



Insect Pests of Jute

Identification and Management



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Contents

Chapter	Page No.
Foreword	i
Preface	ii
Introduction	1
Insect Pests Identification	3
Preliminary Insect Identification Clues Based on Life Stages	3
Succession of Insect Pests in Jute	4
Major Pests	5
Indigo caterpillar	5
Grey weevil	7
Stem weevil	8
Yellow mite	10
Mealybug	12
Semilooper	14
Jute hairy caterpillar	16
Minor pests	18
Stem girdler	18
Red mite	19
Emerging / New Insect Pests Reported in Jute	19
Gram caterpillar	19
Safflower caterpillar	20
Green semilooper	21
Tussock hairy caterpillar	22
Mesta hairy caterpillar	23
Leaf Webber	23
Leaf miner	24
New Reports of Natural Enemies on Insect Pests of Jute	24
<i>Protapanteles obliquae</i>	25
<i>Meteorus spilosomae</i>	25
Tachinid fly	26
<i>Parachremylus spp.</i>	26
<i>Aenasius arizoensis</i>	27
Nuclear Polyhedrosis Virus	27
Integrated Pest Management in Jute	28
References	29

Foreword

There is no doubt that the commercial and environmental importance of jute (*Corchorus olitorius* and *C. capsularis*), will be realized more in future due to greater awareness about the adverse consequence of synthetic fibres for its abuse in the environment as well as policy initiatives for restricting the synthetics in packaging and related ventures. Besides, this crop has much socio-economic impact on sizable number of small and marginal farmers of Eastern India. Although raw jute covers only 0.4-0.5% of the total cropped area in the country it contributes approx. Rs. 4809 crore to India's total value of output from agricultural commodities. Besides being a commercial crop, jute industry provides employment to 0.37 million workers.

Still jute goods increasingly face competition underpinning the environmental and social attributes. It is very important to maintain complete production, processing, value addition and marketing continuum in sustainable manner for betterment of this sector.

The production of jute has remained stable in the range of 10-12 million bales during last 5 years. Although the area under cultivation has witnessed a decline of 15.05 % during the same period, the demand of raw jute could be maintained due increase in productivity. ICAR-CRIJAF has been continuously developing new high yielding varieties supported with improved production, retting and plant protection technologies. Promotion of these technologies among the jute growers has sustained the total production of raw jute. However, it is very challenging to maintain the productivity growth rate of raw jute in future because of increasing cost of resources for jute cultivation, the erratic climatic condition and fluctuating market price for raw fibre.

The jute crop has also experienced the effect of the gradual shift in the climatic pattern in terms of increased diversity and intensity of biotic stresses. Sometimes the farmers witness the problem of insect infestation in such a magnitude that due to lack of preparedness and knowledge about the pest management, they fail to control the pest effectively. In this context, this technical bulletin which has enumerated the identification, biology, nature of damage and management of insect pests of jute on the basis of latest available information will be of immense practical use for jute growers, extension scientists, students and other stakeholders.



(Jiban Mitra)

Director, ICAR-CRIJAF

Preface

Jute is one of the cheapest source of bast fibres primarily cultivated in India and Bangladesh. Among the two types of cultivated jute, *tossa* jute occupies >90% of the jute growing area mainly in the states of West Bengal, Assam, Bihar, Odisha and UP. During the period of 120-140 days of jute crop, many sucking, foliage feeding and internal borer pests cause damage to the crop at various crop growth stages resulting in loss of yield and quality of fibre. These insect and mite pests may be categorized into major and minor pests depending on their regularity of occurrence and severity of damage caused to the crop. The intensity of crop damage varies in different jute growing areas as well as in different years depending on the prevailing weather conditions, variety, method of cultivation and the activity of predatory and parasitic organisms.

In recent years, jute crop has witnessed the effect of the gradual shift in the climatic pattern in terms of increased diversity and intensity of biotic stresses. The pest out breaks in jute have become more frequent which elevated the minor pests to the status of major pests.

Identification of insect pests of crop plants and its natural enemies is the first step towards its management. The identity of the insects and natural enemies primarily depends on time of infestation and nature of damage. Hence, the idea about the damage gives first hand clue about the insect involved in causing the damage. This bulletin describes in detail about the nature of damage, biology and life cycle, the knowledge of which is very much essential for proper decision making in initiating the pest management activities. The comprehensive information in insect pests and natural enemies of jute given in this bulletin will certainly be useful for jute growers, students, extension workers, teachers and other stakeholders. The authors are very much thankful to the Director, ICAR-CRIJAF for providing necessary facilities in bringing out this bulletin.

B. S. Gotyal
S. Satpathy
V. Ramesh Babu
K. Selvaraj

Introduction

Jute (*Corchorus olitorius* and *C. capsularis*), grown as a rainfed summer crop is one of the important bast fibre crops cultivated in South East Asia especially in India. Like other crops, pest problem is considered to be one of the bottlenecks responsible for low productivity and declining quality. More than 30 species of pests including insects and mites infest jute crop from seedling stage to harvest which cause yield loss up to 31-34%. Severe infestation of these insect pests also affects the fibre quality causing loss in tensile strength, formation of knotty fibre and reduction in the length of fibre (Rahman and Khan, 2012; Rahman and Khan, 2006). Among different insect pests of jute, stem weevil (*Apion corchori*); jute semilooper (*Anomis sabulifera*); yellow mite (*Polyphagotersonemus latus*); hairy caterpillar (*Spilosoma obliqua*) and indigo caterpillar (*Spodoptera litura*) are the most important pests which occur regularly. Besides, gram caterpillar (*Helicoverpa armigera*); safflower caterpillar (*Condica capensis*); green semilooper (*Amyna octa*); leaf webber (*Homona* sp.) and leaf miner (*Trachys pacifica*) are reported to infest jute in the recent past. Among the sucking pests, intensity of damage caused by yellow mite has been enhanced to great extent and cotton mealybug (*Phenacoccus solenopsis*) has emerged as a new pest sometimes causing devastating damage.

Tossa jute occupies 80% of the jute growing area as against 20% under white jute. In general the incidence of major pests except stem weevil is more on *tossa* jute than on white jute. However, the intensity of crop damage varies in different jute growing areas as well as in different years depending on the prevailing weather conditions, variety, method of cultivation and the activity of predatory and parasitic organisms. The report of cotton mealybug and gram pod borer in jute indicates the emerging new pests which may cause economic damage in future. The cotton mealybug, *P. solenopsis* usually occurs more frequently in jute during the early hot and dry condition. Under favourable condition and availability of alternate hosts the pest spreads to new geographical areas. Certainly, the manifestation of erratic weather parameters with respect to crop phenology has enhanced the pest status of few existing pests, besides predisposing the infestation of new species on jute. The infestation of yellow mite (*P. latus*) and hairy caterpillar (*S. obliqua*) are more regular and severe even raised to the status of outbreaks which may need greater attention in future for timely and effective management because of their economic damage.

The seasonal and long term changes in climatic condition affect the insect pests of crops. Insects have short generation times and high reproductive rates, and hence they are more likely to be most affected by climate change because environmental factors have a strong influence on the development, reproduction, and survival of insect pests and their natural enemies (Bale, *et al.* 2002). Long and short term fall out of global warming has already been experienced in Indian agriculture.

The jute crop has also witnessed the effect of the gradual shift in the climatic pattern in terms of increased diversity and intensity of biotic stresses. The pest outbreaks in jute have become more frequent which elevated the minor pests to the status of major pests. Considering the occasional, low input management strategy adopted in these crops, the enhanced pest status and severity of the existing pests, and the report of many new insect pests indicate the role of various abiotic stresses in triggering this dynamism in the pest scenario. During the period of 120-140 days of jute crop, many sucking, foliage feeding and internal borer pests cause damage to the crop at various crop growth stages. These insect and mite pests may be categorized into major and minor pests depending on their regularity of occurrence and severity of damage caused to the crop (Table 1).

Table 1. List of insect and mite pests of jute crop

Common name	Scientific name	Family	Order
Major insect and mite pests			
Hairy caterpillar	<i>Spilosoma obliqua</i>	Arctiidae	Lepidoptera
Jute semilooper	<i>Anomis sabulifera</i>	Noctuidae	Lepidoptera
Jute stem weevil	<i>Apion corchori</i>	Curculionidae	Coleoptera
Yellow mite	<i>Polyphagotarsonemus latus</i>	Tarsonemidae	Acarina
Mealybug	<i>Phenacoccus solenopsis</i>	Pseudococcidae	Hemiptera
Grey weevil	<i>Mylocerus discolor</i>	Curculionidae	Coleoptera
Indigo caterpillar	<i>Spodoptera litura</i>	Noctuidae	Lepidoptera
Minor insect and mite pests			
Stem girdler	<i>Nupserha bicolor</i>	Lamiidae	Coleoptera
Termite	<i>Odontotermes obesus</i>	Termitidae	Isoptera
Red mite	<i>Tetranychus coffeae</i>	Tetranychidae	Acarina
New insect pests reported			
Leaf miner	<i>Trachys pacifica</i>	Buprestidae	Coleoptera
Gram caterpillar	<i>Helicoverpa armigera</i>	Noctuidae	Lepidoptera
Safflower caterpillar	<i>Condica capensis</i>	Noctuidae	Lepidoptera
Green semilooper	<i>Amyna octa</i>	Noctuidae	Lepidoptera
Mesta hairy caterpillar	<i>Euproctis scintillaus</i>	Lymantriidae	Lepidoptera
Tussock caterpillar	<i>Dasychira mendosa</i>	Lymantriidae	Lepidoptera
Leaf webber	<i>Homona</i> spp.	Tortricidae	Lepidoptera

Insect Pests Identification

Identification of insect pests of crop plants is an important pre-requisite for initiating the decision making process for pest management. Knowledge and expertise in pest identification enable to work with ease not only in experiments related to insect pest management but also in promotional, advisory and other outreach activities. Although pest identification is a very vast and complex subject and essentially needs the knowledge of taxonomy and morphology, from the pest management point of view, few key points related to particular insect and its damage symptoms facilitate proper identification for their management in jute.

The identity of the insects and natural enemies primarily depends on time and nature of damage. Hence, idea about the damage gives first hand clue about the insect involved in causing the damage. Usually particular group of insects cause damage in similar pattern. The arthropod complexity and population in the field associated with different crops includes both the pests and natural enemies. Prior knowledge with respect to the host plant-insect-natural enemy association and interrelation makes the task of identification simple at the first hand.

Preliminary Insect Identification Clues Based on Life Stages

The knowledge of different life stages of insects helps in identification of the insects. Such information depicts some identifiable characters of those pests. Characters related to the specific life stages of particular insect may be considered for easy and quick identification of the insects from pest management point of view.

Egg-Nymph-Adult

The nymph resembles a miniature adult but it represents the immature stage. Both nymph and adult often share the same food source. The wings develop during the nymph stages as wing buds. These grow larger at each successive instars and fully developed at the final moult. The wings therefore develop outside the body. This type of life cycle is seen in various insects, including plant and leafhoppers, whiteflies, dragonflies, grasshoppers, earwigs, cockroaches and true bugs.

Egg-Larva-Pupa-Adult

The larva (or caterpillar) is the growth phase. It is generally very different from the adult. Usually the larva and adult use different food sources. In pupa there are no visible signs on the outside of the body, used to be called the "resting" stage. When outside conditions are suitable, the final moult occurs and the adult insect emerges. The wings develop inside the pupal case. Butterflies, moths, bees, wasps, true flies and many other insects, including beetles have such type of life cycle.

Many features are to be considered in different life stages of insect which lead to easy identification. Stage-wise few general characters to be considered in insect pest identification are as mentioned below.

Egg: Place of oviposition, shape and size, solitary/gregarious, covered/open, colour of eggs/its cover

Larva: Place of damage, nature of damage (defoliation, boring, nibbling, rolling), type (caterpillar, semilooper, grub, maggot), size, specific effects like dots spots etc. on the body, presence/absence of stripes/lines, number position, color and pattern of lines, presence/absence and position of hairs.

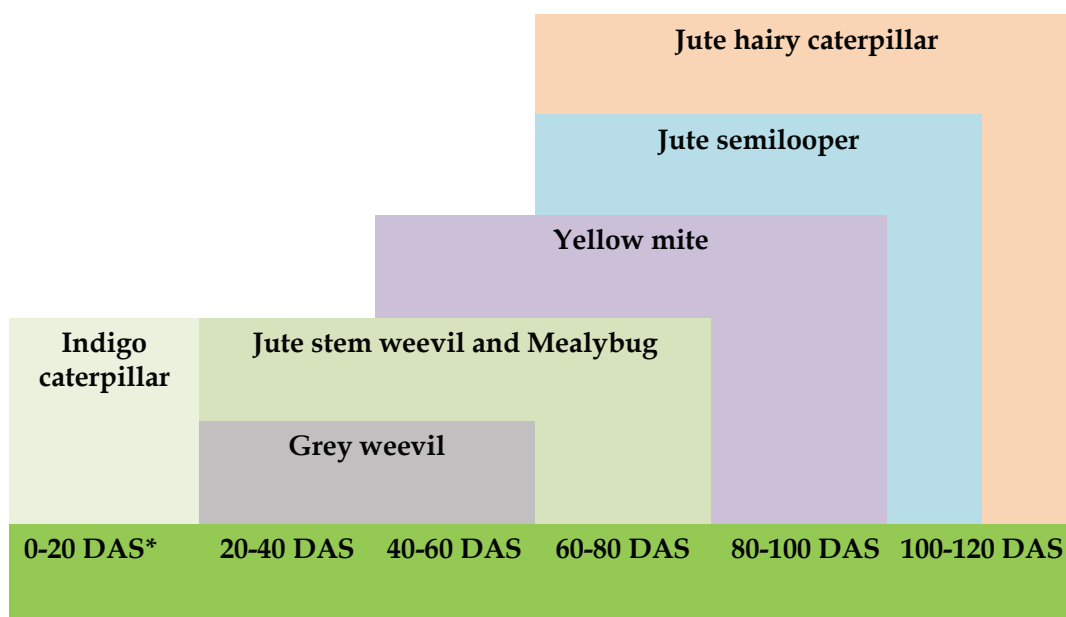
Pupa: Color, size, special feature on the pupal case, place of formation.

Adults: Type of antennae, color (specific color of wings, head, thoracic region, abdomen), wings (venation, special feature), size.

Nymph: Size, color, place of activity, presence/absence of wings.

Succession of Insect Pests in Jute

The insect pests cause damage to jute crop from seedling to fiber maturity phase. These pests are very specific to the phenology and infest the crop at particular stage of the plant. The occurrence of pests is associated with specific stage of crop and starts infesting on attainment of that particular stage.



*Days after sowing

Infestation period of jute pests with respect to crop growth stages

Major Pests

Indigo caterpillar

Spodoptera litura Hubner

(Noctuidae: Lepidoptera)

Description and Biology

This pest usually infests during the seedling establishment and early growth phase of jute crop just after first pre-monsoon shower. Usually the crop sown in fields with solanaceous vegetables as previous crop are more prone to damage. The adult moths emerge from hibernating pupae during March and start laying eggs. The incubation period of eggs ranges between 3-4 days. The fecundity of females vary from 1000-2000 eggs/female in 100-200 egg masses. The newly hatched larvae are light green with black head. The full-grown and full fed larvae seek shelter usually on the soil surface at the base of the plant, under clods or among leaves and such other debris. There are six larval instars completed in 10- 20 days and pupates inside soil. The pupa is light brown which become brown in the later part and pupal period lasts for 4-10 days. The adult longevity ranges from 7-10 days. The total life cycle is completed in 27-31 days.



Egg mass of indigo caterpillar



Larvae of indigo caterpillar



Pupae of indigo caterpillar

Eggs are spherical slightly flattened, 0.6 mm in diameter orange-brown or pink in color. The egg batches are covered with hair scales which give off a golden brown color. Egg masses are 4-7 mm in diameter. Full grown larval body length ranges from 23 to 32 mm. Younger larvae tend to be lighter green while older ones develop to a dark green or brown color. A bright yellow stripe along the dorsal surface is a characteristic feature of the larvae. The larvae also have no hair and have two black spots in

the dorsolateral portion. The pupa is typically 15–20 mm long, and its color is red brown. A characteristic feature is the presence of two small spines at the tip of the abdomen that are about 0.5 mm long each. The adult stage is a typical small noctuid moth with dark-spotted forewings with a strongly variegated pattern and paler lines along the veins and greyish white hind wings with grey margins measuring 40–45 mm long in wing expanse. Adult moths are on average 15–20 mm long and have a total wingspan of 30–38 mm. The body is grey-brown and the forewings are patterned with dark grey, red and brown colors. The hind wings are greyish-white with a grey outline.



Adult indigo caterpillar

Nature of Damage

- It is a highly polyphagous pest sporadically assumes destructive nature in the early sown jute crop.
- Its activity is confined to seedling or early plant establishment stage.
- Their infestation cause twisting of top leaves and stunted plant growth. March to April is the peak period of infestation.
- The young larvae after hatching feed on tender leaves in groups.
- The feeding activity of grown up larva is generally confined to a few hours early in the morning and late evening.
- The caterpillars are very voracious feeder and quite large patches of foliage are quickly stripped causing heavy defoliation.
- The leaves are skeletonized; the older caterpillars often devour the entire lamina.
- In jute typical damage is noticed in young seedlings, which are cut on the ground surface by the larvae causing reduction in plant stand.

Management

- Early infestation can be spotted by monitoring of the insect underside the clods and the base of the plants prior to the damage and initiation of spray.
- Hand picking and destruction of egg masses / gregarious larvae in the early hours when they are active on plant parts can reduce the damage to great extent.
- Prior to the infestation, on the basis of monitoring, chlorpyrifos 2 ml/lit may be sprayed in the base of the plant.
- The early instar larvae can be managed by spraying neem seed kernel extract (NSKE) 5% along with suitable sticker.
- In case of severe infestation, application of quinalphos 25 EC @ 1.5 ml/lit or synthetic pyrethroids such as cypermethrin 25 EC 0.5 ml/lit, or lambda cyhalothrin @ 1 ml/lit should be done.

Grey weevil*Mylocherus discolor* Bohemam

(Curculionidae: Coleoptera)

Description and Biology

This is a highly polyphagous pest which attacks several cultivated crops. This insect was first reported on jute in 1974 (Das and Ghosh, 1974). Earlier this pest was reported as minor pest of jute. Nowadays it has become very regular causing infestation during 30-50 days after sowing. The crop is mostly infested by grey weevil during April - June months. One or two pre-monsoon showers, temperature range of 35-39°C and RH 85-94% are conducive for the maximum incidence of grey weevil. Female lays about 200 eggs in soil during the oviposition period which hatches in 3-4 days. Larval period varies from 20-55 days. Adult longevity is about 60 days. It hibernates in the larval stage during winter.

Identification

The grub is 3-4 mm long, apodous and creamy white in color which remains in soil. The adult weevil is 10 mm in length, grey in color with dull white spots on elytra with long clubbed antennae. Antenna is 12 segmented the first being the longest. Eyes are black, prominent, and present laterally at the base of rostrum. Elytra are prominent covering the abdomen completely and covered by green scales. The adult weevil has an elongated head that forms a snout. The mouth is at the end of the snout.

Nature of Damage

- This pest mainly damages *tossa* jute, white jute varieties are immune to the attack by grey weevil.

*Adult grey weevils**Grey weevil damaged jute plant*
Courtesy: T. Ramasubramanian*Grey weevil damaged jute field*

- The weevils attack 30-50 days old plants and cause considerable damage by making holes in the leaves and in severe cases cause defoliation.
- Unopened tender apical leaves are mostly damaged by this pest. The damaged spots/ holes magnifies along with the growth of the leaf.
- The adults feed on leaves by making irregular holes on the apical leaves.
- Grubs are voracious feeder of roots causing stunted plant growth.

Management

- The crop should be properly monitored to observe the activity of adult weevils on leaves and the damage caused by them.
- As preventive measure, in endemic areas balanced application of fertilizers is advocated as excess nitrogenous fertilizers aggravate the plant damage.
- Foliar application of botanicals containing azadirachtin 1% @ 3ml/lit twice at 10 days interval reduces grey weevil infestation.
- In case of considerable leaf damage two rounds of cypermethrin 25 EC @ 0.5 ml/lit at fortnightly intervals may be sprayed on the crop.

Stem weevil

Apion corchori Marshall

(Curculionidae: Coleoptera)

Description and Biology

The stem weevil occurs in all the jute growing tracts of India. This is one of the harmful pests in white jute that causes average estimated fibre loss of about 18% (Datt, 1958). *C. capsularis* more susceptible to stem weevil infestation. Although its infestation prolongs through considerable period of the crop, maximum damage is witnessed in seedling stage. Crops sown early are more susceptible than those sown comparatively late. Cloudy damp weather associated with low daytime temperatures of both soil and air is congenial for incidence and multiplication during April-May. Early sown crop with more nitrogenous fertilizers suffers most.

The adult female lays glistening white eggs singly in the holes gnawed by it on the stem at the bases of apical petioles. Up to 675 eggs are laid during its oviposition and incubation period of about



Stem weevil grubs



Adult stem weevil
Courtesy: K Mandal

3 days. It is usually inactive during daytime and escapes notice easily. Larval period lasts for 8-18 days and pupates within stem. Adults survive up to 209 days.

Identification

The adult is active early in the morning, makes circular feeding holes on the topical leaves. The small weevil is only 1.8 mm in length and 0.8 mm in breadth, brown or dull black and has small whitish setae on its body. The eggs are gnawed inside the stem and remain cryptic till the damage caused by the grubs is visible. The eggs are very small and glistening white in color. The grubs are apodous; readily emerge out on tearing the damaged shoot at the portion of wilting in the stem. The grub is yellowish white with a light brown head, body wrinkled, remains within the stem and starts feeding on the tissues inside the bark. The adult insect is small, around 1.2 mm in length, and greyish black in color.



*Stem weevil grub on damaged shoot
Courtesy: T. Ramasubramanian*

Nature of Damage

- The adults, both male and female feed on jute foliage. Small pin holes seen in the lamina due to such feeding indicate presence of insect.
- The female makes one or more punctures at the top nodes, where knot is formed and there are corresponding numbers of grubs inside the plant.
- The destruction of the tissues by the grub results in withering and drying of the crown leaves just above the spot where the insect is concealed and the leaves below remain unaffected.
- Damage of apical meristem checks the vertical growth and adversely affects the quality and development of fibre.
- In older plants mucilaginous substances are formed around the tissues damaged by the grub that binds the fibres together; which breaks at these points during fibre extraction and results in '*knotty fibre*'.



*Weevil damage in seedlings
and older plants*

Management

- Removal and destruction of stubbles and self-sown plants avoid the carry of the pest and reduce the infestation.

- Sowing of the crop, both *tossa* and *white* jute varieties in the late April remarkably reduce the incidence of stem weevil as compared to those sown in late March or early April.
- Balanced application of nitrogenous, phosphatic and potassic fertilizers reduces the pest attack, because imbalance use of nitrogenous fertilizers increases the incidence of the pest.
- In endemic areas of weevil infestation, preventive soil application of carbofuran (1 kg ai/ ha) is effective in managing the pest.
- Need based foliar spray of cypermethrin 25 EC @ 0.5 ml/lit in early hours can control the damage caused by stem weevil.

Yellow mite

Polyphagotarsonemus latus Banks

(Tarsonemidae: Acarina)

Description and Biology

Yellow mite is one of the important destructive pests of jute. It is widely distributed in all the jute growing tracts of India. *Tossa* jute suffers more due to yellow mite infestation than the white jute. This pest remains active throughout the year on different crops. High temperature and humidity with sunshine during April to July favor for multiplication. The fibre yield loss due to this pest has been estimated to be 38% depending upon the level of infestation between 20-50% (Keka *et al.*, 2008). The fibre strength is reduced by 2-3g/ tex in the infested plants.

Eggs are laid on the under surface of tender leaves and hatch into protonymph within 31-36 hours. Approximately 23 eggs are laid throughout the life period. The newly hatched nymphs of both the sexes are white in color, which gradually turns to yellow after 24 hours. Females are larger than males and their average life span is about one week. The average life span of males is 6 days. After hatching, male yellow mite moves very slowly for 2-3 hours and sucks sap from the ventral surface of tender leaves. The nymphal period in case of female is on an average 24 hours, whereas in case of male the same is 18 hours. Adult is a tiny (0. 25 mm), yellow color mite which is not visible in naked eyes. The entire life cycle is of about 8-10 days, which helps in building populations very fast. The mite has 14 generations on an average in



Yellow mites on jute leaf

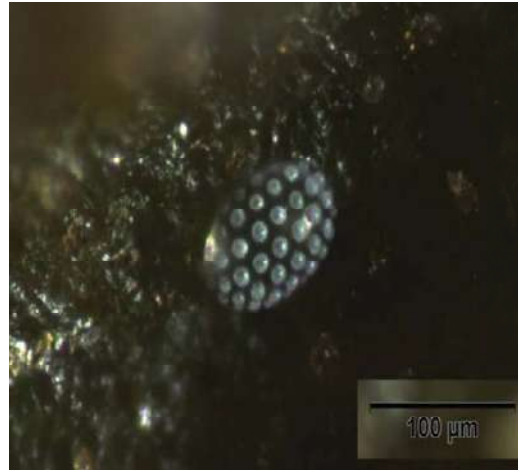
a season on jute crop and sometimes one overlaps the other.

Identification

The eggs are colorless, translucent and elliptical in shape, about 0.08 mm long and are covered with 29 to 37 scattered white tufts on the upper surface. Young broad mites have only three pairs of legs. They are slow moving and appear whitish due to minute ridges on the skin. As they grow, the size ranges from 0.1 to 0.2 mm long. The quiescent stage appears as an immobile larva. After one day, the larva becomes a quiescent nymph that is clear and pointed at both ends. Female nymphs are often



Adult yellow mite



Yellow mite eggs

carried about by males. Female mites are about 0.25 mm long and oval in outline. Their bodies are swollen and light yellow to amber in color with an indistinct, light, median stripe those forks near the back end of the body. Males are similar in color but lack the stripe. The two hind legs of the adult females are reduced to whip-like appendages. The male is smaller (0.11mm) and faster moving than the female. The male's enlarged hind legs are used to pick up the female nymph and place her at right angles to the male's body for mating.

Nature of Damage

- Both nymphs and adults suck the sap from the ventral surface of young leaves even before they are unfolded.
- The mid rib of leaves curves downwards and the lamina rolls inwards from two sides.
- The secondary veins wrinkle and give the leaf a rough and crumpled look and do not grow to their full size.



Yellow mite damaged jute plant

- The infested leaves turn deep green with coppery brown shades with typical inverted boat like shape and drop prematurely.
- The vertical vegetative growth of the crop is arrested, internodes become shortened and significant yield loss occurs regularly.

Management

- In peak summer the crop needs to be irrigated immediately to subside the damage and acute stress caused due to mite infestation.
- The *tossa* jute varieties viz., JRO-204 and JRO-524 are less susceptible and comparatively more tolerant to mite.
- Line sown crop harbors less mite population and suffers less from mite damage
- Early sown jute crop suffers more from mite infestation. Instead of March, the crop sown in April escapes the damage of mite to greater extent.
- Foliar spray of mineral oil @ 3 ml/lit + neem oil @ 3ml/ lit twice at 35 and 50 days after sowing may be applied for management of yellow mite.
- Two sprays of spiromesifen 240 SC @ 0.8 ml/ lit at 36 and 46 DAS may be applied for protecting the jute crop from yellow mite.
- Need based spray of abamectin 1.8 EC @ 0.8 ml/lit or fenazaquin 10 EC @ 1.5 ml/ lit alternatively at fortnightly interval is quite effective for mite management.

Mealybug

Phenacoccus solenopsis Tinsley

(Pseudococcidae: Homoptera)

Description and Biology

Cotton mealybug, *P. solenopsis* has been reported to be a new pest of jute crop in 2012 in South Bengal. (Satpathy *et. al.*, 2016). This mealybug is highly polyphagous and occurs in many economically important crops. Upon hatching it moves out, select a suitable place and start feeding. Greater survival and high reproductive potential and shorter generation time even in adverse climatic condition facilitate to establish on the crops and many other alternative weed hosts. Earlier three species of mealybugs i.e. *Maconellicoccus hirsutus*, *Ferrisia virgata* and *Pseudococcus filamentosus* had been reported to infest jute. Recently, for the first time cotton mealybug, *P. solenopsis* has been recorded on jute (*C. olitorius* and *C. capsularis*) and kenaf (*Hibiscus cannabinus* L. and *H. sabdariffa* L) in West Bengal. High temperature and stretches of dry period and less number of rainy days favor its



Male mealybug

infestation. The infestation of mealybug on tossa jute particularly in the early crop growth stage of the plant during intermittent stretches of dry period has been witnessed in many parts of south Bengal.

The developmental period from immature crawler to adult stage is greater for males and it is 18 - 19 days as compared to females (14-15 days), it is probably due to the additional molt to the pupal stage in males. Females show dynamic patterns of fecundity with the number of crawlers produced per female are about 340-350. The reproductive period lasts for 30-35 days. Parthenogenesis with ovoviviparity (96.5%) dominant over the oviparous (3.5%) mode of reproduction. Adult females live up to 42-45 days. Males account for less than 5% of the population, and live for 1 -2 days.



Female mealybug with ovisac

Identification

Eggs are yellow in color laid in sac, 3-4 times the body length and covered with white wax. Nymphs are yellow in color with 4-5 instars. The first instar larva referred as crawler is the most active stage. Adult female of *P. solenopsis* generally has paired dark spots and/or stripes dorsally which are covered with a powdery, waxy secretion with six pairs of transverse, dark bands that are located across the pro-metathoracic segments. Oval to elongate insects with 17 pairs of lateral and terminal waxy filaments which are characteristics to the particular genus. The ovisac is composed of fluffy, loose-textured wax strands. Adult females range from 2 to 5 mm long and 2 to 4 mm wide. It usually has short lateral wax filaments and slightly longer terminal wax filaments (less than a half as long as the body). The adult females of *P. solenopsis* have usually paired black dorsal markings. The adult male has distinct head, thorax and abdomen and has a pair of membranous wings in the mesothorax.



Mealybug on jute plant

Nature of Damage

- Apical meristem is the most susceptible part of the plant.
- Plants infested during vegetative phase exhibits symptoms of distorted and bushy shoots, crinkled and/or twisted bunchy leaves, and plants become stunted and dry completely in severe cases.

- The damage is mostly caused by the immature stages of mealybug which suck the sap.
- The vertical growth of plant is arrested with shortened internodes and the plant gives bushy appearance.
- Repeated attacks on the stem cause the development of crust due to which fibre bundles resist separation at the time of retting, resulting in the formation of 'barky fibre'.
- Late season infestation during reproductive stage of the crop results in reduced plant vigor and early crop senescence.



Mealybug infested jute plants

Management

- Preventive seed treatment with thiamethoxam (70 WS @ 5g/ kg seed) or clothianidin (50 WDG @ 3g/ kg seed) is very effective against mealybug.
- The insecticide application requires careful observation on status of natural enemies and the distribution and density of mealybug colonies.
- Need based application of insecticides is recommended to suppress the outbreak of mealybug population.
- The systemic insecticides are more effective against mealybug crawlers.
- Foliar spray of profenophos 50 EC @ 2 ml/lit prior to seed treatment with thiamethoxam (70 WS @ 5g/ kg seed) or clothianidin (50 WDG @ 3g/ kg seed) is recommended for integrated management of mealybug.
- The control of ants which help the mealybug colonies to grow and spread by soil application of chlorpyrifos 20 EC @ 2 ml/litre or malathion dust 5% @ 25kg/ha restricts the mealybug crawlers to spread to non-infested plants.

Semilooper

Anomis sabulifera

(Noctuidae: Lepidoptera)

Description and Biology

Semilooper is one of the most specific pests of jute causing foliar damage and occurs in almost all the jute growing tracts. The larva is easily noticed when they crawl by producing a loop in the middle. The pest passes the winter in soil in the pupal stage and the moths appear in May - June. Crop loss due to this pest was estimated up to 50%. The magnitude of loss in fibre depends on the age of the crop,

extent of infestation during crop growth. High forenoon relative humidity for 15 days followed by drizzling during night hours and bright sunshine during day time is more conducive for the outbreak of the semilooper. The crop is most susceptible at 50-80 DAS.

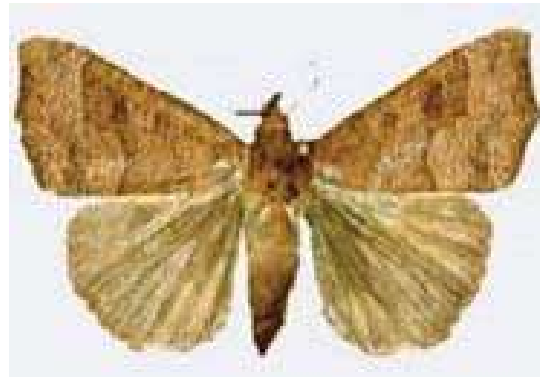
A female may lay more than 150 eggs which look like water droplets. Life cycle of this moth includes egg, 5-larval stages, pupa and adult. The fecundity of a healthy gravid female is 165 eggs. Incubation period of egg is 2-3 days. Larval period ranges from 9-16 days and third instar larvae are the most destructive stage of the pest and pupate under dry leaves or soil crevices.



Semilooper on jute plant
Courtesy: T. Ramasubramanian

Identification

Eggs are laid singly on under the leaf blades and they are tiny and glisten like yellowish green pearls which hatch within 2-3 days. The larvae are slender, greenish with light yellow head, narrow dark green dorsal lines and a waxy, dark lateral stripe. Adults are brownish male; the hind wing is lighter in color. Larvae are usually 2.4 to 3.0 cm long. The adult is a dull brown moth with darker spots on the wings.



Semilooper adult

Nature of Damage

- Damage starts in all cases from unopened leaves in upper part of the plant which represent the most susceptible portion.
- Approximately 95% of the damage is restricted to 9 fully opened leaves of the crop.
- Newly hatched larvae are very active and start voraciously feeding on the epidermal membrane of one side of the mesophyll, leaving the epidermal membrane intact.
- As the leaves grow bigger, cuts



Semilooper infested jute field
Courtesy: T. Ramasubramanian

become evident and the edges of the tender leaves are eaten, serrated, diagonal cuts in apical leaves.

- In case of severe infestation the growing points are eaten and destroyed, the stems are totally defoliated and induce profuse branching; internodes are shortened resulting in reduction of fibre yield and quality.
- In seed crop, scooping of terminal stem causes drooping of the plants and larvae damage seed capsules by making holes on the capsules that affects the quality of seed inside.

Management

- Balance use of fertilizers is the key to reduce semilooper infestation.
- Sampling of the pest in row length of 1.5-2.0 m is ideal for getting the most reliable estimates of semilooper infestation.
- Plough the infested fields after harvest to kill the pupae.
- *Bacillus thuringiensis* is effective against the jute semilooper. Foliar spray of *Bt* formulation may be recommended @ 1kg/ ha.
- The EILs were determined during the crop stage at which the pest significantly affected the yield. Individual EIL for semilooper is 10% plant damage at 55 DAS.
- Whenever the damage by semilooper reaches 15% then any contact insecticide such as profenophos @2 ml/lit, fenvalerate 20EC @ 1.0 ml/lit or cypermethrin 25EC @ 0.5 ml/lit may be applied.
- The insecticidal sprays need to be targeted towards the apical portion of the plant rather than covering the whole plant from top to bottom as the infestation of the pest is confined to the top leaves.

Jute hairy caterpillar

Spilosoma obliqua Walker

(Noctuidae: Lepidoptera)

Description and Biology

It is a polyphagous pest which infests several crops including jute, mesta, ramie and sunnhemp. However, jute is the most preferred host. It was once considered as a sporadic and irregular pest on jute but nowadays in high rainfall areas it is a regular and major pest on jute causing 20% fibre yield loss. High humidity, rains with intermittent sunny



Egg mass of jute hairy caterpillar

days and high temperature is the congenial condition for hairy caterpillar infestation.

The female moth lays up to 1000 eggs with a pin head in a cluster on the underside of leaves which hatch in 5 days. After about 2-3 weeks of voracious feeding the larva becomes full grown and measures around 4.5 cm. They pupate either in dry soil or among dry leaves. Its life cycle is completed within 30 to 40 days.

Identification

Eggs are light green in color, laid in clusters on the underside of leaves. The larva is orange colored with broad transverse bands and tufts of yellowish to black hairs. Adults are crimson colored medium moths with red abdomen. Wings are pinkish with numerous black spots. At each segment the body is covered with innumerable red hairs. The female moth is 1.5 cm long and 4 cm at wing expanse. The forewings are buff colored with black spots and hind wings are whitish; the body is of light red color with alternate black spots.

Nature of Damage

- Young larvae feed gregariously and scrap the chlorophyll content mostly on the under surface of the leaves.
- Later they disperse to the entire field and prefer to defoliate the older leaves particularly the third and fourth stages feed voraciously on the jute foliage and may completely skeletonize the plant. In later stages, the larvae eat the leaves from the margin.
- The damaged leaves of the plant give an appearance of net or web and under severe condition complete defoliation may occur.
- The pest causes damage to jute during June and continued till mid-September coinciding with 60-100 day old crop.



Jute hairy caterpillar larva



Gregarious hairy caterpillar on jute plant
Courtesy: T. Ramasubramanian



Hairy caterpillar damaged jute field

Management

- Line sowing with CRIJAF seed drill and maintenance of optimum plant population of 5-6 lakhs/ discourage population build up in the crop.
- Regular monitoring to spot early oviposition and egg masses in the early stage, when the caterpillars remain gregarious on leaf, it is easy to destroy them after plucking such infested leaves and then dipping them in insecticidal solution.
- When caterpillars disperse, their control is achieved by insecticidal spraying of lambda cyhalothrin 5 EC @ 1.0 ml/lit or indoxacarb 14.5SC @ 1.0 ml/lit to reduce the pest population to a greater extent.
- Early instar larvae are more vulnerable to the larval parasitoid, *Protapanteles obliquae*. In case of greater activity of parasitoids, insecticidal interference may be avoided.

Minor Pests

Survey and surveillance for occurrence of insect pests in jute since last 10 years detected few pests hitherto not considered to infest the jute crop have been reported to occur in jute agro ecosystem. Few new insect pests those infest jute are green semilooper, *Amyna octa*; leaf webber, *Homona* spp. and gram caterpillar, *Helicoverpa armigera* Hubner. It's very important to regularly watch the activity of these pests in jute to judge the future pest status of new pests. Such information will be the guide for making decisions with respect to the management of such insect pests.

Stem girdler

Nupserha bicolor Dutta

(Lamiidae: Coleoptera)

This pest has been reported in jute long back in 1949. The damage is mostly observed in young plants and grown up plants suffer least. High humidity and



Typical symptom of Stem girdler damage



Stem girdler beetle damaged jute plant

rainfall break the larval diapause during March-April. The damage caused by this pest both in fibre and seed crop of jute is very meagre and irregular. The adult beetle girdles the stem at two levels 1-1.4 cm apart before it starts oviposition. Three punctures or slits are made within the two girdles and the middle slit is used to lay single egg. Because of girdling, nutritional transfer is arrested and the stem above the lower girdle die and dry up. Branching takes place below the lower girdle of such stem. After hatching the larva feeds on pith tissue, moves downwards along the central hollow and pupates within stem. Ovipositional damage by female is more than the larval feeding.

Eggs are yellowish and 1.5 mm in diameter. Grub is yellowish, about 14 mm long when full grown but shrink to half of the size before going to diapause. The adult is 8-10 mm long, orange color beetle. Head and tip of the elytra, body are cylindrical.

Red mite

Oligonychus coffeae Nietner
(Tetranychidae: Acari)

Red mite is more common on white jute. This mite lives under web and sucks the sap from lower surface of the leaves. Its incidence is sporadic in nature, but occasionally it causes serious damage to the crop. The affected leaves become leathery, turn yellow and drop off prematurely. Intermittent shower followed by dry spell with high humidity are quite favorable for the incidence of the mite (Das, 1948). The red mite is only red in winter when hibernating. In fact they are usually yellowish-green in color with two dark patches, one on each side of the body.



Red mite infested jute plants

Emerging/ New Insect Pests Reported in Jute

Gram caterpillar

Helicoverpa armigera
(Noctuidae: Lepidoptera)

The gram caterpillar is a cosmopolitan pest and widely distributed in India. Earlier, *Helicoverpa armigera* was not reported on jute. During survey of insect pests infesting jute in *kharif*, 2012, first time *H. armigera* was recorded to damage *tossa* jute,

C. olitorius in North 24 Parganas district of West Bengal (Selvaraj *et. al.*, 2013a). After hatching, the larvae feed on tender leaves and shoots. In severe cases, larvae scoop the succulent stem, which results in wilting and drying of the stem topically above the damage point. The pest defoliates, feeds and cuts the terminal succulent portion of stem of about 65-70 days old crop which cause drooping and drying of stem that eventually reduces fibre yield.



Gram caterpillar on jute stem

Eggs are yellowish-white and laid singly on leaves. The first and second larval instars are generally yellowish-white to reddish-brown in color, without prominent markings. Fully grown larvae are 30-40 mm long. The pupa is brown, 14-18 mm long, with smooth surface, rounded both anteriorly and posteriorly, with two tapering parallel spines at posterior tip. The adults are stout-bodied moth of typical noctuid appearance, with 3.5-40 cm wing span. Forewings have a line of 7-8 blackish spots on the margin and a broad, irregular, transverse brown band. Hind wings are pale-straw color with a broad dark-brown border that contains a paler patch; they have yellowish margins and strongly marked veins and a dark, comma-shaped marking in the middle. Antennae are covered with fine hairs.



Gram caterpillar damaged jute stem

Safflower caterpillar

Condica capensis

(Noctuidae: Lepidoptera)

The infestation of this pest on jute was reported in 2014. It occasionally feeds on *tossa* jute. The caterpillar is often confused with gram caterpillar, *H. armigera*. This is one of the important insect pests of safflower in India. The larvae in the early stages make holes in the leaves and they feed voraciously as they grow.

The greenish spherical eggs are laid singly on the jute leaves and a female lays about 400 eggs. The fully grown larva are brown in color, smooth, tapering towards the posterior region, network of brown lines on head and slightly hampered anal segment. Creamy white line on dorso-lateral side, measures about 25mm.



Safflower caterpillar on jute leaf



Safflower caterpillar

The larval period lasts for about two weeks. It pupates in leaf debris and adult emerges in about 8 days in laboratory condition. The adult moth is stout with dark brown forewings having a pair of eye like markings in the center and the hind wings are little brown.

Green semilooper

Amyna octa

(Noctuidae: Lepidoptera)

During the survey of insect pest infestation, green semilooper, *Amyna octa* was first reported to infest jute on the apical part of the plant in farmer's field at 24-Parganas (N) of West Bengal (Ramesh Babu, *et. al.*, 2015b). Unlike the jute



Green semilooper damage on jute leaves



Adult green semilooper

semilooper (*Anomis subulifera*), this green semilooper is polyphagous in nature. Beside jute this pest is reported to feed on other host plants such as sweet potato, sunnhemp, mesta and ramie. The larvae

feed voraciously making large irregular holes on the jute leaves.

The *A. octa* larvae are green in color, about 18-20 mm in length having setae on the body and white stripes on dorso-lateral from anterior to posterior region. When alarmed the larva usually jumps from the host and continues to wreathe and wriggle wildly. Prior to pupa formation, larvae turn pinkish from green color and body length contracted. In this stage, they make leaf folds by joining two leaves with their webs and pupate therein. Adult moths are uniformly dusky brown in color with snout and faint wavy white markings and have two prominent white spots on the forewings of males.

Tussock hairy caterpillar

Dasychira mendosa

(Lymantriidae : Lepidoptera)

The tussock hairy caterpillar, *Dasychira mendosa* is a polyphagous pest of wild and cultivated plants. It is reported for the first time on jute (*Corchorus* spp.) from West Bengal (Selvaraj *et. al.*, 2016). The pest is active throughout the year but its activity is



Adult tussock caterpillar



Larvae of tussock caterpillar

reduced in winter. It lays egg in groups on lower surface of the leaves. It is a gregarious feeder and causes defoliation of jute leaves.

The larvae are densely urticating hairy and often have tufts of hairs on the dorsal aspects of certain segments. Larva is greyish brown with dark prothoracic and pre anal tufts of hairs. The adult is a medium sized moth, with dark transverse lines on fore wings, tufts of hairs are seen at anal end in the female and eggs are covered with these hairs.

Mesta hairy caterpillar*Euproctis scintillaus*

(Lymantriidae: Lepidoptera)

Mesta hairy caterpillar, *Euproctis scintillaus* also a polyphagous pest. Although it infests mesta, very recently it was reported for the first time on jute (*Corchorus* spp.) from West Bengal (Selvaraj *et. al.*, 2016). The larva has yellowish brown head, a yellow dorsal stripe with a central red line on the body and tufts of black hairs dorsally on the first three abdominal segments. The adult is a medium sized moth, with yellow transverse lines on fore wings, tufts of hairs are seen at anal end in the female and eggs are covered with these hairs.



Adult mesta hairy caterpillar

Leaf webber*Homona* sp.

(Tortricidae: Lepidoptera)

This leaf webber is reported for the first time on jute (*Corchorus* spp.) from southern Bengal during 2015 (July- September) (Ramesh Babu *et. al.*, 2015a). They feed upon the leaves of the host plants and become fully grown in 3-4 weeks. A fully grown caterpillar measures about 22 mm in length. The young larvae fold the leaf in the manner that the margin of leaf blade comes together and then starts feeding from its edge. When mature, they bind several leaves together to make a nest. The mature larvae feed on the leaves, often leaving partly fed or dead leaves on plants. This feeding activity causes distortion of the leaves and young shoots and also defoliation, which can be seen from a distance.

The wings are held roof like over the body when the insect is at rest. The fore wings bear an oblique band and few transverse wavy lines. The adult moth is brownish-yellow, small in size with a wing expanse of about 25-27 mm.



Leaf webber larva on jute



Adult leaf webber

Leaf miner

Trachys pacifica Kerremans

(Buprestidae: Coleoptera)

During field survey in the Research Farm of ICAR-CRIJAF, Barrackpore, North 24 Parganas during 2013, the adults of leaf mining beetle, *Trachys pacifica* Kerremans was observed on leaves of jute forming irregular white patches or zig-zag passage (Selvaraj *et. al.*, 2014). The adult of the leaf miner is a hard bodied elongated beetle with three curved transverse stripes seen on the elytra. It is basically a minor and sporadic pest of jute, its grub mines leaves under epidermis even all the leaves of plants during early stage of crop. Its activity is predominantly restricted during rabi season and *C. olitorius* is more susceptible than *C. capsularis*. The damage is more prevalent in plants grown under glass house condition.



Leaf miner in jute leaf



Leaf miner damaged jute plant

New Reports of Natural Enemies on Insect Pests of Jute

Natural enemies which help to subside pest population are an important component of sustainable agricultural production that aims to decrease the application of chemicals. The activity of natural enemies mainly depends on the stability of the agro ecosystem, its habitat management, which is a form of conservation biological control. Such ecological approach favors natural enemies and enhances biological control in agricultural systems. Natural enemies also require colonizing ability which allows it to keep pace with changes to the habitat in space and time. Most important is the type of insecticides used or intervened in management of insect pests. Application of selective and biorational insecticides are compatible with the activity of natural enemies. In jute also many natural enemies and entomopathogens have

been reported to parasitize, predate and infect the insect pests causing damage to the crop.

***Protapanteles obliquae* (Wilkinson)**

(Braconidae: Hymenoptera)

The survey for natural enemies of jute pests was conducted in jute growing areas of North 24 Parganas district of West Bengal during *Kharif* 2012. *Protapanteles obliquae* (Wilkinson) is one of the most important larval parasitoid of jute causing extensive parasitisation. It is a density dependent larval parasitoid and first time reported in jute ecosystem (Selvaraj, *et. al.*, 2015). The full grown *P. obliquae* emerged out through the ventro-lateral body region of the jute hairy caterpillar larva (mostly 2nd-3rd instars). The activity of this parasitoid was noticed from mid-May to mid-July during the cropping season. The parasitoid, *P. obliquae* is a gregarious, endoparasitoid specific to *S. obliqua* and parasitize to the extent of 38% up to third instar of larvae.



Hairy caterpillar parasitized by Protapanteles obliquae

Immediately after exit from the host, each grub begins to spin a white cylindrical cocoon and soon compact mass of milky white cocoons appear on the side of the host larva. The pupal cocoons measures about 4 mm in length with a maximum width of 2-3 mm. The adult wasps emerge by cutting a circular lid at the end of the cocoon. Adult wasps were slender with long antennae and black in color and emerge in 4-6 days after pupation.



Adult Protapanteles obliquae

Adult wasps emerge by cutting a circular lid at the end of the cocoon. Adult wasps were slender with long antennae and black in color and emerge in 4-6 days after pupation.

***Meteorus spilosomae* Narendran and Rema**

(Braconidae : Hymenoptera)



Meteorus spilosomae

The survey for natural enemies of jute pests was conducted in jute growing areas of North 24 Parganas district of West Bengal. *Meteorus spilosomae* Narendran and Rema was identified and the report confirms the parasitisation by *M. spilosomae*, a larval

parasitoid of *S. obliqua* in jute ecosystem for the first time in 2012 (Selvaraj *et. al.*, 2013b).

It is a solitary, koinobiont endoparasitoid, specific to *Spilosoma obliqua*. The apodous grub emerges from the host insect body (mostly 3-4th instar) followed by formation of pupal cocoons. This parasitoid is reported to cause up to 77% parasitisation under field condition, indicated the possibility of these parasitoids to be used as potential natural enemy of *S. obliqua* of jute through conservation, augmentation and mass multiplication.



Adult *Meteorus spilosomae*

Tachinid fly

Sisyropa spp.
(Tachinidae : Diptera)

Adult parasitoids emerging from pupa of jute semilooper, *Anomis sabulifera* were collected for identification. Adults appeared greyish to blackish in color resembling common house flies. Antennae were aristate type and characterized by robust bristles at the tip of the abdomen. Based on the morphological characteristics, the parasitoid was identified as *Sisyropa* spp. (Diptera: Tachinidae) by Zoological Survey of India, Kolkata (Ramesh Babu *et. al.*, 2018 Unpublished). The parasitoid was prominent during the mid-April to last week of May. The later larval instar stage of *A. sabulifera* was more vulnerable to the parasitoid. *Sisyropa* spp. is characterized to be a solitary endoparasite.



Adult tachinid fly

Parachremylus spp.

(Braconidae: Hymenoptera)

The parasitoid emerges from the leaves infested with the leaf miner grub with body length 2.5 mm and forewing length about 2.7 mm (Selvaraj *et. al.*, 2014). As per the literature the complete host range of *Parachremylus* spp. has not been known yet. Perhaps this is the first report of the genus *Parachremylus* as a larval parasitoid of leaf mining beetle, *Trachys pacifica* Kerremans in jute crop from India.



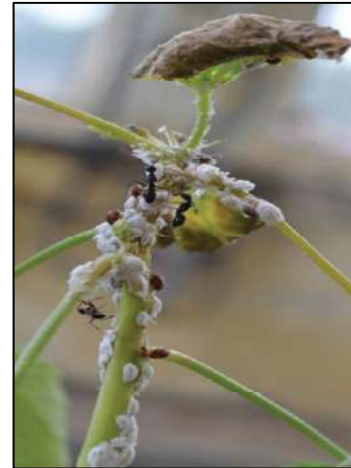
Adult *Parachremylus* spp.
Courtesy: Photographer, direct.com

***Aenasius arizoensis*, Hayat**
(Encyrtidae : Hymenoptera)



Adult Aenasius arizoensis
Courtesy: Moazzem Khan

This parasitoid which emerged from the mummified mealybug in jute was identified as *Aenasius arizoensis* Hayat from Insect Biosystematics facility of IARI, New Delhi. The extent of average parasitisation on mealybugs in these plants ranged from 15-32% with peak activity during the month of second fortnight of June to late August (Satpathy, *et. al.*, 2014). The parasitisation is dependent upon the density of mealybug



Mealybug parasitized by Aenasius arizoensis

population. The widespread occurrence of *P. solenopsis* on diverse host plants, natural enemies also proliferated in many agro-ecosystems. This was the first report of parasitoids from the jute and mesta based ecosystem.

Nuclear polyhedrosis virus (NPV)

Nuclear Polyhedrosis Virus (NPV) occurs naturally and produces about 93% of disease in the hairy caterpillar larvae. The natural epizootic on hairy caterpillar caused by infection of this NPV has been evidenced in farmers' field. This NPV has the potential for its use as microbial bio control agent of hairy caterpillar.



NPV infected hairy caterpillar larva

Integrated Pest Management in Jute

The following strategies may be considered for IPM of insect pests of jute.

- Tolerant varieties such as JRO 204 (Suren), JRO 524 (Navin) and JRC 212 (Basudev) may be recommended for cultivation in the yellow mite endemic areas. Cultivation of JRO 7835 should be discouraged in grey weevil endemic areas.
- Line sowing with CRIJAF-seed drill reduces the infestation compared to the broadcasted crop. It adversely affects the congenial microclimate for growth, development and infestation of mite and hairy caterpillar.
- The intensity of pest attack in jute is greatly influenced by the date of sowing. The level of incidence by stem weevil, grey weevil and yellow mite is more on early sown crops, but the reverse is true with respect to semilooper incidence. The date of sowing from 4th week of March to 2nd week of April is optimum in order to minimize the pest incidence.
- Self-sown plants and weeds should be removed properly to avoid carryover of the pests.
- *Bt-k* commercial formulations and neem formulation with 10,000 PPM azadirachtin may be incorporated as a component of jute IPM in case of organic jute cultivation particularly for management of lepidopteran pests.
- Neem oil @ 4ml/ lit was reported to be effective against the jute semilooper, *A. sabulifera*. This may be included as one of the important components in the IPM practices.
- It is suggested to pluck the leaves with early stage gregarious larvae of hairy caterpillar prior to the spray of insecticides. It is one of the important practices needs to be followed in the management of jute pests.
- Two sprays of spiromesifen 240 SC @ 0.8 ml/lit at 36 and 46 DAS and profenophos 50 EC @ 2.0 ml/lit at 66 and 76 DAS are optimum for protecting the jute crop each against yellow mite and lepidopteran pests. The EILs were determined during the crop stage at which both the pests significantly affected the yield. Individual EIL for yellow mite and lepidopteran pests were 42 mites/cm² area on second unfolded leaf and 10% plant damage, respectively.
- Need based application of foliar spray of fenazaquin 10 EC @ 1.5 ml/ lit or propargite 57 EC @2.5 ml/lit or spiromesifen 240 SC @ 0.8 ml/lit for yellow mite and profenophos 50 EC @ 2.0 ml/lit or lambda cyhalothrin 5 EC @ 1.0 ml/lit or indoxacarb 14.5SC @ 1.0 ml/lit for lepidopterans at different frequency and intervals are recommended for suppression of economic damage.

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