BIONOMICS OF *ODOIPORUS LONGICOLLIS* OLIVIER (COLEOPTERA: RHYNCHOPHORIDAE) ON BANANA PLANT (*MUSA PARADISICA*)

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ABSTRACT: The banana pseudostem weevil *Odoiporus longicollis* Olivier has been recorded for the first time in Poonch and Rajouri districts of Jammu region as a major pest of banana plant (*Musa* spp.) which are grown in patches in this area. Both larvae and adults caused extensive tunelling in the leaf sheaths as well as in core region. Percentage incidence ranged between 47-61.2 per cent with a mean of 54.55±2.28 per cent. Mating occurs in mating spaces between leaf sheaths. One egg laid in one air chamber. Egg is cylindrical, yellowish white. Larvae are apodous, soft, and cylindrical with dark brown head and pass through five larval instars. Elongated cylindrical cocoons are formed for pupation by winding short pieces of fibrous materials of the leaf sheath. The pests breed throughout the year and do not undergo winter rest. Black and reddish brown adults were recorded from the splitted pseudostems of the damaged banana plants and colour difference represents a phenomenon of non sex limited variation in conspecific sympatric phena of the pest.

KEY WORDS: Biology, banana, *Odoiporous longicollis*, Rajouri, Poonch.

Banana and plantains constitute the fourth most important crop of the developing world and India is the largest producer in the world. Of the 40 million tons of fruits produced in India, banana occupies the top position with an annual output of 13.5 million tons from an area of 4, 00,000 hac (Justin et al., 2008, Padmanaban et al., 2001). Banana (*Musa* spp.) is an important fruit commonly grown in tropical and subtropical parts of the world. Banana is attacked by number of pests, major insect pests include rhizome weevil *Cosmopolites sordidus*, banana aphid *Pentalonia nigronervosa*, fruit and leaf scarring beetle *Colaspis hypochlora*, burrowing nematode *Radopholus similis*, among which major key pest is banana pseudostem borer, *Odoiporus longicollis* Olivier, a monophagous pest of banana and plantains limiting the production and productivity, posing serious threat to banana production (Visalakshi et al., 1989, Valmayor et al., 1994, Shukla & Kumar, 1970). It is estimated that banana pseudostem borer causes 10-90 per cent yield loss depending on the growth stage of the crop and management efficiency (Padmanaban & Sathiamoorthy, 2001). Dutt & Maiti (1972a) have worked out the bionomics of the pest in Tamil Nadu. Bananas containing three natural sugars-sucrose, fructose and glucose combined with fiber. A banana gives an instant, sustained and substantial boost of energy. Research has proven that just two bananas provide enough energy for a strenuous 90 minute workout, when compared to an apple, it has four times the protein, twice the carbohydrate, three times the phosphorus, five times the vitamin A and iron, and twice the other vitamins and minerals, also rich in potassium and is one of the best value foods around. The information on this important insect pest under the condition prevailing in Jammu & Kashmir and adjoining states is very

limited and inadequate. In order to plan a suitable control measure, knowledge of the incidence of the pest and the population of the pest during different seasons is very much essential. Thus, an attempt has been made in order to find out the occurrence, mode, extent of damage, biology and life cycle of pseudostem borer of banana grown in Poonch & Rajouri districts of Jammu (J & K) and the pest population during different seasons under field conditions.

MATERIALS AND METHODS

Collections were made from Bhainchh, Kanoyian, Poonch, Khanetar and Lassana from Poonch and Rajouri districts of Jammu province, where the banana plant is commonly available. Studies were conducted during the period 2005-2008 when the occurrence of the pest was at peak. Rearings were made through culture on potted cage plants. As adults though copulated did not oviposit in captivity, oviposition was studied under field conditions in cages. Egg period was determined from freshly laid eggs. These eggs were placed in the niches and on moist filter paper in petridishes to prevent their desiccation before studying them for hatching.

In order to determine the individual larval periods cellular rearing was done. Freshly oviposited places on previously uninfested shoots were covered by thin wire mesh cages and examined regularly. From the collected data only the total larval period could be derived. For determining the instars, newly hatched larvae and the subsequent stages were subjected to Dyar's law (Dyar, 1890). For determing the pupal period matured larvae collected from the infested plants were observed at intervals till the emergence of adults. For morphological studies larvae, pupae and adults were preserved in 90 per cent ethyl alcohol. Eggs were preserved in 5 per cent formalin with few drops of glycerine. At each locality 3-5 plots were considered and samples of 12-140 plants observed per plot. For studying number of generations, the time taken to complete adult stage in one generation in capitivity was considered.

OBSERVATIONS AND DISCUSSION

Distribution

The results revealed the distribution in Jammu and Kashmir as: Rajouri, Poonch, Sunder Bani districts of Jammu; and from literature Tamil Nadu (Padmanaban, 2001 & Padmanaban et al., 2001); Kerala (Visalakshi et al., 1989); Manipur (Prasad & Singh, 1989; Mathew et al., 1997; Assam (Isahaque, 1978); Gorakhpur -U.P. (Shukla & Tripathi, 1978); Eastern Uttar Pradesh (Shukla & Kumar, 1969; 1970); Cachar, Sibsagar and Dalfa Assam; Kolkata, Murshidabad, Behrampore, Siliguri, Darjeeling, Kalimpong and Pashok; Purnea West Bengal; Andaman Islands (Lefroy, 1909), Hooghly, Howrah, Burdwan, 24-Parganas, Midnapur, Nadia, Murshidabad; Kalyani-West Bengal (Dutt & Maiti (1972a); Imphal, Manipur (Ram & Pathak, 1987); and Narmada and Surat, Gujarat (Patel & Jagadale, 2003); Bihar (Tiwary, 1971).

It is known from South and South-East Asia (Padmanaban & Sathiamoorthy, 2001); Java (Froggatt, 1928); Kwangtung, Hong Kong (Hoffman, 1933); Sri Lanka (Jepson, 1935; Dias, 1936); Taiwan (Kung, 1955), China, Malaysia, Indonesia and Thailand (Valmayor et al., 1994); Vietnam (Kiem, 1995); China (Zhou & Wu, 1986 and Luo et al., 1985); Kathmandu valley, Nepal (Singh, 1966; Lefroy, 1909, Froggatt, 1928, Shukla & Kumar, 1970; Isahaque, 1978); China, Japan, Andaman Isaland, Myanmar (Shukla & Kumar, 1969, 1970), Java, Sri Lanka (Zarazaga &

Lyal, 1999) also. Hence can be considered cosmopolitan to Asia, and is reported for the first time from Jammu region of Jammu and Kashmir.

Hosts

It is a monophagous pest of banana plants (*Musa* spp.); both larvae and adults cause severe damage to banana plants (Shukla & Kumar, 1970).

Pest status

Though both larvae and adults makes extensive tunnels and galleries in the pseudostems, throughout the year. Maximum of 51 adults and 61 individuals at different stages of development were recorded on single plant. Percentage incidence ranged between 47-61.2 per cent with a mean of 54.55±2.28 per cent and this reveals its serious pest status. Shukla & Kumar (1969) recorded it as a serious pest of plantain in the eastern part of Uttar Pradesh. Similar observations were made in West Bengal by Dutt & Maiti (1972b). Shukla & Kumar (1970) observed that 70 per cent of the banana plants were attacked by this pest in Uttar Pradesh. Isahaque (1978) reported the considerable loss caused by this pest to banana crop in Assam.

Seasonal occurrence

Adults breed throughout the year, though activity slows down during December to February. Being internal feeder adult do not undergo hibernation or winter rest; though, during winter the adults remained confined in the basal decomposed part of the pseudostem and become more active during monsoon period i.e. July to September tunneling the pseudostem in the upper parts even up to the bunches. Larvae starts feeding gregariously, making tunnels in the leaf sheaths of the pseudostem and move upwards till pupation, by making a cylindrical and elongated pupal cocoon of the fibrous plant material.

Nature and symptoms of damage

The major symptoms of infestation are exudation of sap from the leaf sheaths, small pin-head sized holes on the stem, fibrous extrusions from the bases of leaf petioles; exudation of a gummy substance from the holes on the pseudostem, yellowing and withering of leaves and decaying of peduncles resulting in the immature ripening of fruits. The holes are circular in outline, with brownish boundaries and about 1 mm in diameter. The sequence of holes is the characteristic feature found in a vertical line and approximately equidistantly placed; holes are found upto distance of 6 feet from the ground in heavily infested older plants, as compared to the younger ones.

In the advanced stage, pseudostem become pale, very short, foliage bends down and becomes yellow and the plants do not attain the desired size. The size of the bunch gets considerably reduced. If true stem and peduncles are tunneled after flowering, the fruit does not develop properly, presenting a dehydrated condition with premature ripening or complete blackening of the bunch itself.

The pseudostem of the infested plants when split open, exhibits extensive tunneling both in the leaf sheath and in the core region. It is observed that all the stages of the pest are found in large numbers mostly in the peripheral region of the plants. The depths of the tunnel made by the larva range between 8 and 10 cm. The tunnels may go as high as the fruit peduncle or to the lower most collar region nears the rhizome. Ultimately the hollow tunneled pseudostems break and topple either by the action of the wind or are unable to bear the weight of the maturing bunch. Larvae feed voraciously and riddle the pseudostem making holes

on the outer surface of the pseudostem for better aeration of the tunnels. The late stage larvae (fourth and fifth instars), cause maximum damage. Adults often remain within the decomposing tissues of the pseudostem.

Almost similar observations has already been made by Froggatt (1928), Hoffmann (1933), Kung (1955), Singh (1966), Shukla & Kumar (1969, 1970), Dutt & Maiti (1972b), Isahaque (1978), Luo et al., (1985), Prasad & Singh (1989), Visalakshi, et al., (1989), Zhou & Wu (1986), Padmanaban et al., (2001) and Padmanaban & Sathiamoorthy (2001).

Life Cycle

Mating behavior

Field observations revealed that mating occurs in the mating spaces specially encarved by the adults while feeding between the leaf sheaths. Frequent mating is observed.

Pre-oviposition and oviposition behavior

The pre-oviposition period is 15-30 days and the adult weevil mate throughout the day and night. During June-July females makes small slit with rostrum on the outer epidermal layer of the leaf sheath down up to the air chamber, and insert their ovipositor to lay single egg. Usually one egg is laid in one air chamber but under laboratory conditions a cluster of 4-5 eggs at the cut end of the pseudostem within the air chamber has been laid by the gravid female. Almost similar observations were recorded in Java by Froggatt (1928). There is a relationship between the diameter of the ovipositional slit, rostrum of the female and the ovipositor. The diameter of the ovipositional slit is 0.67±0.015 mm, diameter of rostrum base is 0.57±0.02 mm and the ovipositor diameter is 0.47±0.073 mm (Justin et al., 2008). The number of eggs deposited is considerably reduced as the number of weevils increases, indicating the existence of a spacing pheromone, epideitic compounds which acts as a deterrent to conspecific females (Ranjith & Lalitha, 2001; Justin et al., 2008).

Egg & Incubation period (Fig. 1)

Freshly laid eggs are yellowish-white, more or less cylindrical with rounded ends, with somewhat prominent area of air space at the anterior end. The egg measures 2.21±0.02 mm in length ranging from 2.06-2.32 mm and 1.02±0.01 mm in width ranging from 0.93-1.12 mm. Incubation period varies from 3-5 days in summer and 5-8 days in winter (Dutt & Maiti, 1972a).

Larva (Fig. 2, 3 & 4)

There are 5 instars. Full grown larva apodous, not “C” shaped, soft, fleshy, cylindrical, wrinkled, dark brown head with strongly sclerotized mandibles, body covered with sparse, brownish setae of different lengths. The width of the head capsule in the successive instars increase in the geometrical progression (Singh, 1966). Spiracles are conspicuous and more or less elliptical. Thoracic spiracles larger than the abdominal spiracles except the 8^{th} abdominal pairs which is the largest and placed dorsally. Middle segments are wider than the thoracic and the caudal segments. Pleural fold of each segment is prominent. The 8^{th} and 9^{th} abdominal tergites are highly chitinised and collectively form the anal plate bends which is provided with four setae posteriorly on either side, each arising from a small tubercle. The anal plate bends downward and extends slightly anteriorly on

the ventral side. The full grown larva measure 16.0-20.0 mm in length with a mean of 18.22±0.43 mm and 5.0-9.0 mm in width, with a mean of 7.11±0.45 mm. Head capsule varies from 4.0-5.0 mm in length with a mean of 4.72±0.12 mm and 3.5-4.0 mm in width, with a mean of 3.94±0.05 mm. Larval period lasts for 26.2 days in summer and 68.1 in winter (Dutt & Maiti, 1972).

Feeding behavior

Immediately after emergence, the neonate larva starts feeding on the tissues around the air chamber of the leaf sheath (Fig. 2); while feeding the larvae moves across in a horizontal or in slight oblique direction and bores into the inner leaf sheaths. The third, fourth and fifth instars are voracious feeders and riddle the pseudostem by cutting sometimes holes on the outer surface for better aeration of the tunnels, thereby cause heavy damage to the plantations. The movement of the apodous larvae inside the tunnel is facilitated by the rhythmic movements of the body and by the propulsive action of the anal plate which becomes well chitinised from the third instar onwards.

Pupation

The pupation takes place inside the adjoining leaf sheaths of the pseudostem in a cocoon formed by plant fibres. The fifth instar larvae before entering into prepupal stage makes the cocoon by winding short pieces of fibrous materials of the leaf sheath around its body, thus completely enclosing itself within the cocoon, where they transforms into pupae after passing through prepupal stage (Fig. 5). The cocoon dark brown, elongate, cylindrical and is formed along the long axis of the leaf sheath. Cocoon measures 21-34 mm in length with a mean of 28.80±0.76 mm and 9-12 mm in width, with a mean of 10.90±0.22 mm.

Pupa (Fig. 6)

Pupa is exarate, pale yellow; head and the base of the rostrum with few prominent setae, having a pair of setae each near the middle and apical region of the rostrum. Rostrum reaches upto the first coxa ventrally. Prothorax anteriorly bears two pairs of chitinised setae on the raised papillated structures. Wing pads hard lying in between the distal ends of the meso and metathoracic legs on the ventral side. Legs sharply bent and applied to the ventral side. Abdomen ten segmented and bears sparse setae on either side. Size of pupa varies between 15.0-20.0 mm with a mean of 17.67±0.62 mm in length and 5.0-6.5 mm with a mean of 5.58±0.18 mm in breadth. Pupal period including pre emergence resting period of adult lasted for 20-24 days in summer and 37-44 days in winter. Pre emergence resting period ranges from 4-6 days (Dutt & Maiti, 1972). Pupa ultimately transform into adult which emerges out from the cocoon through an oval emergence hole made by the adult itself with its mouth parts at anterior end of the cocoon or sometimes at the middle of the cocoon (Fig. 7). Emergence hole varied between 5.0-6.0 mm in length with a mean of 5.35±0.10 mm and 4.5-5.0 mm in width with a mean of 4.95±0.03 mm. Even after transforming into adult, the beetle remains in the cocoon for about 5-8 days, with an average of 6.4±0.16 days, attains maturity and then finally emerges out. In Kerala total life cycle is completed in about 42 days and adult longevity is about 90-120 days (Visalakshi et al., 1989).

Adult description (Fig. 8a & 8b)

Adults robust, reddish brown and black, measuring 18.35±0.11 mm in length ranging between 17.5-19.0 mm and 6.15±0.47 mm in breadth, ranging between

5.0-6.0 mm. Snout varies from 3.0-5.0 mm in length with a mean of 3.80±0.13 mm and 0.48-0.56 mm in width with a mean of 0.50±0.01 mm. The weevil has a long life span of 90-120 days (Visalakshi et al., 1989). Black and reddish brown adults were recorded from the splitted pseudostems of the damaged banana plants and colour difference represents a phenomenon of non sex limited variation in conspecific sympatric phena of the pest (Justin et al., 2008).

MANAGEMENT:

Measures to restrain the damage caused by weevil vary widely depending upon the type of banana production systems practised. Large plantations resort to regular application of chemical insecticides to control the weevil. Resource-limited marginal farmers cultivating banana as a subsistence crop are unable to undertake chemical pesticide interventions on a regular basis. In this situation, cultural control strategies assume greater significance due to their ease of application and their compatibility with other methods of control (Padmanaban & Sathiamoorthy, 2001). Control of the weevil is an elusive and complex problem as the life cycle of the pest may be completed within the pseudostem. Application of organochlorine insecticides is no longer carried out due to the possible development of insecticide resistant weevil strains and environmental concerns. Currently stem injection of a systemic organophosphorus compound (e.g. monocrotophos) is extensively used in controlling the pest. As well as other insecticide application methods may be used, such as swabbing along with surfactants, swabbing with mud slurry containing the candidate insecticide, spraying and fumigation of the spaces between the leaf sheaths in the pseudostem. Fumigation of banana plants using Celphos (aluminium phosphide tablets), especially during the vegetative phase is phytotoxic and should be discouraged (Padmanaban & Sathiamoorthy, 2001). Field sanitation, use of healthy suckers, eradication of infested stools is important for the management of weevil. Dried old leaves should be removed for early detection of weevil infestation and to increase the efficacy of chemical application. Suckers should be pruned periodically and infested pseudostems should be removed from the field and destroyed (Tiwary, 1971). Banana stumps remaining in the field after harvest should be destroyed as they act as weevil refugia and breeding sites. The disc-on stump and longitudinal split pseudostem traps can be efficiently used to monitor and reduce the weevil population, among which the disc-on stump is effective due to the higher exudation of the plant fluids (Padmanabhan & Sathiamoorthy, 2001). Clean cultivation, use of healthy suckers, eradication of infested stools, steeping of rhizomes and spraying the plants with 0.05 per cent dieldrin is recommended for the control of the weevil.

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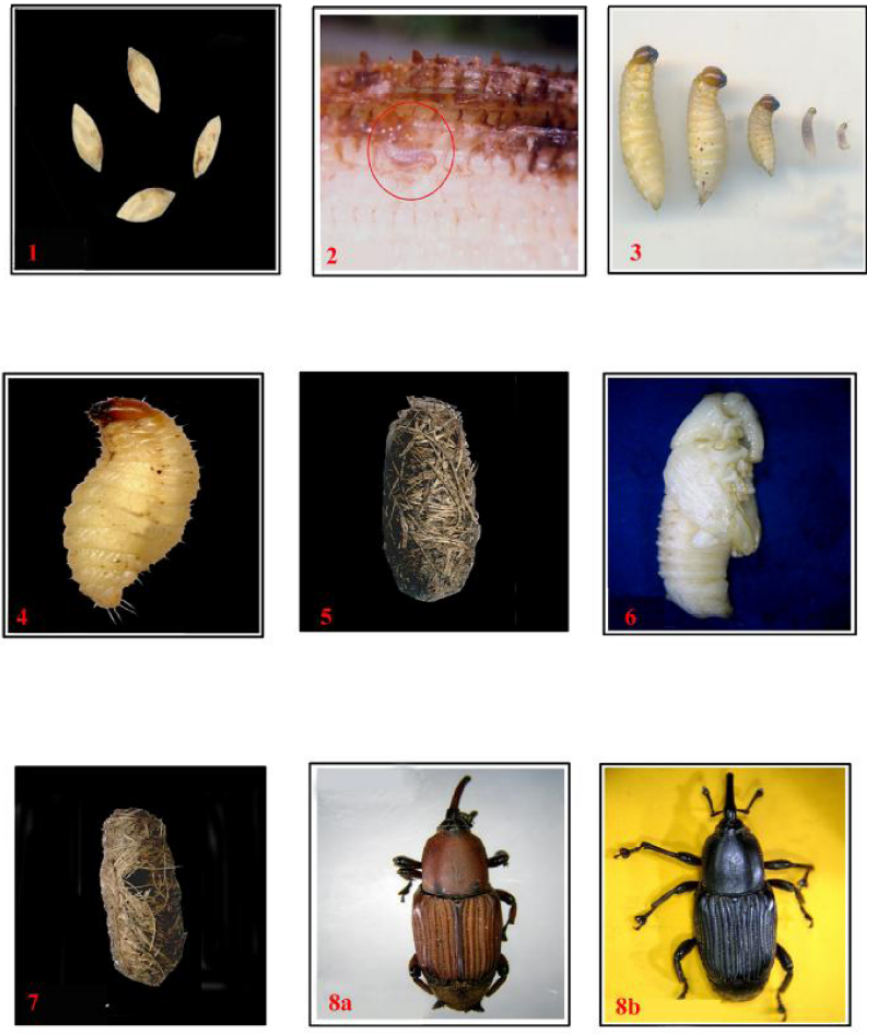

Figures 1-8. 1. Eggs; 2. Neonate larva in the air chamber; 3. Larval instars; 4. Final instar larva; 5. Pupal cocoon; 6. Pupa; 7. Cocoon with emergence hole; 8a-b. Adult.