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Bionomics of Soybean Pod Borer, *Cydia ptychora* (Meyrick) (Lepidoptera: Tortricidae) under *in vitro* Condition

Sujata Karoshi[1], R. Channakeshava[2], S.S. Udikeri[1]

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ABSTRACT

Background: The post-flowering pest pod borer, *Cydia ptychora* causing huge yield losses in soybean. It is said to be active in soybean ecosystem from September to December with 10.50-91.29 per cent incidence. The maximum incidence (95.55%) was observed to be in July sown crop.

Methods: Culture of the insect was initiated by collecting larvae and pupae from infected soybean crop and was shifted to rearing cages. Ten pairs of newly emerged adult moths were released in plastic container containing soybean pods for oviposition. On hatching, larvae were reared on soybean pods till pupation. Moist sand was provided for pupation. Further, the life cycle was tracked thoroughly to understand bionomics.

Result: Freshly laid eggs were pearly white, translucent, spherical having mean length of 0.49±0.016 mm and 0.31±0.009 mm width. Larval development completed within 20.86±4.59 days passing through five instars. The pupal period lasted for 9.13±2.45 days. Longevity of male and female was 1.90±0.80 and 4.93±1.60 days respectively. The total life cycle of the pod borer from egg to adult was 34.53±4.90 days.

Key words: Bionomics, *Cydia ptychora*, Pod borer, Soybean.

INTRODUCTION

Soybean [*Glycine max* (L.) Merrill] is an important pulse as well as oilseed crop in the world. It is also called as “Wonder crop” or “Miracle crop” of the 21st century for its unique chemical composition, wider geographical adaptation and for multiple uses. Its seed contains 40% good quality protein and 20% oil. Soybean protein is relatively rich in amino acids like, lysine (6.4%), cystine and methionine. In India, soybean is cultivated over an area of 11.99 m.ha with production of 11.88 m.t. and productivity of 991 kg/ha (Anonymous, 2021). Important soybean producing states in India are Madhya Pradesh, Maharashtra and Rajasthan contributing about 92-93 percent of area and production. In Karnataka, soybean occupies 0.38 m.ha with production of 0.39 million tones and productivity of 1026 kg/ha, which stands in fourth position by area and production.

The damage by the insect pests considered as one of the main impediments in stepping up soybean production. It grows profusely with soft, succulent and green foliage, which provides an ultimate source of food and shelter to insects. Approximately >380 species of insects have been reported from soybean from different parts of the world (Arangba Mangang *et al.,* 2017). A number of pests severely attack the developing soybean pods cause huge yield losses. The major post flowering pests includes, pod borer complex which cause 60-70% yield loss (Gubbaiah *et al.*, 1975; Kalyan *et al.,* 2017). Amongst this group, *Cydia ptychora* (Meyrick) (Lepidoptera: Tortricidae) cause yield loss upto 90 per cent and has gained paramount importance as a serious pest of soybean in recent years. The pest is restricted to the northern parts of Karnataka presently. Since last 40-50 years no research work on biology of *Cydia ptychora* has been done in India but for scanty information. In this context attempt was made to understand the life history of pod borer *Cydia ptychora* to aid management suitably.

[1]Department of Agricultural Entomology, College of Agriculture, Dharwad-580 005, Karnataka, India.
[2]AICRP on Soybean, University of Agricultural Sciences, Dharwad-580 005, Karnataka, India.

Corresponding Author: R. Channakeshava, AICRP on Soybean, University of Agricultural Sciences, Dharwad-580 005, Karnataka, India. Email: channakeshavar@gmail.com

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MATERIALS AND METHODS

The study on biology of pod borer, *Cydia ptychora* was carried out in the laboratory of Department of Agricultural Entomology, College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka, India during 2020-21. The temperature of 28.3±1.0°C and relative humidity of 76±2% was maintained during the course of investigation. About 30 insects were taken for the study and duration of each stage was averaged and expressed in days.

Stock culture

Culture of the insect was initiated in the laboratory by collecting larvae and pupae of *Cydia ptychora* from infested soybean fields. Further, soybean plants (JS 335) raised separately which was used in the rearing cages (30×30×30 cm^3) to maintain culture. From this culture, 10 pairs of newly emerged adult moths (male and female) were collected and released in plastic container (12×10 cm) having soybean pods for egg laying. A cotton swab dipped in 10% honey solution was provided as adult food. On hatching, larvae were transferred to soybean pods and reared until pupation. The moist sand was provided for pupation. Mass culture was maintained in the laboratory by providing well-developed fresh seeds of soybean and the food was changed alternative days. The adults that emerged from such pure culture were used for further study.

Eggs

Fresh eggs of pod borer were obtained from by enclosing emerged copulating pair of moth into plastic container measuring 12×10 cm. Soybean pods were provided for oviposition and cotton swabs of 10% honey as food for adult moths. Eggs were transferred to small glass vials along with pods. About 30 eggs were kept individually in a small vial for incubation.

Incubation period

Measurement of the eggs was made with help of occular micrometer. Observation was made continuously from egg laying to egg hatching and that period is accounted as incubation period, expressed in days.

Hatching

The eggs laid every day were counted till the death of female moth, fecundity was assessed and expressed as hatching (%).

Larval period

On hatching, neonate larvae were transferred to soybean plants and kept individually in rearing cages (25×20×25 cm^3) and observations were made on larval development. Body length and width of larvae was measured by micrometer. During this study, each larva was provided with fresh half matured seeds, which was changed every day. Number of days required hatching to entering into pupation was taken as larval period.

Pupal period

Fully developed larvae was transferred to individually to glass specimen tube (8 cm×3.5 cm) filled with moist sand to the depth of 2.5 cm for pupation. Observation was made till adult emergence and period from pre pupal stage to eclosion was noted as pupal period.

Adult longevity

Longevity of adults was studied by enclosing adults in specimen tubes individually (7.5 cm×2.5 cm). Longevity of both male and female was recorded in the presence (10% honey) and absence of food. Days from adult emergence to death was taken as adult longevity. The total life cycle was computed from the day of egg laying to emergence of adults.

Fecundity

Fecundity of female moth was studied by enclosing copulating pairs at the rate of one pair per plastic jar provided with fine wire mesh lid. They were provided with one or two fresh pods which were intact with stalk for oviposition, which were changed daily. Cotton swab dipped in 10 percent honey was kept as food for moths. The total numbers of eggs laid till death were counted through 40X lens.

Morphometry

Morphometric data was recorded stage-wise. Length and width of eggs, larvae, pupae and wing span length of both male and female moths were recorded under stereo-microscope at 40X with high resolution digital camera. The images were analyzed and the measurements were recorded into computer.

RESULTS AND DISCUSSION

Egg

Freshly laid eggs of *Cydia ptychora* on the soybean pods were pearly white, translucent, spherical with flattened base and chorion was with reticulate pattern of sculpture. Eggs were laid singly or in overlapping groups of 2-12 eggs. After 20-24 h of oviposition reddish spots appeared beneath the chorion which coalesces later to form red coloured ring on the upper portion of the egg after 40-48 hours of oviposition. After 72 hours of oviposition large number of red spots appeared and at this stage eggs looked almost red colour with base of the egg light red in color (Fig 1). Just before few hours of hatching red colour of the egg disappear completely and it turned to light yellowish. The incubation period lasted for four days in the laboratory.

Larva

During the larval period caterpillar moulted four times and thus included five instars during its life cycle (Fig 2). The newly hatched caterpillar appeared as tiny, light yellowish with black head capsule and dark prothoracic dorsal plate. Larva consisted three pairs of legs on thorax and four pairs on 3rd, 4th, 5th and 6th segments of abdomen with nine pairs of spiracles on the lateral side of the body. Tiny spines were present over the entire body. First instar caterpillar occupied three to four days. The second and third instar larva was white in colour with darkbrown head capsule and prothoracic shield. Duration of the second instar lasted for two to three days whereas third instar lasted for three to five days. The freshly moulted fourth instar larva was white in color with light brown head capsule at the beginning. From second and third days onwards larval body colour turned to pinkish progressively and larval duration varied from three to five days. Fifth instar larva was pink in colour with slightly light

yellowish brown head capsule and light brown prothoracic shied in the beginning. The colour of the larva began to change from light pink colour to dark pink colour within three to four days. The fifth instar lasted for 5-13 days which is longest among all the instars. The total larval period could vary from 16-27 days with average of 20.86±4.59 days (Table 1).

Fig 1: Eggs laid in clusters on soybean pods.

Fig 2: Different larval instars of *Cydia ptychora.*

Fig 3: Exit hole of the larva near the margin of the soybean pod.

Feeding habit of the larva

The newly emerged larva started to search the suitable site to enter into pod and succeeds within five to six hours after hatching. It was seen that larva was biting the pod and made entrance hole which was very minute and was then healed up quickly and appeared as brown spot on the mature pod. In laboratory, the first, second and third instar caterpillar bored the seed and covered the entrance hole by webbing along with excretory pellets. The fourth and fifth instar larva damages the seeds by feeding fully or partially. The remnants after feeding could be found along with excretory pellets. Further it was recorded that larva completed their development in a single pod and make an exit hole on the pod near the margin or usually between two seeds (Fig 3). These results are in agreement with findings of Patel *et al.* (1986), Perrin (1978), Singh and Jakhmola (1983) reported that neonate larvae enters inside the pod and excavate the seed by leaving excretory pellets inside.

Pupation

The fully-grown caterpillar came out from the pod through an exit hole, immediately dropped down and entered the soil for pupation. It prepared an earthen oval shaped shell lined with silk and covered with soil particles. Under laboratory, caterpillar was pupated inside the silken cocoon within pod or pupated over the surface of the pod by spinning the silken cocoon due to the absence of soil (Fig 4).

Pupa

Freshly formed pupa was obtect type with dark brown colour. The wing pad covers the posterior part of the body ventrally upto fourth abdominal segment. Dorsally all the nine segments were visible. Eyes were black in color, which were slightly elevated in position. On both the surface of the body, spines were present. The pupal period varied from 7-13 days.

Adults

Female body was covered with grayish yellow scales and male body with dark grey scales. Antennae are setaceous type. Legs are covered with scales and colors of the scales were similar to the scales on the abdomen. Forewings were dark grayish in color with three elongate black spots which were located in the middle region of the forewing. The hind wings were uniformly dark brown, which were very much fringed (Fig 5). The adult males lived for three to four days, whereas females lived for 8-12 days. The total life cycle of the insect from egg to adult varied from 27-46 days with an average of 34.53±4.90 days.

The present study confined the findings of Adimani (1976) and Kumar (1978) wherein larvae possessed five instars when observed at Dharwad on soybean and cowpea. The larva completed its development in a single pod under field condition in 18-25 days and thus indicated

Fig 4: Site of pupation of *Cydia ptychora* in soil and pods.

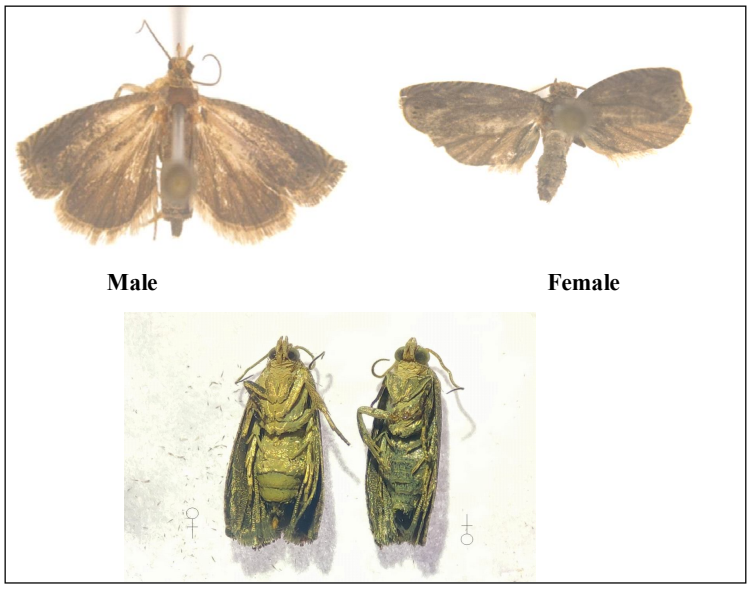

Fig 5: Dorsal and Ventral view of female and male adult moth.

non-migratory nature. The pupal period occupied for eight to nine days.

Contrastingly, total larval period of *Cydia ptychora* was limited to 11-14 days in Nigeria (Taylor, 1964). This study lacks stage wise information on larvae. Singh and Jakhmola (1983), Olaifa and Akingbohungbe (1981) recorded pupal period of 8-12 days and 12 days, respectively. Such variations could be attributed to local climatic factors. Ezueh and Taylor (1981), Abhilash (2005) and Dawoodi *et al.* (2010) also recorded larval period ranging from 25 to 35 days with five larval instars at different locations.

Adult longevity

The longevity of the male moths in presence of food (10% honey) ranged from three to four days, whereas female moth lived for 8-12 days under laboratory conditions (Table 2). Further, the longevity of the male moths in the absence of food ranged from two to three days whereas female moth lived for 3-7 days (Fig 6).

Sex differentiation in the adults

In female moths, the abdomen appeared stout and covered with dark coloured scales at the tip of abdomen (anal tuff of hair). Generally female was bigger in size as compared to the male and also has elongated black spot present on the ventral side of the hind wing (jugal area) (Fig 5). Thus adult sexual dimorphism in *Cydia ptychora* was observed and confirmed the findings of Amarnath (2000).

Mating behavior

Mating took place during the early morning hours within two days after adult emergence. Both male and female moths

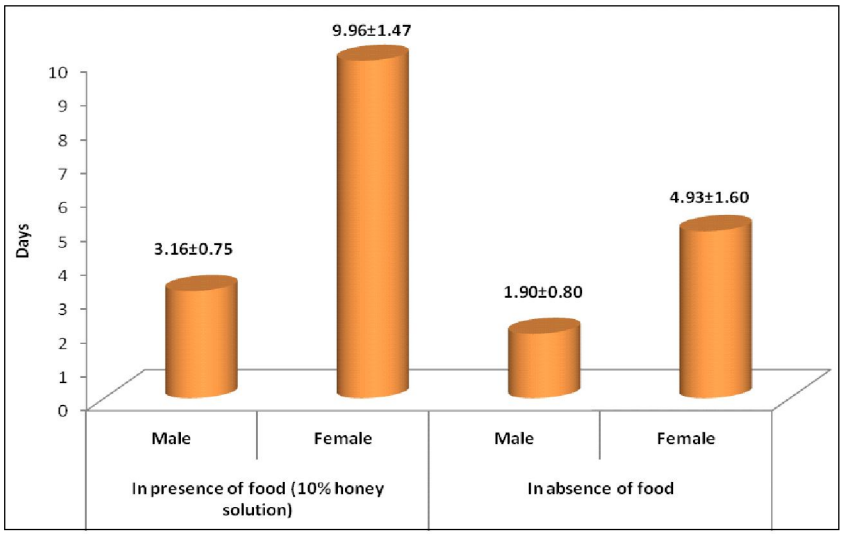

Fig 6: Duration of adult longevity of *Cydia ptychora.*

Table 1: Duration of different life stages of *Cydia ptychora* reared under *in vitro* condition.

Parameters	Range (days)		Mean±S.D
	Minimum	Maximum	(days)
Incubation period	4.00	4.00	4.00±0.01
Larval period			
1st instar	3.00	4.00	3.20±0.42
2nd instar	2.00	3.00	2.35±0.49
3rd instar	3.00	5.00	3.51±0.83
4th instar	3.00	5.00	3.75±0.71
5th instar	5.00	13.00	8.51±2.84
Total larval period	16.00	27.00	20.86±4.59
Pupal period	7.00	13.00	9.13±2.45
Adult male	3.00	4.00	3.16±0.75
Adult female	8.00	12.00	9.96±1.47
Total life cycle	27.00	46.00	34.53±4.90

Sample size (n) = 30.

Table 2: Fecundity of *Cydia ptychora* under *in vitro* condition.

Parameters	Minimum	Maximum	Mean±S.D
Pre-ovipositional period*	2.00	3.00	2.40±0.51
Ovipositinal period*	6.00	11.00	8.37±1.85
Post-ovipositional period*	1.00	1.00	1.00±0.01
Fecundity**	90	224	143.60±49.95
Egg hatchability %	60	80	69.70±21.73

(*) Days (**) Numbers n=30.

actively move towards the wall of cage and mated in distal end-to-end position. Moths were found to mate only once in life cycle.

Time and duration of oviposition

After mating female laid eggs on the pods both singly and in group. Egg laying started on the second day after mating. Oviposition was observed during night and early morning hours in the laboratory. The pre-oviposition period lasted for two to three days, oviposition period occupied for 6-11 days and post-oviposition period lasted for one day (Table 2).

Fecundity and hatchability

The fecundity per female varied from 90-224 eggs when they were fed with ten percent honey. The range of egg hatchability per cent was varied from 60-80 percent with average of 69.70±21.73 (Table 3).

The present findings are in agreement with results of Adimani (1976) who revealed that adult male lived for three to four days and female for about 10-15 days in presence of food. Further single female moth laid on an average of 207 eggs, with range of 181-224 eggs. Kumar (1978) also reported that the female moth of pod borer laid 122 and 133 eggs on cowpea and soybean pods, respectively. Taylor (1964) observed 4.20 and 3.90 days of average length of life of the female and male respectively, and 4 to 30 eggs per female with an average of 17.2 eggs in 1.80 days. However, these observations deviate from our observations. The high fecundity observed during the present investigation may be due to the honey provided to the adult female and the favorable climatic conditions that prevailed during the period of this investigation.

Morphometric studies of different life stages of *Cydia ptychora*

Eggs measured about 0.49-0.51 mm in length and 0.29-0.32 mm in width. First instar larva ranged from 0.95-1.03 mm with an average of 0.99±0.036 mm in length. The average width of the head capsule was 0.18±0.031 mm. The second instar larval body was varied from 2.40-2.60 mm length and 0.15-0.32 mm width. The length of the third instar larva varied from 3.30-3.60 mm with an average of 3.45±0.097 mm and 0.45±0.063 mm in width of the head capsule. The larval length of fourth instar larva ranged from 5.20-6.30 mm with average of 5.75±0.385 mm and width of the head capsule measures 0.73±0.066 mm. The length of

Table 3: Morphometric data of different life stages of *Cydia ptychora*.

Parameters		Range (mm)		Mean±S.D. (mm)
		Minimum	Maximum	
Egg length		0.49	0.51	0.49±0.016
Egg width		0.29	0.32	0.31±0.009
1st instar	Length	0.95	1.03	0.99±0.036
	Width	0.09	0.20	0.18±0.031
2nd instar	Length	2.40	2.60	2.50±0.095
	Width	0.15	0.32	0.29±0.046
3rd instar	Length	3.30	3.60	3.45±0.097
	Width	0.28	0.49	0.45±0.063
4th instar	Length	5.20	6.30	5.75±0.385
	Width	0.32	0.75	0.73±0.066
5th instar	Length	9.80	11.00	10.30±0.373
	Width	0.90	1.50	1.25±0.121
Pupal length		6.60	10.30	7.19±0.796
Pupal width		2.20	4.60	2.40±0.539
Adult male wing span length		1.25	1.42	1.32±0.057
Adult female wing span length		1.40	1.55	1.49±0.479

Sample size (n)= 30.

the fully grown larva varied from 9.80-11 mm and 0.90-1.50 mm in width. The pupa measures 7.19±0.796 in length and 2.40±0.539 in width at the thoracic region. Mean wing span of adult male moth was 1.32±0.057 and female was 1.49±0.479 (Table 3). The present work is in close agreement with the earlier reports of Adimani (1976); Singh and Jakhmola (1983).

CONCLUSION

Cydia ptychora reared on soybean exhibit total life cycle of 27-46 days with five larval instars. The eggs were microscopic and soon after emergence neonate enter the pod and plug the entry hole. Then start feeding the seeds till the last instar. Last instar larvae drop down from pod through exit hole to the soil for pupation. Adults mate only once in its life cycle. The absence of polygamy is a unique feature to exploit in mass trapping or mating disruption. This first report on biology and bionomics of *Cydia ptychora* on soybean helps in understanding the pest better and aid in pest management.

Conflict of interest: None.

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