

BIOLOGY OF *MYTHIMNA SEPARATA* (LEPIDOPTERA) ON *HORDEUM VULGARE* IN ARID COLD DESERT OF KARGIL LADAKH (J&K, INDIA).

JS Tara and Zakir Hussain

Department of Zoology, University of Jammu, Jammu (J&K, India)

ABSTRACT

Kargil lies in the cold desert region of Ladakh with extreme climatic conditions. Agriculture is the main livelihood limited to certain and slopes. Cereals are the main source of carbohydrate for the population. *Hordeum vulgare* is the staple crop of the area with high food value and produced at a large scale. Keeping this in view, the present study was carried out for the first time in the district Kargil of Jammu and Kashmir state. During the study various insects were found to cause damage to the crop. The oriental armyworm, *Mythimna separata* was recorded more destructive. Adult feed on the crop plant, lay egg on the lower side of the leaves and the larval stage exhibit the destructive stage. This insect pest feed on the crops affect their growth and decrease the yield.

Key words: *Mythimna separata*, *Hordeum vulgare*, Biology, Kargil, Ladakh

INTRODUCTION

Ladakh region consists of two main districts namely Kargil and Leh. The Kargil district of Ladakh region lies at an altitude of 2000 - 3000 metre between 32 °10" to 36 °15" latitude and 75° 13" to 80 ° 13" longitudes in the northern most part of Jammu and Kashmir State covering an area of 14086 km². The areas possess a tough terrain along with rock-strewn topography separated from the Indian subcontinent by the Great Himalayan range and to the north edged by the Karakoram Range. This cold desert region is characterised by low precipitation mostly in the form of snow, extreme temperature variations, high wind velocity, thin atmosphere with high ultraviolet radiations, sparse plant density and a fragile ecosystem. Agriculture is the main livelihood among both the rural and the urban people of this area; however the agriculture production is entirely based on irrigation that is confined to flat valleys and lower slopes with ensured accessibility of water. The cropping season is very short i.e., May to September due to the long severe winters. Single cropping is dominant while as double cropping is limited only to those areas that lie below the altitude of 3000 metre. Over the years the people of this region developed a unique farming system that is well suited for this environment. The area remains inaccessible to the outside world for about five to six months because of the encircling mountains and heavy snowfall during winter.

Cereals are the main widely grown crops in the world as they are the main source of carbohydrates for the majority of population. Barley (*Hordeum vulgare*) (Gramineae or poaceae) is the fourth most important cereal crop after rice, wheat and maize that is produced globally. It consists of approx. 65% of carbohydrate, 13% protein, 6% β-glucan, 2% free-lipids and 1.5% minerals, however, total dietary fibre ranges from 11% to 34% and soluble dietary fiber from 3% to 20% (Maher Noaman, 2017). With the change in the environmental condition and the global food problems demand for the cereal crop has tremendously increased especially those that are drought tolerant and combat other abiotic stresses such as

barley and wheat. Barley (*Hordeum vulgare*) is a rich source of carbohydrates and beta glucan in comparison to other cereals. It has received great interest from health professionals for its fibre content and β -glucan in particular, which has been shown to decrease in blood cholesterol, blood pressure, blood glucose in diabetes type 2, weight reduction and preventing colon cancer. It has been proved to reduce blood cholesterol level and glucose concentration, thus may be useful for the patients suffering from diabetes and high-cholesterol related syndromes.(Maher Noaman, 2017). The local crops cultivated in Kargil include barley (*Hordeum vulgare*), wheat (*Triticum aestivum*), buckwheat (*Fagopyrum tararicum*), oats (*Avena sativa*) and millet (*Panicum miliaceum*). The two main important crops grown in the region is wheat and barley. However barley, the mainstay of traditional Ladakhi food (Angchok *et al.*, 2009) is produced at a large scale in the area. The extreme climatic conditions that prevail in the arid cold desert have overcome by the barley crop which is drought tolerant and demand low water. It has been cultivated for the human consumption as well as the animal feed. The staple diet of the area is huskless barley or grim which is roasted and grinded as flour, *gamphay* (local language) and *tsampa* (Tibetan). This nutritious flour is used with tea and even with water as *Kholak* in the breakfast and lunch which is simple and easy to make. Barley is also a source of fermentable material for the local beer; *Chang*. The local population face shortage of animal feed during winter as no cultivation is possible so they have to stock up the animal feed for their cattle. This shortage of fodder is accomplished from this crop. *Mythimna separata*, the oriental army worm (Lepidoptera: Noctuidae) is a serious polyphagous pest of erratic occurrence that caused huge economic losses by decreasing the crop production nationwide annually (Xingfu *et al.*, 2016). The larvae feed on the almost all the agricultural plants and due to its unrestricted multiplication results in heavy loss of tender foliage (Bai *et al.*, 1990). The countries that experienced heavy losses include India, China, Australia, Bangladesh, Japan and New Zealand. (Sharma and Youm, 1999). Each year it migrates by a seasonal, multi-generation, long-distance roundtrip between southern and northern China (Jiang *et al.*, 2011). The gregarious behaviour of the larvae influences yield losses when damage occurs and the outbreaks of this pest result in complete crop losses. It is greyish brown, stout bodied and medium sized. Forewing is pale brown irrorated with blotches and dark speck, bear two white spots at the lower angle of the cell enclosing a black speck with their edges indistinct, lower margin with reniform white spot, blackened external wing margin from top towards backward along with a row of dark point. Hindwing is pale suffused with fuscous with dark external margin. Sexual dimorphism is not exhibited.

MATERIAL AND METHODS

The present study was carried out in the district Kargil during the year 2016-17. The study area was divided into three main stations namely Trespone, Sankoo and Panikhar. The observations were made in the crops field and in the makeshift of laboratory also. During the survey *Mythimna separata* was found to be one of the major pests of barley crop. The infested crops were taken to the laboratory to study the biology of the pest at a temperature of $20\pm 6^{\circ}\text{C}$ and relative humidity (RH) of 27-29%. The mode of damage by the larval instars was studied and photography was done to show the different stages during the life cycle.

RESULTS

resent study inculcates the observations of subsequent biological aspects during the life cycle of *Mythimna separata*, a major pest of cereal crops and barley in particular in Kargil- Ladakh of J&K, India.

Copulation

Mythimna separata is a noctuid moth, being active at night; they prefer night time and early morning for copulation. The couple associate in such an approach that the abdomen of one individual comes in close contact of the other. Copulation takes about 5-8 minutes and the couple separates.

Oviposition

After copulation, eggs are laid in clusters in 2-3 rows in overlapping manner on the lower surface of leaves of the host plant and behind the sheath, stalks and cracks of bark and dry stalks of wood. Egg is creamish light brown, shiny and spherical in shape with a thinly reticulate surface. Egg is about 0.8mm to 1.0mm in length..

Larval stage

The larvae of *Mythimna separata* represents the damaging phase and affects the development and the yield of crop plant. It possesses one intermediate light dorsal strip bordered by two wide blackish-brown strips on lateral side along spiracle line. The brown coloured spiracles possess a black rim. The caterpillar spread out in a line across grazing land and lawns and slowly move forward like an army corps or groups, consuming the foliage they encounter and thus acquires the oriental armyworm as common name. Newly hatched larvae feed on the epidermis of the leaf leaving only the midribs during the vegetative growth. The early larval instar caused great harm to the leaf while as the mature larvae climb up the ear head stalk during the night time, feed voraciously on it and the bits of the head drop down. Earlier larval instar was light black in colour without the appearance of strips. Prominent head, larger than the body with dark coloured bidentate mandibles. Body was thin, small, black and segmentation of the body not distinguished. The abdominal legs were underdeveloped and fragile in first and the second instar. The mature fifth larval instar was large, with different white, black and dark orange and green alternate strips that extended from head till the end. Head dark orange with a tinge of two black strips. Body segmented with well developed black and cream coloured abdominal and thoracic legs. The contrasting white, black and alternative orange with red strips over the body becomes prominent and clearly visible.

Total larval period remains for 23-29 days.

Prepupa

During this stage, the mature fifth larval instar stops feeding, becomes inactive and contracts its body and its appendages and complete body gets shrunked. This shorter phase marks the prepupal period and remains for about 2-3 days.

Pupa

The inactive prepupa falls on the ground and rest in the soil. It spins a cocoon around itself which earlier was light creamish in colour and turns dark brown towards maturity. The male pupa was observed to be slightly smaller than female. The pupal size ranges between 10-15 mm; however the total pupal period was observed between 8-15 days. Pupa represents the resting stage.

Adult

Adult punctures a hole in the pupal case and penetrates out of it. After emergence, it continues vibrating its wings and starts moving. Freshly emerged adult was bright; light brown with furry rounded head, smooth filiform antennae, and abdomen covered with hairs.

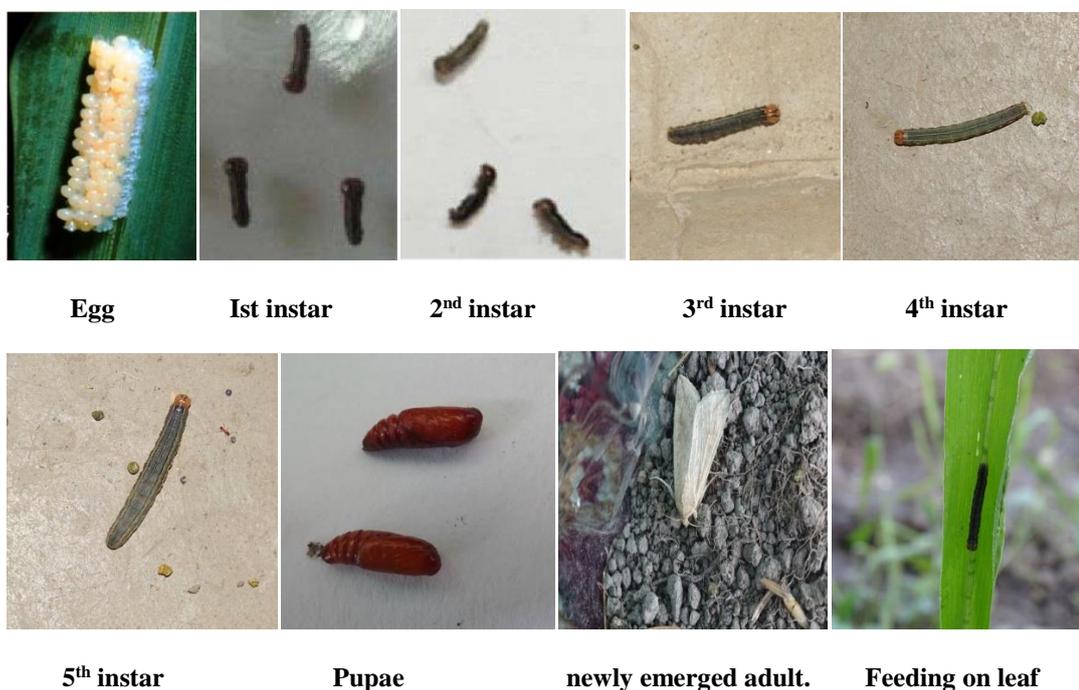
The wing span is about 42 - 45mm.

Table I: Morphometric studies of different stages of *Mythimna separata*.

Stages	Length	Mean±SD	Breadth	Mean±SD	Head Cap.
Egg	0.8-1.0mm	1.08±0.07			
First instar	3.0-5.0mm	3.86±0.71	0.7-1.2mm	0.92±0.17	0.3-0.4mm
Second instar	7.0-13mm	8.98±2.02	1.2-1.5mm	1.32±0.13	0.4-0.6mm
Third instar	20-23mm	21.5±1.03	1.7-2.1mm	1.72±0.33	1.5-2.3mm
Fourth instar	29-32mm	31.3±1.46	2.3-2.4mm	2.33±0.03	2.6-2.7mm
Fifth instar	35-39mm	36.52±1.45	2.5-3.3mm	2.92±0.28	3.6-4.2mm
Pupa	10-15 mm	12.4±1.74	3 - 3.5mm	3.22±0.17	

Table II: Duration of different stages of *Mythimna separata*.

Stages	Duration (Days)	Mean±SD
Copulation	3-5 min	
Incubation	4.0 – 5.0	4.38±0.33
Larval period	23- 29	26.24±1.99
Pre-pupal period	2.0 - 3.0	2.48±0.35
Pupal period	8.0 – 15	11.98±2.64
Total life cycle	37 -52	44.92±5.67





Damaged barley stem.

Barley field

Adult (Upperside)

Adult (Underside)

Figure: Different life stages of *Mythimna separata* and their damage.

DISCUSSION

The yield losses and incidence of wide spread of the insect pest *Mythimna separata* is due to increase in fertilizer use and increased area under irrigation, continuous cultivation and alteration in farming systems by introducing high yielding varieties. In China maize is extensively planted cereal crop reaching 39 million ha in 2011 from 29 million in 2007. It is the important host plant of *Mythimna separata* which account for 2.9 % yield loss in the production of maize in north and northeast China in the year 2012. Since 1950-2013, the pest infested 5.28 million ha. of cropland (average annual area) in China. It is a long distance migratory insect that moves along the wind currents and its migratory behaviour has been established in Japan and China (Ma, 1979). In India it was a minor pest prior to 1950 since then it caused serious damage to maize (*Zea mays*), wheat (*Triticum aestivum*), sorghum (*Sorghum bicolor*), rice (*Oryza sativa*) and pearl millet (*Pennisetum glaucum*). The outbreak of this pest was recorded in Andhra Pradesh during the year 1977, 1978 and 1981 and during 1980-81 at Dharwad, Karnataka (Sharma and Davies, 1983), Kullu, Himachal Pradesh in 1983 (Thakur *et al.*, 1987), Hissar, Haryana in 1984 (Singh *et al.*, 1987). In northern part of India it has been reported to nourish on graminaceous crops and caused significant damage intermittently. (Verma and Khurana 1971; Bindra and Singh 1973; Butter *et al.* 1979; Chaudhary and Singh 1980; Singh and Manchanda 1981). However, in the fragile ecosystem of district Kargil, agriculture production is limited spatially to certain valleys and plains with ease to the access of water. It has also temporal restriction that allows cultivation only to about five to six months during May to September in the year due to the long severe winters. Barley (*Hordeum vulgare*) is the main cereal crop of this area cultivated at a large scale which is used in their daily diet. As the insect pests are significantly decreasing the crop yield so it is important to know more about them in order to reduce the loss. The infestation of this insect pest on *Hordeum vulgare* was observed highest at Trespone station out of the three stations which is situated at the lower altitude at about 2300 metre in comparison to others. Keeping this in view, the present research study was carried out in the district Kargil for the first time however *Mythimna separata* has been studied as the insect pest on other crops also. It has been reported to feed on the panicles of the rice crop and an approximate of 20% panicles was clipped by this pest decreasing its yield (Santiago *et al.*, 1997). Hill and Atkins (1982) studied the effect of defoliation by this pest on the maize yield and found the reduction in the yield only with more than 67% of defoliation. Further at this level the yield was reduced by 44%. Deol and Singh (1991) studied the behaviour and the biology of *Mythimna separata* on wheat and observed to pass through four generations in a year. The larval period in different months varied

from 17 to 69 days, pupal period ranged from 8 to 32 days and longevity of about 4-11 days. The results show variation with the present study perhaps due to the different weather parameters as the study area lies at a higher altitude with different topography and climatic variation.

CONCLUSION

In district Kargil, agriculture is a major livelihood among the local population. Only few crops are being cultivated prominently wheat and barley in the area with spatial and temporal limitations. The present study is a pioneer step in documentation of insect pest associated with barley crop. *Mythimna separata*, a polyphagous pest has been reported as a major pest on barley crop in district Kargil for the first time.

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