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To study the larval behavior of leaf roller (*Argyroplote leucaspis*) in litchi at northern hill region of Chhattisgarh

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Abstract

The study was undertaken on Leaf roller, *Argyroplote leucaspis* larval behavioral at laboratory condition during year 2015 and 2016 at RMD College of Agriculture and Research Station, Ambikapur, Surguja Chhattisgarh. Leaf roller, *Argyroplote leucaspis* larva completed its development in five instars. Fifth instar larva occupied more time to convert into pre pupal stage (4.63 days) of larval length, weight and percent leaf damage was also highest in fifth instar larvae of 11.27 mm, 25.08 mg and 78.01 percent respectively. Third instar larvae started rolling the leaves with silk threads. Rolls were constructed and occupied by one or more larvae. The larvae matured up to fifth instar and completed pre pupal and pupal stage inside the leaf roll.

Keywords: litchi chinensis, larval, larval behavior, instar, pupal instar

1. Introduction

Litchi, *Litchi chinensis* (Sonn.) is one of the most important sub-tropical fruit belongs to the family Sapindaceae. It is native to southern China and introduced in India during the end of 17th century. The top five litchi producing countries are China, India, Taiwan, Thailand, and Vietnam. India ranked second after China in area as well production. India and China account for 91 percent of the world's litchi production.

India produced total 26,509 million metric tonnes with an area of 83 thousand hectares and average productivity of 7.00 metric tonnes per hectare (Anonymous, 2013) [2]. Litchi it requires precise climatic conditions, there are only few states namely, Bihar, West Bengal, Uttaranchal, Uttar Pradesh, Himachal Pradesh, Assam, Tripura, Punjab and Jharkhand growing the fruits commercially.

It is an extremely environmental sensitive fruit crop that requires specific climatic conditions, growing best in regions with short, dry, and cool, but frost-free winters (daily maximums below 20–22 °C), and summers that are long and hot (daily maximums above 25 °C) with high rainfall (1200 mm) and high humidity (Singh, 2002) [13]. Bihar has monopoly in production and north Bihar particularly Muzaffarpur shares 85 per cent of the total area under litchi cultivation, where soil and climatic conditions are very congenial for its growth and fruiting.

The environmental conditions of Chhattisgarh hills is also very suitable for the production as nearly 4,469 hectares area with production of 27,077 metric tonnes and average productivity of 6.06 metric tonnes per hectare, which indicates encouraging possibilities of production for this crop (Anonymous, 2012) [1]. Litchi is a highly priced, popular and major table fruit in Chhattisgarh. It comes to market in the months of May-June when the market is full of other fresh fruits, particularly mango and jackfruit. but in spite of the availability of different types of fruit in the market the demand for fresh litchi is always very high due to its unique taste, flavor and colour.

Litchi is mostly consumed as a table fruit but is also preserved and canned. 100 gm of fresh edible portion contain 63-64 calories, 81.9-84.83% water, 0.68-1.0gm protein, 0.3-0.58gm fat, 13.31-16.4gm carbohydrates, 0.23-0.40gm fiber, 0.37-0.50gm ash, 8-10 mg calcium, 30-42 mg phosphorus, 0.40 mg iron, 3mg sodium, 170 mg potassium, 28 mg thiamine, 0.40 mg nicotinic acid, 0.05 mg riboflavin and 24-60 mg ascorbic acid (Mondal and Amin, 1990., Bose and Mitra 1990; Scanlan, 1995) [9, 3, 11]. The sugar content of litchi ranging between 10 and 22 per cent owing to variation in cultivar and climatic conditions.

Litchi is affected by numbers of factors. Among the factors insect pests and post-harvest losses are a major constraint. It has been infested by numbers of insect pest (Hameed *et al.*, 2001) [5]. There are more than 54 insect and mite pests known to attack litchi tree and its fruits but only a few, namely litchi mite (*Aceria litchii* Keifer), litchi fruit borer (*Conopomorpha cramerella* Snellen), litchi leaf roller (*Dudua aprobola* Meyrick) and bark eating caterpillar, *Indarbella* spp. cause serious damage to the crop (Lall and Sharma, 1978., Sharma, 1985., Hameed *et al.*, 1999 and Mukherjee *et al.*, 2007) [8, 12, 4, 10].

The symptoms of leaf injury by the larvae are manifested through rolling of tender leaves and feeding inside. The leaf injured by the leaf roller varies between 16.70 to 71.60 per cent while tree infestation varies from 12.88 to 53.54 per cent during August to February (Lall and Rahman, 1975) [6]. As a result of larval injuries, the infested twigs distort and wither. Litchi trees with severe infestation show very poor flowering, resulting into considerable reduction in crop yield (Lall and Mallik, 1976) [7].

2. Materials and Methods

The behavior of larvae of leaf roller, *Argyroplote leucaspis* was studied on laboratory condition at Rajmohini Devi College of Agriculture and Research Station, Ambikapur Surguja (Chhattisgarh) during 2015 -2016. For the studying of larval behavior of leaf roller durations of larval instars, larval length, larval weight and feeding efficiency were recorded on different larval stages.

The durations of different larval instars (days) were recorded and larval length (mm) was observed with the help of standard ocular micrometer fitted to a stereoscopic binocular microscope. Larval weight was measured by electronic weighing machine.

Feeding efficiency of leaf roller larvae determined by percent leaf damage. The leaf bits of size 2 X 2 cm were placed in Petridis and all instars of larvae of leaf roller were released to feed. Larvae were starved for 5 hour before placing them on Petridis. After every 24 hr, leaf area damage was recorded by Leaf Area Index (LAI) using the butter paper and graph paper.

3. Results and Discussion

The larval behavior of leaf roller, *Argyroplote leucaspis* (Meyr.).

Leaf roller is a cosmopolitan pest and besides India, has been reported on various fruits in Hawaii, South Africa, Australia and China. Besides litchi, longan, rambutan, rose, kaitha, jamun, chhota, amaltas are other plants damaged by this pest. The symptoms of leaf injury by the larvae are manifested through rolling of tender leaves and feeding inside. As a result of larval injuries, the infested twigs distort and wither. The incidence of leaf roller can be observed on litchi trees throughout the year. However, severe infestation can be observed on new flushes. Mating and oviposition, took place during night. The female moth laid 150 to 200 creamy white eggs singly under the surface of newly emerged tender leaves. Incubation period varied from 2-8 days as per environmental conditions. The larval period varied was of 7 -14 days and pupal period of 7 – 24 days and pupated within the clipped pieces of the leaf. Adult emerged 7 – 10 days after pupation. The level of infestation varied from 10-40% in litchi during the present studies.

To study life cycle and larval behavior of litchi leaf roller, *Argyroplote leucaspis* (Meyr.)

To study life cycle and larval behavior of litchi leaf roller, grafted litchi plant was potted in a plastic pot with fine soil. Care was taken till the plant properly acclimatized to the existing environment and later it was covered with netted nylon mesh. The plant was watered regularly for proper establishment. The eggs of litchi leaf were roller collected from the field and placed on caged litchi plant for recording observations on larval growth and behavior. From the experiment it was observed that most of the eggs hatched within 3 to 5 days after collecting from the field. The larvae upon hatching went on searching for the new leaves. After reaching to new leaf it went to tip of the leaf where soft portion was available and start feeding. Feeding on tender parts of the leaves continued till the larvae reached up to 3rd instars. The leaf rolling started at end of 3rd instars to early stage of 4th instars. Instars change was observed from standard ocular micrometer fitted to a stereoscopic binocular microscope by confirming the shed head capsule. The fourth instars larvae used to feed both on tender and matured leaves by rolling them. Larvae reached up to 5th instar before going for pupation. Most of the larvae pupated within the rolled leaf, but in rare cases the larvae came out of rolled leaf and formed silken threads around itself which transformed to cocoon. Overall the larval and pupal period was completed by 9 to 11 days and 8 to 9 days, respectively. During the study larval duration length and weight was recorded at each larval instars discussed below.

Larval duration (in days)

Larva of leaf roller, *Argyroplote leucaspis* completed their life stages with five larval instars. Duration between instars were studied in the laboratory.

The instars were measured by the mounted off head capsule's width by the help of stereomicroscope with a micro meter. During the course of study in 2015, first, second, third, fourth and fifth instars of leaf roller larvae had the duration of complete his life stages 1.00, 1.25, 2.25, 2.00 and 5.00 days, whereas in 2016 life stages of leaf roller larvae completed its life stages 1.75, 1.50, 1.75, 2.25 and 4.25 days, respectively. On the basis of two year's mean the life stages of different larval instars of leaf roller recorded in the first, second, third, fourth and fifth were 1.39, 1.38, 2.00, 2.13 and 4.63 days respectively.

Larval length (mm)

The studies on larval length of leaf roller, *Argyroplote leucaspis* under laboratory conditions revealed that there were five distinct larval instars, and there was variation in length of larvae of different instars. The insect pupated after five instars. During the course of study 2015, the length of first, second, third, fourth and fifth instars of leaf roller larvae was 0.75, 1.25, 5.23, 7.35 and 11.24 mm, whereas in 2016 the length of leaf roller larvae was 0.80, 1.23, 5.35, 7.43 and 11.30 mm, respectively. On the basis of two year mean larval length of different instars of leaf roller first, second, third, fourth and fifth was recorded to be 0.78, 1.24, 5.29, 7.39 and 11.27 mm respectively.

Larval weight (mg)

The weight of larva directly depends on the feeding activity on leaf. Results revealed that there was an increase in weight from second larval instars. The larva of the first instars was

very minute and was unable to measure, so the data from second instars to pupation has been recorded. The weight of second, third, fourth and fifth instars of leaf roller larvae was 1.53, 2.32, 8.23 and 25.25 mg, whereas in 2016 the weight of leaf roller larvae was 1.35, 2.54, 7.89 and 24.96 mg, respectively. On the basis of two year mean, the larval weight of different larval instars of leaf roller second, third, fourth and fifth was 1.44, 2.43, 8.06 and 25.08 mg respectively.

Leaf area damage (%)

The feeding efficiency of leaf roller larvae was determined by per cent leaf damage. The data presented in table 4.11 revealed that per cent leaf area damage was maximum in fifth instars larvae. The leaf area damage of first, second, third, fourth and fifth instars of leaf roller larvae were 5.23, 13.25, 22.23, 65.35 and 76.69 per cent, whereas in 2016 leaf area damage of leaf roller larvae was 4.75, 15.37, 25.45, 63.57 and 79.33 per cent, respectively. On the basis of two year mean data the leaf area damage of different larval instars of leaf roller of first, second, third, fourth and fifth was 4.99, 14.31, 23.84, 64.46 and 78.01 per cent respectively.

Larval behavior

Larval behavior of litchi leaf roller was observed in potted one year old litchi tree covered with net. Newly hatched larvae were observed daily for recording development of instars and behavior, including changes in gregarious feeding habit and rolling of leaves. Larval preference for preexisting leaf rolls was evaluated using 5 larvae of each instars. Each larva was placed individually on a leaf and observed larvae for 1h, recording their movement. Larvae started feeding from the ataxia leaf surface. Larvae wove silk threads between leaf veins. Larvae typically fed starting from the leaf border and

progressing toward the midrib. Third instars larvae started rolling the leaves with silk threads. Rolls were constructed and occupied by one or more larvae. Larvae fed from inside the roll, causing small dips and bumps to become visible on the outer surface. Larvae matured reached up to fifth instars' and completed repupal and pupal stages in side of leaf roll.

On the basis of mean of two year larva of leaf roller, *Argyroploce leucaspis* as per tab 4.11 completed their life stages of different larval instars of leaf roller first, second, third, fourth and fifth in 1.39, 1.38, 2.00, 2.13 and 4.63 days respectively. The larval length of different larval instars of leaf roller first, second, third, fourth and fifth was 0.78, 1.24, 5.29, 7.39 and 11.27 mm respectively. The larval weight of different larval instars of leaf roller second, third, fourth and fifth was 1.44, 2.43, 8.06 and 25.08 mg respectively. More or less similar results were found by Singh and Kumar (1997) who studied the biology of litchi leaf roller, *S. leucaspis* laboratory and observed that, adults of the pest mated 2-4 days after emergence, during the night. The pre-oviposition period was 1-2 days, the oviposition period was 4-6 days, fecundity was 37-127 eggs/female and per cent age hatch was 80%, the incubation period was 2-6 days, the larval period was 10-18 days, the prepupal period was 1-3 days, and the pupal period was 8-10 and 8-13 days in males and females, respectively.

Similarly, Nair and Sahoo (2006) studied the bionomics of the litchi leaf roller (*Argyroploce. leucaspis*) on litchi cv. Bombaiya. Maximum pest population was observed during December and March-June. The incubation period, larval period, prepupal period, pupal period and adult longevity were 3-5 days, 14-16 days, 1.0 day, 8-9 days and 5-6 days, respectively, which is in accordance with the present studies particularly the larval duration.

Table 1: Duration, length, weight and leaf area damage by different instar of litchi leaf roller, *Argyroploce leucaspis* on variety (Ambika Litchi – 1) years in 2015- 2016.

Different Larval Stages	Litchi leaf roller, <i>Argyroploce leucaspis</i>													
	Durations (Day)			larval length (mm)			Larval weight (mg)			Leaf area damage (%)				
	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean	2016	Mean
1 st Instar	1.00	1.75	1.39	0.75	0.80	0.78	-	-	-	5.23	4.75	4.99	4.75	4.99
2 nd Instar	1.25	1.50	1.38	1.25	1.23	1.24	1.53	1.35	1.44	13.25	15.37	14.31	15.37	14.31
3 rd Instar	2.25	1.75	2.00	5.23	5.35	5.29	2.32	2.54	2.43	22.23	25.45	23.84	25.45	23.84
4 th Instar	2.00	2.25	2.13	7.35	7.43	7.39	8.23	7.89	8.06	65.35	63.57	64.46	63.57	64.46
5 th Instar	5.00	4.25	4.63	11.24	11.30	11.27	25.20	24.96	25.08	76.69	79.33	78.01	79.33	78.01
Total larval Period	11.50	11.50	11.53											

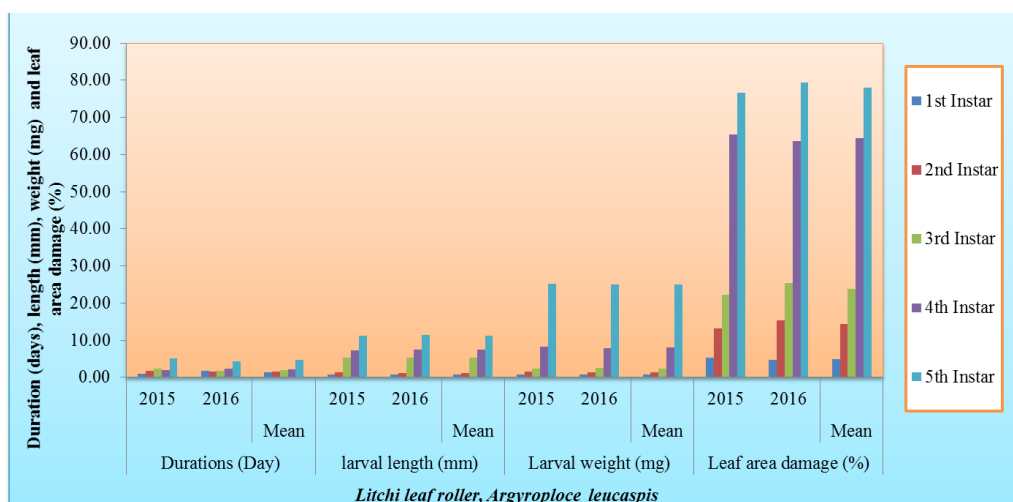


Fig 1: Duration, length, weight and leaf area damage by larvae of litchi leaf roller, *Argyroploce leucaspis* at Ambikapur during the crop growth years during 2015-2016



Plate 1: Behavior study of leaf roller in litchi plant in cage condition

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5. Conclusion

Leaf roller, *Argyroplote leucaspis* larva completed its life stages in five larval instars. Fifth instar larva occupied maximum time (4.63 days) to convert into pre pupal stage. Larval length, weight and percent leaf damage was also highest in fifth instar larvae with 11.27 mm, 25.08 mg and 78.01 percent respectively. Third instar larvae started rolling the leaves with silk threads. Rolls were constructed and occupied by one or more larvae. Larvae matured to fifth instar and completed per pupal and pupal stage in side the leaf roll.

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