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# Effect of season on the development of Rice hispa, *Dicladispa armigera* in Barak Valley of Assam

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Rice hispa, *Dicladispa armigera* (Olivier) (Coleoptera: Chrysomelidae) is a major pest of paddy in many regions of the world including Assam, India (Butani & Jotwani 1976; Zafar *et al.* 1986). Systematic surveys in different stages of the region have shown 13 major insect infestations in Assam (Barwal *et al.* 1994; Dutta & Hazarika 1994). It causes extensive damage to the vegetative stage of plants resulting in 35–65% loss in yield throughout Assam, since the crop is attacked by the pest immediately after sowing until harvest (Dutta & Hazarika 1992; Hazarika & Dutta 1991; Rajek *et al.* 1986). An attacked paddy field looks completely sun-burnt and plants become stunted in growth (Rahman *et al.* 2002). *D. armigera* is endemic in Cachar and Karimganj districts of Barak valley, Assam causing havoc infestation in all the three crop seasons, viz., Amon (monsoon rice), Boro (dry season / winter rice) and Aus (summer rice). The Aus crop does not suffer much, but late transplanted Amon and Boro paddy are seriously damaged, reaching up to 100% crop loss in certain cases (Bhattacharjee & Ray 2010).

Herbivorous insects display marked temporal variation in abundance and activity, mainly in response to changes in temperature and photoperiod (Speight *et al.* 1999; Wolda 1988). Such variation in the tropics are more complex and less well understood, although it is clear that rainfall rather than temperature or photoperiod is more important (Fensham 1994; Louton *et al.* 1996). In tropical regions with distinct wet and dry seasons, many insect species attain maximum adult abundance during the wet season, probably in response to changes in plant physiology and growth (Didham & Springate 2003; Wolda 1989), in particular the abundance of new foliage (Fensham 1994; Novotny & Basset 1998; Shapiro 1975). Seasonal variability of arthropods can be extremely high, reflecting periodic food supplies or environmental changes such as rainfall (Denlinger 1980) or temperature (Mani 1968). Temperature can impact insect physiology and development directly or indirectly through the physiology or existence of hosts. Depending on the development strategy of an insect species, temperature can exert different effects (Bale *et al.* 2002). Since the biology of an insect is affected by the prevailing environmental conditions, a detailed study on the biology of *D. armigera* in different crop seasons was carried out.

The study was conducted in the Department of Ecology and Environmental Science, Assam University, Silchar, North-East India (longitude of 92º45´25.9˝E and latitude of 24º41´29.9˝N with altitude of 36 metre above m.s.l.). The climate of the region is sub-tropical warm and humid (Nath *et al.* 2016). Climatological data of the study area is incorporated in Fig. 1. Primary culture of *D. armigera* in the laboratory was initiated from the field-collected adults and maintained on potted rice plants covered with net cage. The biology of *D. armigera* was studied on potted rice plants in different crop seasons (Aus, Amon and Boro). Rice cultivars (20-d-old-plant) were grown in earthen pots (7 cm diameter) enclosed in mosquito proof fine mesh wire net cage (25 cm × 50 cm × 25 cm) with five replications and were kept in the departmental garden to maintain the homogeneity of natural environmental factors. A pair of freshly

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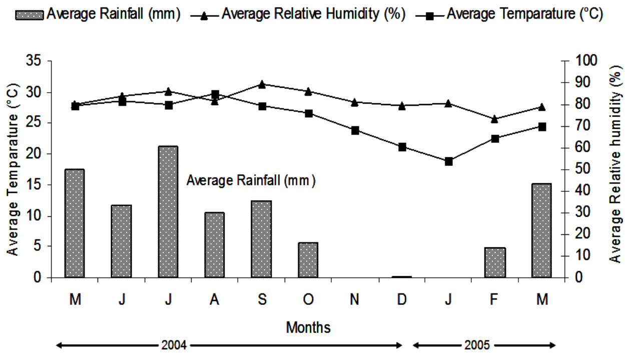


**Fig. 1.** Climatological data of the study area.

emerged adults was released on each cage potted plant for oviposition and subsequent studies on the biology included copulation period, pre-oviposition period, oviposition period, post oviposition period, incubation period / egg stage, fecundity, larval period, pupal period and adult longevity. For determining sex-ratio, 100 adults in each season were collected randomly from Dargakona (near university campus) and the adjacent rice fields.

The growth index (GI) was calculated by employing the formula:

Growth index (GI) = n / t

where 'n' is the per cent immatures attained adult stages and 't' is the time taken to complete the life-cycle.

Multifactorial comparisons between abiotic factors (mean temperature, mean relative humidity and mean rainfall); life cycle parameters and their relationship in three crop seasons were calculated using principal component analysis in PAST version 1.89 (Hammer *et al.* 2001).

Study revealed that copulation period persist for 1.07 ± 0.14 hours during Aus season, 1.10 ± 0.12 hours in Amon season and 1.18 ± 0.21 hours in Boro season. The pre-oviposition period varied from 2–4 days in different seasons. It was observed to be 2.60 ± 0.24, 3.20 ± 0.37 and 3.20 ± 0.49 days during Aus, Amon and Boro seasons respectively. The freshly laid egg was pale yellow and oval shaped but after 2–3 days it turned brownish in colour. The eggs were laid singly on the tip of the rice blade leaf partially increated beneath the epidermis of leaves. The number of laid eggs varied in a cluster form from 5–25.

The egg laying period varied from 12–15 days. It was observed 14.40 ± 0.75, 14.80 ± 0.66 and 14.20 ± 0.58 days during Aus, Amon and Boro seasons respectively. The duration of egg stage was 3–5 days. It was observed 3.80 ± 0.37, 4.60 ± 0.51 and 5.20 ± 0.20 days during Aus, Amon and Boro seasons, respectively. Fecundity was recorded maximum (82.53 ± 0.67) in Amon season followed by Boro season (73.25 ± 0.26) whereas Aus season recorded least (69.25 ± 0.37) (Table 1).

The newly hatched grub was pale yellow in colour and dorsoventrally flattened in shape. The period of this instar varied 2.20 ± 0.37, 2.40 ± 0.24 and 2.40 ± 0.24 days respectively during Aus, Amon and Boro seasons. Duration of 2nd instar varied 2.60 ± 0.24, 2.60 ± 0.24 and 3.40 ± 0.51 days during Aus, Amon and Boro seasons respectively. The period of 3rd instar varied 3.40 ± 0.24, 3.80 ± 0.37 and 3.80 ± 0.37 days during Aus, Amon and Boro seasons respectively. 4th instar varied in duration 3.60 ± 0.40, 3.40 ± 0.67 and 4.20 ± 0.58 days during Aus, Amon and Boro seasons respectively. The fully-matured larvae became sluggish and stopped feeding at the approach of pupation. Pupation took place inside the leaf tunnel. The newly formed pupae were yellowish in colour, but later on it became brownish colour. The pupa was dorso-ventrally flattened in shape. Pupal period were 6.20 ± 0.37, 6.60 ± 0.51 and 6.80 ± 0.58 in Aus, Amon and Boro seasons (Table 1).

The newly emerged adult was small, tiny, white-pale yellow in colour, but after some time it became shiny bluish in colour with fringed short spines on the dorsal side. The average life span of male was found to be 27.40 ± 0.51 during Aus season, 28.20 ± 1.39 during Amon season and 28.00 ± 0.45 during Boro season. Whereas the average life span of female was found 37.80 ± 1.24, 38.80 ± 1.71 and 38.40 ± 1.03 during Aus, Amon and Boro seasons respectively. During Aus season, M: F ratio was highest (1:1.16) and slightly less in Boro season 1:1.11. It was 1:1.12 during Amon season. Growth Index was recorded maximum (3.52) in Amon season followed by Aus season (2.40) and least was recorded in Boro season (1.56) (Table 1).

## *Multivariate analysis*

Multifactorial comparisons using principal component analysis clearly indicated correlations between various abiotic factors, life cycle parameters and their relationship in different crop seasons. The principal component analysis (PCA) and their correlation were shown in Fig. 2. Among the data first factor $F_1$ represents 68.99 per cent of variability, while the second factor $F_2$ represents 31.00 per cent of variability with Eigen value of 10.34 and 4.65, respectively. Out of fifteen

**Table 1.** Biology of *D. armigera* during three crop seasons in Barak valley of Assam.

| Parameters | Duration of days (Mean ± SEm)* | | |
|---|---|---|---|
| | Aus season | Amon season | Boro season |
| Mean Temperature ($^0$C) | 28.46 ± 0.25 | 26.97 ± 0.61 | 21.84 ± 0.59 |
| Mean RH (%) | 83.54 ± 1.09 | 83.53 ± 0.93 | 73.57 ± 1.78 |
| Mean Rainfall (mm) | 15.21 ± 1.91 | 7.26 ± 2.22 | 4.01 ± 3.20 |
| Copulation Period (hrs.) | 1.07 ± 0.14 | 1.10 ± 0.12 | 1.18 ± 0.21 |
| Pre-ovipositional Period (days) | 2.60 ± 0.24 | 3.20 ± 0.37 | 3.20 ± 0.49 |
| Ovipositional Period (days) | 14.40 ± 0.75 | 14.80 ± 0.66 | 14.20 ± 0.58 |
| Post ovipositional period (days) | 14.80 ± 0.66 | 15.20 ± 0.58 | 15.80 ± 0.37 |
| Fecundity (numbers) | 69.25 ± 0.37 | 82.53 ± 0.67 | 73.25 ± 0.26 |
| Incubation Period / egg stage (days) | 3.08 ± 0.37 | 4.60 ± 0.51 | 5.20 ± 0.20 |
| Larval Period (days) | | | |
| I instar | 2.20 ± 0.37 | 2.40 ± 0.24 | 2.40 ± 0.24 |
| II instar | 2.60 ± 0.24 | 2.60 ± 0.24 | 3.40 ± 0.51 |
| III instar | 3.40 ± 0.24 | 3.80 ± 0.37 | 3.80 ± 0.37 |
| IV instar | 3.60 ± 0.40 | 3.40 ± 0.67 | 4.20 ± 0.58 |
| Total larval Period (days) | 10.80 ± 0.09 | 11.30 ± 0.08 | 12.40 ± 0.08 |
| Pupal Period (days) | 6.20 ± 0.37 | 6.60 ± 0.51 | 6.80 ± 0.58 |
| Longevity of Male (days) | 27.40 ± 0.51 | 28.20 ± 1.39 | 28.0 ± 0.45 |
| Longevity of Female (days) | 37.80 ± 1.24 | 38.80 ± 1.71 | 38.40 ± 1.03 |
| Sex ratio (M : F) | 1 : 1.16 | 1 : 1. 12 | 1 : 1.11 |
| Complete Life cycle (days) | 19.40 ± 0.51 | 20.80 ± 0.37 | 25.60 ± 0.51 |
| Growth Index (G. I.) | 2.40 | 3.52 | 1.56 |

* Average of ten (10) replications (Mean ± SEm)

parameters, ten parameters were occupied on the right side of the biplot viz., copulation period (CP), pre ovipositional period (PrOP), post ovipositional period (PoOP), fecundity (Fe), incubation period (IP), total larval period (TLP), pupal period (PP), longevity of male (LM), longevity of female (LF), complete life cycle (CLC) showed positive correlation with one another; whereas mean temperature (MT), mean relative humidity (MRH), mean rainfall (MRF), ovipositional period (OP), growth index (GI) were occupied on the left side of the biplot showing positive correlation with each other. Parameters occupied on the left side of the biplot showing negative correlation with the parameters on the right side. Aus season showed higher positive correlation with MT, MRH and MRF whereas Boro season showed higher positive correlation with CLC, CP, TLP and PoOP; Amon season showed higher positive correlation with OP and GI. MRF showed maximum negative correlation with CLC, CP, TLP and PoOP followed by MT and MRH.

Studies on the biology of *D. armigera* revealed that Boro season showed maximum time duration and Aus season showed the minimum time duration for the development of life-stages. Sen & Chakravorty (1970) reported that entire life-cycle occupied about 15 to 25 days during July and August (Amon season) from West Bengal which corroborates our findings (20.80 ± 0.37 days). Vadalia *et al.* (1989) have reported 3.5 ± 0.50, 13.69 ± 3.90 and 22.20 ± 10.40 days as pre-oviposition, oviposition and post oviposition periods respectively from Gujarat, irrespective of any crop season that partially supports our findings. Dogra *et al.* (2006) found that, in different generation (Amon season) pre oviposition, oviposition and post oviposition periods varied during two year study period in Himachal Pradesh, which highly corroborates our findings. Sen & Chakravorty (1970), Butani & Jotwani (1976) and Vadalia *et al.* (1989) have reported incubation periods irrespective of any crop season ranging from 3–7 days which supports our findings. The mean incubation period during different generations observed by Dogra *et al.* (2006) supports our observations. Sen & Chakravorty (1970) found total larval period 7–12 days but Vadalia *et al.* (1989) have mentioned 8.63 days as average larval period. Dogra *et. al.* (2006)

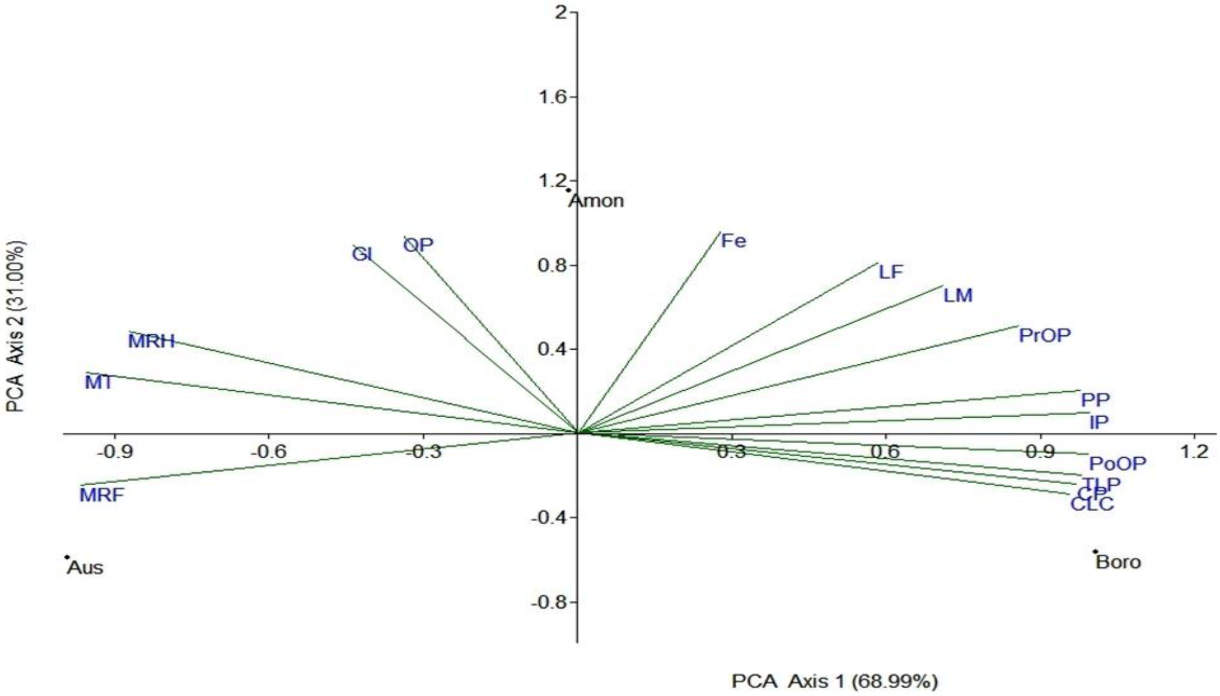


**Fig. 2.** Multifactorial comparisons of various abiotic factors, life cycle parameters and their relationship in different crop seasons using principal component analysis (PCA). MT–mean temperature, MRH–mean relative humidity, MRF–mean rainfall, CP–copulation Period, PrOP–pre ovipositional period, OP–ovipositional period, PoOP–post ovipositional period, Fe–fecundity, IP–incubation period, TLP–total larval period, PP–pupal period, LM–longevity of male, LF–longevity of female, CLC–complete life cycle, GI–growth index.

reported the variation of total larval duration which corroborates our findings. Pupal period lasts for 6.20 to 6.80 days during the three seasons which more or less supports observations of Sen & Chakravorty (1970), Vadalia *et al.* (1989) and Dogra *et al.* (2006). Prakasa Rao *et al.* (1971) reported that the life span of adult insect is 78 days at Cuttack climatic condition which is almost double the longevity of our findings. But Vadalia *et al.* (1989) have reported average longevity of males and females as 34.90 ± 8.00 and 41.50 ± 10.00 days respectively which supports our findings. Female longevity observation by Dogra *et al.* (2006) supports the findings of our study. The females survived longer periods than the males in all three crop seasons. Regarding the sex-ratio of male: female no fluctuation was observed during the study period which does not support the findings of Sen & Chakravorty (1970).

Insects damage plants or crops either as nymphs or larvae or as adults, or in both immature and adult stages. Understanding the insect biology with different life-stages of major insect pests often reveals when the pest is most vulnerable to control measures and helps lead to successful management efforts. In case of rice hispa, both nymphs and adults affects paddy severely, entire larval and pupal stages remain inside the leaf blade by creating tunnel and feeding on the leaf tissue. Hence, management practice should be implemented in view of their adult out break with immature stages.

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