Further intensive studies based on different doses of different plant materials should be done.
3. More chemicals and botanicals should be included in further elaborative research for controlling sucking insect pest okra.

CHAPTER VI

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CHAPTER VII

APPENDICES

Appendix I. Physiological properties of the initial soil

Characteristics	Value	Critical value
Partical size analysis		
% sand	26	-

% silt	45	-
% clay	29	-
Textural class	Silty clay	-
Ph	5.6	Acidic
Organic carbon (%)	0.45	-
Organic matter (%)	0.78	-
Total N (%)	0.03	0.12
Available P (ppm)	20.00	27.12
Exchangeable K (me 100^{-1} g soil)	0.10	0.12
Available S (ppm)	45	-

Appendix II: Monthly record of air temperature, rainfall and relative humidity of the experimental site during the period from April 2011 to August, 2011

Date/Week	Temperature		Relative humidity (%)	Rainfall (mm) (Total)
	Maximum	Minimum		
April	33.5	23.2	64	123
May	33.4	24.6	76	235
June	32.6	26.3	80	314
July	32.3	26.7	79	356
August	31.1	26.5	82	409
September	32.4	26.4	77	207

Source: Bangladesh Meteorological Department (Climate and Weather Division), Agargoan, Dhaka- 1207