

CASE REPORT

An Outbreak of Armyworm, *Mythimna separata* (Walker) in Jhum Rice of Arunachal Pradesh: A Case Study

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ABSTRACT

Background: Rice is the most important food crop of Arunachal Pradesh and Jhum rice constitutes a major traditional cultivation system. Infestation of armyworm, *Mythimna separata* (Walker) was noticed in the form of an outbreak in several villages of West Siang and Lepa Rada districts of Arunachal Pradesh in the first week of July 2017.

Aim: The aim of this study was to assess the severity of the crop infestation during the outbreak and also the cause of its natural suppression.

Objectives: The study was conducted with the objective to record the level of infestation of *M. separata* in Jhum rice along with the association of natural enemies, if any.

Material: Surveys were conducted to record the level of infestation in the field. Observations were recorded on the number of larvae per plant as well as number of plants infested.

Result: The level of infestation of paddy was recorded as 89.67 ± 0.03 per cent with 6.37 ± 0.61 larvae per plant which after 10 days, reduced to 78.7 ± 0.03 per cent with 5.34 ± 0.23 larvae per plant. Further, it dropped down to 14.7 ± 0.05 per cent with 0.17 ± 0.06 larvae per plant and ultimately to 6.3 ± 0.025 per cent infestation with 0.07 ± 0.03 larvae per plant. A braconid, *Cotesia ruficus* and a dipteran parasitoid were also found parasitizing the larvae of *M. separata*.

Conclusion: The armyworm, *M. separata* has the tendency of emerging in the form of outbreaks causing heavy crop infestation. The parasitoids identified in the study could be of immense importance in managing such an outbreak in future.

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KEYWORDS

• Armyworm • *Cotesia ruficrus* • *Mythimna separata* • Natural enemies • Outbreak

Key Message: Bio-control agents have immense potential in suppressing an insect-pest outbreak in a natural way.

INTRODUCTION

Arunachal Pradesh, lying in the eastern Himalayas, is the largest of all the north eastern states of India occupying 83,743 sq-km area. The state has a rich biodiversity both in terms of flora and fauna. Agriculture is the main source of livelihood for its people where nearly 85% of them depend directly or indirectly on it (Bhagawati *et al.*, 2017). Rice is the staple food of Arunachal Pradesh occupying around 137.28 thousand ha area. Although vulnerable to landslides (Singh and Singh, 2024), shifting cultivation (*Jhum*) constitutes a major traditional cultivation system. The state is also a hotspot for a number of local races of paddy. Owing to this richness in paddy area and germplasm diversity, it faces infestation of a variety of insect-pests. Among these, the Armyworm, *Mythimna separata* (Walker) is an economically important pest. It is polyphagous in nature and apart from paddy; it also infests wheat, maize, sorghum, millets etc. Being

nocturnal in behaviour and a serious defoliator, it also cuts the panicles in the later stage of the crop. Owing to its migratory behaviour, it can disperse a long distance and therefore, the pest is distributed throughout the country. The female of the species lays nearly 500-900 eggs which last for a week. Larval development generally takes 14-22 days; pupa matures in 8 to 9 days; adult lives for 4 to 5 days and the total development period takes around 26-38 days (Ganiger *et al.*, 2018). In view of this, we report a case of an outbreak of *M. separata* during *Kharif* 2017 in a particular locality of Arunachal Pradesh.

CASE SUMMARY (STUDY)

An outbreak of armyworm, *Mythimna separata* (Walker) was observed from several villages viz. *Sago*, *Ngomdir*, *Doje Jelly*, *Doje-Jeku*, *Bagra*, and *Angu* villages (Table 1) of West Siang and Lepa Rada districts of Arunachal Pradesh in the first week of July 2017 (Figure 1).

Table 1: Latitude and longitudes of locations where outbreak was observed

Name of Location	N	E	Altitude (Feet)
<i>Angu</i>	28°03.847'	94°44.891'	1440
<i>Bagra</i>	28°04.492'	94°45.440'	1416
<i>Doji-Jelly</i>	28°04.207'	94°48.674'	1321
<i>Ngomdir</i>	28°03.630'	94°49.168'	1420
<i>Doji-Jeku</i>	28°05.004'	94°47.651'	1124
<i>Sago</i>	27°59.051'	94°48.445'	3833
<i>Lipu Namchi</i>	28°00.318'	94°44.051'	2456



Figure 1: Outbreak of Armyworm, *Mythimna separata* in rice field of Arunachal Pradesh, India

The study was conducted to record the level of infestation of *M. separata* in *Jhum* rice along with their natural enemies. Surveys at intervals of 10 days were done to record the infestation in the field and also its parasitisation, if any, in the laboratory. Observations were recorded on the number of larvae per plant and number of

plants infested. Large number of larvae were collected, brought to the laboratory and reared for examining the presence of natural enemies, if any. The collected larvae were kept singly in glass tubes and reared on their natural diet for emergence of natural enemies (Figure 2).



Figure 2: Laboratory rearing of field collected larvae of *M. separata* in glass tubes

On 1st July 2017, the level of infestation was recorded as 89.67 ± 0.03 per cent with 6.37 ± 0.61 larvae per plant. After 10 days, the infestation reduced to 78.7 ± 0.03 percent with 5.34 ± 0.23 larvae per plant. Further, the infestation of armyworm drastically dropped down to 14.7 ± 0.05 per cent with 0.17 ± 0.06 larvae per plant on 20th July and only to 6.3 ± 0.025 per cent with 0.07 ± 0.03 larvae per plant on 30th July (Table 2). A dipteran parasitoid emerged from the larvae of *M. separata* reared in the laboratory which was dirty white in colour (Figure 3). The maggots were 10.27 ± 1.87 mm in length and took 3.33 ± 2.97 days to pupate after emergence from the host larvae. Initially, the pupae were light brown coloured which later turned to dark-brown. The dark-brown

coloured pupa measured 6.13 ± 0.74 mm and 3.02 ± 0.13 mm in length and breadth, respectively whereas the pupal period was recorded as 10.2 ± 1.42 days. The parasitisation per cent of this dipteran maggots recorded from the field collected *M. separata* larvae on 1st July was 11.48 ± 2.80 which increased to 72.20 ± 7.09 per cent by the 10th of July. This might be one of the important mortality factors aided in suppressing the outbreak. It would be worthwhile also to mention that large number of cocoon clusters was observed on the rice plants in early July (Figure 4). The adults emerged in large numbers from the cocoons which were taxonomically identified as *Cotesia ruficrus*.



Figure 3: Maggot, pupa and an adult (from left to right) of the dipteran parasitoid emerged from the laboratory reared larvae of *M. separata*



Figure 4: Cluster of cocoon of the braconid, *Cotesia ruficrus*, observed in association with *M. separata* infestation

Number of clusters of cocoons per 100 plants was observed as 18.67 ± 10.60 on 1st July, 31.33 ± 11.59 on 10th July, 7.33 ± 4.04 on 20th July and 6.67 ± 1.53 on 30th July. There were 8 to 25 cocoons observed in one cluster whereas number of cluster varied from 1 to 4 on a single plant. The drastic reduction in the level of infestation of armyworm may also be attributed to the parasitisation of *C. ruficrus* initially and later by the dipteran parasitoid. Both these parasitoids might have considerable potential in managing the outbreak and bringing down the infestation of armyworm. Mass multiplication in laboratory and practical utilization of these parasitoids for the purpose of biological control of *M. separata* are the prospects ahead.

Table 2: Showing infestation level of *M. separata*, parasitization % (dipteran maggots) and cluster cocoons of *Cotesia ruficrus* in Jhum rice

	% infestation (<i>M. separata</i>)	No. of larvae per plant (<i>M. separata</i>)	Parasitization % (Dipteran maggots)	No. of Cluster cocoons (<i>C. ruficrus</i>) per 100 plants
1st July 2017	89.67 ± 0.03	6.37 ± 0.61	11.48 ± 2.80	18.67 ± 10.60
10th July 2017	78.7 ± 0.03	5.34 ± 0.23	72.20 ± 7.09	31.33 ± 11.59
20th July 2017	14.7 ± 0.05	0.17 ± 0.06	*	7.33 ± 4.04
30th July 2017	6.3 ± 0.025	0.07 ± 0.03	*	6.67 ± 1.53

* Study not conducted due to non-availability of sufficient numbers of larvae

DISCUSSION

The armyworm, *M. separata* is an economically important polyphagous pest which, many times, comes in the form of an outbreak. Infestation of this occurs occasionally but heavily in the form of outbreaks (Oku, T. and Kobayashi, T., 1974; Wang *et al.*, 2006; Ganiger *et al.*, 2018). According to Ganiger *et al.* (2018), long spell of drought followed by rains is conducive for the outbreak of armyworm. Temperature and humidity of a particular location play a vital role in its multiplication. Excess of nitrogenous fertilizer as well as trash mulching also adds to its population explosion. Also, conditions which suppress its natural enemies can uncheck its growth and multiplication. Oku and Kobayashi (1974) reported an outbreak of *M. separata* during the early summers of 1971 and 1972 in the Tohoku district of Japan. They attributed this outbreak to the migratory behaviour of the moths, mean air temperature, direction and strength of the wind. In a study conducted by Sharma *et al.* (2002), rainfall and humidity (both maximum and minimum) were positively correlated with

the moth catches of *M. separata* in light traps, while maximum temperature, evaporation, solar radiation, sunshine hours, and wind velocity showed a negative correlation. According to them, 54 to 68% variation in moth catches could be explained by the previously prevailed (2 to 4 weeks) weather conditions. They also reported several parasitoids species which contributed in suppressing the outbreak. In addition to that, *C. ruficrus* (observed also in our study) was reported by them as the principal mortality factor of *M. separata*, which caused parasitism to the extent of 47%. *C. ruficrus* plays a vital role in reducing the feeding potential of the armyworm, *M. separata* (Hill, 1988). In another study conducted by Bhat *et al.* (2024), *M. separata* infestation in maize grown in the Kashmir valley was found to be positively correlated with maximum and minimum temperature whereas relative humidity and rainfall had a negative correlation. Wang *et al.* (2006) found the involvement of nectar rich plants, especially the milk vetch, *Astragalus sinicus* L in stemming the outbreak. Their study inferred

that the availability of ample amount of nectar during their migration assist them in reaching their target destination and its consequent outbreak. Apart from the milk vetch, rape *Brassica napa* L. and six other species were also reported as important sources of nectar which supports them during their migration. Overall, the causes behind population shoot up and outbreak of the armyworm, *M. separata*, has much more to be investigated.

CONCLUSION

The armyworm, *M. separata* (Walker) has been frequently reported for its outbreak which is largely attributed to the migratory behaviour of its adults. Several weather and ecological factors play a key role in regulating its population dynamics. The case study of the outbreak in several villages of West Siang and Lepa Rada districts of Arunachal Pradesh revealed its association with a braconid (*C. ruficus*) and a dipteran parasitoid which proved to be prominent in suppressing the outbreak in a natural way. This underlines the potential of these two parasitoids in bringing down the pest population in a significant way. Further exploration of natural enemies, their conservation and augmentation may aid in managing such outbreaks in future.

Conflict of Interest: The authors declare no conflict of interest in the content of the manuscript and study undertaken.

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Ethics Declaration: The study conducted adheres to all the ethical principles and guidelines.

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