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## Biodiversity of insect pests of rice in India

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**Abstract**

Insect pests of rice are affected by climate change directly through physiological effects due to changes in temperature and precipitation and indirectly through effects due to changes in the quality of host plants. Species that depend on each other like plants and insects that pollinate them, do not always adapt to changes at the same time. The environmental changes alter both the timings and rate of interactions with food plants, competitors and natural enemies. Loss of genetic variability in the newly established host range tends to influence the ability of insect populations to adapt the changing climatic conditions involving new food plants, competitors and natural enemies. It is interesting to mention that the insect pest scenario of the crop gradually changing with gradual changes in crop cultivation practices and climate change, especially the higher temperature. Several major pests have become minor and many minor pests attained the status of major pests. There are records of many new pests shifting the host and also some invasive pests due to change in their habitat. There are many good examples of such changing insect pest scenario in rice crops.

**Keywords:** Rice, pest, diversity

**Introduction**

Rice is the most important field crop in India and it exhibits a good example of changing insect pest scenario in rice in recent pasts. After the green revolution in India, there has a constant increase in the number of insect pests, and a concomitant shift in their pest status, diversity and spread (Sain and Prakash, 2008) [23]. In short, climate change will affect the pest incidences and their severity as limiting factors as well as favorableness of growing conditions (Ananthakrishna, 2007) [1].

**Stem Borer**

Among major insect pest of rice, stem borer has shown geographical variation in its species composition like; yellow stem borer, white stem borer, dark headed borer and pink borer across the country. Though, yellow stem borer is the dominant species, white stem borer and pink stem borer species were found in hill regions, parts of Punjab and Haryana in north India and Kerala in South India (Prakash *et al.*, 2005) [15]. Shifting of pest on host due to change their habitat (Prakash, 2013) [18].

The rice stem borers having wide distribution in almost all the rice growing countries and constitute an economically important group of pests. In India, there are five predominant rice stem borer species (Table 1).

**Table 1:** Different rice stem borer species in India

1	Yellow stem borer (YSB)	Scirphophaga incertulas
2	White stem borer (WSB)	Scirphophaga innonata
3	Pink stem borer (PSB)	Sesamia inference
4	Stripped stem borer (SSB)	Chilo polychrysus
5	Dark headed stem borer (DSB)	Chilo suppressalis

The composition of stem borer has been changing for the last two decades. In the North, at Ludhiana, the white stem borer, pink stem borer and yellow stem borer occurred at equal proportion during maximum tillering stage; during flowering stage the yellow stem borer was dominant and during dough stage pink stem borer attack was almost 90% dominant. At Kaul,

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Haryana, during kharif 2005, the yellow stem borer was dominant in maximum tillering stage; but pink stem borer and yellow stem borer were equal in heading stage. In the East, white stem borer was dominant during tillering and maximum tillering stage at Titabar and yellow stem borer was dominant during heading stage. At Wangbal, yellow stem borer was dominant throughout the season, at heading stage population of white stem borer was recorded about 30% of the composition. In Odisha and Andhra Pradesh, white stem borer and pink stem borer both were recorded to occur along with yellow stem borer (Tewari *et al.*, 2010)<sup>[29]</sup>. An estimate made at National Rice Research Institute, Cuttack suggests that every 1% increase in stem borer damage registered a loss of 0.28% at vegetative stage and 0.62% at the heading stage. In deep water rice about 40% stems have been damaged by stem borers resulting 20-40% grain yield loss and increase in 1% yield loss in deep water rice is attributed to 2% damaged stem at harvesting stage (Catling *et al.*, 1987)<sup>[6]</sup>. In Odisha, about 27% grain yield loss has been estimated in semi-deep-water rice due to stem borer infestation in heading stage and for every 1% increase in white ear incidence the grain yield loss was 29-49 kg/ha in different varieties (Tripathy and Senapati, 1995)<sup>[31]</sup>. Further, it is reported that each 1% stem damage resulted in reduction of 0.01 to 0.016 g grain yield/panicle (Senapati *et al.*, 1994)<sup>[24]</sup> and 0.1 to 0.16% total yield loss (Tripathy, 1992)<sup>[30]</sup>. The yellow stem borer eggs hatch in 5-8 days which may prolong further in winter. The larvae pass through 4-7 instars with a total duration of 30-40 days. At high temperature 29-35°C development is accelerated with a minimum of 4 instars and in poor nutrition and adverse weather condition the number of instars increases up to seven. Pupation takes place inside the rice stem, straw or stubble. The threshold temperature for pupal development is 15-16°C. A pupa developed into an adult in 6-8 days depending upon weather conditions. The entire lifecycle is completed in 50-70 days and there are 4-6 generations in a year (Senapati and Panda 1999)<sup>[25]</sup>.

### Plant hoppers

The delphacid plant hoppers like brown plant hopper (BPH) *Nilaparvata lugens* and white backed plant hopper (WBPH) *Sogatella furcifera* earlier considered as seasonal pests are becoming serious pests in many rice growing states of India. During the kharif 2007, there was a severe infestation of the plant hoppers in Punjab and Haryana in about 3.0 lakh acres. This has been a regular pest in the Godavary delta in Andhra Pradesh and Bellary and Sindanur areas in Karnataka and in

Burdwan district of West Bengal. These days plant hoppers occur round the year in serious proportions (Behera *et al.*, 2013)<sup>[15]</sup>. Occurrence of green leaf hopper (GLH) from October to early November has been delayed in Odisha and West Bengal due to late commencing of winter. Presence of large number of green leaf hoppers in rice cultivar Satabdi were observed during end of November 2006 at Cuttack. It was evident from meteorological data of CRRI Cuttack that there was rise in monthly maximum and minimum temperature of 29.5 °C and 20.3 °C, respectively in November 2006, which was 2-2.5 °C higher than temperature in the corresponding month of previous year. Other meteorological factors *viz.*, scanty rainfall (5.2 mm), less sunshine hours (6.5hrs) favored green leaf hopper build up in the later part of Kharif 2006 at Cuttack. Earlier during 1980s and 1990s maximum green leaf hopper population were recorded during Diwali festival time and after which the population used to decrease, but now since 2001, the green leaf hopper population continues to increase beyond Diwali festival (Singh, 2009)<sup>[26]</sup>. The brown plant hopper (BPH), *Nilaparvata lugens*, a major pest of rice in India, is known to migrate long distances every year for favourable climate where conditions are suitable, causing considerable damage to the rice crop. This pest was recorded a problem in rice cultivation in Korea in 18<sup>th</sup> century, migrated to China in early 1920s and further migrated to Japan in 1930s and to Sri Lanka in 1940s and finally to India in 1950s. In India, brown plant hopper outbreaks were recorded in T.N. in 1950-52, later its outbreaks were recorded in A.P. during 1959-59, in Odisha and Maharashtra in 1965-66, in Kerala in 1971-72, in U.P. and Punjab in 1973, In Karnataka in 1975 and in Bihar in 1989-90. Brown plant hopper has been a major threat to rice production in most major rice growing areas of India. If we look to the past scenario of brown plant hopper occurrence, it was a sporadic pest in different states during 1958-1969 (Ghosh *et al.*, 1960)<sup>[10]</sup>. But towards 1973 it became the major pest and continued to create havoc in all rice growing states till 1882 and was considered as a pest of national importance. The intensity of occurrence was gradually declined during 1983-1986 and it remained almost inconspicuous up to 1999. The credit was showed to the development of resistant/tolerant varieties and also of different groups of insecticides. But, in spite of all these developments, brown plant hopper again became the pest in south and eastern states of the country during 2000-2005. Afterwards, it became more aggressive in northern states upto 2010 (Table 2).

**Table 2:** Severity of BPH in India in the last decade of 2001-2010.

Year	States
2001	Andhra Pradesh, Punjab
2002	-
2003	Tamil Nadu
2004	Tamil Nadu
2005	Odisha, Karnataka, Tamil Nadu
2006	Andhra Pradesh
2007	Haryana
2008	Haryana, Uttarakhand, Odisha
2009	Karnataka, Odisha
2010	Haryana, Maharashtra, Odisha, Puducherry, Punjab, Tamil Nadu, Bihar, A.P.

Today this pest is found in almost all rice growing areas in India except hilly areas (Prakash, 2012)<sup>[17]</sup>. The incidence of brown plant hopper is recently reported in low hills of Himachal Pradesh and is likely to increase (Stanley *et al.*,

2009)<sup>[27]</sup>. The multiplication rate of brown plant hopper was high at 31± 2°C. Rate of egg laying was affected beyond 25 and above 33°C. Humidity of 75-80% was suitable for egg laying and hatching. Egg laying was reduced by 22% with

reduction of afternoon humidity to 60-65%. Below it there was considerable reduction of egg laying upto 53% along with 37% hatching in the humidity range of 40-55%.

White backed plant hopper (WBPH), *Sogatella furcifera* attack on paddy in India was reported first from Surat, Pusa, Puna and Nagpur as early as 1903. Subsequently it was observed in Bihar and Bengal during 1919, Jabalpur and its neighboring districts of Madhya Pradesh during 1960, in Punjab during 1966 and in Rajasthan during 1986. It has also been recorded in Andhra Pradesh, Assam, Bihar, Delhi, Haryana, Himachal Pradesh, Karnataka, Maharashtra, Manipur, Odisha, Tamil Nadu, Uttar Pradesh and West Bengal (Chelliah and Gunathilagaraj, 1990)<sup>[7]</sup>. In general, it is reported to be more severe in the areas where resistant varieties of brown plant hopper have been grown. Outbreaks of white backed plant hopper have been recorded from several states of India. About 1000 ha of rice were hopper burned in Punjab during 1983 September. About 8000 ha in Cachar and Karimganj district of Barak Valley in Assam during May-June 1985. This outbreak was favoured by high rainfall in early April followed by prolonged dry period with high temperature and humidity in May (Saha, 1986)<sup>[22]</sup>. Damage to early rice during 1983 in Manipur was attributed to the unusually heavy rains and flooding in the Imphal Valley at that time (Barwal, 1984)<sup>[4]</sup>. In Karnataka, white backed plant hopper outbreaks was reported during 1986 Kharif in the Visveswaraya canal tract of Mandhya may be due to high nitrogen fertilizer (130 kg/ha) with frequent heavy rain during September-October (Gubbaiah and Revana, 1987)<sup>[11]</sup>. Weekly averages of 28.59°C, 69.55% relative humidity, 8.18h

sunshine and 71.7 mm rain were reported to favour white backed plant hopper outbreaks in Delhi (Garg and Sethi, 1980)<sup>[9]</sup>.

### Gall midge

Rice gall midge, *Orseolia oryzae* remained a wide spread pest up to 1990s with emergence of six biotypes, causing serious losses in new areas like Bihar, North East state of Manipur in addition to some traditional areas of Odisha, Andhra Pradesh, Madhya Pradesh and Kerala (Table 3). For about last one decade, it is not a serious pest and occurring only in endemic pockets causing insignificant yield losses (Sain and Prakash, 2008)<sup>[23]</sup>. The cultivation of resistant varieties in an intensive way over a long period was associated with development of new biotypes. Suspected biotype occurrence in two places like Warangal in Andhra Pradesh and Cuttack in Odisha was observed during 1955 (Khan and Murthy, 1955)<sup>[12]</sup>. Four biotypes of gall midge exist in India (Kalode and Bentur, 1989)<sup>[13]</sup> and recently one more biotype from Kerala state capable of damaging the newly identified donors has been reported (Anonymous, 1994)<sup>[2]</sup>. Under normal weather conditions, the life cycle of rice gall midge completes in 19-21 days but in winter months from December to February, it takes 32-39 days. The sex ratio varies in different months and in different biotypes i.e. 1 male to 4 females in biotype 1, 2 and 5 while it is 1 male to 2 females in biotype 4. Due to inbreeding depression in the net house or in the control conditions, sometimes only females emerged making the successive maintenance difficult.

**Table 3:** Different biotypes of rice gall midge in India

Gall midge Biotypes	Locations in India
GMB1	Warangal, Raipur, Sambalpur and Madurai
GMB2	Cuttack and Bhubaneswar
GMB3	Ranchi and Manipur
GMB4	Sakoli and Srikakulam
GMB5	Moncompu

### Leaf folder

Rice leaf folder was another pest of minor significance earlier, which has assumed major pest status in the entire country particularly in areas of high fertilizer use. Three leaf folder species viz., *Cnaphalocrocis medinalis*, *Marasmia patnalis* and *Marasmia exigua* occurs commonly in Eastern India, of which *Cnaphalocrocis medinalis* is dominant and wide spread.

### Leaf folder outbreaks

i. Development of forewarning system for leaf folder indicates that first appearance of damaged leaf (cv- Lalat) due to leaf folder attack during *kharif*, 2008 in the rice field was on 7<sup>th</sup> August, at Central Rice Research Institute Cuttack, Odisha. ii. Maximum leaf damage recorded was 14.2%. Extent of leaf damage (%) at weekly interval was 1, 2, 2.8, 8.2, 5.2, 12.7, 14.2, 10. iii. Simple correlation studies indicated that, sunshine hour, rainfall, maximum temperature and relative humidity-I were positively correlated with leaf folder incidence with respective correlation coefficient values such as sunshine hours (0.28), rainfall (-0.435), number of rainy days (-0.356), maximum temperature (0.423), minimum temperature (-0.406) and relative humidity I (0.361). iv. Growing degree days (GDD) were calculated from CRRRI meteorological data for 2001, 2002 and 2003 from August 8 as the beginning of leaf folder incidence and it was observed

that the years with high initial growing degree days, recorded high incidence of leaf folder damage. This could be due to more number of generations by the leaf folder, as development is quickened under higher temperature and life cycle is completed early (Rath *et al.*, 2014)<sup>[21]</sup>.

Simple correlation studies indicated that, sunshine hour, rainfall, maximum temperature and RH-I were positively correlated with leaf folder incidence.

### Cut worms

Cut worms are becoming serious in many rice growing areas in the east part of the country. Recently severe damage was reported to 30,000 ha of rice in Assam. Since last few seasons, some of the cut worms like, the climbing cutworm, *Mythimna albistigma* Moore; ear cutting caterpillar *Mythimna seperata* Walker and leaf eating caterpillar *Spodoptera compta* Moore, have been regularly occurring in coastal Andhra Pradesh and the Eastern States.

### Swarming caterpillar

The most important cut worms of the rice crop in India is the rice swarming caterpillar *Spodoptera mauritia* which was consider as minor pest has now becoming major pest due to climatic change. The rice swarming caterpillar, has acquired a status of major pest in Odisha, Bihar, Chhatisgarh and Jharkhand during *kharif* 2007-09, 2011-12 and devastated

paddy crop in early stage (Prakash *et al.*, 2009, Anonymous, 2010, Tanwar *et al.*, 2010 and Prakash, 2013)<sup>[2, 16, 18, 28]</sup>. There was a severe outbreak of rice swarming caterpillar in Western Odisha particularly in districts of Sonepur, Bolangir, Sambalpur, Bargarh and Kalahandi in *kharif* 2008. Swarming caterpillar attack was first reported at Birmaharajapur block of Sonepur district during June, 2008 and then it spread to Tarava, Sonepur and Binica blocks. However, the rice crop recovered from the damage due to timely application of DDVP and endosulfan insecticide. The Agalpur block of Balangir district, Padmapur block of Bargarh district and Banipadar village of Kalahandi were severely affected by this pest during *kharif* 2008. The local climatic condition mainly heavy rainfall, nearby hills, forest coverage and river might have contributed to the pest outbreak (Rath *et al.*, 2014)<sup>[21]</sup>.

#### Some examples of infestation are as follows

- 1105 ha direct sown and 531 ha nursery of rice were affected during *kharif* 2008 in 347 villages of 8 blocks of Bargarh district.
- In Padmapur district, the rainfall was inadequate in Padmapur, Paikmal, Jharbandh and Gaisilet block and cracks and crevices have developed in the field which encourages the outbreaks of this pest.
- In Bolangir district, 3132 ha was affected in 348 villages in 9 Blocks.
- In Sonepur district, Birmaharajapur Block was highly affected by this pest in 13 grampanchayat in 1450 ha area
- In 2009, Outbreaks of swarming caterpillar reported in Badapalaspal grampanchayat of Harichandanpur Block of Keonjhar district in 300 ha area of rice (207 ha direct sown, 61 ha transplanted and 32 ha nursery till 30.7.2009)
- 63 mm rainfall in June-2009 and 465 mm rainfall was recorded during July 2009 such type of distribution of rainfall favour out breaks in nearby forest areas.

#### Rice hispa

The rice hispa, *Dicladispa armigera* was a minor pest earlier has assumed the status of major pest in irrigated paddy field, lowland boro rice cultivation in West Bengal, Assam and North-East Indian states. In Odisha, hispa outbreak was reported at Bainsia, Ballav and Ambabati grampanchayat of Gondia block of Dhenkanal District during 1<sup>st</sup> week of September, 2008. About 1300 ha area was affected covering varieties like Annapurna, Pooja, Swarna and Lalat. Besides climatic factors, effect of vast areas of swampy land nearby and unweeded fields might have contributed to hispa outbreak in that locality (Rath *et al.*, 2014)<sup>[21]</sup>. In south India, high humidity after rains and intermittent light sun-shine seems to favour increase in hispa population. In north-eastern India, rainfall was reported to show negative effect on the activity of hispa (Ghosh *et al.*, 1960)<sup>[10]</sup>. Heavy rainfall in July followed by low rainfall in August and September was characteristic of epidemic years. In eastern India, heavy rains in July followed with a long gap or light occasional rains and also more uniform night and day temperature during August are conducive to hispa outbreaks. Rains have negative effect on hispa and the pest appears on a serious level during less rain months when hot and humid conditions prevails. Prakash Rao *et al.*, (1971)<sup>[19]</sup> reported that, top dressing with high level of nitrogen during period of pest abundance resulted in greater susceptibility to this pest. Planting in July suffered considerable infestations by the two early broods; they soon recovered and reached a stage of least susceptibility for the

two succeeding broods. But planting in August suffered from severe hispa damage with less chance of recovery. Dhaliwal *et al.*, (1980)<sup>[8]</sup> found hispa incidence to be increase with the increase with nitrogen (N) level up to 100 Kg/ha. However, at 150 Kg N/ha hispa incidence decrease considerably.

#### Case worms

The rice case worm, *Nymphula depunctalis* (Guen.) is a problem in lowland and semi-deepwater rice ecology and an important pest in vegetative stage. Usually this pest occurs in low populations in paddy fields with standing water because of its semi aquatic mode of life cycle. It is found in irrigated and rainfed wet land environments and is more prevalent in rainy season. The population of this pest often remains at a lower level, but sometimes the sudden increase in their number cause severe damage to crop. Infestation is more severe in dwarf, compact, heavy tillering and high yielding varieties and the maturation of the rice crop delayed by 7-10 days. Highest population of the pest coincides the periods of high rainfall and high humidity. Variation in temperature do not seem to be correlated with the pest population (Pillai *et al.*, 1979)<sup>[14]</sup>.

#### Mealy Bug

In rice, increasing incidence of mealy bug was observed in states of Odisha, Jharkhand and W.B. during last five year. Severe drought, bad drainage and poor soil increase the mealy bug infestation. Primarily the pest is reported to cause heavy damage in upland rice due to dry atmosphere. Temperature around 40°C with moderate humidity is congenial for the population buildup of the mealy bug. Poorly maintained, weekly fertilized crops under low moisture conditions are susceptible to the mealy bug. Presence of alternate hosts in fields or on the field bunds help for rapid multiplication of mealy bugs. Ants and irrigation water help in plant to plant and field to field migration of the bug.

#### Other pests

Blue beetle, *Leptispa pygmoea*, a defoliator has become a common pest in Kerala and white grub, *Holotrichia* spp. in the hilly region of Uttarakhand state (Ramesh Babu, 2010)<sup>[20]</sup>. There are other insect pests of regional significance such as gundhi bug and termites are major insect pest of upland rice ecology whereas white grubs are problems in specific upland hill rice.

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