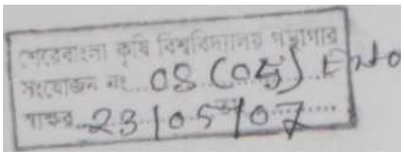
MANAGEMENT OF SUCKING AND CHEWING PESTS OF HILL COTTON, *Gossypium arboreum* Linn. IN JHUM CULTURE

MONG SANUE MARMA

DEPARTMENT OF ENTOMOLOGY
SHER-E-BANGLA AGRICULTURAL UNIVERSITY
DHAKA - 1207

JUNE 2006

MANAGEMENT OF SUCKING AND CHEWING PESTS OF HILL COTTON, *Gossypium arboreum* Linn. IN JHUM CULTURE



MONG SANUE MARMA

REGISTRATION NO. 01505

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

MASTER OF SCIENCE (M.S.)

IN

ENTOMOLOGY

SEMESTER: JANUARY-JUNE, 2006

Approved by:

Professor Abdul Jabber Howlader, Ph.D.
Supervisor

Professor Jahanara Begum
Co-supervisor

Associate Professor
Mohammed Ali, Ph.D.
Chairman
Department of Entomology

CERTIFICATE

This is to certify that the thesis entitled **"MANAGEMENT OF SUCKING AND CHEWING PESTS OF HILL COTTON, *Gossypium arboreum* Linn. IN JHUM CULTURE"** submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (M. S.)** in **ENTOMOLOGY** embodies the result of a piece of *bona fide* research work carried out by **MONG SANUE MARMA** Registration No. **01505** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

Dated: June **2006**
Place: Dhaka,Bangladesh

(Professor Abdul Jabber Howlader, Ph.D.)
Supervisor
Advisory Committee

DEDICATED
TO
MY HEAVENLY FATHER

LIST OF ABBREVIATED TERMS

FULL NAME	ABBREVIATION
Agro-ecological Zone	*AEZ*
And others (at elli)	*et al.*
Cotton Development Board	CDB
Hill Cotton Research Station	HCRS
Hill Cotton - 1	HC- 1
Soil Resources Development Institute	SRDI
Degree Celsius	°C
Centimeter	cm
Meter	m
European Union	EU
Food and Agricultural Organization	FAO
Gram	g
Hectare	ha
Hour	hr
Kilogram	kg
Millimeter	mm
Month	mo
Number	no.
Percent	**%**
Randomized Complete Block Design	RCBD
Sher-e-Bangla Agricultural University	SAU
Square meter	**m^2**
Integrated Pest Management	IPM
Bangladesh Agricultural Research Council	BARC
Lady Bird Beetle	LBB
Red Cotton Bug	RCB
Dusky Cotton Bug	DCB
Praying mantid	P. mantid

ACKNOWLEDGEMENTS

The author is proud to express his deep sense of gratitude to, profound appreciation of and high regard for his honorable research supervisor Dr. Abdul Jabber Howlader, Professor. Department of Zoology, Jahangirnagar University, Savar, Dhaka. Without his sincere interest, intellectual guidance, scholastic supervision, valuable suggestions, constant encouragement and helpful advice, it would have been difficult to complete the research and dissertation within the stipulated period.

Cordial and sincere thanks are also expressed to respected Jahanara Begum, Professor, Department of Entomology, SAU, Sher-e-Bangla Nagar, Dhaka as cosupervisor of this work for her valuable suggestions and kind assistance with the preparation of this thesis.

The author expresses his heartfelt gratitude to the honorable teachers Dr. Md. Serajul Islam Bhuiyan, Professor; Former Professor Dr.Idrish Ibnal Azim; Dr. Mohammed Ali, Associate Professor; Md. Abdul Latif, Assistant Professor; Md.Razzab Ali,Assistant Professor; Md.S.M. Mizanur Rahman, Lecturer; other teachers at the Department of Entomology; Md. Zakir Hossain, Associate Professor; Noor Md Rahmatullah, Assistant Professor Department of Agricultural Statistics, SAU, Dhaka and Dr. Mossaraf Hossain, Professor Department of Entomology, BAU for providing encouragement during this work.

The author cordially and respectfully wishes to express his sincere thanks to the honorable former state Minister, Ministry of Agriculture and present state Minister. Ministry of Civil Aviation and Tourism, Mr. Mirza Fakrul Islam Alamgir for his kind help in facilitating this research.

The author is immensely appreciative of the fruitful encouragement received from Mr. Moni Swapan Dewan, Deputy Minister, Ministry of Chittagong Hill Tracts Affairs during the study.

Grateful thanks and appreciation are extended to Mr. Abdul Baten, former Executive Director; Mr. Shamsul Alam, present Executive Director, Mr.A.K.M. Amdadul Huq, Deputy Director; Mr.Golam Rasul, Senior Marketing Officer; Mr. Abul Kalam Azad, Seed Production Specialist and the officers and staff of the Cotton Development Board (CDB), Dhaka for their administrative help and encouragement during the study.

Mr. A.K.M. Abdur Rouf, Principal Scientific Officer (in charge), and the officers and staff of the "Hill Cotton Research Station", Balaghata, Bandarban generously provided the facilities and assistance necessary for the field research work.

Sincere appreciation is expressed to Md. F. Zaman, CSO, BJRI, Dhaka; Jalal Uddin Md. Shoaib, PSO, SRDI. Dhaka; Dr. Abul Khayer, Professor, Department of Botany, Jahangimagar University, Savar, Dhaka; Md.Kamal Uddin, Professor, Department of Crop Botany, SAU, Dhaka; Md. Abul Hossain, Cotton Agronomist; Md. Farid Uddin. Deputy Director, Ms Kamez Fatema, Training Officer, Cotton Development Board (CDB); Md.Osman Goni, Senior Assistant Chief; Md.Samimuzzaman, Assistant Chief, Ministry of Agriculture; Dr.Khalilur Rahman, Director (Manpower & Training), BARC; Md. Masuduzzaman; Dr. Ferdoushi Begum and Dr. Sk. M. Ahaduzzaman of DAE, Dhaka for their kind cooperation with this study.

Thanks and appreciation are extended to Almalinda C. Morales-Abubakar, former FAO/EU Cotton IPM Country Officer and Dr. Gillian W. Watson, Associate Insect Biosystematist Plant Pest Diagnostic Center, California Department of Food and Agriculture, USA for their encouragement during the study.

The author feels proud to express his sincere appreciation and heartfelt gratitude to Deputy Registrar Academic Khondker Selim Reza; Assistant Controller Khondoker Asaduzzaman of SAU, Dhaka; Mr. Aungsa Thoi Marma. Executive Director, Eco- Development and Mr Shourov Marma, Agriculture Officer of Caritas ICDP-CHT Bandarban. for their co-operation and inspiration of this research.

The author expresses his heartiest gratitude and indebtedness to his fellow MS students and well-wishers, especially Mr. Mong Sing Thowai Marma, final year student; Mr. Shyama Prashad Chackma, Semester 2, SAU and Mr. Uchimong Chowdhury, Project Officer, Oxfam GB, Bangladesh Program for assistance with preparation of this thesis on the computer.

Finally, the author expresses his deepest gratitude to his beloved mother, brothers, sisters, wife, fathcr-in-law, mother-in-law and all his relatives for their everlasting love, patience, unlimited sacrifice, encouragement and inspiration in all stages of these higher studies.

The Author

CONTENTS

CHAPTER	TITLE	PAGF
	ACKNOWLEDGEMENT	**vi**
	LIST OF CONTENTS	**ix**
	LIST OF TABLES	**xi**
	LIST OF PLATES	**xii - xiii**
	LIST OF APPENDICES	**xiii**
	ABSTRACT	**xiv**
CHAPTER 1	INTRODUCTION	1
CHAPTER 2	REVIEW OF LITERATURE	7
CHAPTER 3	MATERIALS AND METHODS	26
3.1 Description of the experimental site		26
3.1.1 ocation of the experimental site		26
3.1.2 1 condition		27
3.1.3 Climate		27
3.2 Experimental material		28
3.2.1 Cotton seed		28
3.2.2 Insecticides		28
3.2.3 Fungicide		28
3.3 Experimental detail		28
3.3.1 Prepation of experimental plots		28
3.3.2 Seed dressing		29
3.3.3 Seed sowing		30
3.3.4 Emergence		30
3.3.5 Mortality		30

CONTENTS (cont d)

CHAPTER	TITLE	PAGE
3.3.6	Application of fertilizer	30
3.3.7	Intercultural operation	30
3.4	hstimation of sucking and chewing insect -pest population	30
3.4.1	Procedure of threshold level for aphid, jassid and whitefly	30
3 .4.2	Procedure of threshold level for red cotton hug and bollworm	31
4.4.3	Estimation of insect pest populations during the plant reproductive stage	31
3.4.3(i)	Hand picking	31
(ii)	Beating	31
.(iii)	Sweeping with a net	31
(iv)	Pitfall trapping	32
(v)	Natural Enemies	33
(vi)	Identification of captured insect pest species	34
3.5	Estimation of threshold level of different insects	34
3.6	Application of Insecticides	34
3.6.1	The Arrangement of the plots under each treatment	35
3.6.2	Experimental treatments - A	36
3.7	Determination of plant characters	36
3.8	Assessment of insect population	38
3.9	Environmental data	38
4.0	Determination of yield and yield contributing characters of I Iill Cotton	38
4.1	Harvesting and Processing	38
4.2	**Statistical analysis**	**39**
CHAPTER 4	**RESULTS AND DISCUSSION**	**40**
CHAPTER 5	**CONCLUSION**	**62**
	REFERENCES	**64**
	APPENDICES	

LIST OF TABLES **70**

TABLE	TITLE	PAGE

Table-1.Effect of Vitavax-200 fungicide on the emergence of hill cotton (HC-1), *(iossypium arhoreum Linn.* *41*

Table-2.Influence of Vitavax-2(K) (fungicide) on the mortality of hill cotton, *(iossypium arhoreum* L. seedling starting from 21 to 49 days after sowing 43

Table -3.Effect of Vitavax-200 on the plant characters of hill cotton (HC-I) sowing *Gossypium arhoreum* Linn after 81 days after sowing 44

Table-4.Name of insects and their mean number collected during sweep netting on 81 days after sowing from various plots 46

Table- 5.Name of organisms and their mean number trapped in Pit Fall Trap on 155 days after sowing tirom various plots 47

Table - 6.The comparative Ahid populations before and after the I^{s1} and 2^{nd} application of different concentration of the Neembacidin and Roxiban 20EC 51

Table -7. Average Jassid and Whitefly population after 15 days of the I^{s}*, 2nd and 2^{nd} application of different concentrations Neembacidin and Roxiban 20EC in Hill Cotton (Hc-1) 53

Table-8.Effectiveness of different concentrations Neembacidin and Roxiban 20EC against Bollworm and Red Cotton Bug in Hill Cotton (HC-1) 55

Iable- 9.Effect of different doses of Neembacidin *(Azadirachta iruiica* A. Juss) and Roxiban 20EC on the yield and yield contributing characters of hill cotton (IIC-1) 59

LIST OF PLATES

PLATE	TITLE	PAGE
1	Bandarban sadar Upazilla and the middle portion (round blackpoint) is Hill Cotton Research Station (HCRS)	27
2	A Jhum cultivation land, steep slope, a small house for resting and a farmer weeding in the field	29
3	Several earthworms and some little ants were seen in the trap which was placed between the cotton crops	32
4	A lady bird beetle grub was eating aphids on the cotton leaf	33
5	A snake was found near the experimental field	33
6	A bird was found during the land preparation	33
7	A red dragonfly was sitting on the cotton leaf	33
8	Reproductive stage of Hill Cotton plant	37
9	Mixed cropping in Jhum cultivation, single row cotton and single row rice, okra type leaf narrow shape	37
10	Harvesting or picking stage (100% boll splitting) of Hill Cotton, tribal farmers are collecting the bolls, a special type of earring cage made by bamboo, locally known as thoroung	39
11	Cotton aphids colony and sucking sap from the leaf	52
12	Nymph (Jassid) sucking sap from the leaf	52
13	Affected cotton leaf by sucking insects	52

LIST OF PLATES (contd)

PLATE	TITLE	PAGE
14	Nymphs(Red cotton bug),sucking sap from splitting boll	56
15	Affected bolls by sucking pest of cotton	56
16	Cotton shoots were damaged by boll worm larva	58
17	An immature boll was affected by a bo 11 worm larva	58

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
1	Initial soil status of Hill Cotton Research Station (HCRS), BaJaghata and SRDI, Raicha experiment field in growing season	70
2	The average temperature, humidity and rainfall of Bandarban in growing season 2005	71
3	Spray log: Insecticide spray application in the experimental plot	72

MANAGEMENT OF SUCKING AND CHEWING PESTS OF HILL COTTON, *Gossypium arboreum* Linn. IN JHUM CULTURE

By

MONG SANUE MARMA

ABSTRACT

Hill Cotton (Malvaceae, *Gossypium arboreum* Linn.) is an important cash crop grown by the tribal farmers on hill slopes in the Chittagong Hill Tracts, usually as a component crop in Jhum cultivation (traditional shifting cultivation). Farmers sow the cotton seed together with other crops, eg. rice, maize, ginger, turmeric, banana, sesame, cassava and various fruits (Farid and Mujibullah.1990). A variety of pests are responsible for reducing the growth and yield of hill cotton. Among the insects pests sap-sucking species like cotton aphid (Homoptera. Aphididae, *Aphis gossypii* Glover), Jassid (Homoptera, Cicadellidae, *Amrasca biguttula* Ishida), Whitefly (Homoptera, Aleyrodidae,Z?t'me'.s/a *tabaci* Gennadius), Red Cotton Bug (Hemiptera. Pyrrhocoridae, *Dysdercus cingulatus* Fabricius) and chewing insects like the spotted bollworm (Lepidoptera, Noctuidae, *Earias vittella* Fabriciav) are the most damaging (Bohlen, 1984/85). This study evaluated the effect of two pesticides and a fungicide on the productivity of hill cotton in Jhum cultivation. A randomized complete block design experiment was conducted in the experimental fields of Hill Cotton Research Station, Balaghata, Bandarban Hill District to compare the effectiveness of a botanical pesticide (Neembacidin) and a synthetic organophosphorus insecticide (Roxiban 20EC) for the management of the infestation and damage by the above insect pests. Both products significantly reduced the number of psets; however, Neembacidin (derived from the tree. *Azadirachta indica* A.Juss, Meliaceae) provided better control of insect pests than Roxiban 20EC. The effectiveness of fungicide, Vitavax-200. was also evaluated for its role in cotton seedling emergence and mortality. Use of Vitavax-200 was found to have no effect on seedling emergence, but it significantly reduced subsequent seedling mortality in treated fields in comparison with the untreated controls. The results of the present experiment denoted that timely use of a fungicide, Vitavax-200 and a botanical pesticide, Neembacidin may prove to be of immense practical value for improving the production of hill cotton. *Gossypium arboreum* Linn, in the Chittagong Hill Tracts.

INTRODUCTION

Cotton is the most important textile fibre in the world. It is the second most important cash crop in Bangladesh, where it has been cultivated since very ancient times. The amount of raw cotton required to keep more than 152 textile mills in Bangladesh running is about 0.65 million bales of cotton lint per year. Currently only 12 — 15 % of this raw cotton requirement is supplied by cotton produced in Bangladesh; the country depends on the import of raw cotton (Iqbal. 2002).

The cotton plant belongs to the genus *Gossypium* (family Malvaceae). Two varieties of cotton, i.e. American cotton, *Gossypium hirsulum* Linn., which produces medium staple fibres and hill cotton or comilla cotton, *Gossypium arhoreum* Linn, which produces short staple fibres are grown in Bangladesh (Iqbal. 2002). American cotton has been grown in Bangldesh since 1977; short staple hill cotton (comilla cotton), was being grown in the Chittagong Hill Tracts (CHT) before 1977. Recently the Cotton Development Board (CDB) of Bangladesh has started an initiative to increase production of both American and Hill cotton. As a result, the two varieties of cotton have become important cash crops in Bangladesh.

In the past, *Gossypium arhoreum* Linn, was commercially known as comilla cotton but it is now known as hill cotton (Baten. 2005). Hill cotton is grown only in the Chittagong Hill Tracts (CHT).

I he hill farmers grow cotton in Jhum (shifting) cultivation. They intercrop the cotton with rice, maize, cassava, turmeric, ginger and various fruits (Farid and Mujibullah, 1990). The farmers produce yam from this cotton for making their own clothing. In addition, hill cotton has particular religious importance to the Buddhist community. They use cotton in their religious ceremony known as “Kathin Chibar Dan” means to provide clothing to the monks by making cotton cloth from lint within one day (24 hours). For this reason, the tribal people of the hill tracts area have been cultivating hill cotton for centuries.

Production of this historical crop is declining year by year. It is reported that during 1950 about 23,500 ha of land was brought under the cultivation for this crop, producing about 18.000 bales of lint cotton. However, after construction of the Kaptai Dam (1961- 1962) the hill cotton growing area was reduced to about 13,000 ha, producing 5,560 bales of lint cotton (Wadud and Moniruzzaman, 2001).

In the Chittagong Hill Tracts area, the pest complex in the hill cotton crop is very sensitive because of the topography and soil type. This pest complex includes sap- sucking insects, chewing insects and diseases of cotton. The commonest fungal diseases in Jhum-cultivated cotton fields of the Chittagong Hill Tracts is seedling blight (*Rhizoctoniia solani*) and wilt (*Fusarium oxysporum f sp vasinfectum).* It is reported that the plot may be damaged if the disease infestation increases, and application of the fungicide may reduce disease occurrence (Islam *et al*., 2005). These diseases are soil and seed borne and spread in water. If it rains during the cotton seed-sowing period, the

emergence of cotton seedlings becomes very poor, rhe high humidity and moderate temperatures (around 28 °C) typically found in the hilly area favours development of fungal diseases. Soil temperature and moisture at the time of sowing and few days after are important. Primary and secondary infections are favoured by temperatures between 30° and 35°C. Irregularly dry and hot weather also favours the development of diseases (Singh. 1973).

In the Chittagong Hill Tracts, hill cotton is cultivated during the kharif season. Different stages of the cotton plants (i.e. seedling, reproductive, maturity and harvesting stages) are attacked by insect pests. Infestation by insects depends on temperature, humidity and the quality of food available. Lists of important insect pests of hill cotton are given below.

List of insect pests of hill cotton in the Chittagong Hill Tracts, Bandarban.

SI. No.	Common name	Scientific name	Family	Order
1.	Cotton aphid	*Aphis gossypii* Glover	Aphididae	Homoptera
2.	Cotton jassid	*Amrasca higuttula* Ishida	Cicadellidae	Homoptera
3.	Cotton whitefly	*Bemisia tabaci* Gennadius	Aleyrodidae	Homoptera
4.	Red cotton bug	*Dysdercus cingulatus* Fabricius	Pyrrhocoridae	Hemiptera
5.	Spotted bollworm	*Earias vittella* Fabricius	Noctuidae	Ivepidoptera

Aphis gossypii Glover, commonly called the cotton aphid, belongs to the family Aphididae (order Homoptera). This insect has a large range of host-plants. In the past cotton aphid was considered to be of minor importance, but in recent years it has emerged as a major pest of cotton worldwide. Aphids attack the crop shortly after germination, and

are able to multiply very rapidly. They feed on phloem sap and excrete sugary “honeydew", which accumulates on the leaves and bolls. This sticky honeydew sometimes seriously reduces the quality of the lint (Bohlen. 1984/85).

Amrasca biguttula Ishida known as cotton leafhopper or cotton jassid. belongs to the Family Cicadellidae (order Homoptera) and is a major pest of cotton; it is possibly the most important cotton pest in Bangladesh. It has a wide range of cultivated host-plants. Jassid suck sap from tender parts of cotton plants, sometimes causing the edge of the leaves to curl downwards. Cotton jassid damage alone may reduce yield by 50 %, and damage by jassids and bollwoms together may reduce yield by as much as 70 % (Wadud and Moniruzzaman, 2001).

Dysdercus cingulatus Fabricius belongs to the family Pyrrhocoridae (order Hemiptera). In recent years, red cotton bug has been developing into a serious pest of hill cotton. The bugs attack the bolls, piercing them with long mouthparts to feed on the contents of the developing seed.

Spotted bollworm, *Earias vittella* Fabricius, belongs to the family Noctuidae (order Lepidoptera). The species is widely distributed in India. China, Pakistan. Vietnam. Thailand and Africa (Dhaliwal and Sing, 1981). The spotted bollworm is a major damaging pest of cotton, attacking the tender parts of the plants, i.e. shoots, squares, bolls etc. Sometimes it can cause about 50% reduction of the total yield of cotton (Sarker and Hossain, 2001). The alternative host of the spotted bollworm is okra. *Hibiscus esculentus*

Linn. In view of the loss of yield that insect infestation of cotton can cause, effective insect control measures are needed to improve cotton production. It has been reported that application of insecticides at 14-day intervals may balance the incidence of different species of insects (Sarker and Hossain, 2001); but there is also evidence that the indiscriminate use of pesticides causes phytotoxicity and the destruction of beneficial organisms like predators, parasitoids, microorganisms etc. (Bari and Sarder, 1998).

Insecticides and fungicides have direct effects on insects by inhibiting feeding, growth, reproduction and by killing natural enemies (Henrichs, 1968) and pesticide poisoning of field workers is also a serious concern. Consequently there is increasing interest in botanical pesticides as a less toxic, biodegradable alternative to synthetic chemical insecticides. Botanical pesticides are considered to be target specific, environment friendly and less dangerous to human health. Some of the botanical pesticides have high insectistatic activity, i.e. they disrupt the development of immature insects. Pesticide derived from the neem tree *(Azadirachta indica* A. Juss, family Meliaceae) has been tested against 309 species of insects (Dhaliwal and Romesh. 1996).

The schedule of insecticide spray applications against any particular insect is not fixed. It may vary between different crops, and depends on the pest insect population and the need to conserve natural enemies (Debach, 1970). The hill farmers usually apply insecticide on weekly or calendar-bascd schedule. There are reports from India that some farmers are using 20 or more insecticide sprays in single growing season (FAO-EU, 2003). Besides the resultant heavy financial burden on the farmers, the impact of such

massive use of poisons on the cotton field ecosystem and the environment is of major concern.

The Cotton Development Board (CDB) of Bangladesh was established in 1972 and has given special attention to hill cotton, in an attempt to increase production of this valuable crop. Collection of germplasm began in 1990. The Bangladesh Government established the Hill Cotton Research Station at Balaghata. Bandarban in 1994 (Wadud and Moniruzzaman, 2001) under the Chitagong Hill Tracts Integrated Development and Rehabilitation Project (CDB part), financed by the Ministry of Chittagong Hill Tracts Affairs. Clearly, for the economic development of the Chittagong Hill Tracts as well as the country as a whole. There is great scope to explore and develop the potential of this crop through comprehensive research programmes. Improved management and cultural practices, utilizing modem technologies, should be used to increase the yield of existing vareities or develop improved varieties. The present research was therefore undertaken to investigate the following aspect of hill cotton, *Gossypium arhoreum* Linn, in Jhum culture: (i) Investigation on the effectiveness of a botanical insecticide, Neembacidin. against sucking and chewing insect pests, (ii) Investigation on the effectiveness of a synthetic organophosphorus insecticide. Roxiban 20EC, for the reduction of sucking and chewing pest populations, (iii) Investigation on the effectivity of a fungicide (Vitavax- 200) to reduce hill cotton plant mortality and so increase productivity and (iv) Assessment of the impact of the above insecticides and fungicide for the overall improvement of hill cotton production.

REVIEW OF LITERATURE

Hill Cotton, *Gossypium arboreum* Linn, is generally sown in the month of April and May each year. The tribal farmers are cultivating this crop in the Jhum culture (Shifting cultivation, slash and burning) in the Chittagong Hill Tracts for centuries. Traditional methods are being applied during cultivation practices, rhe literature related to this crop has been found very limited in the country. Methods of land preparation, sowing, intercultural operations, harvesting and processing procedure of this historical cash crop are exceptional. However, a brief literature review has been presented in this chapter.

Ali *et al.* (1993) observed that the coccinellid beetle were dominant arthropod predators in cotton fields followed by the spiders and staphylinid beetle. Arthropod predators play a vital role in the suppression of insect pests. Information relating to the abundance and roles of these predators in the suppression of the insect pests in cotton field are the key inputs for a successful planning and execution of an integrated pest management system for cotton pests.

Amin *et al.* (1998) carried out an experiment at Comilla Cotton Research Station, Bandarban with hill cotton (*Gossypium arboreum* L.) sown in May 1998. The results showed that the 3 time spray application of organophosphorus insecticide in 30 days interval resulted the lowest number of Jassid and gave optimum production of cotton.

Amin *e t al.* (1999) conducted an experiment at Comilla Cotton Research Station, Bandarban, Matiranga - Khagrachari with Cotton, *Gossypium arboreum.* In

May 1999. They mentioned that 3 to 5 time spray of insecticide gave the highest boll (13)/ plant and yield 1454 kg / h seed cotton respectively.

Amin *el al.* (2001) stated that the application of insecticide spray should be done where the Red Cotton Bug was found single (adult / nymph) per 3 plants in the field.

Ahmed *et al.* (2003) stated that the square root transformation is usually applicabale for data in small whole numbers, i.e. number of soil organisms per unit area, the numbers may be small but may have remarkable difference from unit to unit.

Bari and Sardar (1998) carried out an experiment and observed that the bean, *Lablab purpureus* Linn, is a common and protein rich vegetable grown all over Bangladesh. During cultivation the growers face a serious problem with bean aphid. *Aphis craccivora* Koch (= *Aphis medicaginis* Koch). This sucking insect attacks various plant parts and inflicts considerable losses in the bean yield. The young plant seriously suffers from attack of bean aphid and may die. The indiscriminate use of pesticides causes phytotoxicity and destruction of beneficial organisms such as predators, parasitoids, micro organisms and pollinators.

Bohlen (1984/85) described the pest stages and life cycle of the cotton aphid. *Aphis gossypii* Glover,Aphididae, Homoptera.The females (there are no males) are up to about 1.5mm long and are usually darkgreen to black in colour.The females produce nymphs. They are usually greenish to yellowish.The nymphs resemble the adults but are smaller.

There are also winged females who are involved in the distribution of the species. The development of generation takes only few days at high temperature, the shortest being 4 days. Therefore, aphids arc able to multiply very rapidly. The attack of the crop by aphids may start shortly after germination. A characteristic symptom on young plants is the distortion and deformation of the leaves which looks different from those symptoms caused by Jassids. Aphids produce “honeydew” which is the sticky excreta of the pest. In serious infestation the honeydew accumulates on the leaves as a layer and black figure (shooty mould) grows on. Towards the end of the season the sticky honeydew might drop on the lint of open bolls, so that the quality of the lint is seriously reduced.

Bohlen (1984/85) stated that the Cotton jassid, *Amrasca biguttula* Ishida, belongs to family Cicadellidae and order Homoptera. The adult hopper is green in colour and about 3 mm in length. There are 2 black spots on the wings. The female lays the bananashaped eggs in the petioles and main veins of the cotton leaves, rhere are 5 nymphal instars. The nymphs resemble the adults but have no wings. Their development is completed within 1-2 weeks depending on the prevailing temperatures. With a 1 week egg incubation period the whole life cycle is terminated within 2-3 weeks. Heavy rainfall causes a reduction of the jassid populations. The cotton jassid is the most important pest in Bangladesh cotton besides the spotted bollworm. Already shortly after germination the young crop is attacked and the first clearly visible symptoms appear 2- 3 weeks after germination. The edges of the leaves curl downwards and turn their color into yellowish. In an advanced stage of attack the leaf edges turn red and the leaf blade becomes more curled and twisted. Finally the leaves are more or less completely red or brown and look

as though they have been burned by fire. In this way a cotton field can be completely damaged by the leafhoppers with no yield at all. It is the toxic saliva of the pest which causes the severe destruction.

Bohlen (1984/85) stated that tobacco is an important host plant of the Cotton whitefly, *Bemisia tabaci* Gennadius, Aleyrodidae, Homoptera. The cotton whitefly is a sucking insect related to aphids and jassids (Homoptera). The adults look like tiny, whiteflies but they are not related to the true flies, e.g. the housefly. There are 4 nymphal stages of which only the first one is mobile. The last one is called puparium because it is a kind pupal stage. It looks like a scale insect. The life cycle is completed within 2-3 weeks (in summer), rhe sucking activity of the pest can seriously affect the plants and consequently the yields. The nymphal stages produce “honeydew" like aphids so that plant growth and lint quality are reduced, depending on the degree of infestation.

Bohlen (984/85) stated that the Red Cotton Bug. *Dysdercus cingulatus,*
(Pyrrhocoridae. Hemiptera) is a brightly red and black coloured insect up to 18 mm body length. The adults have two circular black spots on the wings. The females lay the two yellowish eggs in the soil around the cotton plants. Within a few days the nymphs hatch and stay in the soil. The 2nd instar nymphs climb the host. There are 5 nymphal instars and the whole nymphal development takes 4 — 6 weeks. The nymph resembles the adult but are smaller and do not have wings. The adult bugs pierce with their long needle-like mouthparts through the boll wall and suck on the seeds. The injection of saliva during sucking into the boll causes the developing fibre to turn yellowish brown in colour

(cotton stainer). Serious damage to the lint is caused if the mouthparts of the bugs contaminated with fungus spores *(Nematospora* sp.) and this fungus is transmitted into the bolls where it damages the lint (internal boll rot). The nymphs also suck seeds but they are usually only able to reach the seeds of an open boll with their mouthparts. The sucking activity of the bugs (adults and nymphs) on the seeds will causes reduction in both the oil content and the germination rate.

Bohlen (1984/85) mentioned that the Spotted Bollworm, *Earias vittella* Fabricius, (Noctuidae, Lepidoptera) is a important pest of cotton in Bangladesh. The eggs are small, 0. 05 mm in diameter, bluish green in colour, with a crown like structure on top. Eggs are mainly laid on the young and tender parts of the plants of the plant like shoots, buds, bolls and leaves (lower side). The larva (caterpillar) is up to about 2 cm in length and varies to some extent in colour and external morphology. Typical is a large while mark on the back. The caterpillars have little spines only, but there are comparatively long hairs. The larval development takes about 14 days with 5 larval instars. Pupation of the larvae takes place either on the plant, usually between bracts and boll or the top 2- 3 cm of the soil. The pupa is enclosed in a cocoon. The moth is with loded. about 1.2 cm in length and has a typical brownish to general stripe on the forewings.The total life cycle takes more or less 1 month, depending on the prevailing temperature. There seems to be no true diapause stage so that up to 12 generations per year are possible. The spotted bollworm is the most important cotton pest in Bangladesh. The larvae cause serious damage by attacking the fruiting points like buds, flower and bolls. In older bolls usually the seeds are eaten. The attack on the buds causes the symptoms of “flared squares" with

the bracts opening thus leaving the bud unprotected. Within the first 2 months after germination of the cotton when no buds and bolls have yet developed, the spotted bollworm attacks the young plants as a “stalk borer” by tunneling from the tip down the stem.

Baten (2005) reported that the Comilla Cotton, *Gossypium arhoreum* Linn, presently termed as Hill Cotton is grown in the district of Rangamati. Bandarban and lChagrachari. Tribal fanners of Chittagong Hill Tracts have been growing Comilla Cotton on hill slopes in Jhum system as mixed crop with rice, maize, sesame, chilli, cucumber, millet, bean and other crops. Cotton is their main cash crop and a part of their religious and social tradition.

Chowdhury *el al.* (2003) carried out an experiment at Hill Cotton Research Station, Bandarban. with cotton, *Gossypium arhoreum* L. in May 2003 for the selection of insecticides (Cymbush 10EC @1.5 ml, Relothrin 10EC @ 2.0 ml, Decis 2.5EC@1.5 ml, and Ripcord 1.5 ml / 1 of water) against Bollworm .The threshold level of Bollworm 0.25 larva or 0.50 egg per plant was determined. The results were recorded that the Ripcord and Cymbush were successfully reduced the pest population.

Debach (1970) stated that the economic injury threshold is not a constant for a given pest species is often overlooked. It will be completely different in a crop that has been frequently sprayed as compared to the same crop which has been unsprayed or very little sprayed for a period of time. The decimation of natural enemies injury

are reached at much lower pest population levels because when natural enemies are eliminated the pest population resurge much more rapidly. An international conference on prediction, forecasts and assessment of economic threshold was held in Viena, Austria in 1969.

Dennis (1983) described that in by the Integrated Pest Management unit of the Queensland University, looper caterpillars *(Anomis flova)* were serious cotton defoliators. However, a large population of larvae was required before many significant reduction in leaf area index (LAI) was recorded. In experiments an artificial defoliation it was found that in general the critical LAI was 3.0 and the critical growth time was between the first flower to the first split bolls, but even than more than 25% defoliation was required to produce a significant yield loss. Aphid outbreaks are common young plants in spells of dry weather which clear up rapidly with the onset of rain. Plants may be defoliated during the aphid attack but there is no that the yield of cotton seed is affected. It is a greenhouse pest of Europe, especially on cucurbits. Recorded as a vector of about 44 virus diseases.

Dhaliwal and Sing (1993) worked with neem oil (30 % EC) against insect pests of cotton and showed that it was effective against *Amrasca biguttula* (Ishida), *Aphis gossypii* (Glover) and *Anophothrips dorsalis* (Hood) but did not show promise against *Pectinophora gossypiella* (Saunders).

Dhaliwal and Romesh (1996) stated that many chemicals protect the plants from pests and pathogens. As many as 2121 plant species have been reported to possess pest control

properties.But in addition to high insectistatic activity,plant species must possess some other characteristics for development into an ideal botanical insecticide.Till today, 450 to 500 species of insects have been tested with neem products and out of them 409 spp were reportedly susceptible at different concentrations. The names of the insect orders and their numbers those are susceptible to neem products are given below:Orthoptera24, Dictyoptera -6, Dermaptera -1, Phasmida -1, Isoptera -6, Hemiptera -82, Hymenoptera - 8, Coleoptera-79, Lepidoptera-36, Siphonaptera-4, Diptera-49, Thysanoptera-13.

Eugene (1992) reported that homopteran aphids, leafhopper psylids.whiteflies.scale insects and other homopterous pests are sensitive to Neem products to varying degrees. For in stance .nvmphs of leafhopper and plant hoppers show considerable antifeedent and growth regulating effects. Lepidoptera. from numerous field trial (notably on various moths), it appears that larvae of most lepidopterous pests are highly sensitive to neem. Indeed, it seems likely that armyworms. fruit borers, com borers and related pests will become the main target of neem products in the near future. Neem blocks them from feeding, although this effect is usually important than the disruption of growth it cause.

Farid and Mujibullah (1990) reported that the economic condition of the Chittagong Hill Tracts (CHT) area is declining. Lack of modem technology is constraint to higher agricultural production and threat to the natural resources in the area. The Chittagong Hill Tract was once very much potential economically.Her forest reserve was the onlysource of raw materials for Kamaphuli paper mills and Rayon mills. The area represents a total of 5093 square miles as per survey conducted by Canadian experts in 1966. Earlier, the

area was mainly occupied by medium and high hills. Presently, the area is increasingly becoming denuded due to faulty management of hills and agricultural practices at steep slope without any conservation measure. There are hill with altitudes of more than 3000 feet having steep slope and long slope. The total annual precipitation is also high (2000mm - 3550mm). The land topography and climate suggest that there can be more reserve forest than what exists. Conversely, agricultural practice under strict conservation system could be developed.

FAO-FU (2003) reported that about Harvesting White Gold - the I PM way, Insect pests are considered major constraints in cotton production. The most common pest control practice is to apply insecticide. In India, in irrigated cotton. 20 or more insecticide sprays per season are very common, often applied on weekly, calendar based schedule.

Gennadius *et al.* (1981) stated that the repeated use of synthetic, pyrethroid. cypermethrin and deltamethrin against bollworm of cotton in Thailand caused the resurgence of whitefly, *Bemisia tabaci.* Similarly, the continuous use of pyrethroids for the control of tobacco budworm and pink bollworm in south California resulted increase the population of whitefly. In India, the over dependence on synthetic pyrethroids for the control of whitefly resurgence in cotton. The out break of whitefly with twelve rounds of application of organophosphate and synthetic pyrethroids and the resurgence of cotton Jassid with repeated use of chloropyriphos @ 1.00 and quinalphos @ 0.50 kg a.i. / h and reported it to be major cause for increase population of Jassid during the flowering phase in recent years due the extensive use of these molecules for the

management of *Helicoverpa armigera* (Hubner) on cotton. The increase in population of Aphid, *Aphis gossypii* (Glover) on cotton with repeated use of synthetic pyrethroids has been observed by many workers.

Hossain *el al.* (2001/2002) conducted an experiment at the seed multiplication farm i. e. Sreepur. Sadarpur, Jagadispur in August 2001 to select the effective chemical (Monocrotophos, monocrotophos - pyrethroids, confidor, confidor - pyrethroids) against whitefly of cotton. The better result was obtained from the mixtured of pyrethroid and confidor.

Hossain *et al.* (2002 - 2003) was carried out an experiment with American Cotton, *Gossypium hirsutum* L. at Sadarpur, Jagadispur and Sreepur in July 2003. The experiment was justified for judicial application of insecticide in the cotton field. Spiny spotted bollworm. *Earias vittella* is the most damaging pest of cotton in Bangladesh.They destroy flowers, buds and bolls and 50% of the total population is damaged by the insect bollworm. The experimental result recorded that Ripcord 10EC received more sprays but the treatment of 10% Nemazol and Ripcord received less number of spray and successfully controlled the massive outbreak of bollworm incidence.

Hossain *et al.* (2004-2005) was conducted an experiment with American Cotton. *Gossypium hirsutum* L. at Sadarpur, Jagadispur and Sreepur in August 2004. They studied the effect of a seed treating chemical (Gaucho) along with restricted use of pyrethroid which would assure the possible degree of safety. The result was promoted the

safer production and less damage to the environment.

llenrichs (1968) mentioned that insecticides and fungicides have a direct effect on insects by inhibiting or stimulating, growth, feeding, reproduction and indirect effect through destruction of natural enemies a through host plant mediated effects. The extent of the direct effect of insecticides and fungicides on insects is dose dependent. They may be toxic at high dosages and stimulate insect growth and reproduction at low dosages.

Ibrahim and Karim (1991) found that the population of cotton jassid *(Amrasca biguttula* Ishida) remained below the tentative economic threshold level (one jassid / leaf) up to 35 days of the plant age in the kharif cotton and 65 days of the plant age in the rabi cotton. Most of the jassids were found in 35-75 days old cotton plants in the kharif and 65- 130 days old cotton plants in the rabi season.

Islam (2005) conducted an experiment at the Hill Cotton Research Station in May 2005 and fertilizer doses were applied. Urea 135kg, TSP 67kg. MP 75kg and Gypsum 50 kg / ha for hill cotton cultivation.

Islam *el al.* (2005) an investigation was taken to evaluate the suitable fungicide to control the seedling blight *(Rhizoclonia solani)* and wilt *(Fusarium oxysporum*) with hill cotton (HC-1) at Hill Cotton Research Station in May 2005.The fungicides were Dithane M-45, Tilt 250 EC, Ridomyl Gold 68WP and Knowin 50WP. The results showed that the Dithane M-45 performed the best in reducing the seedling mortality ot hill cotton.

Iqbal (2002) evaluated that at present two species of cotton are grown in Bangladesh. *Gossypium arboreum* (local known as Comilla Cotton) is grown mainly in hilly areas of the country as Jhum (shifting cultivation through slash and bum) cultivation. Yield in this case is very low, as grown as a mix with many other crops and without any fertilizer. On the other hand, research result shows that, if comilla cotton is grown in the hill foot as a sole crop or inter-crop with aus paddy or com, production could be doubled. At present an area of nearly 1400kg/h comilla cotton is grown. Once famous for its "Muslins" fabrics, Bangladesh meets now only. 12 - 15 % the total requirement of raw cotton. At present 0.65 million bales of lint are required for the 152 textile industries of the country.

Mathews (1984) stated that the techniques for estimating insect pest populations sweep net catches. The net is swung horizontally backwards and forwards through an arc of 180° with the open end perpendicular to the ground. On rice, ten sweeps per plot are recommended, particularly for leafhoppers feeding on the upper parts (the top 25 cm), which one sweep for each step forward. The mouth of the net must be closed as soon as sweeping is completed. The efficiency of sweeping does vary with the methods adopted by different individuals, the stage of the crop, and particularly its height, weather condition including wind speed, temperature and intensity of solar radiation.

Mollah *et al.* (1995) pointed out that cotton was more promising than other Rabi crops; particularly pulses and oil seeds. The annual requirement of raw cotton lor running more than 56 textile mills in Bangladesh is about 0.4 million bales, almost all of which is

imported for foreign currency amounting to I k. 4000.0 million. The existing mills are inadequate to meet the cloth requirement of about 1200 million yards for about 114 million people ol the country. An additional 0.265 million bales of cotton will be required to meet the requirement. Considering the scarcity of foreign exchange, the government has given priority to produce medium staple American cotton in selected areas in this country to meet the requirement of the local textile mills.

Mohan *et al.* (2000) observed that perpetual immunity of *arboreum* cotton to grey mildew *Gossypium arboreum* Linn, is native of India which is cultivated in about 25 % of the total area under cotton, contributing about 18 % to the total population. *Arboreum* cottons are usually coarse, short fibre quick absorbent, suitable for chemical treatment, easily washable and need little pressing. It is low yielder but has high degree of resistance to insect pests and diseases, drought and have wider adaptability to harsh agro- climatic conditions. Seven germplasm lines immune to grey mildew disease namely, EC 174092, Ci 135-49, belonging to *Gossypium arboreum* race Bengalense and the “30805”, “30814”, “30826”, “30838”, and “30836” belonging to *Gossypium arboreum* race Cemum have been identified as the sources of resistance under repeated course of artificial inoculations of the disease.

Munro (1987) stated the origin of cotton. Textile fibres. Evolution of cotton lint, Tetraploid cotton. Early cotton textiles. Spread of the tetraploid cottons, production and consumption, the nineteenth century, short - staple cotton, cotton varieties, the order malvales, the cultivated cottons, the cotton plant. It may be supposed that the cultivated

herbacium cotton were domesticated from the Arabian and Baluchistan race *acerifolium*, and that *arboreum* was first brought into cultivation in Gujerat and Sind. The coarsest counts, *arboreum* cottons with a staple of less than 20 mm (13 / 16), are grown in the Punjab and Haryana Provinces in the north , and in adjoining districts of Uttar Pradesh; *arboreum* and *hirsutum* varieties with staples between 20.5 and 24.5 mm.

Pandey (1998) stated that the eastern region consists of Orissa. West Bengal, Bihar. Assam. Manipur and Tripura. The cotton production in this region is very small. The only cotton of commercial importance called Comillas, is cultivated in the hilly areas of Assam. Manipur and Tripura. The main cotton crop grown in Garo hills is *Gossypium arboreum* race burmanicum; on the Tripura hills it is mainly race bengalense; on the Manipur hills the race is sinerse; and on the Husbai hills, bordering Mayanmar. the race are bengalense and burmanicum. In Assam, cotton is sown in April to May. In West Bengal and Bihar, it is sown in May to June. Picking of bolls starts in October in all monsoon of cotton. Harvesting is completed by December in Assam and continues up to March in Orissa and West Bengal. The rabi cotton comes to harvest during February. The cotton varieties grown in these regions are as short staples.

Pedigo (2002) stated that the conventional insecticides for management, Neem insecticide-Neem tree. *Azadirachta indica* A. Juss (Family-Meliaceae) is believed to deter insect feeding and oviposition and interfere with growth, development and reproduction. Neem insecticide is currently marked under the trade names and these are Azatin®, Align*, Turplex*, Neemachtin[1]* and others.

Prasad (2002) mentioned that pests which causes economic loses, Jassid *(Amrasca biguttula),* Aphid (*Aphis gossypii),* Whitefly (*Remisia (abaci),* Bollworm (*Earias vittella*) .He also mentioned that disease of cotton can be classified as foliar, soil or seed bom. Diseascas are bacterial leaf blight (*Xanthomonas axonopodes* pv. *malvacearum*), leaf spot caused by (*Alternaria macrophora roridum).*

Rashid *et al.* (1997) stated that the area, i.e. Khagrachari, Chittagong Hill Tracts, Bandarban. Chittagong, Cox's bazaar, Hobiganj and molvibazar district. Small areas occur along the northern border of Sherpur. Mymensingh. Sunamganj and Sylhet district, in central and south eastern Sylhet and in the east of Brahmanbaria, Comilla, Feni district. 18171 km^2 (1817100 ha) Northern and Kastem Hills are the 29 number of Agro-Ecological Zone (AEZ) in Bangladesh.

Rouf *et al.* (2003) carried out an experiment at Hill Cotton Research Station, Bandarban, with cotton, *Gossypium arhoreum* L. in May 2003 for the selection of insecticides (Chloropyriphos 20EC@ 3.0ml, Metasystox R-25EC @ 3.0ml. Fefen 20EC @ 3.0ml / 1 of water) against Aphid, Jassid and Red Cotton Bug. rhe threshold level of insects were Aphid 1.5 grade/plant, Jassid 2 nymph or adult / plant and Red Cotton Bug nymph or adult 1/3 plant were determined, rhe results were recorded that 5 sprays of Metasystox performed (Aphid 0.76Jassid 1.21, Red Cotton Bug 0.22) the best.

Sarker and Hossain (2001) carried out an experiment and the results were the Spiny spotted bollworm (*Earias vittella* F.) is the most serious pest in Bangladesh, they

destroyed flowers, buds and bolls and damaged 50% of total production.The farmers used the spray at 14 days interval as well as whitefly *(Bemisia (abaci).*

Schmutterer (1981) stated that the last decade the neem tree, *Azadirachta indica* has come under close scientific scrutiny as a natural source of novel pest control material.Scale insects, mealy bugs (Coccoidea) National Research Council, 1992, many Homopteran insects, particularly plant hoppers, leaf hoppers and aphids are highly sensitive to neem products.

Singh (1973) stated that the high humidity and moderate temperature (28°C) favour development of the disease. Soil temperature and moisture at the time of sowing and a few days after are important. Primary infection is favoured by a temperature of 30°C and secondary infection is better at 35°C. Presence of moisture is very important for secondary infection during the first 45 hours. Dry and hot weather retards development of the disease

Uddin *et al.* (1993) conducted an experiment and the results were 3 sprays of cypermethrin (0.007%) 7 days after sowing , at flowering and at pod setting offered the lowest percentage of leaf infestation (green jassid, *Empoasca kerri*, Pruth). In Bangladesh, although cowpea *(Vigna unguiculata* L.Walp) is cultivated mostly in the district of Chittagong, Chittagong Hill Tracts. Noakhali, Dhaka, l angail, Comilla and Barisal. It has reported that the insect problems are serious mostly in the African countries.

Upadhyay *el al.(* 1998) stated the cotton pests constitute one of the major limiting factors in cotton production. Among 162 species of insects that are associated with the crop of India about 12 species are of major importance accounting for loss in production.

I hey are sucking pests, viz. jassid *(Amrasca higuttula* Ishida), aphid *(Aphis gossypii* Glover), whitefly *(Bemisia tahaci* Gennadius), spotted bollworm *(Earias vitiella* Fabricius) and others.

Venugopal *et al.* (2003) stated that as many as 130 species of insects, few mite species are known to attack cotton crop in the field. However in India five sap feeders viz., jassid *(Amrasca higuttula)',* thrips *(Scirtothrips dorsal i);* aphis *(Aphis gossypii*); white fly *(Bemisia tahaci)',* red spider mite (*Tetranychus urticae*); spotted bo 11 worms *(Earias vittella)',* pink bollworm *(Pectinophora gossypiella)* and foliage feeder, tobacco caterpillar *(Spodoptera litura)* are regular in occurance in different areas. In some areas stem weevil *(Pempherulus affinis)* is also problematic.

Wadud and Moniruzzaman (2001) mentioned that insect pests are the major limiting factors for achieving satisfaction in all most cotton growing countries of the world. Cotton jassid *(Amrasca higuttula)* and different types of bollworm *(Heliothis armigera. Earias vittella, (Pectinophora gossypiella)* appears very insect pests of cotton in Bangladesh.The cotton jassid alone may reduce yield by 50% and along with the bollworms, it may reach up to 70%. Comilla Cotton: the historical background of the Comilla Cotton Research Station including 3 sub station has established in 1994. Before 1947 the report said about 25,000 ha of land was taken under this crop to cultivation.

During mid 1950 about 23.000 ha of land was brought under this crop production and producing lint was 18,000 bales. After Kaptai Dam (1961-1962) the area come down about 13,000 ha which production lint was 5,560 bales.

Walia and Parmer (1972) demonstrated the systemic antifeedent action of neem. Young bean plant systematically treated with neem kernel suspension were hardly damaged by Schistocerca adults. Systemic antifeedent action was also evidenced by low food intake by *Nilaparvata Iugens* female on rice plants grown in soil treated with neem cake.

Watson (2003) stated that keeping arthropods alive for longer will enable innovation and creativity in insect zoo experiments, providing farmers with new learning opportunities. Once a critical masses of 10 - 15 % of farmers have developed these skills, they will be able to pass on their knowledge to other farmers. Better arthropod identification and handling techniques will improve the quality of ecosystem analysis in the 1PM for Cotton in Asia Programme.

Zaman *et al.* (2004) carried out an experiment at Hill Cotton Research Station, with hill cotton (HC-1), *Gossypium arboreum* L. in May 2004. The seed treating fungicides were Bavistin, Vitavax-200, Tilt and Ridomyl Gold. The best result was obtained from Vitavax-200 and the seedling mortality was 36 %.

Zaman *et al.* (2004) conducted an experiment was carried out at the Hill Cotton

Research Station in May 2004 with the same objectives. The results of the 2 years were showed that Metasystox R-25EC was highly effective to control Aphid, Jassid and Red Cotton Bug of Hill Cotton.

Zaman *et al.* (2005) carried out an experiment with hill cotton , *Gossypium arhoreum* L .at Hill Cotton Research Station in May 2005 to find out the effective doses of Perfekthion 40EC .The result was showed that 4.0ml to 5.0 ml / 1 of water performed the best control sucking pest of hill cotton.

Zaman *et al*. (2005) carried out an investigation to study the suitable fungicide to control the seedling blight *(Rhizoctonia solani*) and wilt (*Fusarium oxysporum*) with hill cotton (HC-1) at Hill Cotton Research Station in May 2005. The fungicides were Dithane M-45, Tilt 250 EC, Ridomyl Gold 68WP and Knowin 50WP. Among the fungicides Dithane M-45 performed the best in reducing the seedling mortality of hill cotton.

From the review of literature, it is clear that a very few informations are available for the management of Hill Cotton cultivation. Available information showed that most of the works have been done to focus the types of insects, its infestation; disease and its infestation; chemical insecticide, botanical pesticide, environmental effect and their application in cotton production. The present study, therefore, would help to understand the cultivation practices of Hill Cotton, *Gossypium arhoreum* Linn, in jhum culture.

MATERIALS AND METHODS

The research was conducted to evaluate the effectiveness of a botanical pesticide (Neembacidin, derived from the neem tree, *Azadirachia indicu* A. Juss, Mcliaceae) and a synthetic organophosphorus insecticide (Roxiban 20EC) for the suppression of sucking and chewing pests of Hill Cotton (HC-1), *Gossypium arboreum* Linn, in Jhum culture. Infestation by the following sucking pests (Aphid. *Aphis gossypii* Glover; Jassid, *Amrasca higullula* Ishida; Whitefly, *fie mis* ***Ia*** *tahaci* Gennadius; Red cotton bug. *Dysdercus cingulatus)* and chewing pests (Spotted bollworm. *Earias vittella* Fabricius) were studied. Investigations were also undertaken to assess the effect of a fungicide (Vitavax-200) and the above mentioned insecticides for the improvement of the cotton productivity.

3.1 Description of the experimental site

3.1.1 Location of the experimental site

The area of Chittagong Hill Tracts represents a total of 5093 square miles with hills reaching altitudes of more than 3000 feet (Farid and Mujibullah.l990).The experimental site was located at longitude 22° 10'48" N and latitude 92° 12T3"E, height 650 feet (approximately) above msl (mean sea level).

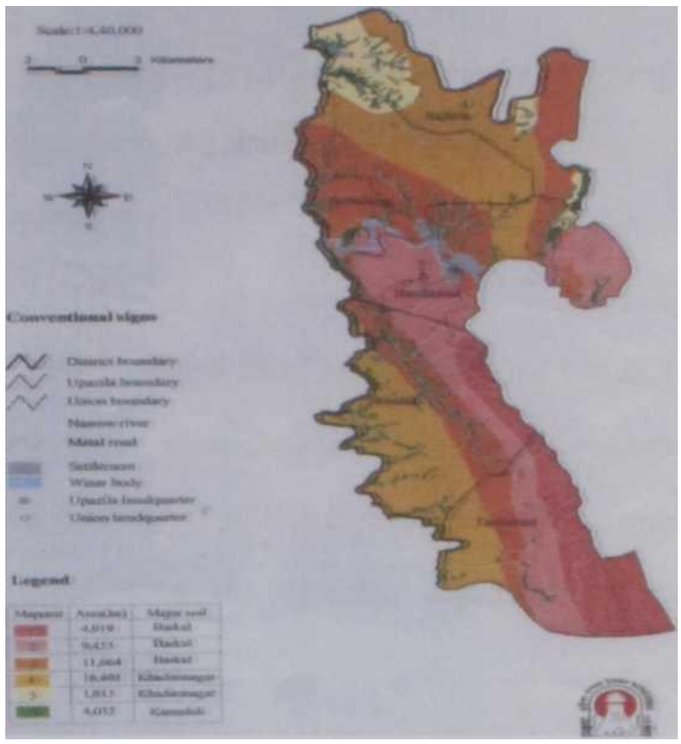


Plate-1. Bandarban Sadar Upazilla and the middle portion (round black point) is Hill Cotton Research Station (HCRS)

3.1.2 Soil condition:

The experimental site was on a steep slope, about 45° to 60° from the bottom level. The soil of the experimental plot was sandy loam in texture. P^{11} values ranging from 5.0 to 5.3; the status of soil nutrients was fairly suitable for cotton cultivation(Appendix- 1).

3.1.3 Climate:

The climate of the experimental area is subtropical and belongs to the Northern and Eastern Hills under the Agro-Ecological Zone (AEZ) number 29 (Rashid *et al.*, 1997). In the rainy season (April to September), it rains heavily. Usually winter starts in early

October, when the temperature fall to mean monthly maximum, minimum and average temperatures were 33.07°c, 23.63°c, 28.36°c respectively. The total average monthly rainfall was 261.8 mm (Appendix-2). These values were known from the Soil Resources Develpoment Institute (SRD1), Bandarban which about 8 km from the HCRS.

3.2. Experimental material:

3.2.1 Cotton seed:

Hill cotton is a bushy annual plant belonging to the family Malvaceae that usually produces white fibres on the seeds. Recently, the Cotton Development Board (CDB) of Bangladesh released a new variety of Hill Cotton (HC-1), *Gossypium arboreum* Linn.The HC-1 seeds were supplied by the Breeding center. Hill Cotton Research Station. Balaghata. Bandarban.

3.2.2 Insecticides:

A botanical pesticide. Neembacidin *(Azadirachta indica* A. Juss) and a synthetic organophosphorus insecticide, Roxiban 20EC were purchased from the local market in Bandarban.

3.2.3 Fungicide:

Vitavax-200 fungicide was obtained from the laboratory of the Hill Cotton Research Station (HCRS). Balaghata, Bandarban.

3.3 Experimental details:

3.3.1 Preparation of experimental plots:

Twenty seven plots (each 3 x 3 m) separated from each other by a gap of at least lm, were used in the experiment. First the jungle (bushy plants, small trees, creepers, vines etc.) were cut down (slashed) and allowed to dry for about 20 days before burning. Then

Plate- 2. A Jhum cultivation land, steep slope, a small house for resting and a farmer weeding in the field

any unbumed parts of plants and roots were removed from the plots, which were left for few days to reach a suitable codition for cultivation. When the conditions became suitable for zero tillage cultivation, the experimental plots were laid out.

3.3.2 Seed dressing:

The fuzz of the cotton seeds was removed by hand with the help of sand. The seeds were treated with a fungicide(Vitavax-200) before sowing. About 3g of the Vitavax-200 was added to 200 - 250 ml of tape water. Then 1kg of fresh hill cotton (HC-1) seeds were dipped into the solution, agitated for 5 minutes with a stick for proper mixing of the fungicide over the grains. The grains were then removed from the solution and sun dried over a news paper for an hour. Thus, the grains were ready for sowing.

3.3.3 Seed sowing:

There were 60 pits in each experimental plot. In each pit 5 seeds were sown together. Unlike usual Jhume culture cotton alone was cultivated in the plots. To protect the soil erosion from the hill the seeds were sown across the hill.

3.3.4 Emergence:

The emergence of the cotton seeds were recorded up to 11 days after sowing.

3.3.5 Mortality:

The mortality of the seedlings was recorded up to 49 days after sowing in every 4 days interval.

3.3.6 Application of fertilizer:

Urea. TSP, MP, Zypsum were used at a dose rates of 135, 67, 75 and 50 kg per ha (Islam, 2005). The fertilizers were applied following the usual procedures of farm standard.

3.3.7 lntercultural operation:

Each plot was weeded after 20, 40, and 60 days of sowing. Thinning was done after 49 days of sowing. Other intercultural operations were done when needed.

3.4 Estimation of sucking and chewing insect -pest population:

3.4.1 Procedure of threshold level for aphid, jassid and whitefly:

For the estimation of aphid, jassid and whitefly population in the experimental plots. 5 plants were randomly selected from each plot, each time. The number of each type of insect on each plant was counted and recorded. The means of insects per plant was calculated for the determination of threshold level of the pest species. This procedure was followed to all selected stages of the pests.

3.4.2 Procedure of threshold level for red cotton bug and bolhvorin:

For the estimation of threshold population of red cotton bug and bollworm, 15 and 20 plants per plot were randomly selected respectively. Rest of the procedures was essentially alike as described above.

3.43 Estimation of insect pest populations during the plant reproductive stage:

The populations of different types of insects present on cotton plants at the reproductive stage were estimated by hand picking, beating, sweeping, pitfall trapping method and the description of the methods were given below.

3.4.3(i) Hand picking:

Red cotton bugs were collected from the cotton plants by hand picking. Clusters of nymphs, found setting on the half-split bolls, were collected by hand. The number of red cotton bugs collected was recorded.

(ii) Beating:

In some plots a large piece of cloth was spread on the ground under the plants, then each plant was bent over the cloth and vigorously shaken with a stick. The insects dislodged from the plant fell on the cloth and were collected. The number of red cotton bugs collected was recorded.

(iii) Sweeping with a net:

During the sweeping, the net was swung horizontally to and fro (Methews, 1984), then the mouth of the net was closed. On each sampling occasion, 3 sweeps of the net were randomly done in each plot. The insects accumulated in the net after sweeping on each plot were transferred into a polythene bag. which was sealed and labeled. Collected insects were anaesthesized within the polethyne bag using chloroform-soaked

cotton, then the types of insects and their numbers were counted and recorded.

(iv) Pitfall trapping:

Pitfall traps were set up in the experimental plots (140 days after sowing). The traps (each consisting of a plastic pot with about 1cm of dilute detergent in the bottom, almost completely sunk into the soil) were set up between the cotton rows. Three pitfall traps were used in each plot each time and the traps were placed in a triangular arrangement. Fifteen days after, the organism in each trap were identified, counted and recorded.

Plate-3. Several earthworms and some little ants were seen in the trap which was placed between the cotton rows

(v) Natural Enemies:

The natural enemies of insects or organisms present in the experimental plots were investigated in the period between the maturation of the crop and harvesting.

Plate- 4. A lady bird beetle grub was eating aphids on the cotton leaf

Plate- 5. A snake was found near the experimental field

Plate- 6.A bird was found during land preparation

Plate- 7.A red dragonfly was sitting on the cotton leaf

(vi) Identification of captured insect pest species:

Insects collected from the experimental plots were identified with the help of taxonomic keys in books, journals, field guides, handbooks and booklets (Watson, 2003). Assistance with difficult identifications was received from specialist at the Hill Cotton Research Station (HCRS), Balaghata, Bandarban.

3.5 Estimation of threshold level of different insects:

The threshold level for each sucking and chewing insect was followed the procedure recommended by the Cotton Development Board (CDB) of Bangladesh, as described in Chowdhury *et al.* (2003) and Rouf *et al.* (2003) respectively. Each level was expressed in terms of the number of that insect type and stage per plant. Threshold levels of the different insect pests are given below:

(i) Aphid 1.5 grade / plant.

(ii) Jassid 2 (nymph or adult) /plant.

(iii) Whitefly 5 to 6 (nymph or adult) /plant

(iv) Red cotton bug 1 (nymph or adult) / 3 plant

(v) Bollworm 0.25 larva or 0.50 egg / plant

3.6 Application of Insecticides :

A botanical pesticide, Neembacidin, derived from the tree *Azadirachta indica* A. Juss and a synthetic organophosphorus pesticide, Roxiban 20EC were tested in the experiment. Each pesticide was applied using a separate knapsack sprayer, to avoid any risk of cross contamination. The cotton plots were divided into 9 treatments, they were marked as I'j - T_9

respectively and each treatment had 3 replications. Plots of T|, T_2, T_3 and I_4 were treated with Neembacidin at a dose rate of 1.5, 2.0, 2.5 and 3.0 ml / 1 of water respectively. Plots of T_5 T_6. T_7 and T g were sprayed with Roxiban 20EC at a dose rate of 1.5, 2.0, 2.5 and 3.0 ml / 1 of water respectively. The amount of insecticide sprayed in each field was at a rate of 200 liters water / ha. The plot T_9 was maintained as an untreated control i.e. same volume of water was sprayed each time, without any insecticide. Infestation of aphids, jassids and whiteflies were recorded on July 6, 2005. and the first insecticide spray was applied on same day. Each insecticide was applied four times at intervals of 15 days, on July 6, 21, August 5 and 20, 2005. Calendar-based spray applications were made at 15 days intervals, on July 6, 21, August 5 and August 20, 2005. fhe spray log is given in Appendix 3.

3.6.1 Arrangement of the plots under each treatment:

fhe Arrangement of the plots under each treatment are shown below

Replication- 1	Replication- 2	Replication- 3
T,	t_2	t_3
t_2	t_3	t_4
t_3	t_4	t_5
t_4	t_5	t_6
t_5	t_6	t_7
t_6	t_7	Tg
t_7	Tg	I_9
T g	T_v	T,
t_9	T,	t_2

3.6.2 Experimental treatments - A

1 he experimental details about the application of vitavas-200, Neembacidin and Roxiban 20EC were given below.

Treatments	Doses of Vitavax-200 g / kg seed	Doses of Neembacidin ml / ₁ of water	Doses of Rexiban 20EC ml / ₁ of water
T,	3	1.5	
t_2	3	2.0	
t_3	3	2.5	
t_4	3	3.0	
t_5	3		1.5
t_6	3		2.0
t_7	3		2.5
t_8	3		3.0
T 9 Water spray only during applying of insecticide			

3.7 Determination of plant characters:

The plant characteristics were observed during the reproductive stage of the cotton plants. Each plant was characterized on the basis of following features of five plants (chosen randomly) from each plot.

(a) Height / plant (b) Branches / plant (c) Leaves /plant

(d) Squares / plant (e) Flowers / plant (0 Bolls / plant

Plate- 8. Reproductive stage of hill cotton plant, broad leaf

Plate-9. Mixed cropping in Jhum Cultivation, single row cotton and single row rice, okra type leaf, narrow shape, reproductive stage of hill cotton

3.8 Assessment of insect population:

The incidences of insect pest populations on different plots were assessed on 81 days after sowing. This was done by direct observation and counting of the number and types of insects from live plants (randomly selected) on each plot.

3.9 Environmental data:

The environmental data (rainfall, temperature and humidity) for the experimental area were obtained from SRDI, bandarban and are shown in appendix- 2.

4.0 Determination of yield and yield contributing characters of Hill Cotton:

The survival of the hill cotton plants at the boll-picking stage, the number of insect- damaged and undamaged bolls, plot yield and yield (kg) / ha of the plots of treatment was determined and compared with each other.

4.1 Harvesting and Processing:

The first picking of bolls was done when 50% of the bolls in the plots were split, on November 15. The collected bolls were dried and preserved for analysis. The second and third (final) pickings were done on November 25 and 30.

Plate - 10.Harvesting or picking stage (100 % boll splitting) of hill cotton, tribal farmers are collecting the cotton bolls, a special type of carrying cage made by bamboo, locally known as thoroung

4.2 Statistical analysis:

All recorded data were analyzed with the Analysis of Variance (ANOVA), DMRT and differences between treatment means were adjudged using a square root transformation, in a Microsoft Statistical (Mstat) programme. The statistical analyses were done following the method described by Ahmed, *et al.,* 2003.

RESULTS AND DISCUSSION

A Jhum culture experiment was conducted with the hill cotton, *Gossypium arboreum* Linn, to evaluate the efTect of a fungicide (Vitavax-200) a botanical pesticide (Neembacidin) and a synthetic organophosphorus pesticide (Roxiban 20EC). The experiment was conducted at the Hill Cotton Research Station. Balghata, Bandarban.

The mean number of hills of the Vitavax-200 (fungicide) treated and control fields having emerged hill cotton seedlings up to 11 days of sowing are presented in Table - 1. Up to 4th day of sowing, no emergences of the cotton seedlings were found both in the Vitavax-200 treated and untreated fields. No observation were made on 5th and $_{6}$ th days because of heavy rain. On 7th day of sowing the respective average percentage emergence of the seedlings were 20, 20, 30, 20, 23, 28, 30, 23 and 27 respectively. Similarly no observations were done on $_{8}$ th and 9th day due to same reason as mentioned above. So, it may be safely noted that the Vitavax-200 fungicide has no significant effects on the emergence of hill cotton seedlings. The respective percentage of emerged seedlings in the treated and control fields after 11 days of sowing were 71.5 and 67. It was noted that on 10°' day of sowing around 40 % of the seedlings emerged. It was very interestingly noted that about 30 % of seedlings emerged between 10 and 1 l'^{h} days of sowing in both the Vatavax-200 treated and control plots.

The experimental results showed that the fungicide had no effect on emergence of the seeds. Significantly higher number of the hill cotton plants were recorded in the fungicide

Table-1. Effect of Vitavax-200 fungicide on the emergence of hill cotton (HC-1), *Gossypium arboreum* Linn.

Vitavax treated plots	Average percentage of hill numbers having emerged seedling on days after sowing							Percentage total emergence
	1	2	3	4	7	10	11	
1	0	0	0	0	12	25	43	72
2	0	0	0	0	12	20	41	68
3	0	0	0	0	18	23	45	75
4	0	0	0	0	12	21	44	73
5	0	0	0	0	14	24	42	70
6	0	0	0	0	17	26	44	73
7	0	0	0	0	18	25	43	71
8	0	0	0	0	14	20	42	70
9 Control plots	0	0	0	0	16	26	40	67

Each datum represents average of three

replications. Zero (0) means no emergence.

treated fields than that of the fields where the vitavax-200 were not used.Due to the use of the fungicide better growth of the cotton plants were recorded. The mortality of the Mill Cotton (HC-1) *Gossypium arboreum* Linn, recorded from the vitavax-200 (fungicide) treated and control plots from 21 to 49 days of sowing are presented in I able- 2 .Each datum represents the average numbers died seedlings recorded from 2 rows out of 6. It was noted that significantly higher number of cotton plants died in the field where vitavax-200 was not used and average of 3.5 plants died in the vitavax-200 treated plots. Whereas, on the same day, the average number of died plants in the control plots were 6.The number of died plants increased as the age of the plants increased. The average number of died plants in vitavax-200 treated and control fields were 39.25 and 61 respectively.

The average height of the plants, number of branches, number of leaves, square number, flower number and boll number per plant of the vitavax-200 treated and untreated fields after 81 days of sowing of the hill cotton plants are presented in Table- 3. The respective number of average leaves on the vitavax-200 treated and control plants were 43.94 and 39.4 (Table- 3). The number of squares in the vitavax-200 treated plants were also slightly higher than that of the squares produced in control plants (Table-3). The average square number produced in vitavax-200 treated and untreated plots were 5.38 and 4-6 respectively. Interestingly, higher number of flowers were found in the control plants than that of the vitavax-200 treated plants. The respective average number of flowers produced in the vitavx-200 treated and control plants were 0.58 and 0.7 (Table-3). Though the numbers of flowers produced

Table-2. Influence of Vitavax-200 (fungicide) on the mortality of hill cotton, *Gossypium arboretum* Linn, seedlings starting from 21 to 49 days after sowing

Vitavax	Mean number of died plants recorded after days of sowing							
treated plots	21	25	29	33	37	41	45	49
1 -	**5**	**9**	**14**	**16**	22	**26**	**31**	**34**
2	**4**	**7**	10	**14**	**19**	21	**24**	**28**
3	6	8	11	**13**	**19**	**24**	**28**	**33**
4	2	6	11	**15**	**18**	**24**	**29**	**32**
5	**3**	**9**	**14**	20	**23**	**27**	**33**	**37**
6	**4**	**5**	8	**15**	20	**26**	**29**	**34**
7	**3**	**9**	**13**	**18**	**24**	**27**	**31**	**36**
8	1	**5**	**9**	12	**17**	21	**27**	**31**
9	6	8	**9**	**23**	**33**	**44**	**54**	**61**
Control plots								

Each datum represents average of three replications.

Table -3. Effect of Vitavax-200 on the plant characters of hill cotton (HC-1) *Gossypium arboreum* Linn-

after 81 days after sowing

Vitavax treated plots	Height (cm)/ plant	Branches Number/ Plant	Leaves Number/ plant	Square Number/plant	Flower Number/plant	Bolls Number/plant
1	92.4	7.66	57.0	4.66	0.4	0.33
2	900	7.0	34.6	3.86	0.8	0.4
3	96.13	8.8	43.0	4.7	0.4	0.2
4	986	7.46	37.6	5.73	0.46	0.26
5	92.2	12.3	39.8	4.9	0.66	0.33
6	113.5	11.7	57.4	8.6	0.6	2.66
7	95.6	8.6	43.13	5.26	0.53	0.33
8	101.8	8.46	39.0	6.6	0.8	0.466
9 Control plots	97.2	8.0	39.0	4.6	0.7	0.4

Each datum represents average observ ations on five plants.

in vitavax-200 treated plants were lower hut the production of bolls number were higher in those plants.

Ilie average height of the plants at 81 days after sowing on the vitavax-200 treated and control plots are 97.52 cm and 97.2cm. Apparently, it was found that almost equal number of leaves were present in vitavax-200 treated and control plants. So, it can be concluded here that vitavax-200 had no effect on the leaves of the plants. Only a slight increase in the production of branches in the vitavax-200 treated plants were noted (Table-3). The average number of branches in the plants of vitavax-200 treated and control plots were 8.99 and 8.0. The vitavax-200 treated cotton plants were noted to have more leaves than that of the control plants, though the difference was not significantly different. The respective number of average bolls produced in vitavax-200 treated and control plants were 0.62 and 0.40 (Table -3). These indicate that vitavax- 200 treated plots had positive impact on the improvement of the plant characters of the Hill Cotton (HC-1).

The names of insects and their respective number collected during sweep netting on 81 days after sowing on the vitavax-200 treated and control fields are presented in Table-4. The common names of the insects those were collected during sweep netting were red cotton bug. dusky cotton bug. flies, spider, ants, green hopper, jassid. bees, blister beetle, dragon fly, damsel fly, butter fly, lady bird beetle, pumpkin beetle, field cricket, weevil, locust, bush hopper, garden cricket and moths. Higher number of insect population were noted between the vitavax-200 treated and control fields. This may be

Table-5. Name of organisms and their mean number trapped in Pit Fall Trap on 155 days after sowing from various plots

Vitavax-200 treated plots	Name of the insects									
	Toad	Snake	Praying Mantid	Spider	Ant	Weevil	Nymph (Red cotton bug)	Field Cricket	Mole Crick	Earth worm
1	0.33			0.88	1.66	0.22	0.77	0.22	0.11	0.66
2	0.03				1.33					0.55
3			0.11	0.99	1.11			0.22	0.11	
4				0.22	2.21		0.44			
5	0.11				0.86	0.33	0.44			0.55
6	0.11				1.10	0.22		0.22		
7		0.11			1.44	0.22	0.55		0.11	0.33
8				1.11	1.22					
9 Control plots	0.44				0.99	0.11				

because the vitavax-200 treated plants were healthy that is why more insects were attracted towards those plants. A list of the names of the organisms captured in pit fall trap from the vitavax-200 treated and control fields are given in Table-5. Ifie common organisms captured in pit fall trap were toad, spiders, ants, weevils, nymph of red cotton bug, field cricket, mole cricket and earthworm. Among the organisms mentioned above, the spider, ant and nymphs of red cotton bugs were significantly higher compare to those. The experimental results showed that the fungicide had no effect on emergence of the seeds. Significantly higher number of the hill cotton plants were recorded in the fungicide treated fields than that of the fields where the vitavax-200 were not used. Due to the use of the fungicide better growth of the cotton plants were recorded.

Better growth of the cotton plants were reflected in all the plant characters studied. Accordingly significantly better results in the height of plants, number of bmches per plant, number of leaves per plant, number of squares per plant, number of flowers per plant and number of bolls per plant were recorded in the vitavax-200 treated plants than that of the plants where vitavax-200 were not used. In the present experiment, mean number mortality of the vitavax-200 treated cotton plants were about 32 % where as in the control plots the mean mortality reached up to 61 %. Similar positive effects of the vitavax-200 were recorded from an experiment carried out at the Hill Cotton Research Station, Balaghata, Bandarban (Zaman *et al.*,2004). They reported about 36% mortality in the vitavax-200 treated plots.

It is pertinent here to mention the findings of (Zaman *et al.*,2005). They studied the suitability of four fungicides (Dithane M-45, Tilt 250EC, Ridomyl Gold 68WP and Knowin 50 WP) to control the seedling blight, *Rhizoctonia solani* and wilt, *Fusarium oxysporum* of the hill cotton, *Gossypium arhoreum* Linn.. Among the four fungicides, they reported that Dithane M-45 performed the best reducing the seedling mortality.

The names of the insects and their respective number on the cotton plants were recorded before the application of insecticides by sweep net and pit fall method. The common names of insects those were collected during sweep netting were Red Cotton Bugs, Dusky Cotton Bugs. Flies, Ants, Green hoppers. Dragonflies, Dameselflies, Ladybird beetles. Locust, Bush hoppers, Garden crickets and Moths. The insects captured in the pit fall traps were Praying mantids. Ants, Weevils, nymphs of Red Cotton Bugs. Field crickets and Mole crickets. The Aphid population was counted by direct observation method. Among the different insects the infestation of Red Cotton Bug, Dusky Cotton Bug , Jassids and Aphids were very high.

The comparative Ahid populations before and after the I$^{s'}$ and 2nd application of different concentration of the Neembacidin and Roxiban 20EC are presented in Table- 6. Before the application of insecticide the Aphid population was almost of equal concentration in all plots. After the application of both 1st and 2nd spray of both the insecticides the Aphid population reduced drastically. The reduction of the Aphid population was noted to be dose dependent for both the insecticides, i.e. as the dose ot the insecticide increased the Aphid population also

decreased gradually. The reductions

There were no marked difference between the reduction of Aphid population by Neembacidin and Roxiban 20F.C (Table-6).The respective means of the Aphid population after the application of 1.5 ml, 2.0 ml, 2.5 ml and 3.0 ml / litre of water of the Neembacidin were 1.93, 1.91, 1.8, and 1.63. The Aphid population in the plots sprayed with 1.5 ml, 2.0 ml, 2.5 ml and 3.0 ml / litre of water of Roxiban 20EC were 1.83, 1.98, 1.78 and 1.77 respectively. The Aphid populations in the control plots were 2.21. The average population of the Jssid and Witefly after 15 days of I^{s1}, 2^{nd} and 2^{nd} application different concentrations! 1.5 — 3.0 ml / litre of water) of Neembacidin and Roxiban together with their controls arc shown in Table — 7.

Populations of both the insects were noted to reduce after the application of either of the insecticides. No marked di(Terences in the reduction of insect number were observed in the lower or higher doses of the insecticide. Marked reductions in the number of both the insects were noted even after 15 days of the application of either of the insecticide.The mean Jassid population after the I^{s}* and 2^{nd} application of Neembacidin and Roxiban 20EC at a dose rate of 1.5 ml / 1 were 1.43 and 3.66. 2.0 ml / I were 3.4 and 3.79, 2.5 ml / I were 2.5 and 2.99 and 3.0 ml / 1 were 2.2 ml and 3.1 respectively. During the same period, the Jassid populations in the control plots were 2.5.

The Whitefly populations were counted only just after the 1^{st} application of the insecticides. Both the insecticide was noted to be equally effective in reducing the

concentration of the Neembacidin and Roxiban 20EC are presented in Table-6

Treatments	Aphid				Mean of Aphid population
	Application of insecticide spray				
	Before spray	1st	2nd	Total	
Ti Neembacidin @ 1.5ml/l	2.26a	1.7b	1.86b	5-81	1.93
T2. Neembacidin @ 2.0 ml/1	2.2a	1.84b	1.7b	5.74	1.91
T3. Neembacidin @ 2.5 ml/1	2.2a	1.82b	1.4c	5.42	1.8
T4- Neembacidin @ 3.0 ml/1	1.2a	1.69b	1.3c	4.89	1.63
T5. Roxiban @ 1.5 ml/1	2.02a	1.80b	1.69b	5.51	1.83
T6 -Roxiban @ 2.0 ml/1	2.30a	1.87b	1.78b	5.95	1.98
T7 -Roxiban @ 2.5 ml/1	2.08a	1.74b	1.47c	5.29	1.78
Tg-Roxiban @3.0 ml/1	2.05a	1.86b	1.41c	5.32	1.77
T9. Control	2.05a	2.26a	2.33a	6.64	2.21
LSD NS 2.3 9** 1.939** ! CV% 12.40 5.45 4.86					

Plate- 11 .Cotton aphids colony and sucking sap from the leaf

Plate- 12. Nymph (Jassid). sucking sap from the leaf

Plate- 13. Affected leaf by sucking insects

I able -*1.* Average Jassid **and wtiitetlv population alter IS aays** 01 **me i , znu ami x appncau.uu u. u.»$_t$. tu.**

concentrations Neembacidin and Roxiban 20EC in Hill Cotton (Hc-1)

Treatments	Jassid				White fly	
	Application of insecticide spray				Application of insecticide spray	
	1st	2nd	Total	Mean	1st	Mean
Ti Neembacidin @ 1.5 ml/1	1.73bc	1.13a	2.86	1.43	6.5a	2.16
T2. Neembacidin @ 2.0 ml/1	1.8abc	1.6a	3.4	1.7	3.46a	1.15
T3. Neembacidin @ 2.5 ml/1	1.6bc	0.9a	2.5	1.25	3.69a	1.23
T4. Neembacidin @ 3.0 ml/1	1.2c	1.0a	2.2	1.1	5.0a	1.66
Ts. Roxiban @1.5 ml/1	1.6bc	2.06a	3.66	1.83	3.76a	1.25
T6 -Roxiban @ 2.0 ml/1	1.86ab	1.93a	3.79	1895	4.5a	1.5
T7 -Roxiban @ 2.5 ml/1	1.46bc	1.53a	2.99	1.495	4.1a	1.36
Tg -Roxiban @3.0 ml/1	1.8bc	1.3a	3.1	1.55	4.0a	1.3
T9. Control	2.4a	2.6a	5.0	2.5	6.36a	2.12
LSD 0.509* NS NS CV% 20 17.33 45						

*** -Significantly different at 5% level, NS= Non significant**

Whitefly population of the Hill Cotton plants. The mean number of Whitefly population in the plots sprayed with 1.5, 2.0, 2.5, 3.0 ml / litre of water of Neembacidin were 2.16, 1.15, 1.23 and 1.66 respectively. The mean insect population were 1.25, 1.5, 1.36 and 1.3 after the application of 1.5, 2.0, 2 .5, 3.0 ml / litre of water of Roxiban 20EC. The same populations in control field were 2.12.

llie population of Bollworm and Red Cotton Bug after the application of concentrations of Neembacidin and Roxiban 20EC are given in Table-8. The Bollworm population was counted after two application of both the insecticides i.e. Neembacidin and Roxiban 20EC. Both the insecticides were found to be equally effective to reduce the population of Bollworm and Red Cotton Bug. 'Hie mean population of Bollworm after the application of 1.5 ml, 2.0 ml, 2.5 ml and 3.0 ml / litre of water of Neembacidin were 0.4, 0.46, 0.46 and 0.26 respectively. The average respective populations of Bollworm were 0.33, 0.40, 0.26 and 0.26 in the plots treated with 1.5ml, 2.0ml. 2.5ml and 3.0 ml / litre of water of Roxiban 20EC. The Bollwonn populations on the above mentioned time were 0.53 in the control plots. The Red Cotton Bug population was counted after 4 applications of both the insecticides (Table-8). Significant reduction in the Red Cotton Bug population was caused by the application of both the insecticides. The reduction of Red Cotton Bug population in the treated plots were noted to be

dose dependent, i.e. as the dose increased the bug population decreased. The comparison of the effectivity of Neembacidin and Roxiban 20EC indicated that the former was more effective than the latter. The respective bug population of the plots treated with 1.5 ml of Neembacidin and Roxiiban 20EC were 0.335 , 0.38; 2.0 ml were 0.305 , 0.30 ; 2.5ml

Table-8.Effectiveness of different concentrations Neembacidin and Roxiban 20EC against Bollworm and Red Cotton Bug in Hill Cotton (HC-1)

Treatments	Bollworm		Red Cotton Bug			
	Application of insecticide spray		After application of insecticide spray			
	2nd	Mean	3rd	4th	Total	Mean
Ti - Neembacidin @ 1.5ml/l	1.2a	0.4	0.39ab	0.28bc	0.67	0.335
T2. Neembacidin @2.0 ml/1	1.4a	0.46	0.33bcd	0.28bc	0.61	0.305
T3. Neembacidin @ 2.5 ml/1	1.4a	0.46	0.28cd	0.20cd	048	0.24
T4. Neembacidin @3.0 ml/1	0.8a	0.26	0.24d	0.15d	0.39	0.195
T5. Roxiban @1.5 ml/1	1.0a	0.33	0.39ab	0.37ab	0.76	0.38
T$ -Roxiban @ 2.0 ml/1	1.2a	0.4	0.35bc	0.25c	0.6	0.30
T? -Roxiban @2.5 ml/1	0.8a	0.26	0.26cd	0.26c	0.52	0.26
T g -Roxiban @3.0 ml/1	0.8a	0.26	0.28cd	0.24cd	0.52	0.26
T9. Control	1.6a	0.53	0.46a	0.42a	0.88	0.44
LSD NS 0.038** 0.067** CV% 43 14.84 30.79						

** -Significantly different at 1% level, NS= Non significant

Plate-14. Nymphs (Red cotton bug), sucking sap from splitting boll

Plate-15. Affected bolls by . sucking pests of cotton

were 0.24 , 0.26; and 3.0 ml were 0.195 , 0.26. The Red Cotton Bug population in control plots were 0.44.

The effect of the use of different concentrations of Neembacidin and Roxiban 20EC on the yield and yield contributing characters of the Hill Cotton (HC-ı) are shown in l able-9. The yield and yield contributing characters were assessed on the basis of plant survival at picking stage, number of affected and unaffected bolls per plant, weight (g) of per boll, yield (kg) per plot and total yield (kg / ha). The survivals of the cotton plants at the picking stage in the insecticide treated plots were significantly higher than that of the control plots. The average percentage survival of the plants in Neembacidin, Roxiban 20EC and control plots were 65.42, 65.42 and 35.00 respectively (Table-9). Slightly higher number of bolls / plant were produced in the insecticide treated plots and no marked differences in the boll production were noted between the Neembacidin and Roxiban 20EC treated plots (Table - 9).

There were no marked differences in the weight of bolls produced in either of the insecticide treated and control plots. No marked differences in the weight of bolls produced in the plots treated with different concentrations of the Neembacidin and Roxiban 20EC were noted (Table - 9). It was very interestingly noted that significantly higher yield of the cotton were recorded in the insecticide treated plots and almost double yield was achieved in the treated plots than that of controls (I able-9). The yield was also noted to increase gradually with the increase of the dose of both the insecticides.

Plate-16. Cotton shoots were damaged by attacking of bollworm larva

Plate-17. An immature boll was affected by a bollworm larva

****= Significantly different at 1 % level, NS= Non significant**

Table- 9. Effect of different doses of Neembacidin *(Azadirachta indica* A. Juss) and Roxiban 20EC on the yield and yield contributing characters of hill cotton (HC-1)

T reatments	Plant survival at picking stage (out of 60)	Percentage	No. of bolIs/Plant			Weight of per boll (g)	Plot yield (kg)	Yield kg/ha (Seed cotton)
			Affected	Unaffected	₁ otai			
Tj- Neembacidin @ 1.5mll	**39**	**65.00**	2	**7**	**9a**	**2.67a**	**0.937b**	**1041.19**
T2. Neembacidin @ 2.0 ml 1	**39**	**65.00**	1	8	**9a**	**2.71a**	**0.951b**	**1056.79**
T3. Neembacidin @ 2.5 ml/1	**39**	**65.00**	2	8	10**a**	**2.75a**	**1.07b**	**1191.54**
T4. Neembacidin @3.0 ml/1	**40**	**66.67**	2	10	12**a**	**2.76a**	**1.32a**	**1471.85**
T5. **Roxiban @1.5 ml/1**	**37**	**66.67**	₁	6	**7a**	**2.73a**	**0.70c**	**785.55**
T6-Roxiban @2.0 ml/1	**39**	**65.00**	2	**7**	**9a**	**2.71a**	**0.951b**	**1056.79**
T7-**Roxiban @2.5ml/l**	**37**	**61.67**	2	**9**	11**a**	**2.72a**	**1.07b**	**1229.92**
T s -Rox iban @ 3.0 ml/1	**41**	**68.33**	2	8	10**a**	**2.69a**	1.10**b**	**1225.32**
Ti>. Control	21	**35.0**	₁	**7**	8**a**	**268a**	**0.450d**	**500.21**
LSD					**NS**	**NS**	**0.07825****	
CV%					**29.64**	**3.70**	**10.31**	

The respective mean yield (kg/ha) of the plot treated with 1.5 ml , 2.0 ml , 2.5 ml and 3.0 ml / litre of water of Neembacidin were 1041.19, 1056.79, 1191.54 and 1471.85. The yield (kg/ha) of the Hill Cotton in the plots treated with 1.5 ml, 2.0 ml, 2.5 ml and 3.0 ml / litre of water of Roxiban were 785.55, 1056.79, 1229-92 and 1225.32 respectively. The yield of the control plots were 500.21 kg/ha. From the above results it was very interesting noted that the botanical pesticide, Neemabacidin is more effective in the control of the pests and thereby higher yield in the production.

Depending on the results of the present experiment, it may be suggested that Neembacidin may be used commercially to improve the production of the Hill Cotton (HC-1) in Jhum culture of the Chittagong Hill Tracts area.

The average Aphid and Jassid populaton after 15 days of the I^{s}* and 2^{IMj} application of different concentrations of Neembacidin and Roxiban 20EC were recorded. Whitefly population was recorded after single application of the insecticides, **rhe** Bollworm population was recorded after 2^{nd} application but the Red Cotton Bug population was recorded after four application of the insecticides in the present experiment. After the application of both the insecticides, all the pest populations were noted to reduce drastically.

The reduction of the pest population was also noted to the dose dependent i.e. as the dose of the insecticides increased, the insect populatioin also decreased gradually. In the present experiment two applications of the insecticides after 15 days intervals

showed effective control of Jassid population (Table -7). Amin *et al.* (1998) mentioned good control of Jassid population with the application of insecticides after 30 days intervals. Amin *et al.* (1999) also reported good production of hill cotton after 3 to 5 sprays of the insecticides. In the present findings. Cotton Bollworm population was very high (Table- 8).

From the discussions presented above, it should be mentioned here that among the available fungicides, the vitavax -200 may prove to be of great practical value. Better growth of the hill cotton plants were noted in the fungicide and insecticide treated plots. Significantly higher yield of cotton (kg/ha) was also achieved in the insecticide and fungicide treated plots. Among the two insecticides tested, the botanical pesticide Neembacidin gave better yield. So, it may be concluded that the Neembacidin, *Azadirachta indica* along with the fungicide (Vitavax-200) may be a good choice for the increase of the production of the Hill Cotton, *Gossypium arhoreum* Linn, in the hilly areas of Bandarban.

CONCLUSION

An experiment was conducted at the experimental fields of Hill Cotton Research Station (HCRS), Balaghata. Bandarban Hill District from May to December 2005 to evaluate the effectiveness of a botanical pesticide, Neembacidin, *Azadirachta indica* A. Juss and a synthetic organophosphorus pesticide Roxiban 20EC against the sucking and chewing pests of Hill Cotton. The soil of the experimental field was sandy loam in texture with P^H value from 5.0 to 5.3.

The population of both the sucking and chewing pests reduced markedly after the application of each of the insecticide. The reduction of pest population by each insecticide were noted to be dose dependent, i.e. as the dose of the insecticide increased, the number of pests reduced gradually .The survival of the cotton plants at the picking stage in the insecticide treated plots were significantly higher than that of the control plots. Significantly higher yield and yield contributing characters were achieved in the insecticide treated cotton plots than that of the controls.

Treatment (T») gave the highest yield (1471.85 kg / ha) followed by T_7 (1229.92 kg / ha), Tg (1225.32 kg / ha) and T_3 (1191.54 kg / ha). The yield of treatments T_2 (1056.79 kg / ha) and Tt (1056.79 kg / ha) produced almost same followed by T| (1041.19 kg / ha). But the lowest yield was recorded in T_9 (500.21 kg / ha) followed by T_5 (785.55 kg / ha).

From the results of the present experiment, it may be said here that the botanical pesticide, Neembacidin is more efTective for the control of the pests and thereby higher yield of the cotton was achieved. It also may be added that the use of fungicide (Vitavax-200) plays positive role for the improvement of hill cotton production. Therefore, it may be concluded from the results of the present experiment that Neembacidin may be used commercially to improve the production of the hill cotton.

REFERENCES

Ali, M., Karim, M.A. and Akter, M. (1993). Abundance of some arthropod predators in Cotton field, Bangladesh Journal of Agricultural Research, Vol. 18, No. 1, 13-18, June 1993.

Amin, M., Chowdhury, N.H.. Moinuddin, F.M., Rouf, A.,Islam, M. and Marma. M.S. (1998) . Number of spray on jassid attack, Ann. Res.Rep. Comilla Cotton Rcscarch Station, Bandarban. pp 22- 24.

Amin, M., Chowdhury, N.H., Moinuddin, F.M., Rouf, A., Islam, M. and Marma. M.S. (1999) . Effect of number of spray on cotton jassid , Ann. Res.Rep. Comilla Cotton Research Station, Bandarban. pp 49 — 51.

Amin. M., Chowdhurey, N.H., Rouf,A., Islam, M.and Marma, M.S. (2001). Pahari Tular Chas, Hill Cotton Research Station, Kothamala Printers. Bandarban. pp 13 -43.

Ahmed,A.R., Bhuiya,A.A. and Hasain,Z. (2003). Experimental Designs, Theory and Application, Brahmaputra Packaging and Printing Industries BSIC Industrial Estate, Maskhanda, mymensingh. P - 6.

Bari, M. N., and Sardar, M. A.(1998). Control strategy of bean aphid with predator, *Menochilus sexmaculatus* (F.) and insecticides. Bangladesh Journal of Entomology, vol.7, June and December 1997, p 21 - 27.

Bohlen, E. (1984/85). Cotton Pests IN Bangladesh, A field guide for pest identification and control, Cotton Development Board. Dhaka, pp 10- 14.

Baten. A. (2005). A forwarding report on Annual Research Review, Hill Cotton Research

Station . Balaghata, Bandarban. P 2.

Chowdhury.N.H.,Rouf, A., Islam,Md.M., Marma,M.S. and Dewan,K. (2003). Screening of insecticides igainst Bollworm of hill cotton, Ann. Res.Rep., Hill Cotton Research Station, Bandarban. pp 34 -35.

Debach,P. (1970). Biological Control By Natural Enemies, real need for Chemical Control, Cambridge University Press., pp 412 — 416.

Dennis,S.H. (1983). Agricultural Insect-Pests of The Tropics And Their Control., Second edition, Cambridge University Press, 1975, 1983 Fundation Books, 2119 Ansari Road, Delhi.pp63 -365.

Dhaliwal,G.S.and Sing,B.(1993). Pesticides,Their Ecological Impact in Developing Countries, Commonwealth publishers. New Delhi (India). Pp 243 — 244.

Dhaliwal,G.S. and Ramesh, A. (1996). Principles of Insect Pest Management, Department of Entomology, Punjab Agricultural University, Ludhiana, India 1998. pi50.

Eugene,B.S. (1992). NEEM. A tree for solving global problems. Report of an Hoc Panel of the Board of Science and Technology for International Development, National Research Council, National Academy Press,Washington D.C. p 44.

Farid,A.T.M.and Mujibullah,Md. (1990). A socio-economic appraisal of farmers of the Chittagong Hill Tracts, Bangladesh Journal of Agricultural Research, vol. 15, No.l, 1990.

FAO-EU. (2003). Harvesting White Gold — the IPM way, IPM Programme for Cotton in Asia, pp 1 - 6.

Gennadius,Wanghoonkong,Dhaliwal,G.S.and Sing,B. (1881). Pesticide And Environment, 1 he Indian Ecological Society, College of Agriculture, Punjub Agricultural University, Ludhiana 141 004 India, pp 87 -93

Hossain.S.M.,Hossain,A.M.and Mian,H.R.(2001/2002). Effect of different chemicals onwhitefly, Ann. Res.Rep., Cotton Delopment Board (CDB), Khamarbari, Dhaka. P 34.

Hossain.S.M., Rahman,H.and Rahman,F. (2002-2003). Combined effect of nemazol and pyrethroid on cotton bollworm , Ann. Res.Rep. Cotton Delopment Board (CDB), Khamarbari. Dhaka (Chapter 4 Entomology Discipline).

Hossain. S.M.and Mian.Md.H.R. (2004-2005). Management of sucking pests of cotton by seed treating insecticide with threshold spray of bollworm . Ann. Res.Rep. Cotton Development Board (CDB). Khamarbari, Dhaka. Entomology discipline, P 1-4.

Henrichs,E.A. (1968). Plant stress - insect interaction. Department of Entomology, Louisiana State University, Baton Rouge, Louisiana, pp 12-19.

Ibrahim,A. and Karim,M.A. (1991). Plant- age specific seasonal abundance of cotton jassid on cotton plants, Bangladesh Journal of Agricultural Research.Vol. 16, No. 1, 11- 16.

Islam,Md.M. (2005). Study on cotton seed rate in mixed cropping system for hill Cultivation, Ann. Res.h Rep., Hill Cotton Research Station(HCRS), Bandarban. pp 15 — 17.

Islam,Md.K.. Zaman,F. and Marma,M.S. (2005). Screening of Fungicides for Management of Hill Cotton Mortality, Ann.! Res. Rep. Hill Cotton Research Station, Bandarban, pp 28-30.

Iqbal,A.(2002). Bangladesh Cotton, ICAC, vol.2 , issue 4, October 2002 . p *p*~ 27- 28.

Mathews,G.A.(1984). Pest Management, Reader in Pest Management, Department of Pure And Applied Biology and Director, Si I wood centre tor Pest Management, Imperial College London. P- 27.

Mollah,A.R.,Biswas,P.R.and Mannan,A. (1995). Relative profitability of cotton and its competing crops in Bangladesh, Bangladesh Journal of Jute and Fibre Research, vol. xx, No. 2, 1995.

Mohan.P.,Mukewar,P.M., Singh.V.V, and Kairon,M.,S.(2000). Science and Technology, SA1C Newsletter, Central Institute for Cotton Research, Post hag No. 2, Shankar Nagar. Post Office, Nagpur- 440 010 (Maharashtra State), India. July- September 2000. Volume 10, NO. 3. p 8

MunroJ.M. (1987). COTTON, Longman Scientific and Technical, Lonman Group UK LTD. Longman House, Burnt Mill Harlow, Essex CM20 2JE,England. pp 2 — 23.

Pandey,S.N. (1998). Cotton Seed And Its Utilization, Directorate of Information and Utilize Publication on Agriculture, Indian Council of Agrcultural Research, Khuthi Anusandhan Bhavan, Pusa New Delhi 110 012 . p 24.

Pedigo,L.P. (2002). Entomology and Pest Management Conventional insecticides for management, P- 405, 4U‘ editionjowa State University, Upper Saddle River. New Jersey 07458.

Prassad,R. (2002). Text Book of Field Crop Production, Directorate of information and Publishing of Agriculture, Indian Council of Agricultural Research, Krishi Anusadan Bhavan, Pusa, New Delhi 110 012. pp 648 - 669.

Rashid,M.M.,Ali,l.M.and Bhuiyan,N.I. (1997). Fertilizeer recommendation guide, Bangladesh Agricultural Research Council, Farm gate, New Airport Road, Dhaka-1215. p 171.

Rouf,A.,Chowdhury,N.H.,lslam,MD.M.,Marma,M.S.and Dewan.K. (2003). Screening of insecticides against sucking pest of hill cotton. Ann. Res.Rep., Hill Cotton Research Station. Bandarban. pp 34 -37.

Sarker,R.A..and Hossain,A. (2001). Determination of effective management practices

bollworms,Bangladesh J.Agril. Res. 26(1): 39- 45, March 2001.

Schmutterer,H. (1981). The Neem Tree, Cambridge : Tokyo VCH, ISBN 3 - 527 - 30054 - 6.p 26.

Singh,G.S. (1973). Plant Diseases, sixth edition Oxford & Ibh Publishing Co. PVT. LTD, New Delhi, Calcutta, pp 99- 100.

Uddin,M,.Huq,S.B..Rahman,M.M. and Saha.U.K.. (1993). Chemical control of the green jassid infestation of cowpea, Bangladesh Journal of Agricultural Research, Vol. 18, No. 1,39-44.

Upadhyay,R.K.,Chamola,B.P. and Dubey. Q.P (1998). Integrated Pest and Disease Management. A.P.H. Publishing Corporation. 5.Ansari Road. Darya Ganj, New Delhi, 110 002. pp 411 - 455.

Venugopal,R.,Prassad,R., Naidu and Savitri (2003). Integrated Insect Pest Management. Agrobios India ,Commonwealth Publishers, New Delhi (India), p 189.

Wadud, M. and Moniruzzaman. F. M. (2001). Disease and Pest Management. Agricultural Reaearch in Bangladesh in the 20th Century,BARC, Farmgate, Dhaka.pp 256 - 264.

Walia.S. and Parmer.B.S. (1972). Pesticide Crop Production And Environment, Oxford IBM Publishing Co. Pvt. Ltd. New Delhi , Calcutta. P 60.

Watson.G.W. (2003). Insects Pests of Cotton and Their Predation, Department of Entomologoy, fhe Natural History Museum,Cromwell Road, Ix>ndon SW7 5BD, UK. pp 1-30.

Zaman.F.,Islam,Md.K. and Marma. M.S. (2004). Effect of different chemicals to control the mortality hill cotton. Ann. Res. Rep., Hill Cotton Research Station. Bandarban. PP 32-

34.

Zaman,F.,Hossain,S.M. and. Marma .M.S. (2004). Screening of insecticides against sucking pest of hill cotton. Ann.Res. Rep. Hill Cotton Research Station. Bandarban. pp 29-31.

Zaman.F.,Hossain.S.M. and Marma,M.S. (2005). Determination of effective doses of Perfekthion 40EC for the management of sucking pests of hill cotton, Ann. Res. Rep.,Hill Cotton Research Station. Bandarban. pp 31- 33.

Zaman,F., Islam,Md.K. and Marma.M.S. (2005). Screening of fungicide for management of hill cotton mortality. Ann. Res. Rep.Hill Cotton Research Station. Bandarban. pp 31- 33.

Appendix- 1.

Initial soil status of Hill Cotton Research Station (HCRS),Balaghata and SRDI.

Raicha experiment field in growing season, 2005

Experimental Field	P^H	OM %	Total Nutrient %	Ca (meq/lOOg of soil)	K (meq/lOOg of soil)	Mg (meq/lOOg of soil)	P (Hg/g of soil)	S (Hg/g of soil)	Zn (Hg/g of soil)	B (Mg/g of soil)
Hill Cotton Research Station, Balaghata	5.3	2.25	0.115	2.54	0.26	1.45	5.08	10.74	0.30	0.43
SRDI, Raicha	5.0	3.35	0.168	2.72	0.32	1.76	3.52	17.18	0.55	0.35

Source: Soil Resources Development Institute, Bandarban. 2005.

Appendix - 2.

The average temperature, humidity and rainfall of Bandarban in growing season 2005

Month	Temperature (°C)			Humidity (%)	Rainfall (%)
	Maximum	Minimum	Mean		
April	34.58	23.44	29.09	81.57	118.00
May	34.61	23.78	29.19	82.19	257.00
June	34.47	25.33	29.90	87.40	224.00
July	32.72	24.73	28.72	88.06	178.40
August	30.86	24.44	27.65	92.61	639.50
September	32.82	24.38	28.60	90.83	548.60
October	33.73	23.81	28.77	85.29	40.00
November	30.80	19.13	24.97	84.70	89.00
Mean i	33.07	23.63	28.36	86.58	261.8

Sorece: Soil Resources Development Institute , Bandarban, 2005.

Appendix - 3.

Spray log : Insecticide spray application in the experimental plot

Name of the insects	Date of insecticide spray application			
	6.7.05	21.7.05	5.8.05	20.8.05
	60 days after sowing	75 days after sowing	90 days after sowing	105 days after sowing
	Aphid	Aphid		
	Jassid	Jassid		
	Whitefly	Bollworm		
			Red cotton Bug	Red Cotton Bug

c»rrr.r--r <C A

OS 0^5 '£•/ & T'*i-

3Q>Yc<rlo-y-L