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Biological and Taxonomic Study of Agriculturally Important Noctuid Pests of Kashmir

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Abstract The present work incorporates thorough investigations on Biology and Taxonomic studies of some insect pests belonging to family Noctuidae, damaging agricultural crops (cereals, vegetables, fruits, oilseeds fodders, medicinal plants and forest range plantation) at different sites viz., Afferwatt; 4000m, Sheeshnag; 3500m, Aru; 2800m, Chandanwari; 3000m, Daksum; 2800m, Bangus valley; 3500m, Sadna Pass; 3500m, Doodpather, 2870m, Dood Ganga, 2600m, of Kashmir Himalaya. The pest immature stages were collected alive from field in different types of collection containers and reared in the Biosystematics Laboratory of SKUAST-K, Shalimar, Srinagar (Jammu & Kashmir), India. Adults were also collected with the help of light traps. The experiment was conducted during 2011-2012 and resulted a total of 69 noctuid adult pest individuals, six noctuid pest species were reared *viz.*, *Thysanoplusia orichalcea* (Fabricius), *Cucullia verbasci* Linnaeus, *Heliothis armigera* (Hubner), *Agrotis ipsilon* (Hufnagel), *Garella ruficirra* Hampson, and *Amphipyra monolitha* Guenee. Taxonomic study of these six species was also carried out.

Keywords: *biology, taxonomy, noctuidae, kashmir himalaya*

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1. Introduction

In Kashmir valley, some insect pests are by far the most serious agents of damage to agricultural crops including economically important plants. The major source of income of Kashmir valley happens to be through silviculture, agriculture and horticulture, it was therefore suggested that in the present work, a preliminary survey, surveillance of insect pests of some crops and economically important plants in Kashmir valley has been carried out. Noctuids are known for their pollination, predation and pest abilities and constitute one of the well studied insect groups. Incredible degree of variation is observed in all the developing stages within the group. Noctuid moths are economically important, as the caterpillars of many species attack a variety of agricultural and forest plants. They may attack any part of the plant such as the foliage, shoot, roots or fruits. Almost every kind of a cultivated plant has one or more pests belonging to family Noctuidae. The damage caused by these insects to various kinds of vegetation is enormous. Plants belonging to Mimosaceae, Malvaceae, Euphorbiaceae, Graminae, Anacardiaceae, Leguminoceae, Myrtaceae, Apocynaceae, Verbenaceae, Coniferae, and Moraceae are frequently found attacked. Of these, plants belonging to the family Graminae and Mimosae suffer maximum damage. Caterpillars belonging to each subfamily of Noctuidae are specific in their choice of host plants.

Larvae and adults of certain noctuids are destructive to various fruit trees. The adults of these moths have particularly well developed proboscis having a dentate tip, with which they pierce the rind and pulp of ripening fruits to suck the juice. The punctured region can easily become infected by fungi or bacteria that will cause the damaged fruit to drop prematurely. Fruits of apple and ficus are seriously attacked by *Plusia orichalcea* Fabr., *Xestia-c-nigrum* Linn, and *Agrotis ipsilon* (Hufn.). Banziger (1987) reported twenty four species of fruit piercing moths from Nepal. *Heliothis armigera* Hubn., attack mango fruits in some parts of India. Apple and pear fruits are attacked by five noctuids of the genera *Orthosia*, *Lithophane*, *Amphipyra*, *Himeila* and *Morrisonia* (Chapman; 1974). Ornamental plants like calendula, lotus, zinnia, datura, rose etc. are attacked by *Spodoptera littoralis* (Boisd.), *Spodoptera litura* (Fabr.) and *Heliothis armigera* Hubner and sunflower (*Helianthus anus*) by *Plusia orichalcea* Fabr. (Rao, 1974; Singh, 1983).

Among the agricultural pests perhaps the most important is *Spodoptera mauritia* (Boisd.), popularly known as the 'paddy swarming caterpillar' because of its habit of appearing in enormous numbers on paddy. *Spodoptera litura* (Fabr.), generally referred to as the 'tobacco cut worm' is another noctuid pest widely distributed in India. Its larvae normally feed on the tender leaves causing serious damage to a variety of crops such

as tomato, chilies, banana, castor, ground nut, soya bean, winged bean and cocoa (Zucchi,1984). The gram pod borer *Helicoverpa (=Heliothis*) *armigera*, Hubn., is a polyphagous pest of tropics, subtr opics and warmer temperate regions of the old world, extending as far as North of Germany and Japan (Hill, 1975). In many parts of India, it causes serious damage to cotton (Bhattacherjee & Gupta, 1972; Sinha, 1983), gram, vegetables, opium, lettuce, castor etc. (Lall, 1964: Nayar et al.,1976). Noctuids are also serious pests of various medicinal plants. *Atropha belladona* is attacked by *Agrotis ipsilon* (Hufn.); *Mentha arvenjis* by *Agrotis nigrisigna* Wlk.; *Hyoscyamus niger* by *Heliothis armigera* Hubn.; *Cannabis saliva* and *Papaver somniferum* by *Heliothis armigera* Hubn. (Meshran, 1994). For this purpose extensive field surveys were carried out at different habitats of Kashmir Himalaya having rich diversity of vegetation, cropping areas and forest zones. During the course of present investigation the damages rendered by various types of pest species to the crops and other economically important plants were kept in mind.

2. Materials and Methods

The study was conducted during 2011- 2012 in different agro forestry habitats in Kashmir Himalaya and have resulted a total of 69 individuals belonging to six species of family Noctuidae. The adult Noctuid pests were collected with the help of light trap and immature stages (eggs, larvae, pupae) were collected alive from field in collection jars, so as to carry them to biosystematics laboratory for rearing out adults of insects. Caterpillars along with their host plant parts, infesting leaves, flowers and buds were collected and reared at room temperatures (18°C – 32°C) mostly during the months of late March to November in laboratory. However, in some cases rearing continued through winters and some adults insect emerged from pupal diapause after winter. Collection jars containing relevant insect material were covered with muslin cloth or guaze held in place by rubber bands for aeration purpose. Fresh food material in cages was made by adding various parts of the host plants in the cages from time to time. Host plant material was carefully examined before it was placed in rearing containers to rule out the possibility of predators, parasites and eggs being introduced accidentally. Care was taken to keep the cages at bay from ants. Rearing containers were monitored frequently for emergence of adult insects, pupae and in some cases even eggs. Careful notes were taken throughout rearing so that all data relative to biology, host plant and host insect is properly correlated. Larvae, pupae or puparia were preserved with reared. Since some larvae pupate in ground, the cages were provided with several centimeters of soil. The adult stage of the insects were collected and presented for identification.

The specimens were identified with the help of available literature and comparing with the specimens lying at IARI, New Delhi and FRI, Dehradun and other electronic and non electronic sources. The male genitalia of the species were dissected out for confirmation of species identification. Different collection sites were selected for the purpose of collection with an altitudinal distribution ranging from 1500m – 4000m amsl. Some of the important collection sites often visited viz., Afferwatt; 4000m, Sheeshnag; 3500m, Aru; 2800m, Chandanwari; 3000m, Daksum; 2800m, Bangus valley; 3500m, Sadna Pass; 3500m. For taxonomic study forewing and hind wing of each species were detached from the body of an adult by giving upward jerk followed by dipping into 70% alcohol for 1-2 minutes, then placing in sodium hypochlorite for 10-20 minutes depending upon the size of the insect for descaling, then transferring the wings into glacial acetic acid for 10 minutes, latter on into carbo-xylol for 15 minutes and mounted finally on a glass slides in DPX mountant. The other morphological features like head, legs, genitalia and antennae were dipped overnight or boiled for 20-30 minutes with 10% KOH solution to get the musculature sufficiently relaxed. Later on KOH was removed by washing the different parts in distilled water for 2 or 3 times. The dissection was performed within a cavity block, with the help of fine forceps and needles under an Olympus SZX7 binocular stereoscope microscope. The dissected body parts were transferred to acetic acid glacial in another cavity block for 10-15 minutes and finally transferred to carbo-xylol for 15 minutes. After clearing the body parts of specimen were mounted finally on a slide in DPX mountant and covered with cover slip. The drawing of wings was done on camera lucida attached to binocular microscope. The photographs of genitalia and other parts were taken by the help of Olympus digital camera (CAMEDIA C-7070). The identified collected material has been deposited in the Division of Entomology, Sheri-e- Kashmir University of Agricultural Sciences and Technology, Shalimar, Srinagar.

3. Result and Discussion

The present work deals with the taxonomic studies and biology with different immature stages of some important agriculturally important Noctuid moths of Kashmir Himalaya with the altitudinal distribution of 1550m to 4500m amsl. Morphological details of the external genitalia considered as a dependable tool for species identification and therefore taxonomic studies of these agriculturally important pest species of family Noctuidae were also studied in the present communication from Kashmir Himalaya. The experiment was conducted during 2011-2012 and resulted a total of 69 Noctuid adult pest individuals, six noctuid pest species were reared *viz.*, *Thysanoplusia orichalcea* (13), *Cucullia verbasci* (06), *Heliothis armigera* (18), *Agrotis ipsilon* (22), *Garella ruficirra* (02), and *Amphipyra monolitha* (08). Taxonomic study of these six species was also carried out.

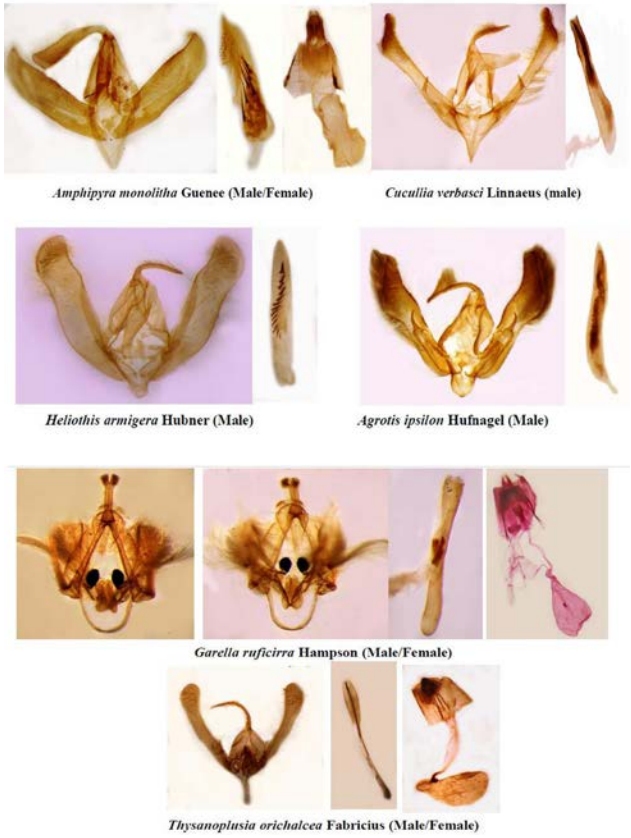
4. Notes on Biology

Eggs, caterpillars, pupae and moths were reared continuously in a constant temperature laboratory maintained under standard conditions at 25°C. The collection was supplemented with field collected moths, larvae, and pupae as these became available. Disease was always a problem so larvae were provided with fresh leaf material daily. Out of the large number of 1st instars only few were able to reach adulthood and few of these were with deformed wings. After the caterpillars had pupated,

they were removed and transferred to large sized cages so that emerging moths had adequate room to extend their wings fully.

5. Eggs

Eggs are globular or spherical in shape ranging from 0.2mm to 1mm in size. With vertical ridges equally spaced on the chorion. The eggs are flat ventrally to form an adhesive disk. Freshly laid eggs were greenish-gray becoming dark brown before hatching. Laid singly or in batches in the axils of branches, flower buds, tender pods, under surface of leaves or on soil surface. The number of eggs laid by a single female varies from species to species; ranging from 4 to 15 eggs in a single batch (Plate 1). In the laboratory at 25°C, incubation takes 4-8 days with the black head capsule visible through the chorion after 3-5 days.



6. Larvae

Freshly hatched larva feeds on the empty egg shell and wanders in search of young leaves, flower buds, and tender pods of plants. The larvae are nocturnal and hide under clods trash or in cracks of the soil during the day and stop all its activities. It feeds variously at night and dusk. Larvae moults several times before pupation. First instar larvae is colourless with a black head capsule, but in the later instars both body and head are green; have only 2 pairs of abdominal prolegs, so progress with a looping motion. Fed on the lower surface of the leaves leaving a window-like upper epidermal layer. Second instar larval damage was characterized by small shot holes on the leaves. The remaining larval instars consumed larger portions of the leaves. Complete defoliation, except for the midrib, was characteristic feeding damage of the last 2 larval instars. The 6th instar required 10 days time to develop. Prior to the prepupal stage, the larvae ceased feeding, defecated, and formed their hybernaculum. No fecal pellets were observed within the hybernaculum. The time taken to reach the maximum size or maturity varied with respect to number of instars occurring; taking a mean of 22 days, whereas few larvae developed more quickly, pupating in the 5th instar after a mean of 18 days.

7. Pupae

At pupation, larvae spin a white silken cocoon in a fold on the underside of a leaf or between leaves on the plant they have been feeding. At first the pupa is bright green but it later darkens to become black on the dorsal surface and green to tan on the ventral. The time spent as pupae was recorded 20-30 days for larvae reared on host plant leaves in the laboratory under standard conditions. Pupal period varies from species to species ranging from 10-50 days while in some cases pupal period continues beyond 2 months and adult emerge from pupal diapauses after 3-4 months (Cucullia verbasia). Pupa is obtect green when freshly formed turns dark reddish brown after few days (Plate 1). The pupa ranges from 1.7 - 1.8 cm in length. Climate and food availability determines the number of generation of a particular species, usually 4 generation in a year are most common but the number may reach upto a maximum of 13 in case of *Plecoptera reflexa* Guenee in a single year (Mathur, 1942).

7.1. *Amphipyra Monolitha* Guenee, 1852

Larvae are green, eruciform with dorsal and lateral white yellow bands along either side, extending from anterior to the posterior end of the body, posterior end pointed or triangle shaped. Larvae infested walnut plants between the months May and June. During laboratory rearing of caterpillars a change in colour was observed i.e. a few days later the larvae developed light green colour than again parrot green color with the white lateral bands and finally fully grown larvae spins white cocoon in which pupation takes place, pupae is dark brown and adult emerges after 38 days (Figure 1).

Figure 1. Different stage of Amphipyra monolitha Guenee

Host Plant: walnut leaves (Juglans regia)

Male: Uncus simple, broad, flate anteriorly, straight, sclerotized and thumb-like. Tegumen elongate,

asymmetrical, anteriorly pointed and posteriorly club-like. Vinculum pointed, sacculus well marked, large, flattened and symmetrical; Valva large, moderately seclerotized and with few scattered hairs/spines. Juxta squarish. Corona with few prominent spines.

Aedeagus: Uniformly sclerotized and of moderate length. Pointed anteriorly and swollen posteriorly, Vesica with a highly sclerotized long spines, ductus ejaculatorius entering at the posterior end.

Female: Ovipositor lobes long, well-developed, sclerotized, beset with fine setae. Posterior apophyses longer than the anterior. Ostium bursae rectangular, lightly sclerotized. Ductus bursae very short and broad, continued into a cylindrical bursa. Signum not distinct. Corpus bursae bag shaped, long and extensive (Plate 1).

7.2. *Cucullia Verbasci* Linnaeus, 1758

Larvae consume entire green portion of young leaves leaving only the Wool which is made up of sharp stellate spicules. Punctures on the leaves produce a lace like cut out, which makes them to dry up. Older larvae feed voraciously, consuming the entire leaf including the rib. Young larvae conceal themselves in tunnels made out of wool. Last instar larva spins a silken cocoon out of wool and dead leaves of the plant. Early instar larvae are creamish in color, turn progressively green and the older caterpillars are creamish white with yellow spots having annulations along entire length. Only one generation was recorded during the current study, larvae being active on the plant from May to September (Figure 2).

Figure 2. Different stage of Cucullia verbasci Linnaeus

Host Plant: *Verbascum thapsus*.

Male: Uncus long and slender with a subapical part ending in a pointed process. Scaphium well developed, conical in shape. Tegumen, long, narrow and slender. Tuba analis well developed. Vinculum triangular, shorter than the tegumen with medially curved narrow arms. Saccus swollen and broadly U shaped. Valva long with a swollen basal and an apical distal half. Harpe sharp and pointed.

Aedeagus: Long, cylindrical and conical anteriorly, a slightly curved notch present on left side just behind the tip of the anterior side. Middle region and anterior side highly sclerotized mostly occupied by long spine. Cornuti distinct long spine well sclerotized. Ductus ejaculatorius entering at the posterior swollen end. (Plate 1)

7.3. *Heliothis Armigera* (Hubner, 1808)

Larvae of *Heliothis armigera* were found active from the middle of May to the last week of July with maximum incidence during the month of June. An overall incidence on different host plants during the course of seasons ranged between 10-25 per cent of the observed plants. Larvae inflicted varying degree of damage to the ten host plants under six plant families; being maximum in case of *Atropa acuminata*, *Aquilegia nivalis*, and *Salvia sclarea*. In case of two former plant species mainly the raw and mature fruits were bored by the larvae, inflicting severe damage to seeds, while in case of latter flowers and shoot tips were gnawed seriously. Damage to the fruits, flowers, shoot tips and leaves of these host plants was 60, 50 and 45 and 10 per cent respectively. First and second instar larvae fed on the leaves of shoot tips while as the higher instar larvae fed on the reproductive organs of the plant; berries, pods and flowers. In case of Inula racemosa, the caterpillars bore into the shoot tips causing them to dry up with a black sooting effect. Laboratory rearing of the caterpillars reflects that there are color variations among the larvae. In some cases the early instars were grayish while as in others they were light yellowish or green in color. As the larvae grow they progressively turn brownish and the last instar achieves a deep brown color with two creamish stripes along lateral sides of the body; one on each side from anterior to the posterior end of the body. However, in a few cases larvae retained green color till pupation. Pupal period calculated during the laboratory rearing varied from 14-20 days. Pupation took place successfully in most of the cases without any provision of soil in rearing jars. In a few cases, larvae showed cannibalistic behavior during rearing process (Figure 3).

Figure 3. Different stage of Helicoverpa armigera (Hubner)

Host Plants: Wheat, Sorghum, Maize, Tomato, Salvia sclarea, pea, Aquilegia nivalis, Atropa acuminata, Inula racemosa, Sassurea costus, Lavatera cahemiriana, Nepeta sp., Rheum emodi, and Hyoscyamus niger

Male: Uncus simple, tightening to apex, straight, sclerotized and thumb-like. Tegumen elongate, asymmetrical, anteriorly pointed and posteriorly club-like. Vinculum pointed, sacculus well marked, large, flattened and symmetrical; Valva large, highly seclerotized and with scattered spines. Juxta squarish but flattened medially.

Aedeagus: Uniformly sclerotized & of moderate length. Vesica with a row of cornuti, highly sclerotized triangular, ductus ejaculatorius entering at the posterior end. (Plate 1)

7.4. *Agrotis Ipsilon* (Hufnagel, 1776)

The black colored larvae of this species caused extensive damage to the crop. About 20-25 per cent plants were destroyed by the cut worms between the months of June and July. Eggs are laid on the lower surface of leaves lying close to ground. Young caterpillars feed on the leaves while as the older ones feed at the base of stems.

Seedlings are cut through at ground level. Last instar larva prepares an earthen cocoon for pupation. (Figure 4)

Figure 4. Different stage of Agrotis ipsilon (Hufngel)

Host Plants: Potato, Chilies, Gram Sorghum, Linseed, Bajra & *Picrorhiza kurroa*.

Male: Uncus very much elongate, and bearing a tuft of long hairs at the tip. Tuba analis and Scaphium not prominent. Tegumen with elongate arms, Vinculum short and broad; saccus U-shaped. Valvae elongate well developed; fringed with dense hairs; sacculus well developed; Harpe elongate with sharp tips, with wide basal portion, extending longitudinally. Transtilla membraneous. Juxta moderately sclerotized.

Aedeagus: Long, cylindrical and conical anteriorly, vesica in the form of a dark marking covering more than half. Middle region moderately sclerotized. Cornuti not distinct. Ductus ejaculatorius entering at the posterior end (Plate 1).

7.5. *Garella Ruficirra* Hampson, 1976

Larvae are stout, light green with black head and light brown anal segment. During the course of rearing the caterpillars turned brownish from posterior end to anterior end. Adult moths are orange brown with a wing span of 22-28 mm. The fore wings exhibit a wavy pattern of lines (Figure 5).

Figure 5. Different stage of Characoma nilotica Hampson

Host Plant: Walnut fruit (Juglans regia)

Male: Uncus very much elongate, upturned straight, bifid apically and bearing a tuft of long hairs at the tip. Tuba analis prominent. Scaphium well developed. Tegumen with elongate arms, Vinculum broad; saccus U-shaped. Valvae short, not well developed; sacculus moderately developed with a fringe of long hairs; development of a darkly scaled process from the transtilla.

Aedeagus: Moderately long, broad at the anterior and posterior end, tapering at the center, Vesica with a large V- shaped spine-like median sclerotized carnuti at the center. Ductus ejaculatorius entering at the middle portion.

Female: Ovipositor lobes short, sclerotized and setosed. Posterior apophyses longer than the anterior. Genital plate circular without any notches. Ostium bursae, simple, V-shaped, ductus bursae very long. Corpus bursae elongate with a tube-like basal half and an expanded distal half. A patch of short spicules in the middle forming the signum (Plate 1).

7.6. *Thysanoplusia Orichalcea* (Fabricius, 1775)

Among the lepidopterans this species was found to be most rampant both in terms of incidence and host spectrum. Green, eruciform larvae with a characteristic looping gait were recorded from host plants, defoliating the plants from the middle of May to July. Larvae fed from the underside of leaves. Early instars gnaw at the epidermal tissue producing a fine netted appearance; later instars feed voraciously on lamina cutting through holes in it. Extent of damage to leaves varied from 10-35 per cent of the leaf area. Incidence of attack varied from 5-65 per cent among various plant species. Pupation took place in light brown silken webs secured further by leaf folds. (Figure 6).

Figure 6. Different stage of Trysanoplusia orichalcea (Fabricius)

Host Plants: Onion, Cabbage, Cauliflower, *Inula racemosa*, *Salvia sclarea*, *Mentha piperita*, *Atropa acuminate*.

Male: Uncus very long and slender with subapical part ending in a pointed process. Tegumen, short and broad well sclerotized. Tuba analis indistinct. Vinculum long. Saccus swollen and broadly U shaped. Valva long with a swollen an apical half. Harpe indistinct. Costa curved.

Aedeagus: Moderately stout and almost cylindrical, tapering posteriorly. Anterior end swollen with a long prominent sclerotized line from anterior end to posterior end, needle like structures or rod shaped process forming cornuti.

Female: Ovipositor lobes short, sclerotized and setosed. Posterior apophyses longer than the anterior. Genital plate circular without any notches. Ostium bursae, simple, V-shaped, ductus bursae very long, joined at the left side. Corpus bursae cap shaped with expanded basal half and concave distal half. (Plate 1).

8. Conclusion

The thorough field research work on Biology and taxonomy was accomplished with the objectives to identify the Noctuid species of this area and to assess incidence and seasonal flight activity of different species

encountered, damaging various crops and economically important plants of Kashmir Himalaya. Field observations have revealed that the adults started coming to the traps during the month of May onwards. The period of peak activity of the pests was recorded to be during the months of June and July comprising maximum individual catch. The study also reveals that the maximum population of the pest species was within the range of one month i.e. in the month of July and it has been further observed that occurrence of these pests remain active from June to October with the peak emergence during July followed by August and was no more detected from ending October onwards. The present findings revealed that the mean maximum temperature 24.5°C and mean minimum temperature 13.4°C and average rainfall 7.9 mm proved conducive for the multiplication of the pests in the particular area. The present research has revealed for the first time in Kashmir, the common occurrence of all the Noctuid species including some serious /major pests of agricultural, horticultural and forestry importance of Kashmir covering three seasons viz., spring, summer and autumn during the year 2011-2012. The rise in temperature has been responsible for abundant catch, showing average maximum temperature 24.5°C and average minimum temperature 13.4°C with average rainfall 7.9 mm. There existed a definite relationship between catches and the meteorological phenomena like temperature (maximum and minimum) and rainfall. The actual Noctuid pest activity started since 1st week of May and continued till the last week of August.

References

[1] Banziger, H. 1987. Biological and taxonomic studies on immature and adult Fruit-piercing moths in Nepal, with reference to Thailand. Nat. Hist. Bull. Siam Soc. 35: 1-17.

[2] Bhattacherjee, N. S. and Gupta, S. L. 1972. A new species of Heliothis Ochsenheimer (Lepidoptera: Noctuidae) infesting cotton and tur (Cajanus indicus) in India with observations on the three other common species of the genus. Jour. Nat. Hist. 6 (2): 147-151.

[3] Chapman, P. J, 1974. Green fruit worms. Plant Sci. ent. 6:15pp.

[4] Hill, Dennis S. 1975. Agricultural Insect Pests of the Tropics and their Control. Cambridge University Press, Cambridge. 516 pp.

[5] Lall, B. S. 1964. Vegetable pests, 187-211 in Entomology in India (ed. Pant. N.C), the Ent. Soc. India, New Delhi.

[6] Mathur, R. N. 1942. On the biology of the Noctuidae (Lepidoptera). Indian For. Rec. (N.S.) ent. 7. 74-154.

[7] Meshran, P. B. and Joshi, K.C. 1994. A new report of Spodoptera litura (Fab.) Boursin (Lepidoptera: Noctuidae) as a pest of Jatropha curcas Linn. Indian Forester. 120 (3): 273-274.

[8] Nayar, K.K., Ananthakrishnan. T. N. and David, B.V. 1976. General and Applied Entomology, X + 589 pp. New Delhi. Tata Mc Graw Hill Publ. Co. Ltd.

[9] Rao, S.P.V. 1974. Occurrence of Spodoptera litura (Fabr.) (Noctuidae: Lepidoptera) on rose flowers in Coimbatore (India). Indian Jour. ent. 35 (1) 70.

[10] Sinha, S. N., Chakrabarti, A. K. 1983. Outbreak of Heliothis arrnigera (Hubner) on various crops at Karnal. Indian J. ent. 45 (4): 475-477.

[11] Sinha, S. N., Chakrabarti, A. K. 1983. Outbreak of Heliothis arrnigera (Hubner) on various crops at Karnal. Indian J. ent. 45 (4): 475-477.

[12] Zucchi. R. A. and Silveira, Neto. S. 1984. Taxonomic notes on Spodoptera dolichos (Fabr. 1974) and S. androga (Cramer, 1782) (Lepidoptera; Noctuidae). Resumos. ix. Congnesso Brasileiro de Entomologia Londrina Pr. 22 a 27: 7-84.