Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

J E Z S Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(2): 575-577

Received: 12-01-2017
Accepted: 13-02-2017

Salman Khan
Forest Entomology Division, Forest Research Institute, P.O. New Forest, Dehradun, Uttarakhand, India

Mohsin Ikram
Forest Entomology Division, Forest Research Institute, P.O. New Forest, Dehradun, Uttarakhand, India

Vijay Vardhan Pandey
Forest Pathology Division, Forest Research Institute, P.O. New Forest, Dehradun, Uttarakhand, India

Correspondence
Salman Khan
Forest Entomology Division, Forest Research Institute, P.O. New Forest, Dehradun, Uttarakhand, India

First record of *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae) on *Ginkgo biloba* L. (living fossil tree)

Salman Khan, Mohsin Ikram and Vijay Vardhan Pandey

Abstract
Spodoptera litura, also known as tobacco cutworm is a serious pest of many crops. It was first recorded on *Ginkgo biloba* tree. *S. litura*, infest the leaves of *G. biloba* and present on most of the leaves of the tree. It was observed that the larvae were stuck to petiole of the leaves forming circular position. Details of the collected *S. litura* specimens including its structure and morphology have been discussed in details. Their control measures have also been discussed in details.

Keywords: *Spodoptera litura*, *Ginkgo biloba*, Dehradun, *Trichogramma*, Pests

1. Introduction
Spodoptera litura Fabricius is a polyphagous insect belonging to Class: Insect, order: Lepidoptera and family: Noctuidae is also known as tobacco cutworm infesting almost 120 different plants belonging to 44 families all over the world; 60 plants known from India [1-4].
Ginkgo biloba is considered as the oldest tree species survived on earth, with a history of about 200 million years back [5]. *G. biloba* is a rare and endangered tree species mostly unique to China and the only living member of the *G. biloba* order of the plant [6]. Once *Ginkgo* species were common to Asia, North America and Europe. However, they were destroyed in most areas during the Ice Age, and now only a single species is surviving in restricted natural distribution [5]. *G. biloba* was widely cultivated for various aims such as memory enhancer and in traditional Chinese herbal medicines due to its chemical contents of the leaves. *G. biloba* produces many important secondary metabolites, among which ginkgo flavonoids and ginkgolide are unique and important [7]. The species is highly adaptive with varying seasonality, rainfall, and temperature. Earlier, *G. biloba* was planted as an ornamental tree and also for food and timber requirements [8].
Among the main host plants species attacked by *S. litura* in the tropics are *Colocasia esculenta*, cotton, groundnuts, jute, maize, rice, soybeans, tea, tobacco, vegetables (aubergines, *Brassica*, *Capsicum*, cucurbit vegetables, *Phaseolus*, potatoes, sweet potatoes, *Vigna* and others [9, 10]. *S. litura* feeds on the underside of leaves causing feeding scars and Early larval stages remain together radiating out from the egg mass. Many holes and cavity shape structure may be observed due to feeding pattern of *S. litura* Larvae and in certain cases, whole shoot tips wilt above a hole is also observed [11, 12]. Feeding damage can also occur as tunnels form such as in cabbage [13]. *S. litura* lay their eggs underneath of the leaves in the cluster of 200 to 300 eggs, covered with brown scales. Eggs of *S. litura* are spherical and somewhat flattened, 0.6 mm in diameter, laid in batches and covered with the hair scales from the tip of the abdomen of the female moth. The eggs are pale orange-brown to pink in colour. After 3 days the larvae emerge out and undergoes several colour phases from green to almost black. The larva undergo 6 instars form and larval period goes up to 9-14 days. They are hairless, variable in colour (blackish-grey to dark-green); the sides of body of larvae having longitudinal bands of dark and light colour, also dorsal side have two dark semilunar spots, may attain 40-45 mm in length. The hatching period is 4 days and further, it pupates in soil. The pupae are 15-20 mm long of red-brown colour having spines on abdominal end. The total life cycle of *S. litura* is 25 days [14]. The males of *S. litura* mate with an average of 10.3 females and females with 3.1 males [15]. The adults of *S. litura* are smaller than the other cutworms/armyworms, with silvery grey to greyish brown in colour. Forewings have a lighter spot near the centre and hindwings are paler with darker borders, having a light band at the wing edges [16].

The objective of the study was to identify the insect pests of *G. biloba* especially for *Spodoptera* spp. and its identification up to the species level.

2. Material and Methods

The observation was taken at Dehradun, Uttarakhand for *Ginkgo biloba* tree defoliator if any during August, 2016 to October, 2016 and found that the leaves were attacked by the larvae of *Spodoptera litura*. Every individual tree was searched for this defoliator and collected. The larvae of *S. litura* mainly present on the petiole of the leaves of the tree and covered almost half of the tree. The larvae feed on the leaves and petiole of *G. biloba.* Larvae were collected by handpicked method and laboratory reared by providing the leaves of *G. biloba* for feeding purpose. Due to the unfavourable temperature and improper moisture content, mortality of the larvae occurs at very high rate. But fortunately, we were able to save 2-3 larvae which eventually turned to pupae and so on. In the laboratory the larvae completed its life cycle on *G. biloba* leaves (Fig. 1) only. Later on, the adult moth was identified using different key available and verified from NFIC (National Forest Insect Collection, Dehradun). Photography was done using Nokia-Lumia Camera. Different characters were studied using Stereoscopic zoom binocular microscope made by Aark International. Specimens of *S. litura* were preserved for future research related to comparison or morphometric analysis.

3. Result and Discussion

The adult of *S. litura* was almost 2 cm long and 1 cm wide during sitting position. In stretch form, an adult *S. litura* was 2 times longer than its width. The hindwings were 1.5 times of the length of an adult. The antennae were ½ of the length of the adult *S. litura*. The eyes were dark black and first pair of the leg was slithery and with hairs. The antennae were very thin and long. The abdominal part was also covered with small shiny hairs. The abdominal end was dark in colour with hairy pattern. The forewings were rough in colours with the serrate marginal of light black and light yellow-creamish colour zebra pattern. The X shape structure was also present on the forewings with light yellow-creamish colour (Fig. 1). The hindwings were almost transparent with hairy margin of creamish to white colour. Brambila [17] made notes on the proper identification of the *S. litura* with the characters of forewings and veins. Female moths of *S. litura* produce a potent sex pheromone/hormone which attracts a large number of male moths in the field for mating [18]. The forewings of *S. litura* were grey to reddish-brown in colour with a variegated pattern and paler lines along the veins. Similarly, the hindwings were greyish-white with grey/dark hairy margins, often with dark veins in *S. litura* but absent in *S. littoralis* (important character for distinguishing *S. litura* and *S. littoralis*). The variability and similarity of these two species often make it difficult to distinguish them visually on first sight because of maximum similarity in physical appearances but can be separated with taxonomic keys.

For control of *Spodoptera litura*, many botanical pesticides have been identified and being used. Extract of *Azadirachta indica, Vitex negundo, Citrus sinensis* and *Zingiber officinale* can be used to control the larvae of *Spodoptera litura* [19]. *Melia dubia* can also be used as a botanical pesticide against *S. litura* [20]. Chemical control includes spraying of chlorpyriphos 20 EC 2 L /ha or dichlorovos 76 WSC 1 lit/ha [21]. Rao and others [22] have identified different species (71) of insect parasitoids parasites of *S. litura* of different stages. The parasite belonging to seven families of Hymenoptera and two families of Diptera. Divya [1] also state that there are about 100 parasitoids, 50 predators and more than 12 entomo-pathogens, recorded on *S. litura* in different countries including *Andrallus spinidens, Cameron* and *Cotesia marginiventris, Chrysoperla, Glyptapanteles africanus Harpactor costalis, Telenomous remus Nixon* and others. The biological control of eggs of *Spodoptera* spp. are possible using *Trichogramma* spp. (Hymenoptera: Trichogrammatidae) as they lay their eggs inside the eggs of host insects [23]. *Telenomus remus* is a more aggressive parasitoid than *Trichogramma* spp. against *Spodoptera* spp. due to its large size, stronger capabilities, which allows it to penetrate all layers of the egg mass and parasitize each egg [24]. 9 different larval parasites such as *Snellenius manilae* (Ashm.), *Apanteles ruficrus* (Hal.), *Campoletis chlorideae* Uchida, *A. plutellae* Kurd., *Charops bicolor* (Szepl.), *Microplitis pallidipes* Szepl., *M. tuberculifera* (Wesm.), *Meteorus* sp. and *Euplectrus* sp. and 1 egg parasitoid, *Trichogramma dendrolimi* have been identified on *S. litura* insect [25]. Other *Trichogramma* spp. can be utilised in controlling such harmful insects biologically [26].

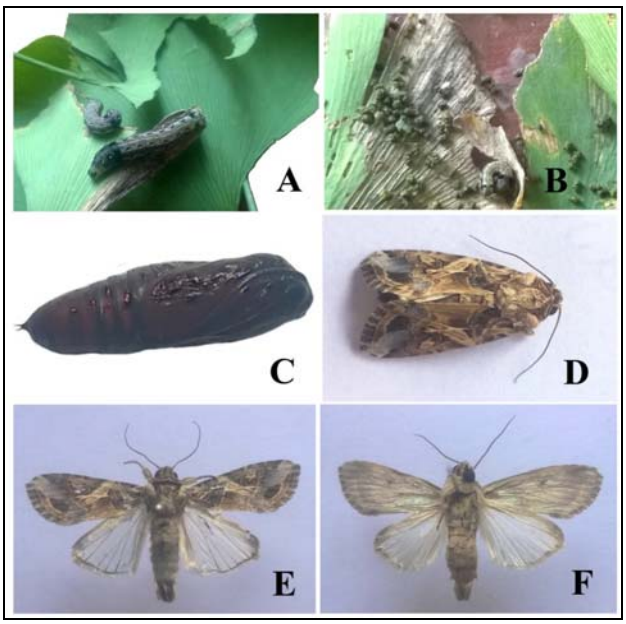

Fig 1: (A-F) of *Spodoptera litura*: A & B: Larvae feeding on *Ginkgo biloba* leaves; C: Pupa; D: Adult moth; E: Dorsal view of adult moth and, F: Ventral view of adult moth.

4. Acknowledgements

The authors are greatly indebted to the Director, Forest Research Institute, Dehradun, for providing necessary research facilities. Author are thankful to Dr. Mohd. Yousuf for research support and also thankful to Dr. Sudhir Singh, Head, Forest Entomology Division of Forest Research Institute, Dehradun for his constant support.

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