EFFECT OF NEEM AND SOME OTHER PLANT EXTRACTS ON YELLOW MITE OF JUTE, *POLYPHAGOTARSONEMUS LATUS* (BANKS)

BY

MD. DELWAR HOSSIN

REGISTRATION NO. 00323

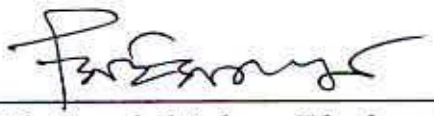
A Thesis
Submitted to the Faculty of Agriculture
Sher-e-Bangla Agricultural University, Dhaka,
in partial fulfilment of the requirements
for the degree of

MASTER OF SCIENCE
IN
ENTOMOLOGY

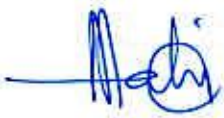
SEMESTER: JULY-DECEMBER, 2008

Approved by:

(Dr. Md. Abdul Latif)
Associate Professor
Dept. of Entomology
Supervisor



(Dr. Md. Serajul Islam Bhuiyan)
Professor
Dept. of Entomology
Co-Supervisor



(Dr. Md. Abdul Latif)
Chairman
Examination Committee

Dedicated to
My
Beloved Parents

DEPARTMENT OF ENTOMOLOGY

Sher-e-Bangla Agricultural University

Sher-e-Bangla Nagar, Dhaka-1207

CERTIFICATE

This is to certify that the thesis entitled, **"EFFECT OF NEEM AND SOME OTHER PLANT EXTRACTS ON YELLOW MITE OF JUTE, *POLYPHAGOTARSONEMUS LATUS* (BANKS)"** submitted to the Department of Entomology, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN ENTOMOLOGY** embodies the result of a piece of bona fide research work carried out by **MD. DELWAR HOSSIN,** Registration No. 00323 under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated:

Dhaka, Bangladesh

(Dr. Md. Abdul Latif)
Associate Professor
Dept. of Entomology
SAU, Dhaka
Supervisor

ACKNOWLEDGEMENT

"Absolute trust and faith in the Almighty Allah will be the basis of all actions". First of all the author would like to express his deepest sense of gratefulness to Almighty Allah, who enables him to complete his research work and submit this thesis for degree of Master of Science (MS) in Entomology.

The author expresses his sincerest gratitude, heartfelt respect immense indebtedness and profound respect to his reverend Supervisor Dr. Md. Abdul Latif, Associate Professor, Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka for his scholastic guidance, affectionate feelings, invaluable suggestions, continuous encouragement and blessing in conducting the research work and constructive criticism in preparing the manuscript of the thesis like a pathfinder pole-star.

The author is honored to express his respect to his profound teacher and Co-supervisor Professor Dr. Md. Serajul Islam Bhuiyan Department of Entomology, Sher-e-Bangla Agricultural University, Dhaka for his encouragement, co-operation, kind comments and invaluable suggestion in improving the manuscript and in preparation of this thesis.

The author humbly desires to acknowledge his heartfelt gratitude to Md. Najrul Islam, SSO, Entomology Division, Bangladesh Jute search Institute BJRI, Dhaka for their constructive suggestions, criticism, valuable advice and constant encouragement during the course of study.

Thanks to all other respectable teacher of the Department of Entomology Sher-e-Bangla Agricultural University, Dhaka for their valuable advice, instruction, guidance and constant inspiration to conduct the research work and successful completion of the thesis.

The author express his grateful thanks are due to Abu Syed, Husain, Nazmul, Rafiq, for providing knowledge and good suggestion about my thesis as well as Enamul for his data analysis and Jewel for his computer composing of the thesis with utmost care and sincerity.

Finally, the author sincerely expresses his heartiest gratitude and owes every thing to his beloved father Md. Abu Hanifa, mother Bilkis Begum, brother Anower and all my family members, who were always anxious for higher education and their sacrifice, patience, constant encouragement and blessings throughout the entire period of the higher study in his life.

December, 2008 **The Author**

EFFECT OF NEEM AND SOME OTHER PLANT EXTRACTS ON YELLOW MITE OF JUTE, *POLYPHAGOTARSONEMUS LATUS* (BANKS)

BY

MD. DELWAR HOSSIN

THESIS ABSTRACT

The experiment was conducted to evaluate the effectiveness of neem and some other plant extracts against yellow mite of jute, *Polyphagotarsonemus latus* (Banks) at the Jute Agriculture Experimental Station (JAES), Manikgonj, Bangladesh. Green and dry neem leaf, turmeric powder, garlic, mehogoni seed, green allmonda leaf and neem oil were tested against the pest in this experiment. Among the different plant materials neem oil showed the best performance in reducing yellow mite population and increased number of leaves plant^{-1}, stem height, base diameter and yield of jute. Mehogoni seed extract also showed the similar efficacy against the yellow mite of jute. Green and dry neem leaf extracts, turmeric powder and garlic paste also significantly reduced the mite infestation but their efficacy was unsatisfactory. Neem oil and mehogoni seed extract might be used for the control of yellow mite but it needs to explore the toxic compound of mehogoni seed.

CONTENTS

CONTENTS (Contd.)

CONTENTS (Contd.)

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
BJRI	=	Bangladesh Jute Research Institute
DAS	=	Days After Sowing
SAU	=	Sher-e-Bangla Agricultural University
%	=	Percentages
CV%	=	Percentages of Co-efficient of Variance
CD	=	Critical Difference
Hr	=	Hour (s)
ppm	=	Parts Per million
^{0}C	=	Degree centrigade
DMRT	=	Duncan's Multiple Range Test
NS	=	Non Significant
Cm	=	Centi-meter
et.al	=	and others
RTV	=	Rice Tungro Virus
NO	=	Neem Oil
RH	=	Rice Hispa
etc.	=	Etcetera

Chapter I

Introduction

CHAPTER I

INTRODUCTION

Jute *(Corchorus capsularis* L. and *Corchorus olitorius* L.*)* is the most important cash crop in Bangladesh. Jute fibre is extensively used all over the world for its versatility, durability and fineness. It is also for the production of newsprint paper, carpet, hessians, gunny bags, ropes, juton etc. Now a day, jute sticks are used in making partex. Nevertheless, our agricultural community is dependent to a large extent on jute and jute products.

Jute is mostly grown in the Indo-Bangladesh region and in some countries of the South East Asia. It ranks second only to cotton among all the natural fibers in production. With respect to production, Bangladesh ranks second among the jute growing countries of the world. The land and climatic conditions of Bangladesh are congenial to the production of good quality of jute. Two species, *C. capsularis* L. and *C. olitorius* L. are cultivated for fibre. In Bangladesh, about 408089.06 hectares of land were under jute cultivation for the year of 2006 and total yield was 4375580 bales (BBS 2006).

Jute is liable to damage by about 40 species of insects and mites at all stages of the growth from seedling to harvest (Kabir 1975). Among them yellow mite *Polyphagotarsonemus latus* (Banks) is one of the most common and a serious pest of jute (*Corchorus spp.*). In Bangladesh, jute crop is frequently attacked by yellow mite, and as a result of its infestation, the plant is very much affected. About 38% loss in fibre yield by yellow mite was estimated under field condition (Kabir 1975). The yellow mite of jute commonly known as yellow tea

mite is a very destructive pest and causes damage to both fibre and seed crops. Its damage is better known as 'Telenga' or 'Telchita' disease in Bangladesh. It appears on jute at the end of April when the plants are about one foot tall. The damage of the terminal shoots is seldom visible before June. Initial mite attacks are usually seen near dwellings and shady places of leaves. It seems that the mite is carried from plot to plot of the jute planting by wind. The adult mites also play an important role in the dispersal and distribution by carrying female nymphs to younger leaves. The nymphs are held above the male's body by means of a sucker like organ near the tip of posterior terminus. Both yield and quality of fibre are reduced due to attack of this pest.

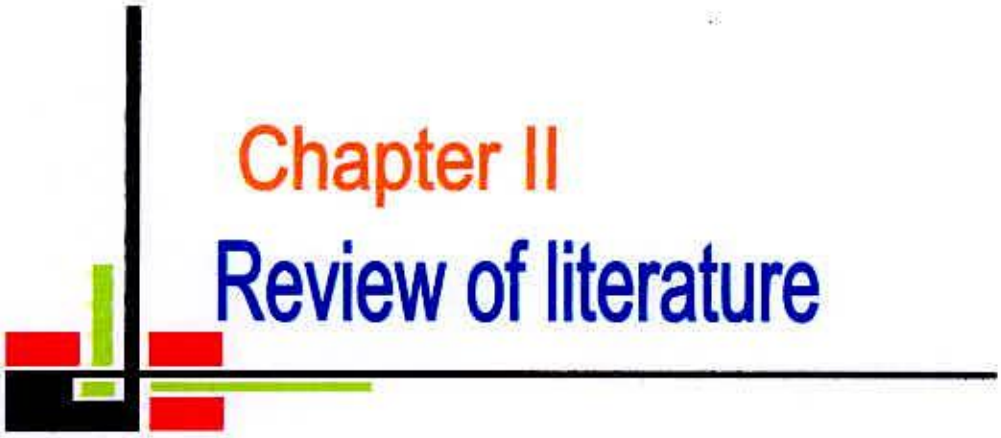
Management of mite is based mainly on its chemical control. But the use of chemical acaricides may cause pest resurgence and their residual effect resulting in environmental, social and other problems. To minimize the use of these in mite control programmes, alternative substances are now strongly felt in many developed countries. The biologically active natural plant products can play a significant role in this regard. These products may help to keep the drawbacks of conventional methods within bounds. Plant products are environmentally safe, less hazardous, less expensive, biodegradable and readily available.

Many plants exhibiting pesticidal properties have been known since time immemorial. Among the botanical insecticides pyrethroids, rotenoids, nicotinoids and unsaturated isobutyl amides have been studied extensively and information relating to structure-activity relationships of these compounds is now well documented Crosby (1971). Over the past 50 years, more than 2000

plant species belonging to different families and genera have been reported to contain toxic compounds and a multitude of chemical compounds possessing diverse and novel types of structural patterns being isolated from various plants (Adityachaudhury *et al.* 1985). In recent years the derivatives of neem (*Azadirachta indica*) have come under close scrutiny of scientist around the world as the most promising source of natural insecticides (Saxena 1989). However, reports on the use of neem oil in jute pest management are scanty in Bangladesh. Neem has been reported to have antifeedant, repellent, toxicant, insect growth inhibitors, chemosterillant and anti oviposition activity (Gujar 1997).

In Bangladesh, few studies have been conducted on the efficacy of neem and other plant extracts against yellow mite attack. Therefore, an attempt has been made to provide information for using plant materials as input for the control of yellow mite. Thus, the study was undertaken to fulfill the following objectives:

- To evaluate the efficacy of different plant materials against yellow mite of jute,
- To determine the effect of different plant materials on growth and yield of jute against yellow mite attack,
- To find out the promising plant materials for the control of jute yellow mite.



Chapter II

Review of literature

CHEPTAR II

REVIEW OF LITERATURE

Works with the neem and other plant extracts for the control of jute mites in Bangladesh and elsewhere are very scanty. Literatures cited below reveal some information about the use of different plant extract in Bangladesh and other countries against important insects and mites.

2.1 Effect of different plant extracts for controlling mite pest

Banu (2007) conducted an experiment to compare some non-chemical approaches to control jute yellow mite and jute hairy caterpillar in greenhouse and field condition during 2004-2006. In greenhouse condition, double spray of green neem leaf extract @ 1:20 and dry neem leaf @ 1:50 was found to be effective and gave 74.63% and 70.83% mortality 72 h after treatment on potted plants. However, in field condition, double spray of green neem leaf extract and dry neem leaf extract gave 67.70 % and 72.20% reduction of infestation 7^{h} day after spray. The fibre yield was also increased by 19.9% (2.17 ton ha^{-1}) for green leaf extract and 35.9% (2.20 ton ha^{-1}) for dry neem leaf over the control treatment, respectively. In addition, hand picking method was found to be effective, easiest, economic and eco-friendly.

Banu and Singh (2007) studied the effect of neem leaf extracts (dry and green) in green house and field condition during the period from 2003-05 against jute yellow mite. Dry neem leaf @ 1:50 and green neem leaf @ 1:20

gave 62% and 64% mortality, respectively. Fibre yield was increased by 39.95% and 35.93% over the control treatment.

Pasini *et al.* (2003) Observed that the effect of a commercial formulation of neem oil at different stages of the life cycle of the red mite of paraguaytea showed that the formulation was efficient in controlling adults. *Azadirachiin* also affected the fecundity of the female mites.

Palaniswamy and Ragini (2003) sprayed 5% aqueous extracts of *Adathoda vasica, Vitex negundo, Azadirachta indica, Aristolochia bracteata, Lippia nodiiflora, Argemone mexicana sansevieria* sp. and *Aloe* sp. on chillies 30 days after transplanting in Tamil Nadu, India. The *polyphagotersonemus lotus* populations were reduced and *Aloe* sp. also recorded to be the lowest population at 0.67 mites leaf^{-1}.

Sanguanpong and Schmutterer (1992) found that pentane extract and cold pressed neem oil reduced the fecundity of the mites on treated plants and the survival of nymph hatched from treated eggs. Application of pentane extract or neem oil in sublethal concentration caused growth disrupting effects on the nymphal stages and ovicidal effects.

Pande *et al.* (1987) they found neem leaf extract 1% and neem seed carnal 5% to be effective against *tetranychus neocaledonicus* and *Tetranychus urticae* respectively.

2.2 Effect of different plant extracts on different insect pests

Prasad *et al.* (2007) field experimental results of spraying of neem oil at 2.0% gave average fibre yield of 2.88 and 2.76 tonnes/ha, respectively, which were significantly superior to farmers' practice (2.06 tonnes/ha) and untreated control (1.79 tonnes/ha). The average incidence of semilooper (*Anomis sabulifera*), stem weevil (*Apion corchori*), ash weevil and yellow mite (*Polyphagotarsonemus latus*) as well as stem rot and root rot diseases (caused by Macrophomina phaseolina) in these treatments were significantly low in comparison to farmers practice and untreated control.

Islam (2006) conducted the experiment on the exploration of plant materials extracts for the control of jute yellow mite, *Polyphagotarsonemus latus* (Banks) was conducted at the Department of Entomology, Bangladesh Jute Research Institute, Manik Mia Avenue, Dhaka, during the period from May to August, 2005. The treatments were green neem leaf extract (1:10), green neem leaf extract (1:20), neem oil 1%, neem oil 0.5%, onion bulb extract (1:10), onion bulb extract (1:20), green mahua leaf extract (1:10), green mahua leaf extract (1:20), green nayantara leaf extract (1:10), green nayantara leaf extract (1:20), green karabi leaf extract (1:10), green karabi leaf extract (1:20) and untreated control. Neem oil was emulsified at 0.5 and 1.0% with 0.1% Nikalin. The minimum number of yellow mite was observed in T_3 (neem oil at 1%) during all stages of the plant and it reduced the height percent of mite population over control. Neem oil (1%) significantly reduced the

population of yellow mite, increased plant height and numbers of leaves per plant and decreased the number of increased leaves

Jagjeet *et al.* (2005) treated pigeon pea seeds with 11 seed protectants, i.e. neem seed kernel powder at 20g, neem oil at 10 ml, mustarded oil and groundnut oil each at 7.Sml, turmeric powder at 3.5g, mustard oil + turmeric powder at 3.75ml+1.758, groundnut oil +turmeric powder at 3.75ml+1.75g each per one kg of seed, covering 4m with each of seed, dung cake ash, sawdust and wheat husk and mixed them with half kg of seed by shaking it manually. All the seed protectants, except for sawdust and turmeric powder, recorded significantly higher adult mortality than the control after the first day of treatment. Neem oil was effective (64.33% adult mortality) up to 35 DAT and it were followed by mustered oil + turmeric powder, which recorded only 16.33% adult mortality while other treatments were not effective.

Das and Sing (2005) Field experiments were conducted for the integrated management of jute pests by integrating cultural practices and minimum use of pesticides. Among the pesticides, three chemical pesticides and three non-chemical pesticides were sprayed twice against stem weevil *Apion corchori*, yellow mite *Polyphagotarsonemus latus* and jute semilooper *Anomis sabulifera*. Endosulfan (0.075% a. i.) was most effective against all the major pests of jute. Among the non-chemical treatments, neem oil and Bacillus thuringiensis could control jute semilooper better than chirata (Swertia chirata) extract.

Hath and Chakraborty (2004) conducted an experiment under various integrated systems for the control of insects, mites and diseases of jute (cv. JRO-524) were evaluated in Cooch Behar, India. The treatments consisted of control measures against diseases only (T_1; soil pH was maintained at 5.6-6.0, organic manure was applied at 5 t/ha during sowing, seed treatment with 2 g Bavistin [carbendazim]/kg, application of 1.5 g Bavistin/litre of water when the disease incidence reached 2%, and application of Trichoderma viride to soil at 12x106 spores/ml during sowing), against pests only (T_2; application of 4 ml neem oil/litre of water at 6 weeks after sowing and application of endosulfan at 1 ml/litre of water + *Beauveria bassiana* at 107 spores/ml at 10 weeks after sowing) or against both diseases and pests (T_3; $T_1 + T_2$); recommended practice (T_4; seed treatment with 2 g Bavistin/kg of seeds followed by the foliar application of 1.5 g Bavistin/litre of water at 60-90 days after sowing, and application of 2 ml endosulfan/litre of water at 6-7 weeks after sowing followed by 2 sprays applied at 15-week intervals); and control (T_5; no control measure was adopted). T4 was the most effective against pests, as it resulted in the lowest percentage of leaf damage caused by semilooper (*Anomis sabulifera*; 9.23%), Bihar hairy caterpillar (*Diacrisia obliqua* [*Spilarctia obliqua*]; 7.13%) and yellow mite (*Polyphagotarsonemus latus*; 10.98%). The lowest percentage of plants (2.23%) infected by stem rot (caused by *Macrophomina phaseolina*) was recorded for T_1. The highest fibre yields were obtained with T3 (30.85 quintal/ha) and T4 (30.29 quintal/ha).

Prasad *et al.* (2004) evaluated neem products against yellow stem borer, *Scirpophaga incertulas* on deep water rice and found significantly better than the untreated control. Neemgold Liquid at 2.0% was the most effective neem product and was at par with the standard insecticide, as it recorded very low damage percentage (1.4, 1.6 and 3.8%) and higher yield (13.86, 11.89 and 24.24 q/ha) in 1995, 1996 and 1997, respectively.

Zhu *et al.* (2004) observed biological activity of azadirachtin on rice stem borer, *Chilo suppressalis*. After feeding on water-oats treated with 0.75 and 0.50mg azadirachtin/litre, the third instar larvae were completely dead in 3 and 6 days respectively. Mortality of the newly hatched *C.suppressalis* reached 100% within 24h after treatment with 6, 3, and 2 mg azadirachtin/litre.

Al Maisary *et al.* (2004) examined the effect of neem oil on the 2nd and 4th instars and eggs of *Culex pipiens* under laboratory condition. 46.98% of *C. pipiens* were killed upon exposure to 1000ppm of neem oil. The lower concentration (lOppm, 100ppm) showed little efficiency on the eggs. The continuous treatment of the 2nd and 4^{th} instars with neem oil (100ppm) caused high mortality and complete inhibition of the formulation of mature instars. It is concluded that in general, exposure to neem oil for a short period (24 and 48 hours) is less effective as compared with continuous.

Pasini *et al.* (2003) showed that the 2% formulation of neem oil was efficient in controlling the adults of red mite of Paraguay tea. Azadirachtin also affected the fecundity of the female mites.

Neerja and Saroj (2003) investigated that the efficacy of fresh neem oil in controlling Apis proxima on Indian mustard. Mustard leaves were dipped in fresh neem oil at 2, 1, 0.5, 0.25, and 0.125% and fed to the larvae. Mortality was observed after 24h of exposure. Pupation was minimum at 2% neem oil, while this was maximum with 0.125% neem oil. Pupation and adult emergence decreased with increasing neem oil concentration.

Ogemah *et al.* (2003) observed that neem seed oil at high doses caused more than 80% mortality compared with 4% in the control. Insect population increase was completely inhibited by the doses of more than 7.Sml/kg (Approx. 22.5mg azadirachtin A/kg maize) of neem oil and 3mg of azadirachtin A/kg maize of Neem Azal PC KG 01. Neem oil caused larval mortality in their early developmental stages within the grains.

Rahman *et. al.* (2003) conducted an experiment to evaluate five indigenous plants seed oils viz. Castor, Neem, Pithraj, Safflower and Sesame at concentration of 1, 2, 3, 4, and 5% revealed that al the plant seed oils have grain protectant value against lesser meal worm. The results showed that sesame and neem oil were more effective than Castor, Pithraj, and Safflower oils. The tested seed oils provided good protection for wheat grains.

Eungwijarupanya *et al.* (2002) tested neem extracts containing 0.185% azadirachtin at 3 concentrations 100m1, 200m1 and 300m1 diluted in 5 litres of water, These were applied using a thermal fogger to a 15 years old teak (*Tectona grandis*) for control of teak defoliator, *Hybiaea puera*. After application larvae were collected and reared in the laboratory to observed

mortality. One day after fogging mortality started to increase for these treated with 200m1 and 300m1/5L concentrations and all larvae died within 6 days when treated with 300ml/5L.

Padmasheela and Delvi (2002) tested a commercial formulation of neem oil EC (Nimbex, 0.03%) at different concentration viz. 25ppm, 50 ppm, 75 pmm, and 100 ppm for mortality effects against grubs of *Oryctes rhinoceros* (a coconut pest) at laboratory conditions. In feeding toxicity test, neem oil at concentrations of 50 ppm, 75ppm, and 100ppm caused 20%, 45% and 90% mortality respectively on exposure up to 96 th per day and 100 ppm caused 90.67% mortality of *Oryctes rhinoceros* grubs.

Malinowaki (2002) tested oil from *Azadirachia indica, M. azadirach, Cymbopogon citrates* and *Geranium* in the laboratory to evaluate their effect on *Coccinella undecimpunctata* and A*phis gossypii, Geranium* sp. Neem oil was more repellent to *A. gossypii* than the others for antifeedant.

Qureshi *et al.* (2002) investigated the direct effect of neem extracts on the adult glass beetle, Costelytra zealandica where laboratory bioassay showed that neem caused only low mortality even at the highest dose.

Karmakar and Bhole (2001) observed the efficacy and persistent toxicity of some neem products- neem oil, and nimbicidine against adult of *Epilachna dodecastigma,* the treatments with 2% neem oil and 2% nimbicidine resulted 90.69% and 71.90% mortality respectively.

Shaminathan and Jayaraj (2001) conducted two experiments to evaluated

botanical pesticides like Ipomoea leaf extracts, neem oil and madhuca oil (at 0.3% or 3.0% each) against *Perrisia virgala.* The leaf dip method was used in both experiments and pest mortality was recorded at 24h, 48h, 72h after treatments. In experiments 1, treatments with 3% neem oil recorded the highest mortality (43.13%). Neem recorded 50% mortality at 72h, and in experiment 2, at 48h, fortified (0.3%) neem oil recorded a maximum mortality of 49.3% and at 72h, fortified neem recorded 63.6% mortality.

Arcos *et al.* (2001) conducted that the effect of neem oil was evaluated by using concentrations of 0.5, 1.0, 1.5, 2.0, and 3.0%. They mainly showed that mortality recorded by ingestion was attributed to starvation. Filter paper soaked with neem oil inhibited feeding of *I. marginipennis.*

Ranjana *et al.* (2000) tested five plant extracts *from Azadirachtin indica* karnels, Bulbs of *Allium sativum, Citrus sinensis* rech, *Citrus limm* peels and *Mangrfera indica* leaves each having three concentration (1%, 1.5% and 2%) against pulse beetle, *C. maculatus.* The petroleum ether extract of neem kernel was most effective as 1.5% and 2% level showed 50% and 61.11% mortality.

Sharma (1999) reported that neem seed *(Azadirachtin indica)* kernel powder at 4% and neem leaf powder at 5% protected maize for 5 moths against *Sitophilus oryzae, Sitotroga cerealella, Rhyzopertha dominica* and *Trogoderma granarium.* Neem oil (Neembicidine 2%) effectively reduced the emergence of F 1 and F2 progeny of all the pests and completely protected maize up to 9 moths and suggested that neem products can be mixed with stored maize to protect the grains up to 9 months from the attack of this major pest.

Reddy *et al.* (1999) stated that application of neem *oil (Azadirachtin),* Karanja oil *(Pongamia glubra),* Mahua oil *(Mac/huca lalifulia)* and palmolein oil *(Elaeis gaineenis)* at dosages of 0.5% and 1.0% level effectively protected green gram from *C.chinensis.* Neem oil at 1% level was the best protected followed by palmolein, Karanja and mahua oils. These oils also exhibited contact toxicity and no adults could survive in neem treated green gram at 5% concentration.

Mayabini (1997) studied the efficacy of neem bark decoction, neem based chemicals and neem derivatives (neem oil, leaf extract and leaf decoction) against rice leaf folder *Cnaphalocrosis medinalis.* All were applied as foliar sprays to pot-grown rice plants. Leaf area fed by the larvae was recorded after 48 hours. Neem bark decoction appeared to be a very effective botanical for controlling the rate of feeding and reducing the rate of population.

Deka and Hazarika (1997) observed that neem *(Azadirachta indica)* seed oil (NSO) acted as a potential antifeedant against adult of the chrysomelid, *Dicladispa armigera.* Under laboratory conditions, daily consumption of fresh rice leaves was 1.05 g, 0.08 mg, which was reduced by 50% when leaves were treated with 6.46% NSO.

Raguraman and Rajasekaran (1997) stated the effect of neem oil and neem seed bitters applied at different concentrations as either high volume, low volume or ultra volume sprays to the rice brown plants hopper, *Nilaparvata lugens.* All neem products affected the orientation, probing and feeding time, food ingested and growth and development of *Nilaparvata lugens.*

Lowery *et al.* (1996) reported that neem *(Azadirachta indica)* seed oil (NSO) added to meridic diet at concentration as low as 0.0016% NSO reduced the fitness of *C. rosaceana* resulting in longer developmental times, lower adult emergence rates and reduced egg production compared with controls. Pupation Was completely inhibited at concentration of 0.25 and 1.0% for larvae exposed in the 5th or 6th instar, respectively; rates as low as 0.016% reduced pupal weights and elution rates. For larvae transferred to treated diet in the 5th instar, physical abnormalities in the wings of adults occurred at a rate of 0.004% NSO and increased with increasing treatment rates.

In a laboratory study Haque *et al.* (1996) found that when first and third instars larvae and adults of *Epilachna dodecastigma* were expresed to 0.25, 0.50, 1.O,or 2.0% *neem(Azadirachta indica)* oil applied on brinjal leaf discs, all the first instar larvae were killed at the concentrations before feeding and the feeding activity of third instar larvae and adults decreased with increasing oil concentration.

Braman (1993) observed antifeedant effects of azadirachtin in nymphal tawny mole crickets, *Scapteriscus vicinus* Scudder, in laboratory tests. Crickets surviving treatment grow more slowly and tunneled less than their untreated counterparts.

Islam (1993) determined the comparative efficacy of azadirachtin, the major active ingredient in neem, as a feeding deterrent for six species of noctuids of economics importance; the black armyworm, *Actebia fennica* Tansch, bertha army˙worm, *Manestra configweata* Walker, variegated cutworm, *Peridroma*

sancia Hubner, zebra caterpillar, *Melancra pitta* Harr, Asian armyworm, *Spodoptera litura* Fab. and the cabbage looper, *Trichoplusia ni* Hubner. Fourth instar larvae of *Spodoptera litura* was the most sensitive to the antifeedant effects of azadirachtin whereas *Actebia fennica* was the least.

Nesseh *et al.* (1993) tested the repellent effect of neem oil on adults *of Schistocerca gregaria.* They found that *Schistocerca gregraria* consumed 100% of the leaves of the untreated plant, while the adults started feeding on treated plant after 24 hours of the application.

The antifeedant properties of the seeds of some meliaceous plants were reported by C.S. Foon and Q.Y.Tong (1993). In their experiments with neem seed oil and petroleum ether extracts of the seed kernels of two species of chinaberry they demonstrated their potentials as strong antifeedant against nymphs of brown plant hopper, *Nilaparvata lugens.*

Salsoloy and Embuido (1992) evaluated neem oil for its insecticidal action on cotton bollworm, *Helicoverpa armigcra* Hubner. The oil applied along sprayed on cotton and the effects were compared. Neem oil; sprayed on cotton gave poor control of the pest.

Salem (1991a) found that 100ppm concentration of neem oil extract was the most effective extract against larval feeding of potato tuber moth, *Phthorimaea operculella* Zell.

Salem (1991b) tested pure neem seed oil against the cotton bollworms, *Pectinophora gossypiella* Saund and *Earias insulana* Boisd. The most active

concentration caused reduction in the percentage of infestation nearest to 150 ppm. The percentages of infestation decreased with the increase of neem seed oil concentrations.

Rovesti and Deseo (1990) stated that neem, *(Azadirachta indica)* and its oil, extracts and derivatives including azadirachtin are used as antifeedants, repellents, ovicides and growth regulators; they can also reduce adult fecundity and egg viability.

2.3 Effect of neem oil on insect growth response

Sudipta and Sanjib (1998) reported that larvae of rice moth, *Corcyra cephalonica* (Stainton) were maintained in neem oil (Azadirachtin, 0.03%) absorbed crushed jowar (sorghum) grains in four doses (0.25, 0.50, 0.75,and 1.0 ml; each dose in 20 g of food), with an initial population of 50 newly hatched larvae/100 g of neem absorbed food in each replication. Deformed adults with a prolonged period of development were obtained. Growth inhibition, developmental disturbances and mortality increased markedly with increased doses.

Lowerry *et al.* (1996) reported that neem *(Azadirachta indica)* seed oil (NSO) added to meridic diet at concentration as low as 0.016% reduced pupation and prevented adult eclosion rate of obliquebanded leaf roller *(Chorisloneura rosaseana).* At a rate of 0.0016% NSO reduced the fitness *of Choristofteura rosaceana,* resulting in longer developmental times, lower adult eclution rates, and reduced egg production compared with controls. Pupation was completely inhibited at concentration of 0.25 and 1.0% for larvae exposed in the fifth or

sixth instar, respectively; rates as low as 0.016% reduced pupal weights and elution rates. For larvae transferred to treated diet in the fifth instar, physical abnormalities in the wings of adults occurred at a rate of 0.004% NSO and increased with increasing treatment rates.

Nauman and Islam (1995) found that applications of 3 concentration of oil-free neem seed extracts to cabbage plates in cages did not deter oviposition by individuals of 3 species of noctuid moths, *Trichoplusia sp, Peridroma saucia* and *spodoptera litura.* 1% crude oil emulsion significantly reduced the proportion of eggs laid by *S. litura* on treated plants.

Freisewinkel (1993) found the contact effects of neem oil topically sprayed on third instar nymph of *Locusta migratoria.* In parallel experiment neem oil was applied directly to the abdomen of the nymphs. Feeding larvae at the beginning of the third instar with maize leaves treated with neem oil tested the effectiveness of neem oil given orally. The mortality in feeding experiments was much higher than in spraying or direct application experiments. Treated locusts showed prolonged nymphal developmental and reduced increase in weight.

Nicol (1993) studies the effects the neem seed oil in third instar nymphs of *Schistocerca gregraria.* In cages, which were sprayed with neem oil, the locust showed higher mortality rates, delayed nymphal development and morphogenetic effects of antennae, eyes and wings. Moreover, the adults derived from treated nymphs were smaller in size than those in the control.

In laboratory experiments Venkateswarlu *et al.* (1993) studied the effect of neem oil (0.1, 0.25, 0.50, 1.0 and 1.25%) on growth and development of *Lipaphis erysimi.* At concentration of 1.0, 1.25 and 1.50% all the nymphs reared on treated Indian mustard leaves diet before reaching the adult stage. At the lower concentration nymphal survival, fecundity and growth index of the aphid decreased and developmental period increased.

Rao *et al.* (1993) tested, Neemark, Biosol, Repelin and neem oil at 0.5-3.0% against larvae of *Spodoptera litura* in the laboratory. Repellency, antifeedant activity and developmental period increased with increase in concentration of all pesticides. Adult's emergence, growth, survival, larval and pupal weight, number of eggs laid and hatchability of eggs decreased with increase in concentration. Neem oil had the greatest effect, followed by Neemark, Biosol and Repelin.

Islam (1993) stated the efficacy of azadirachtin, the major active ingredient in the botanical insecticide neem, as a larval growth inhibitor and feeding deterrent for six species of noctuids of economic importance: the black army cutworm, *Actebia fennica,* Tansch., the bertha army worm, *Manu>slru coi fgurata* Walker, the variegated cutworm, *Peridroma saucia* Hubner, the zebra caterpillar, *Melanchra pieta* Harr., the Asian armyworm, *Spodoptera litura* Fab. And the cabbage looper, *Trichoplusia ni* Hubner. When added to an artificial diet, azadirachtin inhibited normal growth of all species in a dose dependent fashion.

Becker *et al.* (1992) observed that natural insecticides, neem, contains the active chemical azadirachtin, which disrupt the hormonal changes in *Bemisia tabaci* causing death during moulting.

In laboratory experiments Schmutterer (1992) applied concentration of 10 and 20 ppm/litre of azadirachtin, of an azadirachtin-free fraction and of 100 ppm/litre or an enriched, formulated seed kernel extract of *Azadirachta indica,* against the 5th larval of *Pieries brassicae.* Application of neem products against young (1st-3rd) larval instar of *Pieries brassica,* which may be typical under practical conditions, led to the death of the caterpillars.

Freisewinkel and Schmutterer (1991) showed that the topical application of neem extract at 0.25 to 1.0 ml/m2 to the 5 nymphal instars of the gregrarious phase of *Locusts migratoria migratorioides* led to increased mortality during moults, prolonged development and reduced fitness. Morphogenetic effects were observed on the legs, wings and antennae. A reduction in weight corresponded to reduced feeding activity. Color changes and supernumerary moults suggested tendencies towards soliterization. The earlier the nymphs treated, and the higher the amounts applied, the more distinct the effects.

Salem (1991a) found that larval mortality ranged between 14.28% to 78.57% and the percent of eggs hatching ranged between 57.5% to 89.4%, when different concentratration from neem seed oil extract, were tested against the potato tuber moth, *Phthorimaea operculella* Zell.

Loke *et al.* (1990) evaluated six concentrations (1.25, 2.25, 5.0, 10.0, 20.0, and 40.0 percent) of neem oil in acetone, for contact toxicity against 2nd and 3rd

larval instars of *Plutella xylostella* L. Significant mortalities of both larval stages were observed with neem oil concentration of 10 percent and above. Although the lower concentration of neem oil appeared to be sub lethal with regard to contact toxicity effect, physiological and growth disruptive effects, such as retardation of growth (prolonged), delayed adult emergence and abnormal adults but the effects were more pronounced in the younger instar. Subsequent treatment of pupae and adults of *Plutella xylostella* with neem oil concentrations of 1.25, 2.25. 5.0 And 10.0 percent showed that pupae were generally not affected by the concentrations tested. However, male and female adult moths treated with 2.5 percent and higher concentrations of neem oil had significantly higher mortalities in 48 hours and shorter longevities than the adults in control.

Mishra *et al.* (1990) reported that brinjal leaves treated with 0.025 and 0.05% neem oil to *Epilachna vigintioctopunctata* increased the duration of life stages in the subsequent generation.

Saxena (1987) found that insects fed far les, grew poorly and laid fewer eggs on rice plants treated with the oil, cake, extracts such as azadirachtin, and their formulation. Contact with or ingestion of neem seed derivatives disrupeted growth of insect pests. Neem oil alone or in combination with seed oil of custered apple *(Artrrona Squamosa* L.) was effective in reducing the survival of *N. virescens* and its transmission of grassy and ragged stunt viruses.

Schmutterer *et al.* (1984) investigated that topical application of neem oil on last instars *N. lugens, S. furcifera* and *N. virescer:s* nymphs resulted in their

premature death. Seventy seven to 100% mortality of S: *furcifera* was caused by neem oil (Saxena *et al.* 1983).

Schmutterer *et al.* (1983) studied the morphogenetic effects of four partially purified fractions of neem seed extracts and two methanolic seed extracts on larvae of rice ear cutting caterpillar, *Mythimna separates* Walker, and the rice leaf folder, C. *medinalis,* larvae fed for 24 hours. On rice leaf cuts dipped in different solution of the partially purified fractions and methanolic extracts exhibited pronounced development abnormalities and mortalities in succeeding larval instars and in pupal and adults stages.

Chapter III

Materials and Methods

CHAPTER III

MATERIALS AND METHODS

The experiment was carried out at the Research Station of BJRI at Manikgonj during the period from April to August 2008. In this chapter, the details of different materials used and methodology followed during the experimental period are described.

3.1. Experimental site

The research work was carried out in the experimental field of Jute Agriculture Experimental Station (JAES), Manikgonj during the period from April to August, 2008.

3.2. Climate

The experimental area is under the sub tropical climate. Usually the rainfall was heavy during Kharif season and scanty in Rabi season. The atmospheric temperatures increased as the growing period proceeded towards Kharif season. The weather conditions in crop growth period such as monthly mean temperature (^{0} C), sunshine hours and humidity (%) were collected from weather Center of JAES, Manikgonj and mean rainfall (mm) are presented in Appendix I.

3.3. Soil

The experimental area belonging to the Agro-Ecological Zone (AEZ-7) "Active Brahmaputra and Jamuna Floodplain". The soil texture was sandy loam.

3.4. Plot size

The size of the individual plot was 3 m x 2.1 m. The space between plot to plot and line to line was 0.75 m and 0.3 m, respectively.

3.5. Planting materials

The variety of jute used for the present study was *Chorchorus olitorius* (Variety 09897). The seeds of this variety were collected from the Seed Department of Bangladesh Jute Research Institute (BJRI), Manikmia Avenue, Dhaka.

3.6. Germination test

Before sowing the seeds were tested for germination in the laboratory and the percentage of germination was found to be over 90%.

3.7. Preparation of different plant extracts

The procedure of preparation of different plant extracts are given below:

3.7.1. Preparation of green neem leaf extract

Fresh green neem leaves (*Azadirachta indica*) were collected from the campus of BJRI, Dhaka. The collected leaves were washed under running tap water. Air dried fresh 10 g of green leaves were taken into an electric blender with 200 ml of water. After blending, the mixture was filtered through fine cloth and the extracts were considered as 1: 20 neem leaf extract.

3.7.2. Preparation of dry neem leaf extract

Green neem leaves were dried for 7 days to obtain dry neem leaves. 10 gram of dry neem leaves were soaked in 300 ml of water for over night and the extracts were filtered through fine lilen cloth to get 1:30 dry neem leaf extract.

3.7.3. Preparation of turmeric powder extract

The dried turmeric (*Curcuma longa*) was collected from Sher-e-Bangla Agricultural University farm. The dried turmeric was grinded by a blender. Ten gram of Turmeric powder was soaked in 400 ml of water for over night and the extracts were filtered through fine lilen cloth to get 1:40 turmeric powder extract. The extract was applied in the field according to the treatment.

3.7.4. Preparation of garlic (*Allium sativa*) paste extract

Garlic is an important botanical to control pest. Fresh garlic was collected from Agargaon Bazar, Sher-e-Bangla Nagar, Dhaka. Ten gram of Garlic were crushed and dissolved in 300 ml of water separately for over night to get 1:30 of Garlic pest extract. The suspensions were filtered through lilen cloth. It was applied in the field as per treatment.

3.7.5. Preparation of mehogoni (*Sweetinia mehogoni*) seed extract

The dried mehogoni seed was collected from Sher-e-Bangla Agricultural University farm.Then cleaned seeds were dried in air. Ten gram of seeds

were crushed and dissolved in 100ml of water separately for over night to get 1:10 of mehogoni seed extract. The suspensions were filtered through lilen cloth. It was applied in the field as per treatment.

3.7.6. Preparation of allamonda (*Allamonda cathartica*) leaf extract

Allamonda is a vital botanical which is the most effective to control pest. The fresh leaves of this plant were collected from Shere-e- Bangla Agricultural University campus. The collected leaves were washed under running tap water. Air dried fresh 10 g of green leaves were taken into an electric blender with 200 ml of water. After blending, the mixture was filtered through fine cloth and the extracts were considered as 1: 20 allamonda leaf extract. It was applied in the field as per treatment.

3.7.7. Preparation of different neem oil concentration

Neem oil used in this experiment was collected from National Tree Fair, Sher-e-Bangla Nagar, Dhaka. The concentration of the collected neem oil was 100%. From this stock, 3% neem oil solution were prepared (3% neem oil , 97 parts water + 3 part oil) with adding required amount of distilled water. The emulsion of neem oil in water was prepared by adding 1% liquid Nikalin detergent (emulsifier) as described by Mariappan and Saxena (1983).

3.8. Land preparation

The selected experimental field was opened in the first week of April 2008

with a power tiller and was exposed to the sun for a week for sun drying. After one week the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good condition for the sowing of jute seeds. Weeds and stubbles were removed and finally obtained a desirable tilth of soil. The experimental field was partitioned into the unit plots in accordance with the experimental layout and design. During land preparation the following fertilizers and its doses were applied (Nazrul 2008)

Name	Dose
Cowdung	10 t ha^{-1}.
Urea	200 kg ha^{-1}
TSP	500 kg ha^{-1}
MP	60 kg ha^{-1}
Zypsum	95 kg ha^{-1}
$ZnSO_4$	11 kg ha^{-1}

3.9. Seed sowing

The seeds were sown on 20 April 2008 into the experimental field. After 3 to 4 days the jute plants came out from the soil.

3.10. Intercultural operation

3.10.1. Weeding

Three times of weeding were done at 15, 35 and 60 DAS.

3.10.2. Irrigation

Irrigation was done as and where necessary.

3.10.3. Application of plant extract

Botanical extract were applied according to the treatment.

3.11. Details of the treatments

Effectiveness of 8 treatments of plant materials to reduce yellow mite infestation to jute plants was determined. The treatments and the control thus included in the study were as follows:

T_1 = Green necm leaf extract @ 1: 20

T_2 = Dry neem leaf extract @ 1: 30

T_3 = Turmeric powder extract @ 1: 40

T_4 = Garlic paste extract @ 1: 30

T_5 = Mehgoni seed extract @ 1: 10

T_6 = Allamonda leaf extract @ 1: 20

T_7 = Neem oil 3%

T_8 = Control

3.12. Design of experiment

The experiment was laid out at Randomized Complete Block Design (RCBD) with three replications.

3.13. Time of spraying

Two times of spraying was done. The first spraying was done at 30 DAS and the second was done at 45 DAS. The spraying was done in the afternoon to avoid bright sunlight and drift caused by strong wind.

3.14 Experimental observation and data collection

Three plants were selected randomly from each pot and the effectiveness of each treatment in controlling mite was determined on the basis of the following parameters by recording data from each of the three plants.

1. Number of mites after 24 hours of spraying
2. Number of mites after 48 hours of spraying
3. Number of mites after 72 hours of spraying
4. Number of mite infested plant
5. Plant height
6. Number of leaves plant^{-1}
7. Number of infested leaves plant^{-1}
8. Number of nodes plant^{-1}
9. Base diameter of plant
10. Fibre yield (t ha^{-1})

3.15. Counting number of mites before and after spraying

The number of white mite was counted with the help of sterio-microscope before and after application of treatments. It was counted at 3 and 7 days after 1st spray and at 24 hrs, 48 hrs and 72 hrs after 2nd spray of treatments application.

3.16. Procedure of data collection

The details of data collection on different parameters are described below:

3.16.1. Plant height

The height of three selected plants was measured with a meter scale from the

ground level to the top of the plants and the mean height was expressed in centimeter.

3.16.2. Number of leaves and mite infested leaves

The total number of leaves from each of sampled plant was counted and the number of mite infested leaves also counted from each sampled plant.

3.16.3. Number of nodes

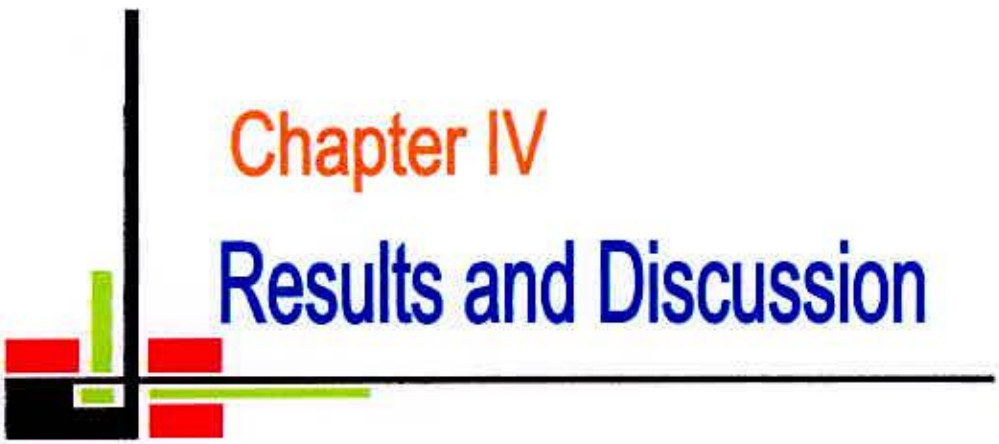
The number of nodes from each of the three selected plants pot was noted and the number was expressed on per plant basis.

3.16.4. Base diameter of plant

The base diameter of three selected plants was measured with a ribbon meter scale from the base of the plants and the mean diameter was expressed in centimeter.

3.17. Analysis of data

The data collected were statistically analyzed to obtain mean values of the treatment developed by Gomez and Gomez (1984) and to obtain the level of significance for analysis of variance developed by Russel (1986) using the MSTAT software. The treatment means were separated by Duncan's Multiple Range Test (DMRT).



Chapter IV

Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

The results on the effectiveness of different plant materials for the control of yellow mite, *Polyphagotarsonemus latus* (Banks) in terms of reduction of mite population on different stages of jute plant have been presented. The impacts of the plant materials on the plant characters have also been shown.

4.1. Effect of neem and other plant extracts on Jute plant infestation by mite.

The number of mite infested plant after 1st spray is shown in Table 1. The results showed that the lowest number of mite infested plant (22.67) was found in T_7 after first spray followed by 24.33, 28.67 and 28.66 in T_5, T_1 and T_4, respectively. There was no significant difference among these treatments regarding this parameter. While the highest number of mite infested plant was found in control treatment, which significantly differ from that of the other treatments. Considering percent plant infestation, T_7 showed the best performance having minimum mite infestation (11.01%). Mehogoni seed extract showed the similar performance having 12.71% infestation of plant.

Similarly, after 7 days of spraying with Neem and other plant extracts, the lowest number of (9.0) mite infested plant was observed in T_7 (neem oil), which was statistically identical with Mehogoni seed extract (10.33) but significantly

different from others (Table 1). The data also express that the plant infestation is identical T_7 and T_5 after 7 days of spraying and they were significantly different from other plant extract treated plants. The number of mite infested plant and percent plant infestation were highest in untreated control plots (T_8) after 7 days of spraying.

Table 1. Average number of mite infested plant and percent plant infestation after spraying of neem and other plants extract.

Treatment	Before spray		3 days after spray		7 days after spray	
	No. of mite infested plant	(%) infestation	No. of mite infested plant	% infestation	No. of mite infested plant	% infestation
T_1	93.00 ab	48.76 ab	28.67 bc	15.15 bc	17.00 c	8.95 bc
T_2	91.33 ab	43.50 b	33.33 b	15.87 bc	21.67 bc	10.31 bc
T_3	93.33 ab	45.67 ab	31.00 b	15.10 bc	19.67 bc	9.58 bc
T_4	101.7 a	51.61 a	28.66 bc	14.55 bd	16.33 c	8.29 cd
T_5	98.33 a	51.34 a	24.33 c	12.71 cd	10.33 d	5.40 de
T_6	96.67 ab	50.06 a	34.67 b	17.97 b	23.67 b	12.28 b
T_7	101.7 a	49.45 ab	22.67 c	11.01 d	9.00 d	4.36 e
T_8	87.33 b	45.69 ab	83.33 a	43.00 a	81.00 a	41.80 a
$CD_{0.05}$	9.67	5.57	5.57	3.44	5.12	3.08
CV (%)	5.44	6.96	7.40	8.13	10.24	9.17

Means followed by the same letters in a column are not significantly different at 5% leave of probability by DMRT.

T_1 = Green neem leaf extract
T_2 = Dry neem leaf extract
T_3 = Turmeric powder extract
T_4 = Garlic paste extract
T_5 = Mehogoni seed extract
T_6 = Allamonda leaf extract
T_7 = Neem oil
T_8 = Control

Green neem leaf extract (T_1) and dry neem leaf extract also showed the equal efficacy after 7 days of spraying. Figure 1 and Figure 2 illustrated the efficiency of neem and other plants extracts regarding the mite infestation over untreated control after 3 days and 7 days of spraying, respectively. All the plant material extracts significantly reduced the mite infestation over control. However, the best results were found by application of neem oil (T_7) and mehogoni seed extracts (T_5). Among the other plant extracts, garlic (T_4) showed the best performance in reducing yellow mite infestation in jute.

The results of the present study regarding yellow mite infestation of jute plant clearly demonstrated that neem oil and mehogoni seed extracts showed the best performance in reducing yellow jute mite population. Garlic extract also significantly reduced the mite infestation although, other plant extracts significantly reduced the mite infestation over control, and their efficacy was low. There is much information else when regarding this study. However the efficacy of neem oil and neem leaf extracts have been reported by other researchers against mite. Banu and Singh (2007) reported the efficacy of neem oil and green neem leaf extracts against yellow mite which supported this findings.

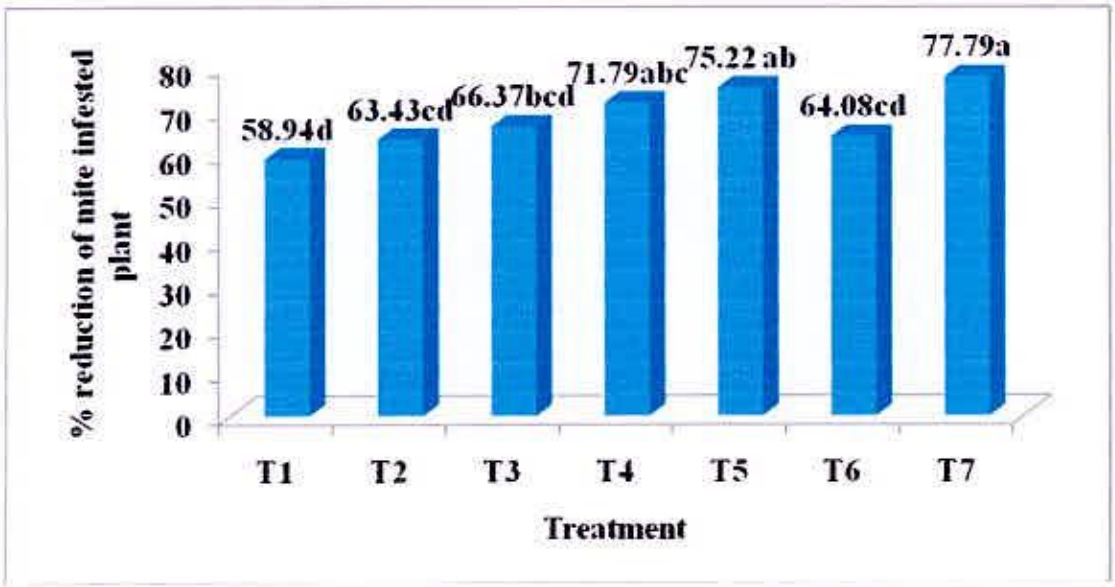


Figure 1. Average percent reduction of mite infested plant after 3 days of spraying with neem and other plant extracts.

T_1 = Green neem leaf extract
T_2 = Dry neem leaf extract
T_3 = Turmeric powder extract
T_4 = Garlic paste extract
T_5 = Mehgoni seed extract
T_6 = Allamonda leaf extract
T_7 = Neem oil
T_8 = Control

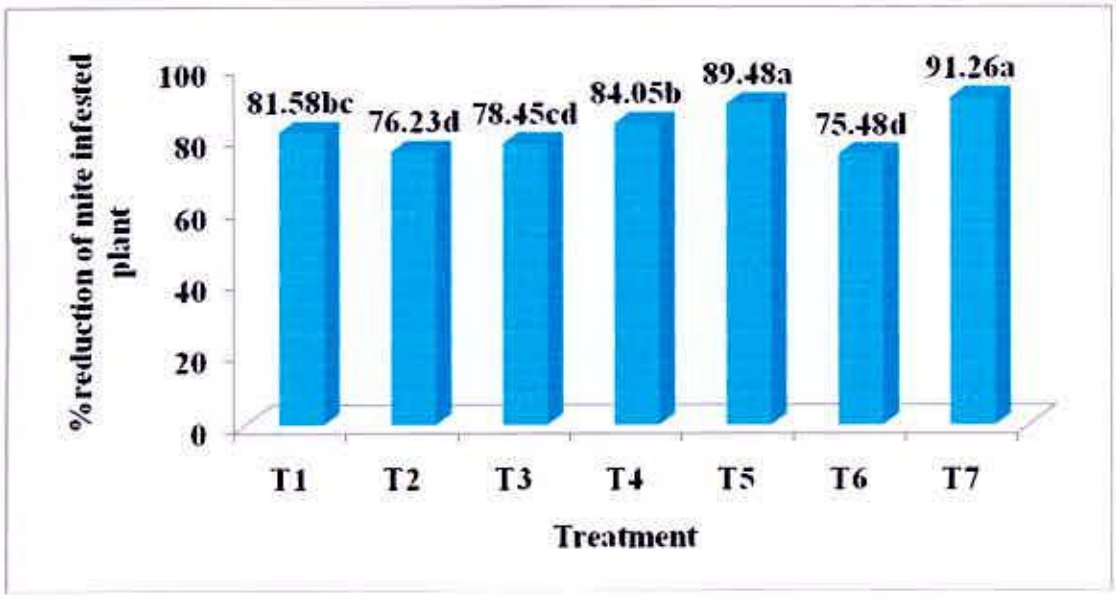


Figure 2. Average percent reduction of mite infested plant after 7 days of spraying with neem and other plant extracts.

T_1 = Green neem leaf extract
T_2 = Dry neem leaf extract
T_3 = Turmeric powder extract
T_4 = Garlic paste extract
T_5 = Mehgoni seed extract
T_6 = Allamonda leaf extract
T_7 = Neem oil
T_8 = Control

4.2 Effect of neem and other plant extracts on population of yellow mite

The effect of neem and other plant extracts on population of yellow mites was determined at different time intervals after spraying. The lowest number (15.00 cm^{-2}) of yellow mite was observed in T_7 after 24 hours of spraying (Table 2), which was statistically identical with the T_1 (18.67cm^{-2}), T_2 (18.33 cm^{-2}), T_3 (17.67cm^{-2}), T_4 (18.67cm^{-2}) and significantly different from other treatments. The maximum number of mite was observed in untreated control T_8 (44.00 cm^{-2}), which was significantly different from the other treatments. After 48 hours of spraying (Table 2), the lowest (7.33 cm^{-2}) population of mite was obtained in treatment T_7, which was statistically similar with T_6 (7.67 cm^{-2}) T_1 (11.00 cm^{-2}), T_3 (9.33 cm^{-2}), T_4 (10.00 cm^{-2}), T_5 (11.67 cm^{-2}) and significantly different from other treatments (Table 2). Significantly maximum number of mite was observed in control T_8 (44.33 cm^{-2}), which was statistically higher than other treatments. Similarly, after 72 hours of spraying, the number of mite was minimum (4.00 cm^{-2}) in treatment T_7 which was statistically similar with T_1 (6.33 cm^{-2}), T_2 (5.33 cm^{-2}), T_3 (6.67 cm^{-2}), T_4 (5.33 cm^{-2}), T_6 (4.67 cm^{-2}) and significantly differ from other treatments (Table 2). The control treatment had the maximum T_8 (45.67 cm^{-2}) number of mites that was significantly different than other treatments.

Significant variation was observed in case of percent reduction of mite population at 24 hours of spraying of different plant materials (Figure 3). The percent

reduction of mite population was found highest in T_7 which was almost identical with T_2 (64.13%) T_3 (64.30%) and T_1 (62.29%). On the other hand, the lowest percent reduction of mite population over control was observed in T_5. Similarly, after 48 hours of spraying (Figure 4), T_7 had better performance in percent reduction of mite population over control and other treatments also significantly reduced mite number over control. After 72 hours of spraying (Figure 5), neem oil at 3% concentration (T_7) had the better performance in reduction of mite population over control and other treatments had significant effect on mite population reduction over control. Therefore, all the plant extracts had the significant effect in controlling mite population, but their effect was varied with concentration. Among different plant materials, neem oil at 3% concentration had the better performance for controlling mite population at all the three times after second spray.

Table 2. Mean population of yellow mite on jute leaves after different time of exposure under different treatments.

Treatments	Before spray	After spray		
	No. of mite cm^{-2} before spraying	No. of mite cm^{-2} after 24 hrs	No. of mite cm^{-2} after 48 hrs	No. of mite cm^{-2} after 72 hrs
T_1	54.67 a	18.67 bc	11.00 bc	6.33 bc
T_2	51.67 ab	18.33 bc	12.33 b	5.33 bc
T_3	50.00 ab	17.67 bc	9.33 bc	6.67 bc
T_4	47.67 ab	18.67 bc	10.00 bc	5.33 bc
T_5	41.67 b	19.67 b	11.67 b	7.00 b
T_6	43.00 b	19.67 b	7.67 c	4.67 bc
T_7	50.00 ab	15.00 c	7.33 c	4.00 c
T_8	46.00 ab	44.00 a	44.33 a	45.67a
$CD_{0.05}$	9.62	4.02	4.01	2.66
CV (%)	6.69	5.38	7.89	9.20

Mean followed by the same letter in a column are not significantly different at 5% level of probability by DMRT.

T_1 = Green neem leaf extract
T_2 = Dry neem leaf extract
T_3 = Turmeric powder extract
T_4 = Garlic paste extract
T_5 = Mehogoni seed extract
T_6 = Allamonda leaf extract
T_7 = Neem oil
T_8 = Control

Other plant extracts, green neem leaf extract at concentration of 1: 2, dry neem leaf extract at concentration of 1: 30, turmeric powder extract at concentration of 1: 40, garlic paste extract at concentration of 1: 30, Mehgoni seed extract at concentration of 1: 10 and Allamonda leaf extract at concentration of 1: 20 had significant effect on controlling yellow mite of jute. Thus, it is clear that neem oil at 3% concentration had the better performance for controlling mite population after 2nd spray.

The results agree with the finding of Islam (2006), who showed that 1% neem oil and green neem leaf was very much effective for reducing mite population in jute. Sanguanpong and Schmutterer (1992) reported that cold pressed neem oil reduced the fecundity of mites on treated plants and the survival of nymph hatched from treated eggs and thus reduced the mite population. They also reported that neem oil in sublethal concentration caused growth disrupting effects on the nymphal stage and ovicidal effects. Therefore, this finding supported the results obtained in the present study.

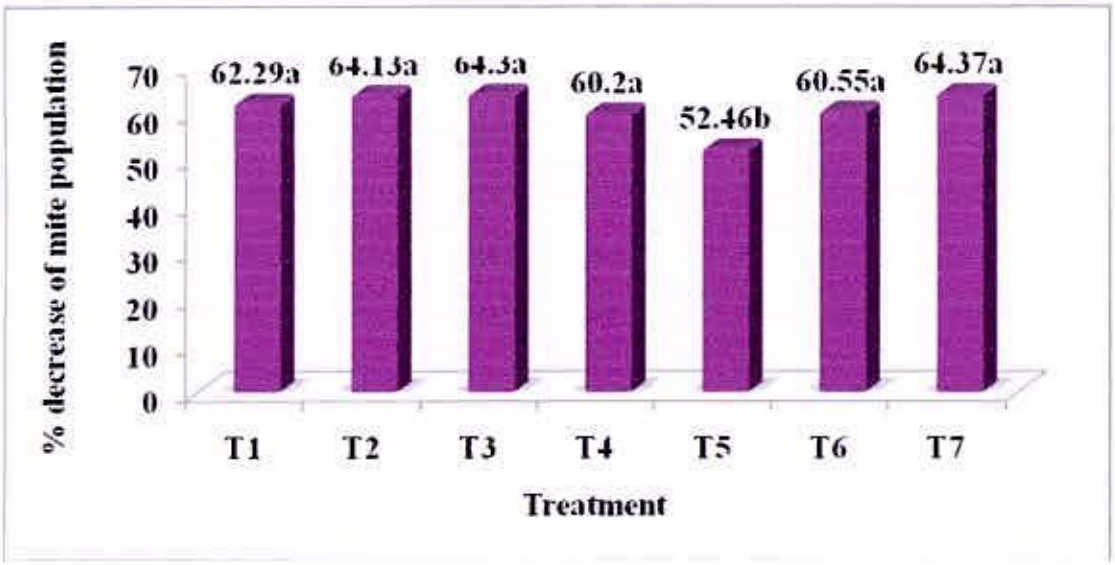


Figure 3. Mean percent reduction of mite population on jute leaves after24 hours of spraying with neem and other plant extracts.

T_1 = Green neem leaf extract

T_2 = Dry neem leaf extract

T_3 = Turmeric powder extract

T_4 = Garlic paste extract

T_5 = Mehogoni seed extract

T_6 = Allamonda leaf extract

T_7 = Neem oil

T_8 = Control

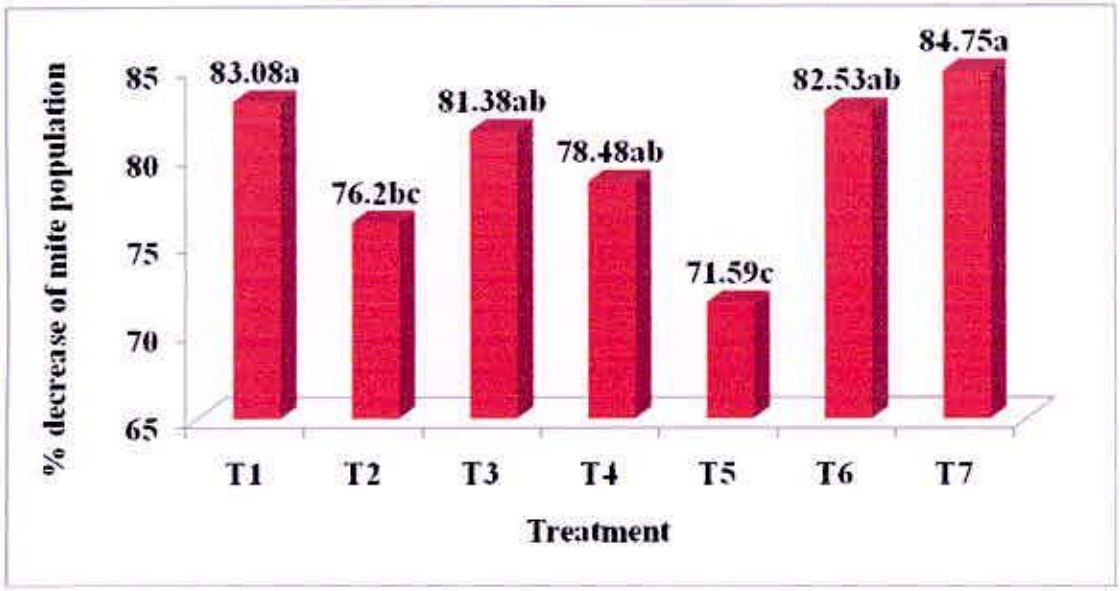


Figure 4. Mean percent reduction of mite population on jute leaves after 48 hours of spraying with neem and other plant extracts.

T_1 = Green neem leaf extract
T_2 = Dry neem leaf extract
T_3 = Turmeric powder extract
T_4 = Garlic paste extract
T_5 = Mehogoni seed extract
T_6 = Allamonda leaf extract
T_7 = Neem oil
T_8 = Control

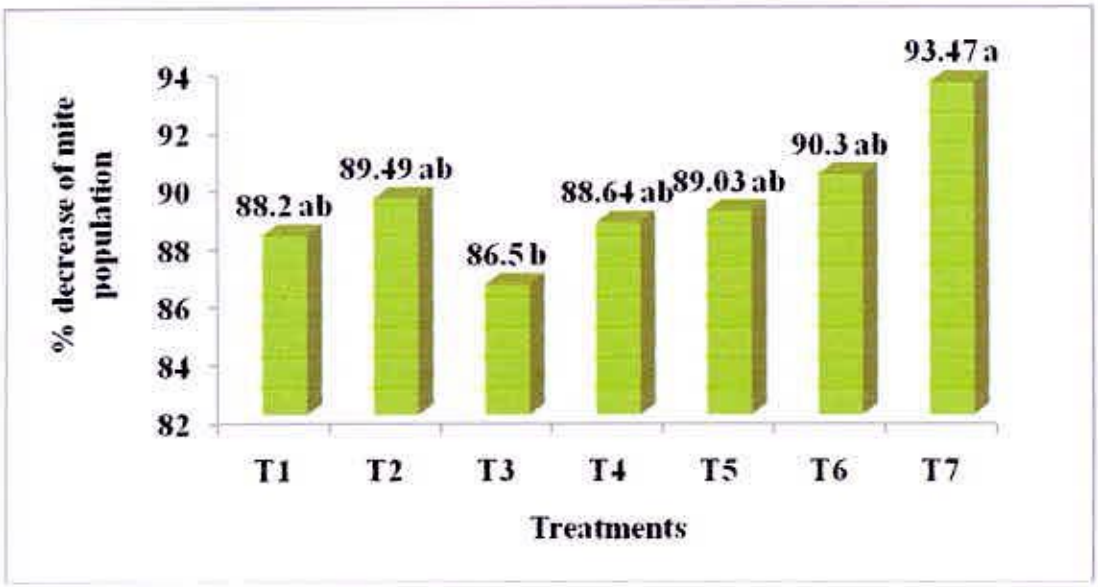


Figure 5. Mean percent reduction of mite population on jute leaves after 72 hours of spraying with neem and other plant extracts.

T_1 = Green neem leaf extract

T_2 = Dry neem leaf extract

T_3 = Turmeric powder extract

T_4 = Garlic paste extract

T_5 = Mehogoni seed extract

T_6 = Allamonda leaf extract

T_7 = Neem oil

T_8 = Control

4.3.1 Effect of neem and other plant extracts on number of leaves plant^{-1}

The effect of neem and other plant extracts on number of leaves plant^{-1} at all three stages is presented in (Table 3). The highest number (27.00) of leaves was observed in T_7, which was statistically similar with T_5 (25.33) but significantly different from other treatments at early stage of the plant. The lowest number (13.33) of leaves was observed in untreated control T_8. At middle stage, number of leaves was the highest (43.67) in T_7 but significantly different from other treatments. The lowest number of leaves was observed in control (T_8) which was significantly different from other treatments. Similarly, the maximum number (64.33) of leaves was observed in treatment T_7 at the late stage of the plant growth, which was statistically different from other treatments. The lowest number (37.33) of leaves was observed in untreated control (T_8), which was significantly lower than other treatments. The above results suggested that different plant extracts had significant effect on total number of leaves per plant at all stages of plant growth. Neem oil extract had better performance than the other plant materials.

Both adults and nymphs of yellow mite suck the cell sap from the tender leaves and infested leaves drop off from the plant due to severe infestation. As a result, number of leaves per plant decreases. Neem oil and other botanical extracts significantly decreased the mite infestation and increased the number of leaves per plant. The similar effect of neem against mite was found by

Palaniswamy *et al.* (2003). They reported that 5% aqueous extract of neem leaves reduced mite population and increased the number of leaves on chili. So, the findings obtained in the present study were in accordance with the above findings.

4.3.2 Effect on number of infested leaves plant^{-1}

The number of mite infested leaves plant^{-1} at three different stages of the plant are presented in Table 3. The lowest number (1.33) of infested leaves was found in T_7 at early stage which was identical with T_1, T_2, T_3, T_4 and T_5. The highest number (5.33) of infested leaves was observed in untreated control (T_8), which was significantly higher than other treatments. At middle stage of the crop growth, (Table 3) the lowest number (1.67) of infested leaves was observed in T_7 and T_6, which was statistically similar with T_1 (2.33), T_4 (2.33) and T_5 (2.00). The highest number (7.00) of infested leaves was found in T_8 treatment, which was significantly different from other treatments. Similarly, at the late stage minimum number (0.33) of infested leaves was observed in T_7, having no significant difference with T_1 (0.67) and T_5 (0.67) (Table 3). The maximum number (5.67) of infested leaves was observed in T_8 which was significantly different from other treatments.

Table 3. Mean number of total and infested leaves of jute and leaf infestation by yellow mite at different stages of the crops under different treatments.

Treatments	Total number of leaves			Infested leaves			% leaf infestation		
	Early stage (35 DAS)	Middle stage (80 DAS)	Late stage (120 DAS)	Early stage (35 DAS)	Middle stage (80 DAS)	Late stage (120 DAS)	Early stage (35 DAS)	Middle stage (80 DAS)	Late stage (120 DAS)
T_1	24.33 b	39.33 b	60.00 b	2.00 bc	2.33 bc	0.67 bc	8.24 c	5.99 bc	1.11cd
T_2	23.00 bc	36.67 c	55.33 c	2.00 bc	2.67 b	1.67 b	8.70 c	7.24 b	3.01 b
T_3	21.33 c	34.67 cd	52.00 d	2.33 bc	2.67 b	1.67 b	11.07 b	7.70 b	3.19 b
T_4	23.67 bc	33.33 d	57.00 c	2.33 bc	2.33 bc	1.67 b	9.81 bc	6.98 b	2.93 b
T_5	25.33 ab	40.00 b	61.00 b	1.67 bc	2.00 bc	0.67 bc	6.61 c	5.00 bc	1.08 cd
T_6	18.00 d	29.33 e	43.67 e	2.67 b	1.67 c	1.67 b	14.95 b	5.67 bc	3.84 b
T_7	27.00 a	43.67 a	64.33 a	1.33 c	1.67 c	0.33 c	4.99 c	3.80 c	0.53 d
T_8	13.33 e	27.00 f	37.33 f	5.33 a	7.00 a	5.67 a	39.83 a	26.00 a	15.20 a
$CD_{0.05}$	2.27	2.16	1.69	1.09	0.91	1.00	5.64	2.46	1.08
CV (%)	8.58	6.44	7.33	10.26	9.11	7.78	7.06	8.16	7.93

Means followed by the same letters in a column are not significantly different at 5% level of probability by DMRT.

DAS = Days after sowing

T_1 = Green neem leaf extract
T_2 = Dry neem leaf extract
T_3 = Turmeric powder extract
T_4 = Garlic paste extract
T_5 = Mehogoni seed extract
T_6 = Allamonda leaf extract
T_7 = Neem oil
T_8 = Control

The results suggested that all the plant extracts had significant effect on reducing the mite attack on jute leaves but their effect varied with concentration of extract and type of plant materials. Neem oil at 3% concentration had better effect on leaf infestation by yellow mite during early, middle and late stages of crop growth. Mite infestation at early stage causes heavy damage to crop. Mite attacked mainly young leaves and tender shoots at early stage of the crop. Neem oil and other plant extracts significantly reduced mite infestation and ultimately reduced number of infested leaves per plant. Neem products act as antifeedant and repellent that reduces the mite infestation on leaves. The similar antifeedant and repellent effect of neem was reported by Rovesti and Deseo (1990). So the result observed in the present study supported the above findings and neem oil may be used as effective controlling agents of yellow mites.

4.3.3. Percent leaf infestation by yellow mite

The data (Table 3) showed that the lowest percent leaf infestation (4.99%) was in T_7 having no significant difference with T_1 (8.24%), T_2 (8.70%) T_4 (9.81%) and T_5 (6.61%) at early stage but significantly different from other treatments. The highest percent of leaf infested (39.83%) was observed in untreated control (T_8) and was significantly different from other treatments. At middle stage of the crop growth, the lowest percent (3.80%) leaf infestation was observed in T_7, which was significantly similar with T_1 (5.99%), T_5 (5.00%) and T_6 (5.67%). The highest percent of leaf infestation

(39.83%) was observed in untreated control, (T_8) and significantly different from other treatments. At late stage of the crop growth, the lowest percent (0.53%) leaf infestation was observed in T_7, which was significantly similar with T_1 (1.11%) and T_5 (1.08%) treatment and significantly different from other treatments. The highest percent leaf infestation (15.20%) was observed in untreated control, (T_8) which was significantly higher than other treatments.

The results suggested that all the plant extracts had significant effect on leaf infestation reducing the mite attack on jute leaves but their effect varied with concentration of extract and type of plant materials. Neem oil at 3% concentration had better effect for controlling percent leaf infestation by yellow mite during early, middle and late stages of crop growth. Neem oil and other plant extracts significantly reduced mite infestation and ultimately reduced number of infested leaves per plant. The similar effect of neem was reported by Rovesti and Deseo (1990). So the result observed in the present study supported the above findings.

4.3.4 Percent decrease of leaf infestation over control

The percent reduction of mite infested leaves over control was the highest (87.31%) in T_7 (neem oil at 3% concentration) which was significantly similar with T_1 (78.87%), T_2 (77.81%), T_4 (75.30%) and T_5 (82.56%) at early stage (Figure 6). On the other hand, the lowest percent reduction of mite infested leaves over

control was observed in T_3 (72.40%) which was identical with T_6 (73.48%). Similarly, at middle, treatment T_7 had better performance in percent reduction of mite infested leaves over control and other treatments also significantly reduced mite infestation over control (Figure 7). At later stage (Figure 8), neem oil at 3% concentration (T_7) had the better performance in reduction of mite infestation of leaves over control and other treatments had significant effect on mite infestation reduction over control. Therefore, all the plant extracts had the significant effect in controlling mite infestation on leaves but their effect varied with concentration. Among different plant materials, neem oil at 3% concentration had better performance for controlling mite mite infestation on leaves at all the three stages.

Other plant extracts, e.g. green neem leaf extract, dry neem leaf extract, turmeric powder extract, garlic paste extract, mehogoni seed extract and allamonda leaf extract had significant effect on controlling yellow mite of jute. Thus, it is clear that neem oil at 3% concentration had better performance for controlling mite infestation on leaves.

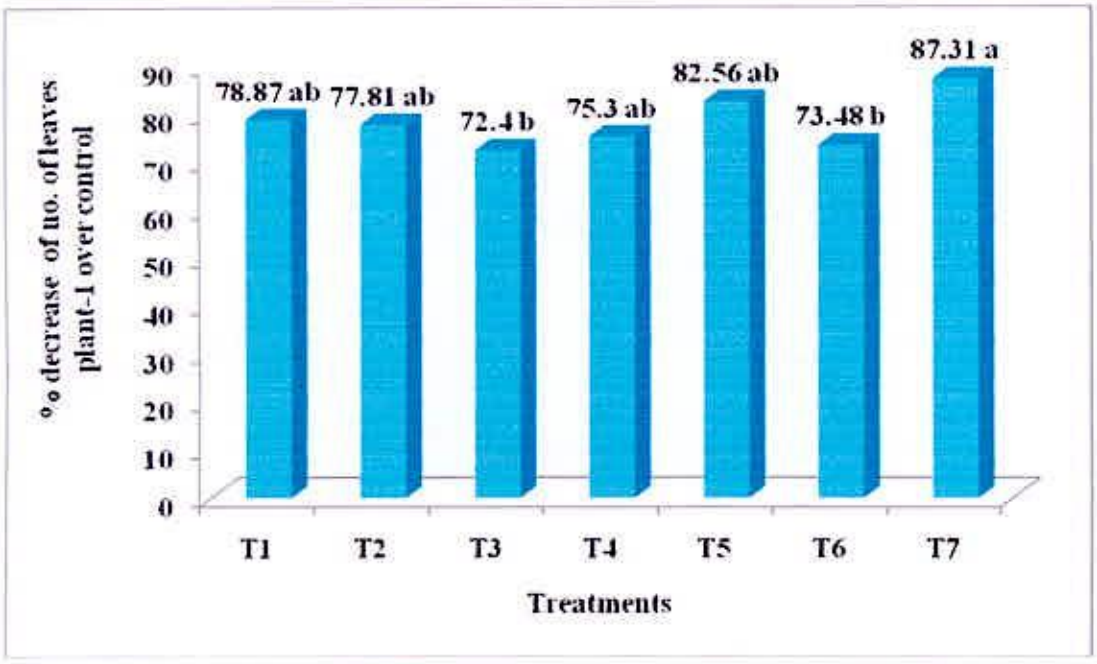


Figure 6. Mean percent reduction of number of leaves plant^{-1} over control at Early stage of the crop under different treatments.

T_1 = Green neem leaf extract

T_2 = Dry neem leaf extract

T_3 = Turmeric powder extract

T_4 = Garlic paste extract

T_5 = Mehogoni seed extract

T_6 = Allamonda leaf extract

T_7 = Neem oil

T_8 = Control

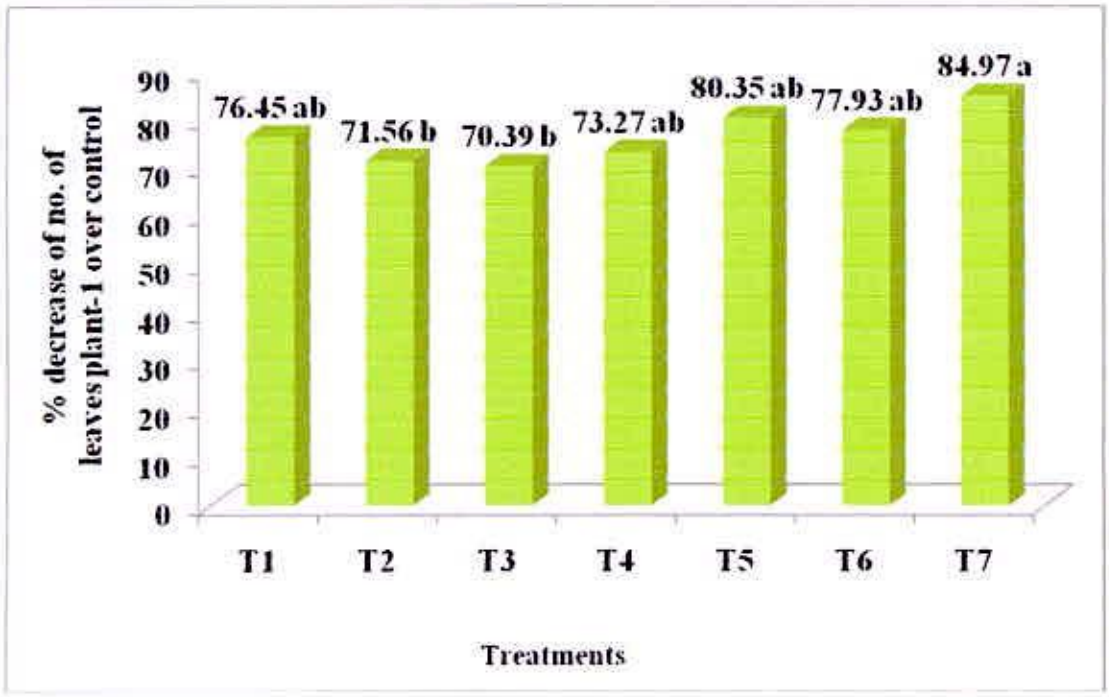


Figure 7. Mean percent reduction of number of leaves plant^{-1} over control at middle stage of the crop under different treatments.

T_1 = Green neem leaf extract

T_2 = Dry neem leaf extract

T_3 = Turmeric powder extract

T_4 = Garlic paste extract

T_5 = Mehogoni seed extract

T_6 = Allamonda leaf extract

T_7 = Neem oil

T_8 = Control

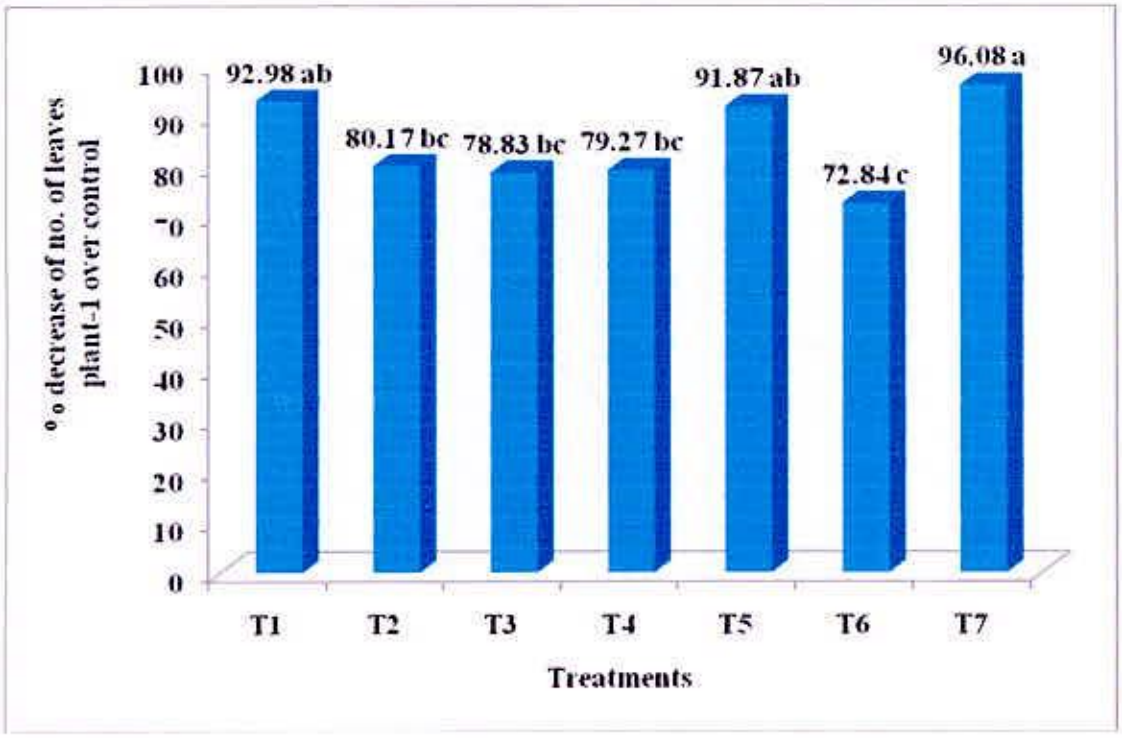


Figure 8. Mean percent reduction of number of leaves plant^{-1} over control at late stage of the crop under different treatments.

T_1 = Green neem leaf extract

T_2 = Dry neem leaf extract

T_3 = Turmeric powder extract

T_4 = Garlic paste extract

T_5 = Mehogoni seed extract

T_6 = Allamonda leaf extract

T_7 = Neem oil

T_8 = Control

5. Effect of different plant extracts on nodes plant^{-1}

The effects of different plant extracts on the number of nodes plant^{-1} at three growth stages of plant are presented in Table 4. At early stage, the lowest (20.00) number of nodes was observed in T_7 having no significant different with T_5. The untreated control (T_8) had the highest number (36.00) of nodes plant^{-1} which was significantly different from other treatments. At middle stage, it was observed that T_7 had the lowest (35.67) number of nodes plant^{-1}, which was statistically identical with T_5 (37.00). The untreated control, T_8 (75.00) had the highest number of nodes plant^{-1} and it was statistically different from other treatments. At late stage of the crop, the lowest number (53.33) of nodes plant^{-1} was observed in T_7, which was statistically different from other treatments. The highest number of nodes was observed in control, T_8 (95.00) which was significantly different from other treatments.

Significant variation was observed in case of percent reduction of nodes/plant over control (Figure 9). The percent reduction of nodes plant^{-1} over control was the highest (44.39%) in T_7 (neem oil at 3% concentration) which was significantly same with T_5 (39.73%) at early stage. On the other hand, the lowest percent reduction of nodes plant^{-1} over control was observed in treatment T_6 (12.94%) which was significantly different from other treatment. Similarly, at middle stage, treatment T_7 (Neem oil at 3% concentration) had better performance in percent reduction of nodes plant^{-1} over control and other treatments also showed significantly reduced number of nodes plant^{-1} over control (Figure 10).

At late stage, neem oil at 3% concentration (T_7) had better performance in reduction of nodes plant^{-1} over control (Figure 11) and other treatments had significant effect on nodes/plant reduction over control. Therefore, all the plant extracts had the significant effect in controlling nodes plant^{-1} but their effect was varied with concentration. Among different plant materials, neem oil at 3% concentration had the better performance for reducing nodes plant^{-1} at all the three stages.

From the above results, it is clear that T_7 (neem oil at 3% concentration) had the better performance on reducing the number of nodes per plant at all the stage of crop growth; it had the lowest number of nodes. Severe infestation of mite on jute plant causes defoliation and stunting of plant growth. As a result of growth stunting, number of nodes increased and the quality of the fibre decreased. Application of Neem and other plant extracts reduced mite infestation and increased plant height that decreased the number of nodes within a unit area. The effectiveness of Neem products in the present study was in accordance with the findings observed by Pande *et al.* (1987).

Table 4. Mean number of nodes plant^{-1} in different stages of the crop under different treatments.

Treatments	Number of nodes/plant		
	Early stage (35 DAS)	Middle stage (80 DAS)	Late stage (120 DAS)
T_1	24.00 e	46.67 d	61.33 e
T_2	28.00 c	50.67 c	66.00 cd
T_3	26.00 d	50.67 c	66.33 c
T_4	26.00 d	49.33 cd	64.33 d
T_5	21.67 f	37.00 e	56.00 f
T_6	31.33 b	55.67 b	68.67 b
T_7	20.00 f	35.67 e	53.33 g
T_8	36.00 a	75.00 a	95.00 a
$CD_{0.05}$	1.82	2.94	1.85
CV (%)	6.37	5.18	7.59

Means followed by the same letter in a column are not significantly different at 5% level of probability by DMRT.

DAS = Days after sowing

T_1 = Green neem leaf extract

T_2 = Dry neem leaf extract

T_3 = Turmeric powder extract

T_4 = Garlic paste extract

T_5 = Mehogoni seed extract

T_6 = Allamonda leaf extract

T_7 = Neem oil

T_8 = Control

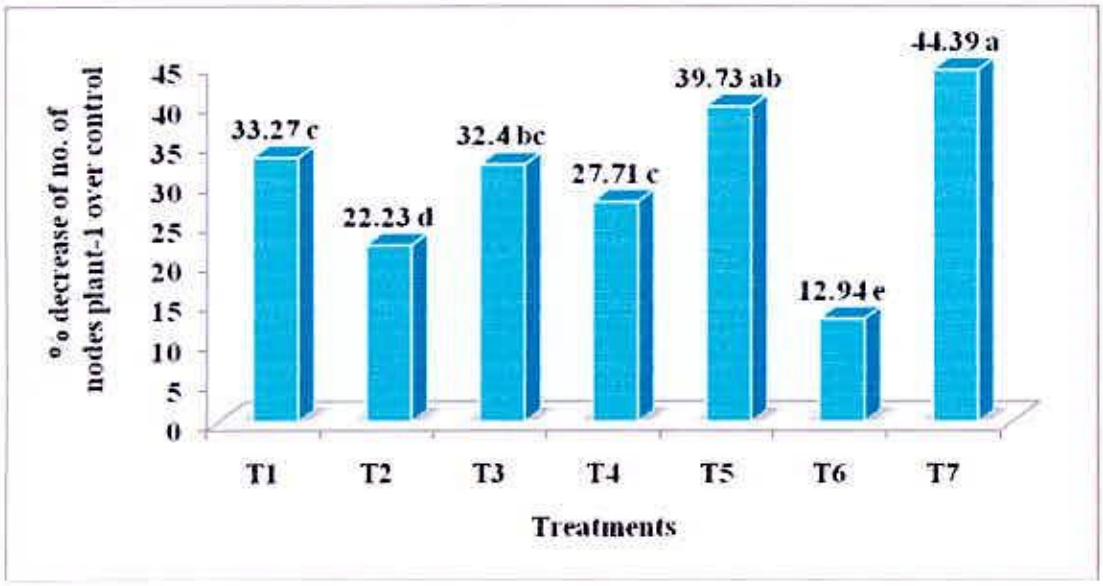


Figure 9. Mean percent reduction of number of nodes plant^{-1} over control at early stage of the crop under different treatments.

T_1 = Green neem leaf extract

T_2 = Dry neem leaf extract

T_3 = Turmeric powder extract

T_4 = Garlic paste extract

T_5 = Mehogoni seed extract

T_6 = Allamonda leaf extract

T_7 = Neem oil

T_8 = Control

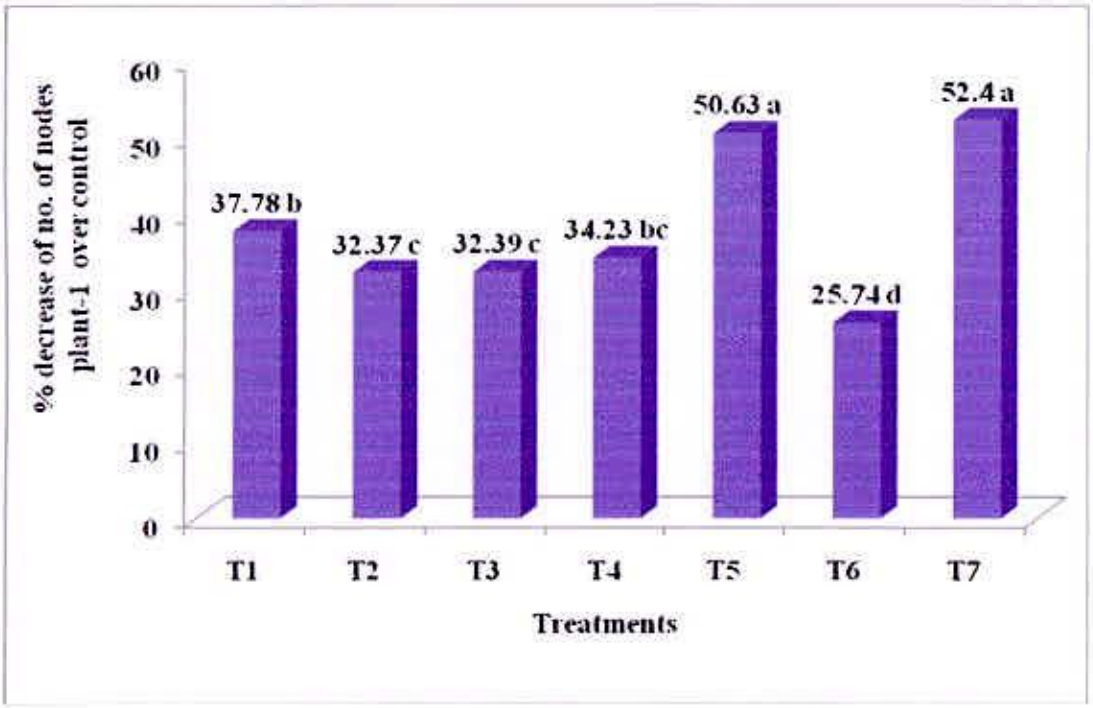


Figure 10. Mean percent reduction of number of nodes plant^{-1} over control at middle stage of the crop under different treatments.

T_1 = Green neem leaf extract
T_2 = Dry neem leaf extract
T_3 = Turmeric powder extract
T_4 = Garlic paste extract
T_5 = Mehogoni seed extract
T_6 = Allamonda leaf extract
T_7 = Neem oil
T_8 = Control

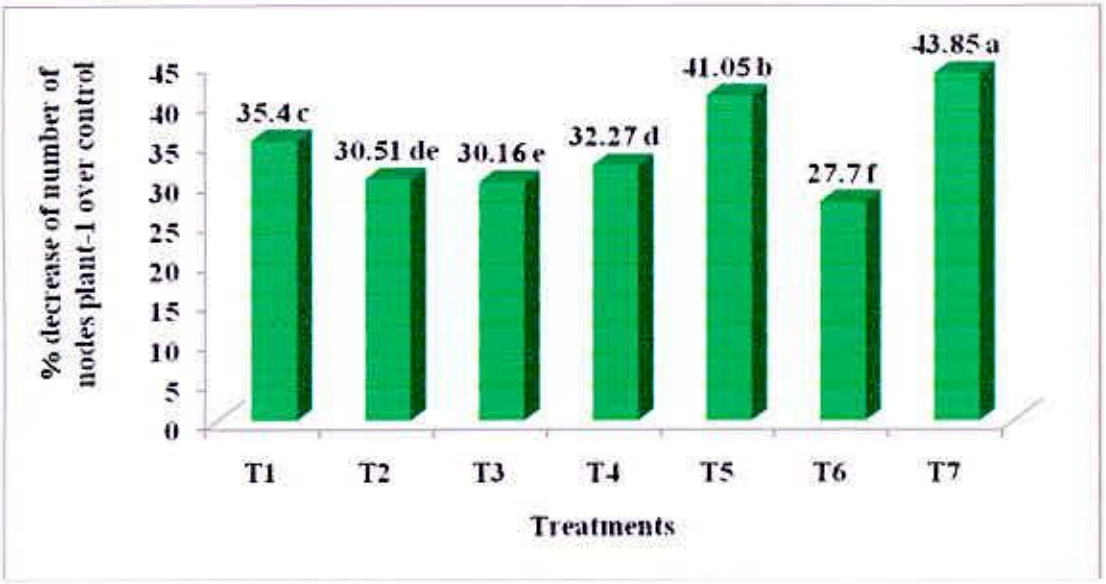


Figure 11. Mean percent reduction of number of nodes plant^{-1} over control at late stage of the crop under different treatments.

T_1 = Green neem leaf extract

T_2 = Dry neem leaf extract

T_3 = Turmeric powder extract

T_4 = Garlic paste extract

T_5 = Mehogoni seed extract

T_6 = Allamonda leaf extract

T_7 = Neem oil

T_8 = Control

6. Effect of different plant materials on growth of jute

6.1. Effect on plant height

The height of jute stem at harvest in stage under different treatments are presented in Table 5. The data showed that the highest plant height (2.95 m) was observed in T_7 which significantly different from other treatments. On the other hand the lowest plant height (2.37 m) was observed in control (T_8) which was significantly different from other treatments.

Percent increase of plant height over control was presented in (Table 5). The highest percent increase of plant height over control (24.64%) was observed in treatment T_7 (Neem oil at 3% concentration) which was significantly different from other treatments. On the other hand, the lowest percent increase of plant height over control was observed in T_6 (8.75%) which was significantly different from other treatment.

Mite infestation in any stage of plant causes growth stunting and finally reduces the plant height. Application of plant extracts decreased mite infestation and ultimately increased plant height. Thus, application of Neem oil at 3% concentration reduced yellow mite infestation of plant growth and increased plant height. The effect of Neem oil on increasing plant height as observed in the present study being in conformity with findings reported by Palaniswamy and Ragini (2003) against yellow mite on chili. They observed that 5% aqueous extract of neem leaf reduced mite population on chilli and increased height.

Table 5. Mean plant height of jute stem at harvesting stage and percent increase of plant height over control under different treatments.

Treatments	Plant height (m)	
	At harvest	Increase over control (%)
T_1	2.80 c	18.16 c
T_2	2.72 de	14.67 d
T_3	2.67 e	12.89 e
T_4	2.73 d	15.35 d
T_5	2.87 b	20.97 b
T_6	2.58 f	8.750 f
T_7	2.95 a	24.64 a
T_8	2.37 g	--
$CD_{0.05}$	0.06	1.47

Means followed by the same letter in a column are not significantly different of 5% leave of probability by DMRT.

T_1 = Green neem leaf extract

T_2 = Dry neem leaf extract

T_3 = Turmeric powder extract

T_4 = Garlic paste extract

T_5 = Mehogoni seed extract

T_6 = Allamonda leaf extract

T_7 = Neem oil

T_8 = Control

6.2. Effect of different plant materials on the base diameter of jute plant

Significant variation was observed on plant base diameter and the effect of different plant materials on base diameter of jute at harvest of plant growth is presented in Table 6. The highest base diameter (15.68 mm) was observed in T_7 which was significantly similar with T_5 (15.08 mm) and significantly different from other treatments. On the other hand, the lowest base diameter (12.27 mm) was observed in control T_8 which was significantly different from other treatments.

Percent increase of base diameter over control was presented in (Table 6). The highest percent increase of base diameter over control (27.87%) was observed in T_7 (neem oil at 3% concentration) which was significantly different from other treatments. On the other hand, the lowest percent increase of base diameter over control was observed in T_6 (12.65 %), which was significantly different from other treatments.

Application of neem oil at 3% concentration reduced yellow mite infestation of plant growth and increased base diameter of jute. The effect of neem oil on increasing base diameter as observed in the present study had better performance compared to other applications.

Table 6. Mean base diameter of jute at harvesting stage under different treatments

Treatments	Base diameter (mm)	% increase over control
T_1	14.58 b	18.90 c
T_2	14.10 bc	14.96 e
T_3	14.22 bc	15.91 de
T_4	14.37 bc	17.14 d
T_5	15.08 ab	22.99 b
T_6	13.82 c	12.65 f
T_7	15.68 a	27.87 a
T_8	12.27 d	--
$CD_{0.05}$	0.19	1.36
CV (%)	8.54	9.42

Means followed by the same letter in a column are not significantly different of 5% leave of probability by DMRT.

T_1 = Green neem leaf extract

T_2 = Dry neem leaf extract

T_3 = Turmeric powder extract

T_4 = Garlic paste extract

T_5 = Mehogoni seed extract

T_6 = Allamonda leaf extract

T_7 = Neem oil

T_8 = Control

7. Effect of neem and other plant extracts of fiber yield of jute under different treatment.

The data (Table 7) showed that the highest yield (2.68 t ha^{-1}) of fiber was obtained in T_7, which was significantly different from other treatments. Mehogoni seed extract (T_5) gave the fiber yield 2.6 tha^{-1}, which was significantly lower than T_7 but higher than other treatments. The lowest fiber yield (1.83 t ha^{-1}) was obtained from the untreated control.

Similarly, the highest fiber yield (44.76%) was increased neem oil treated plots (T_7) followed by 40.60% in mehogoni (T_5) leaf extract and significant different was observed between them. Allamonda leaf extract showed the lowest efficacy regarding this parameter.

The results clearly demonstrated that application all of the plant extracts significantly increased fiber yield of jute. However neem oil and mehogoni seed extracts showed the best performance. These results supported the findings of Banu and Singh (2007) who reported the highest efficacy of neem oil against jute mite. The efficacy of mehogoni seed extract could not be compared due to lack of available information. The results of this experiment may vary with that of others due to extraction and application methods, environmental factors etc.

Table 7. Mean yield of jute fibre under different treatment.

Treatments	Yield	
	Fiber yield tha^{-1}	Increase over control
T_1	2.50 c	35.17 c
T_2	2.26 e	24.33 e
T_3	2.18 f	18.07 f
T_4	2.40 d	29.74 d
T_5	2.60 b	40.60 b
T_6	2.05 g	10.88 g
T_7	2.68 a	44.76 a
T_8	1.83 h	--
$CD_{0.05}$	0.05	3.58

Means followed by the same letter in a column are not significantly different of 5% leave of probability by DMRT.

T_1 = Green neem leaf extract

T_2 = Dry neem leaf extract

T_3 = Turmeric powder extract

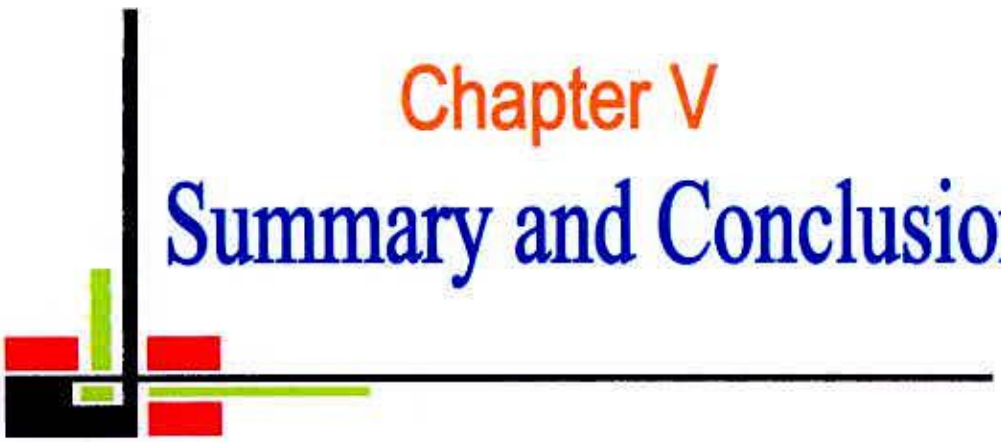
T_4 = Garlic paste extract

T_5 = Mehogoni seed extract

T_6 = Allamonda leaf extract

T_7 = Neem oil

T_8 = Control



Chapter V

Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

Yellow mite is an important pest of jute. In our country this is mostly controlled by the chemical insecticides, which are available in the market. But the present investigation was undertaken to determine the efficiency of different botanicals for the management of white mite of jute using some plant extract. The experiment included seven plant materials extract viz. green neem leaf extract, dry neem leaf extract, turmeric powder extract, garlic pest extract, mehgoni seed extract, allamonda leaf extract and neem oil at different concentration. There were eight treatments including control with three replications. Data on number of infested plant, number of mites plant^{-1}, number of infested and total leaves and number of nodes plant^{-1}, plant height, base diameter and yield of jute were recorded and analyzed statistically.

The different plant materials had significant effects on reducing the number of mite infested plant after different duration of sprays. Effect of different plant materials varied with type of plant species. Neem oil at 3% showed the better performance among all other plant materials in reducing the mite population at different time intervals. Mite infestation at 35 days after sowing (DAS) of first spray was the lowest, 22.67 and 9.00 respectively at 3 and 7 days after first spray and this result was obtained with neem oil at 3% concentration.

With second spray at 45 days after sowing (DAS), mite population cm^{-2} was decreased significantly at 24, 48 and 72 hours after second spray. It was observed that 24, 48 and 72 hours of second spray, mite population cm^{-2} was the lowest (15.00, 7.33 and 4.00 respectively) in neem oil at 3% concentration treated plant where control treatment showed the highest.

Significantly maximum number infested leaves $plant^{-1}$ at early, mid and late stage (5.33, 7.00 and 5.67 respectively) was observed in the untreated control treatment due to severe infestation of white mite and the lowest number of infested leaves was found in neem oil at 3% concentration treated plant which indicated the better performance of neem oil against mite. Application of the different plant extracts reduced the mite attack on leaves, decreased defoliation and increased the number of leaves/plant. The number of total leaves was the highest in neem oil (3%) treated plant at all the three stages and that was the lowest in control plant.

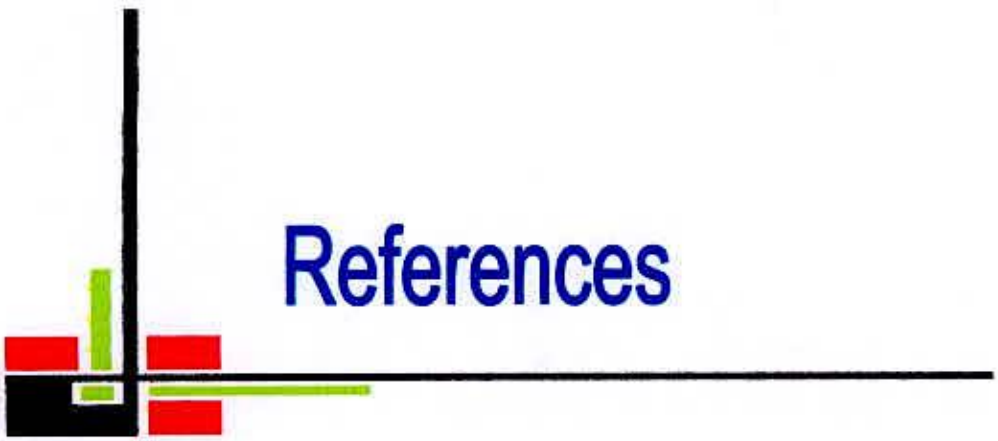
The number of nodes $plant^{-1}$ of jute was also influenced significantly by the application of different plant extracts to control mites at all the three stages of the plant. The lowest numbers of nodes (20.00, 35.67 and 53.33 respectively) at early (35 DAS), mid (80 DAS) and late stage (120 DAS) were observed with neem oil (3%) extracts at all the three stages and highest number of nodes/plant was found with control due to severe mite attack.

The height and base diameter of jute plant increased significantly by application of different plant extracts during all stages of crop growth. Neem oil extract at 3%

concentration significantly increased the plant height and base diameter by decreasing white mite infestation during the cropping season. The highest plant height (2.95 m) and base diameter (15.68 mm) were observed by application of neem oil at 3 % concentration.

The yield of jute was influenced significantly by the application of different plant extracts. Among the treatments under the present study, the highest fibre yield (2.68 t ha^{-1}) was obtained by the application of neem oil at 3% concentration where the control showed the lowest (1.83 t ha^{-1}).

From the above results, it might be concluded that the treatment of neem oil at 3% concentration had significant effect on reduction of yellow mite and increased growth contributing characters of jute as well as produced the highest fibre yield.



References

REFERENCES

Adityachaudhury, N.A., Bhattacharyya, A., Chowdhury and Pal, S. (1985). Chemical constituents of plants exhibiting insecticidal, anti feeding and insect growth regulating activities. *J. Sci. Indus. Res.* **44**: 85-101.

Al Maisary, M.F. and Al-Rahawi, H.M.H. (2004). The effect of different concentrations of neem oil extract of some immature stages of *Culex pipiens* L. mosquito. *University of Aden J. Nat. Appl. Sci.* **8** (ii): 213-218.

Arcos, R.J., Mendex, M.J.T. and Campos, R.R. (2001). The effect neem oil *Azadirachta indica A.* Juss., on the dry wood termite, *Incisitermes marginipennis* (Latreille) (Isoptera: Kalotermitidae). Revista chapingo Serie Ciencias Forestales ydel Ambiente. **7** (ii): 139-243.

Banu, H. and Singh, P.K. (2007). Integrated Management of Jute Pest. *Appl. Environ. Ecol.* **28**(ii): 186-203.

Banu, J (2006). Efficacy of some neem products against yellow mite of jute. *Indian J. Plant Protec.* **27** (ii): 151-158.

BBS (Bangladesh Bureau of Statistics). 2004. Statistical Yearbook of Bangladesh. Statistics Division, Ministry of Planning, Government of the People's Republic of Bangladesh. pp. 91-94.

Becker, H., Corliss, J. and De-Quatko, J. (1992). Control of *Bemisia tabaci* and the potential of Paecilomyces fumosoroseus as a biopesticide. In Bio-control News and Information. 1993. **14**(iv): 71-78.

Braman, S.K. (1993). Azadirachtin affects growth and survival of immature tawny mole cricket. *Entomol.* **76** (iii): 526-530.

Crosby, D.G. (1971). In: Naturally occurring insecticide. Marcel Dekker, New York, pp.73-100.

Das, L.K. and Singh, B. (2005). Integrated management of jute pests. *Environ. Ecol.* **16**(i): 218-219.

Deka, N. and Hazarika, L.K. (1997). Effect of neem seed oil on food consumption and utilization by rice hispa. *J. Pestic. Res.* **9** (i): 113-116.

Eungwijarupanya, S., Yimchareon, S., Sumrid, Y. and Wylie, F.R. (2002). Control of teak defol*iator, Ilyblaea purea* Gamer (Lepidoptera: Hybleidae), by thermal fogger application of neem extras. Proceding of the IUFRO-FAO workshop on pest management in tropical forest plantation, Chanthaburi, Thailand. 2529 May, 1998. FORSPA-Pblication. **30:** 123-125.

Foon, C.S. and Tong, Q.Y. (1993). Experiments on the application of the botanical insecticides for the control of diamondback moth in South China. *J. Appl. Entomol.* **116**(v): 479-486.

Freisewinkel, D.C. and Schmutterer, H. (1991). Contact action of neem oil on the African migratory locust, *Locusta migratoria. Zeitschrift furAngewandle-Zool.* **78** (ii): 189-203.

Freisewinkel, D.C. (1993). Oral and topical effects of seed oil from the neem tree, *Azadirachta indica (A.* Juss.) on nymphs of the African migratory locust, *Locusta migratoria. Deutsche Gescllschaft fur Allagemine and Wandle Enlomologie.* pp. 785-789.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Aricultural Research. 2nd edition. International Rice Research Institute, John Willey and Sons, Inc. Singapore. pp. 139-240.

Gujar, G.T. (1997). *Neem (Azudirachta indica,* A. Juss*)*, a natural insecticide: Status and need for bioassay standards. *J. Pestic. Res.* **4** (ii): 69-79.

Hath, T.K. and Chakraborty, A. (2004). Towards development of IPM strategy against insect pests, mites and stem rot of jute under North Bengal conditions. *J. Entomol. Res.* **28**(i): 1-5.

Islam, M.B. (1993). Growth inhibitory and antifeedant effects of azadirachtin on six noctuids of regional economic importance. *Pestic. Sci.* **38** (i): 57-63.

Islam, M.B. (2006). Growth inhibitory and antifeedant effects of azadirachtin on six noctuids of regional economic importance. *Pestic. Sci.* **62** (ii): 23-34.

Jagjeet, S., Chhilar, B.S. and Kashyap, R.K. (2005). Effectiveness of various seed protectants on adult mortality on pulse beetle, *Callasobruchus maculatus* (F) infesting pigeon pea seeds. Annals Biol. **21**(i): 65-67.

Kabir, A.K.M.F. (1975). Jute pest of Bangladesh. Annual Report. Bangladesh Jute Research Institute, Dhaka. pp 28-33.

Karmakar, M.S. and Bhole, S.R. (2001). Efficacy and persistent toxicity of some neem products against adult of *Epilachna dodecastigma* Weid. *Plant Protec. Bull.* **53** (i-ii): 22-25.

Loke, W.H., Heng, C.K., Basirum, N. and Rejab, A. (1990). Non-target effects of neem (*Azadirachta indica A.* Juss.) on *Plutella xylostella* L., Cabbage, Sawi and Padi. Malaysian Plant Protection Society (Malaysia). Protocol of the 3rd International Conference on Plant Protection in the Tropics. **11:** 108-110.

Lowery, D.T., Bellerose, S., Smirle, M.J., Vincent, C. and Piton, J.G. (1996). Effect of neem oil on the growth and development of the oblique banded leaf roller, *Choristoneura rosaceana. J. Appl. Entomol.* **79** (ii): 203-209.

Malinowaki, H. (2002). Activity of Azadirachtin against Diprionidae larvae. Sylwan, **146** (iv):17-24.

Mariappan, V. and Saxena, R.C. (1983). Custard apple oil and neem oil mixture: effect on survival of *Nephotettix virescens* and on rice tungro virus transmission. *Abstract* 2nd Internternational Neem Conference, Raisch Holzhausen Castle, 25-28 May, 1983. 35p.

Mayabini, J. (1997). Efficacy of some neem products against rice leaf folder, *Cnaphalocrosis medinalis* Guenee. *Indian J. Plant Protect.* **25 (ii):** 160-161.

Mishra, P., Missra, B.K.R. and Patnaik, N.C. (1990). Effect of neem oil on the growth and development of epilachna beetle *Epilachna vigintioctopunctata* (Hbst). *Orissa J. Agril. Res.* **2** (iii-iv): 169-172.

Nauman, K. and Islam, M.B. (1995). Evaluation of neem *(Azadirachta indica)* seed extracts and oils as oviposition deterrent to noctuid moths. *Appl. Entomol.* **76** (ii): 115-120.

Neerja, A. and Saroj, S.R. (2003). Bio-efficacy of fresh neem oil against larvae of mustard sawfly, *Athalia proxima* Klug. Infesting mustard. *J. Entomol. Res. 27*(iv):347-351.

Nesseh, O.M., Freress,T. and Krall, S. (1993). Repellent effect *of Azadirachta indica* (A. Juss.) On akults of *Schistocerca gregaria* Forskal investigations in the Republic of Niger. *Deutsche Gesells Chaft fur Allgemeine and Age Wandle Entomlogie.* pp .835-938.

Nicol, C.M.Y. (1993). Further studies on contact effects of seed oil from the neem tree, *Azadirachta indica* (A. Juss.) on nypmhs of the gregarious phase of the desert locust, *Schistocerca gregaria* F. *Deutsche Gesellschaft fur Allgemeine and Ange Wandle Enlomologic.* pp. 791-793.

Ogemah, V., Reichmuth, C., Buttner, C., Crediand, P.F., Bell, C.H. and Highley, S. (2003). Effect of Neem azal and other neem products on mortality, fecundity and frass activity of the larger grain borer, *Prostephamus truncatua* (Horn) (Coleoptera: Bostrichidae) infesting maize. Proc. 8th Int. Working Conf Stored prod., York, UK, 22-26 July, 2002. pp. 588-595.

Padmasheela, N.C. and Delvi, M.R. (2002). Antifeedant and mortality effects of neem oil (0.03% azadirachtin) against 3rd instar grubs of *Oryctes rhinoceros* L. (Coleoptera: Dynastidae). *J. Entmol. Res.* **26 (iii)**: 239-244.

Palaniswamy, S., and Ragini, J.C. (2003). Influence of certain plant extracts on yellow mite *polyphagotersonemus latus* (Banks) on chillies. Insect Environ. **6** (i), 25-26.

Pande, Y.D., Majumdar, M. and Roy, H.L. (1987). Laboratory evaluation of various concentration of neem *(Azadirachta indica)* leaf extract against *Tetranychus neocaledonicus* Andre infesting okra in tripura. First Natural Seminar On acarology, Kalyani, West Bengal, Oct. 29-31.

Pasini, A., Capelo. S.M. and Oliveira, R.C. (2003). Preliminary assays for efficiency evaluation of neem oil for control of *Oligonychus yothersi (Atari:* Tetranychidae). Departamento de agronomia; C.P. 6001-CEP: 86. 051-970, Londrina, Brazil. Semina - londrina. **24** (ii): 315-316.

Prasad, S.S., Yadav, U.S. and Srivastava, R.K. (2007). Efficacy and economics of integrated pest management against insect pests and diseases of olitorius jute *(Corchorus olitorius)* in eastern Uttar Pradesh. *Indian J. Agric. Sci.* 77(x): 652-656.

Qureshi, M.S., Jackson, T.A., Towsend, R.J., Saville, D. J. and Zydenbos, S.M. (2002). Toxicity of neem and pyrethrum extracts to adult grass grub. Proceedings of Conference, Central Hotel, Routers, New Zealand, 11-15 August 2002. pp. 298-302.

Raguramans, S. and Rajasekaran, B. (1997). Behavioural and physiological effects of neem on rice brown planthopper, *Nilaparavata lugens*. *Madras Agril. J.* **84** (vi): 326-328.

Rahman, M.A., Ahmad, M., Shahjahan, M. and Ahamad, M. (2003). Laboratory evaluation of plant seed oils against the Icssed meal worm, *Alphitohius diaperinus* (Panzer). J. *Asiatic Soc. Bangladesh.* **29** (i): 11-18.

Rani, C.S., Lakhmi, V.K. and Rao, P.A. (2000). Vegetable oils of surface protectants against bruchid, *Callasobrachus chinensis(L.)* infestation on chickpea. *Indian J. Plant Protec.* **28** (ii): 184-186.

Ranjana, S., Becnam,S., Saxena,R. and Saxena,B. (2000). Bioactivity of certain plant extracts against *Callasobruchus maculatus* F. *J. Appl. Zool. Res.* **11** (i): 29-32.

Rao, G.R., Raghavaiah, G. and Nagalingam, B. (1993). Effect of botanicals on certain behavioural responses and on the growth inhibition of *Spodoptera litura* F. *Botanical Pesticides in Integrated pest management.* pp. 175-182.

Reddy, M.U., Bharati, S.R. and Reddy, D.D.B. (1999). Efficacy of some vegetable oils as protectants againsts the pulse beetle, *Callasobrachus chinensis L.* in green gram, *Phaseolus aureus* during storage. *Indian J. Nat. Dict.* **36** (x): 436-442.

Rovesti, L. and Deseo, K.V. (1990). *Azadirachta indica* A, Juss. (neem) and its potentiality in the control of insects. *Informatore Fitopatologics.* **40** (xi): 2732.

Russell, D.F. (1986). MSTAT-C package programme. Crop and Soil Science Department, Michigan State University, USA.

Salem, S.A. (1991a). Evaluation of neem seed oil as tuber protectant against *Phthorimaea operculella* Zell. *Ann. Agric. Sci.*, Moshtohor. **29** (i): 589-596.

Salem, S.A. (1991 b). Response of cotton bollworms, *Pectinophoru gossypiella* Saund *and Earias insulana* Boisd to seed neem kernel pure oil. *Ann. Agric. Sci.*, Moshtohor. **29 (i):** 597-608.

Salsoloy, A.D. and Embuido, A.G. (1992). Efficacy of nem, *Azadirachta indica A.* Juss for controlling cotton bollworm, *Helicoverpa armigera,* (Hubn.). *Cotton Res. J.* **5** (i-ii): 76-77.

Sanguanpong, U. and Schmutterer, H. (1992). Laboratory studies on the effect of neem oil and neem seed extracts on the spider mite Tetranychus *urticae Koch* (Acari: Tetranychidae). *Zeitschrift Fiupfanzenkrankheiten Pflanzenschutz.* **99** (vi): 637-646.

Saxena, R.C. (1989). In: Insecticides of plant origin Philogene B. J. R. and Morand P. ASC Symposium Series 387, Washington, D.C. pp.110-135.

Saxena, R.C. (1987). Decade of neem research against rice insect pests in the Philippines. IRRI, Los Banos, Laguna (Philippines). pp.1.

Schmutterer, H. (1992). Influence of azadirachtin of an azadirachtin-Free fraction of an alcoholic neem seed kernel extract and of formulated extracts on pupationk, adult emergence and adults of the braconid *Apanteles glomeratus. J. Appl. Entomol.* **113** (i):79-87.

Schmutterer, H. Hedyde, J.V.D and Saxena, H. (1984). Effects of neem oil on plant hopper and leafhopper pests of rice, *Oryza sativa.* College, Laguna (Philippines). p. 1.

Schmutterer, H., Saxena, R.C. and Heyde, V. (1983). Morphogenetic effects of some partially purified fractions and methanolic extracts of neem seeds on *Mythimna separata* Walker *and Cnaphalocrosis medinalis.* G.Z. *Angew. Entomol.* **95**:230-237.

Shaminathan, V.R. and Jayaraj, S. (2001). Evaluation of botanical pesticides against the mealybug, *Perrisia virgata* Cockrell (Homoptera: Pseudococcidae) on cotton. *Madras Agril. J.* **88** (vii-ix): 535-537.

Sharma, R.K. (1999). Efficacy of neem products against storage pests in maize. *Annals Agril. Res.* **20** (ii): 198-201.

Sudipta, C. and Sanjib, C. (1998). Food with neem oil affects life and development of rice moth, *Corcyra cephalonica* (Stainton) (Lepidoptera pyralidalidae). *Entomol.* **23** (ii): 153-156.

Venkateswarlu, P., Sharma, C.M. and singh, R.S.J. (1993). Effect of neem oil on growth and development of mustard aphid, *Lipaphis erysimi* (Kalt.). *Bioved.* **4**(ii):139-142.

Zhu, S., Xing, G.Z., Jin, D., Chang, Y. and Liu, F. (2004). Control effects and biological activity of azadirachtin on rice stem borer, *Chilo suppressalis in* paddy fields. *Chiness J. Rice Sci.* **18**(vi): 551-556.

Appendices

APPENDICES

Appendix I. Monthly average of air temperature, relative humidity and total rainfall of the experimental site during the period from April, 2008 to August, 2008

Month	Year	Monthly average air temperature			Average relative humidity (%)	Total rainfall (mm)	Total sunshine (hours)
		Maximum	Minimum	Mean			
April	2008	34.37	26.06	30.218	61.51	180	2546.00
May	2008	34.78	24.57	29.675	64.23	616	2359.00
June	2008	35.40	28.50	31.95	68.14	446	1246.00
July	2008	34.00	29.30	31.65	63.28	476	949.00
August	2008	36.00	29.50	32.75	69.11	318	1307.00

[Source: Bangladesh Metrological Department, Agargaon, Dhaka]

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

Soil Characteristics	Analytical results
Agrological Zone	Brahmaputra and Jamuna Flood Plain
P^H	6.00 – 6.63
Organic matter	0.84
Total N (%)	0.46
Available phosphorous	21 ppm
Exchangeable K	0.41 meq / 100 g soil

[Source: SRDI, Farmgate, Dhaka]