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# Physiological Age Status of Female Adults and Off-Season Survival of Rice Leaffolder *Cnaphalocrocis medinalis* in India

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**Abstract:** Rice leaffolder, *Cnaphalocrocis medinalis*, is one of the major foliage feeders found in the rice growing regions in India. When the crop was at maturity, numerous adults of rice leaffolder were found in the rice fields though the larval population gradually decreased, and no eggs were found on rice leaves. The population characteristics of *C. medinalis* were assessed based on the physiological age status of adults at different crop growth stages. Based on egg development within ovarioles, ovariole appearance, number and colour of fat bodies, and characteristics of bursa copulatrix, physiological age status of the adults was described, which served as a basis for the determination of age composition. *C. medinalis* adults were found during the first week of August on rice plants, of which 44% were in Age 0 with immature ovaries, indicating immigrants. However, 28% adults each were at Ages 1–2 with developing ovaries, indicating local breeding population. The carryover and off-season survival of *C. medinalis* were also studied to determine the contribution of the alternative hosts in the population growth that helped in devising efficient management strategies. Rice was the most preferred host followed by *Triticum aestivum*, *Echinochloa crusgulli* and *Brachiaria plantaginea*. Various routes of the carryover of *C. medinalis* from season to season were discussed.

**Key words:** rice leaffolder; physiological age; carryover; off-season survival; alternative host; ovariole; weed

In recent years, rice leaffolder, *Cnaphalocrocis medinalis* Guenée, is found in all the rice growing regions in India and has emerged as one of the major insect pests of rice. Large scale cultivation of susceptible high yielding varieties, and injudicious application of nitrogenous fertilizers and pesticides have led to an increase in *C. medinalis* populations, resulting in outbreaks in many Asian countries including India (Khan et al, 1988; Barrion et al, 1993; Shanmugam et al, 2006; Kaushik, 2010).

*C. medinalis* is a major migratory pest in many South Asian countries (Riley et al, 1995; Qi et al, 2011). Outbreaks of rice leaffolder infestations have been reported in China, India, Pakistan, Japan, Korea, Malaysia, Sri Lanka and Vietnam (Khan et al, 1988). The Indo-Chinese peninsula serves as the source of leaffolder population that migrates annually during April and May to the south of mainland China, where those moths complete three to four generations before subsequently expanding northward during June and July. Throughout late August to early September, *C. medinalis* migrates back southward and leaves China by November. Leaffolder migration is a key factor that induces the population abundance and infestation (Li et al, 2012). In India, the increased incidence of rice leaffolder has been noted in different states, and reports on the occurrence have been highly variable by location and year (DRR Progress Reports, 2005–2013). However, studies on *C. medinalis* migration are lacking in India.

The larvae of *C. medinalis* feed on young rice leaves during the tillering stage or on flag leaves during the booting to heading stages. The damaged plants have a considerable ability to compensate during the tillering stage, however, damage to flag leaf results in considerable yield loss (Fabellar et al, 1994). During the outbreak period, yield reduction of 30%–

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80% was reported from severely damaged fields (Kushwaha, 1988). Larval densities at more than three larvae per hill at the maximum tillering stage results in 20% unfilled grains, and for every 10% increase in flag leaf area damage, there is 3% increase in unfilled grains (Padmavathi et al, 2013).

In India, rice is grown in almost all the states. There are mainly two rice seasons every year viz., *Kharif* (wet season) and *Rabi* (dry season). Wet season starts from May to June and ends by November to December whereas dry season starts from November to December and ends by March to April. In the southern states including Tamil Nadu, Kerala, Karnataka and Andhra Pradesh, and the eastern states including Orissa, West Bengal and Assam, rice is grown throughout the year in two seasons (double cropped areas). In the northern part of the country comprising of Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, Bihar, Rajasthan, Jammu and Kashmir where rice-wheat cropping system is followed, rice is restricted to wet season only (single cropped areas).

*C. medinalis* completes three to four generations during wet season and two to three generations during dry season in double cropped areas. It survives on a number of weeds during the off-season (Khan et al, 1988, 1996). However, in both seasons, when rice is at maturity, numerous adults of *C. medinalis* can be found in the fields. The present study was conducted to examine the physiological status of *C. medinalis* adults presented at the maturity stage of the crop and also during different crop growth stages. Moreover, the carryover and off-season survival of *C. medinalis* were also studied to determine the contribution of the alternative hosts in the population growth that helps in devising efficient management strategies.

## MATERIALS AND METHODS

### Physiological age status

*Greenhouse study*

*C. medinalis* culture was maintained on Taichung Native 1 (TN1) rice plants under greenhouse conditions, (25 ± 5) °C temperature and 60% ± 10% relative humidity, at Directorate of Rice Research (DRR), Rajendranagar, Hyderabad, India. From this culture, pupae were collected and placed individually in test tubes for adult emergence. Newly emerged adults were collected, paired and released in wooden cages (97 cm × 66 cm × 86 cm) having TN1 rice plants and fed with 20% honey solution. Starting from the date of emergence till death, five female individuals were dissected daily under a compound microscope attached with a camera (OLYMPUS SZ2) and morphological features were recorded. This was replicated four times. This study served as a basis for the determination of age status of field collected adults.

*Field study*

Adults were collected from rice fields of DRR, and females were segregated and dissected to assess the physiological age at different crop growth stages, especially at the harvest stage. Twenty five female adults were dissected at each crop growth stage and compared with the morphological features observed in greenhouse study to know the physiological age of the adults existing in the crop fields.

### Off-season survival and carryover

Most commonly found graminaceous weeds and crops in and around the rice fields of DRR, where leaffolder damage was observed, were collected from the fields and grown in pots in the greenhouse. *C. medinalis* adults were collected from the rice plants which were about to be harvested and kept for oviposition on TN1 rice plants in the greenhouse providing with 20% honey solution. Eggs laid were allowed for hatching. The first instar larvae were used for this experiment. Leaves from weeds and crops were collected and cut into pieces of 5 cm leaf bits which were placed in a Petri dish (9 cm diameter) lined with filter paper. Five 1$^{st}$ instar larvae per Petri dish were released and ten such replications were maintained. A control was maintained with rice leaves for comparison. Feed was replaced on alternate day. Observations on larval survival, number of larvae developed into pupae and number of adults emerged from pupae were recorded. From the data, pupation percent was deduced. Adults emerged were paired and kept for oviposition on respective weeds or crop plants covered with cylindrical mylar cage (45 cm height and 14 cm diameter). Five pairs of adults were used for oviposition study, considering each pair as one replication. Finally growth index was computed (Saxena et al, 1974; Khan et al, 1989).

### Data analysis

Data on growth and development of *C. medinalis* on different host plants included parameters such as survival days, larval duration, fecundity per female and growth index. The data were subjected to analysis of variance after suitable transformation (SAS Institute Inc., 2008). All values were represented as