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Pest Complex of Cultivated Oyster Mushroom in Northeast India: Feeding Losses and Role of Micro-climate in Pest Multiplication

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ABSTRACT

The northeast India is one of the most promising regions for the cultivation of mushroom; where oyster mushroom is a widely accepted and popular food among the local people. Despite higher demand, the year-round production of oyster mushroom is usually not possible, which is mainly due to severe damage by the insect pests and diseases, especially during rainy season. We studied the detailed pest complex of oyster mushroom, their damage pattern and the role of micro-climatic factors on pest multiplication during 2013 and 2014. Various arthropod pests *viz.*, pleasing fungus beetles (*Triplax* spp., *Scaphisoma* spp. and *Megalodacne* spp.) sciarid fly (*Bradysia* spp.), mycetophilid fly (*Allactoneura* spp.), fruit fly (*Drosophila* spp.), rove beetles, noctuid moths, collembolans and mites (*Tyrophagus* spp.) were found infesting oyster mushroom in different months of the year. Pest incidence was found upto 100% during the rainy season (May, June, July and August). Among all, *Triplax* spp. and *Bradysia* spp. were found to be the most destructive pests of oyster mushroom; which were present throughout the year and in turn were responsible for reduction in the marketable yield. A significant positive correlation was observed between the population of beetle, *Triplax* spp. and maximum temperature (r=0.430), minimum temperature (r=0.425) and relative humidity (r=0.352). A significant positive correlation was also found between populations of sciarid fly and maximum temperature (r=0. 541) as well as relative humidity (r=0. 371). This is a first comprehensive study of its kind, where the detailed pest complex of oyster mushroom in northeast India, their damage pattern and population dynamics throughout the year has been documented. Mushroom being a perishable edible food, this study would have immense importance for understanding the mushroom pest complex further for designing of effective management strategies against the major pests.

1. Introduction

Oyster mushrooms (*Pleurotus* spp.), are lignocellulose loving fungus and can be easily recognized in nature due to their peculiar morphology with an eccentric short stem or stipe. Due to simple low cost cultivation technology, it is the most popular cultivated edible mushroom, consumed for its delicacy, flavour, pleasant consistency besides having nutritive and medicinal value (Deepalakshmi and Sankaran 2014). Among all the cultivated mushrooms, *Pleurotus* has maximum number of commercially cultivated species suitable for round the year cultivation (Valverde *et al.,* 2015; Deepalakshmi and Sankaran 2014). The oyster mushroom is one of the most suitable fungal organisms for producing protein rich food from various agro-wastes without composting. It is the 3rd largest cultivated mushroom in the world and it is popularly grown in China, India, South Korea, Japan, Italy, Taiwan, Thailand and Philippines. India produces annually 10,000 tons of oyster mushroom (Das and Sarkar 2016).

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It is popularly grown in the Indian states of Orissa, Karnataka, Maharashtra, Andhra Pradesh, Madhya Pradesh, West Bengal and in the northeastern states of Meghalaya, Tripura, Manipur, Mizoram and Assam (Das and Sarkar 2016; http://agridaksh.iasri.res.in/ html_file/ mushroom /economics_of_oyster_mushroom_cul.htm). The northeast India is one of the most promising regions for the cultivation of oyster mushroom and it is the most popular food of the local people. Owing to high market demand and nutritional value, the cultivation of commercial mushrooms is therefore a growing popular trend in northeast India (Singh *et al.,* 2011). Oyster mushrooms are commonly cultivated in this region by the tribal farmers. Cultivation of oyster mushroom requires a moderate temperature ranging from 20-30°C; with high relative humidity 75-85% during fruiting (Baiswar *et al.,* 2016). The agro-climatic conditions in the northeast India and especially in Meghalaya state are very much congenial for round the year mushroom cultivation (*Pleurotus sajor-caju* (now *P. pulmonarius*), *P. flabellatus, P. sapidu s*and *P. citrinopileatus* during summer months and *P. florida*, *P. eryngii*, *P. fossulatus* and *P. ostreatus* during winter months). However, despite higher demand, farmers are unable to cultivate oyster mushroom, especially during rainy season (May-August) due to severe problems of insect pests, diseases and competitor moulds (Baiswar *et al*., 2014).

The northeastern hill region of India is a part of mega biodiversity hotspot and therefore very rich in terms of flora and fauna. Due to distinct climatic conditions, the pest complex of the cultivated crops is quite different in northeast India than other parts of the India (Azad Thakur *et al.,* 2012; Firake *et al.,* 2012a, 2012b; Firake *et al.,* 2013, 2016). The commercially cultivated mushrooms are highly susceptible to different mycetophagus arthropods and pathogens. Various insects, mites and nematode pests feed on oyster mushroom in India at different growth stages and cause extensive losses in yield and even sometimes cause total crop failure (Deepthi *et al*., 2004). Bhattacharyya *et al*., (1993) reported that the yield of mushrooms was reduced by 49% due to the pest attack. Besides this, very limited information is so far available on pests of oyster mushroom, especially in northeastern states of India. In order to develop eco-friendly and economical pest management strategies, it is crucial to know the associated pests of oyster mushroom and their damage pattern. Since oyster mushrooms are usually cultivated inside the low cost bamboo made sheds (mushroom houses); it is essential to know the role of micro-climatic conditions on population fluctuations of different pests.

We studied the diversity of arthropods associated with the oyster mushroom and their damage pattern. Also, we determined the role of micro-climatic factors on population dynamics of major pests throughout the year.

2. Materials and Methods

The studies were undertaken at the Division of Crop Protection, ICAR Research Complex for NEH Region, Umiam, Meghalaya, India during 2013 and 2014. Three different species of oyster mushrooms *viz*. *P. sajor-caju*, *P. florida* and *Pleurotus* spp. were cultivated in scientifically designed mushroom houses at plant pathology farm of the institute by adopting the standard package of practices (Baiswar *et al.,* 2016). Fruiting bodies of the oyster mushroom, *Pleurotus* (*P. sajor-caju*, *P. florida*, *Pleurotus* spp.) were obtained twice in a week from the two mushroom houses (A. Low cost mushroom house; B. Cemented mushroom house in the Plant Pathology farm) and were examined for the presence of pests in any of their developmental stages *i.e*. egg, larval, pupal or adult stages. The number of different larvae or adult insects were counted, separated and recorded. The immature stages were reared in the laboratory up to the adult stage and the number of each species in damaged fruiting bodies was recorded. Moreover, all harvested mushrooms (both the damaged and healthy) and the mushroom beds were checked frequently for the infestation of any other pests. The entire mushroom houses were also inspected on a frequent basis for the occurrence of such insect pests. All the associated arthropods were preserved and identified in the Insect Biosystematics Laboratory, ICAR Research Complex for NEH Region, Umiam, Meghalaya, India. The identity of the specimens was further confirmed by the experts and available literature. The weight of the total harvest and weight of damaged fruit bodies of oyster mushroom were recorded on a weekly basis during 2013 and 2014. Observations on a number of insect's larvae/adults per 100 gm damaged produce were also recorded at the weekly basis. Per cent damage to fruit bodies of oyster mushroom was calculated by the following formula;

Percent damage to fruit bodies =

$$\frac{\text{Weight of fruit bodies infested/damaged}}{\text{Weight of total harvest of fruit bodies}} \times 100$$

The data on the maximum and minimum temperature (°C) and relative humidity (%) inside the mushroom house were recorded on a daily basis during the whole experimental period.

Pearson's correlation coefficient was calculated to find out the relationship between pest populations and temperature and humidity. IBM SPSS 21 software was used for overall statistical analysis.

3. Results and Discussion

3.1 Arthropod pests damaging oyster mushroom

About 10 arthropod pests were found infesting oyster mushroom in northeast India during 2013 and 2014. The pleasing fungus erotylid beetles (*Triplax* spp. (Plate 1), *Megalodacne* spp. (Plate 2), and *Scaphisoma* spp.) were commonly observed harbouring and feeding on oyster mushroom. Among erotylid beetles, *Triplax* spp. was the dominant pest infesting fruiting bodies in most parts of the year. Among dipteran flies *viz*. mycetophilid fly, *Allactoneura* spp. (Plate 3) and sciarid fly, *Bradysia* spp. (Plate 4) and *Lycoriella* spp. were found feeding on mycelia of oyster mushroom. Other arthropod pests *viz*., rove beetles (Plate 5), noctuid moth (Plate 6), fruit fly (*Drosophila* spp.), and mite (*Tyrophagus* spp.) were also found damaging the mycelia of the oyster mushroom. Large number of collembolans was found on the substrates as well as near the fruiting bodies; however, feeding on mycelia has not been observed. Among all, *Triplax* spp. and *Bradysia* spp. were the most destructive pests of oyster mushroom; which were present in most parts of the year, directly feeding on fruiting bodies and thereby reducing the marketable yield.

Although insect pests are one of the important constraints in round the year mushroom production, no detailed information is so far available on pest complex of oyster mushroom in the northeastern hilly region of India. Few reports are however available from other parts of the India. For instance, Kumar *et al*. (2012) studied the pests of oyster mushroom in Himachal Pradesh and observed the infestation of sciarid fly, *Bradysia* spp., *Scaphisoma* spp., *Staphylinus* spp., along with some species of springtails and mites on oyster mushroom. Joshi *et al*. (2011) also recorded the infestation of oyster mushroom, *Pleurotus* spp. by dipteran sciarid fly, *Bradysia tritici* and phorid fly, *Megaselia sandhui* in 2008 and 2009. The infestation of oyster mushroom by phorid fly, *Megaselia* spp. has been frequently reported by several authors (Mohan and Disney 1995; Deepthi *et al*., 2004; Disney 1994). Deepthi *et al*. (2004) has recorded the beetles, *Staphylinus* spp. and *Scaphisoma nigrofasciatum* infesting oyster mushroom in Kerala, India. Gnaneswaran and Wijayagunasekara (1999) studied the pest complex of oyster mushroom in Srilanka and reported several pests of oyster mushroom including *Drosophila* spp., *Bradysia* spp., springtails and unidentified caterpillars of noctuid moth. Yoshimatsu and Nakata (2003) and Tomalak (2008) also observed the infestation of fruit flies, *Drosophila* spp. and noctuid caterpillars in oyster mushroom in Japan and Poland, respectively. The association of an erotylid beetle, *Triplax* spp. with oyster mushroom has also been reported (Weiss 1920; Boyle 1956; Chantal 1979). However, the detailed pest complex and pest activities throughout the year have not been documented in previous reports.

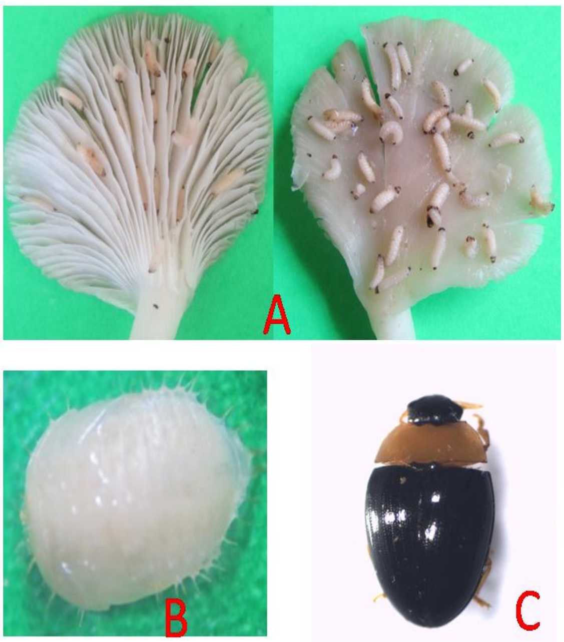

Plate 1. Pleasing fungus beetle, *Triplax* spp., larvae (A), pupa (B) and adult beetle (C)

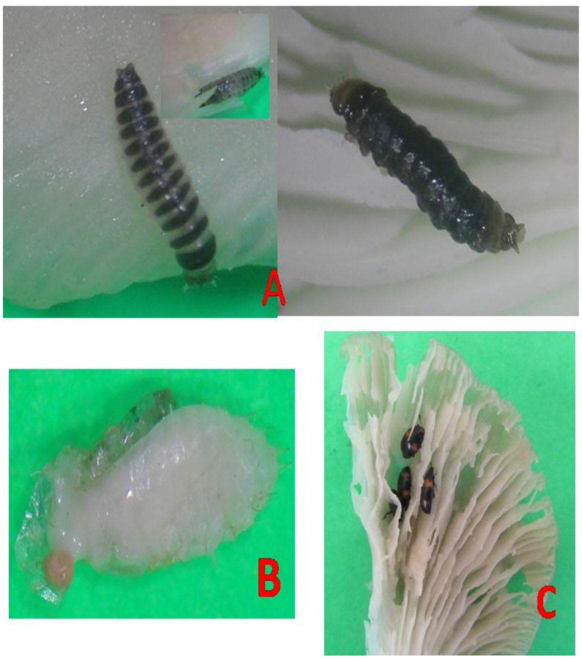

Plate 2. Pleasing fungus beetle, *Megalodacne* spp, larvae (A), pupa (B) and adult feeding on mycelia (C)

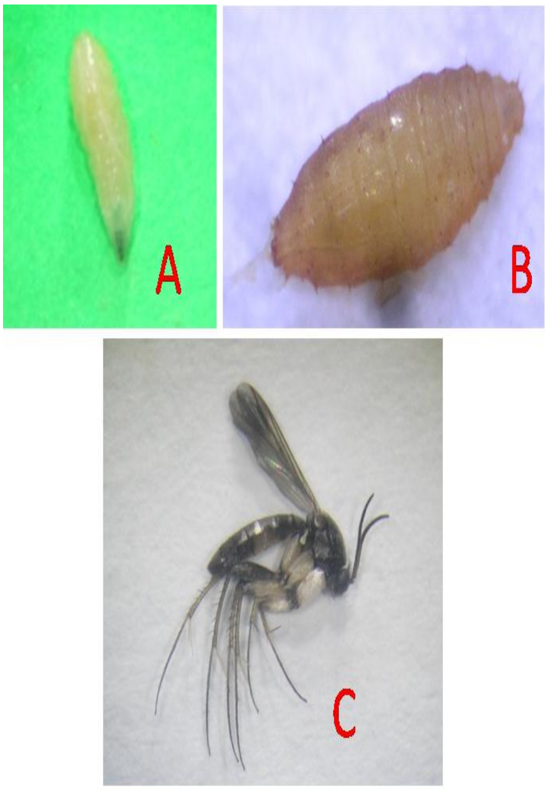

Plate 3. Mycetophilid fly, *Allactoneura* spp., larva (A), pupa (B) and adult fly (C)

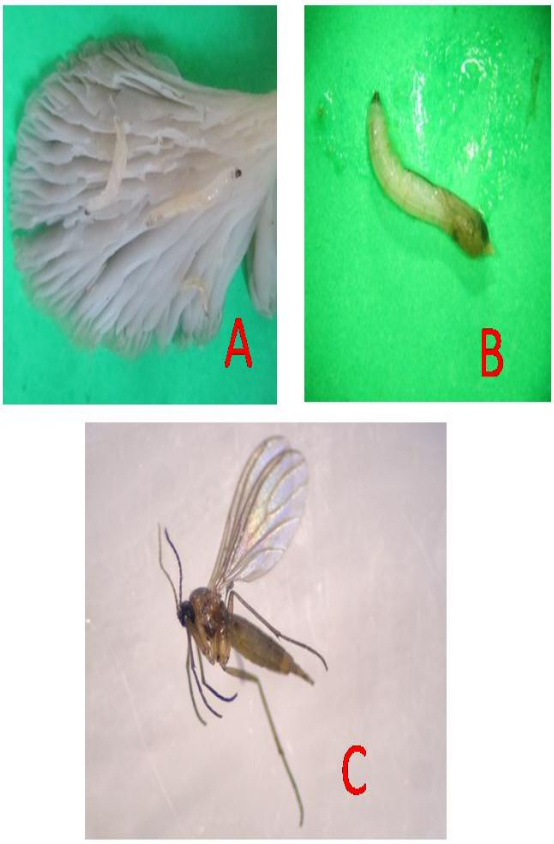

Figure 4. Sciarid fly, *Bradysia* spp., larvae (A), pupa (B) and adult fly (C)

Plate 5. Rove beetle (A) and adult beetles feeding on mycelia of oyster mushroom (B)

Plate 6. Noctuid caterpillar (A), its pupa (B) and adult moth (C)

3.2 Damage pattern of different pests of oyster mushroom and their correlation with abiotic factors

Per cent pest damage to oyster mushroom was found to be highest during the rainy season (May, June, July and August); where 100% of harvested mushroom were found damaged (Figure 1). Lowest damage and infestation of the insect pests was observed in the late week of March, April, October and in the onset of November. No infestation was observed from the 3^{rd} week of November until the onset of the March. The marketable yield of mushroom was found highest during this time. Population of *Triplax* spp. was higher during April to September (Figure 2); while incidence of *Bradysia* spp. was higher during April to November (Figure 3). Incidence of mycetophilid fly, *Allactoneura* spp. was mainly observed during April and May with significant damage to the fruiting bodies (Figure 4). In the present study, pest damage and yield losses were highest during the rainy season. Similarly, Mehelis (1996) also recorded highest marketable yield of oyster mushroom during the winter months in Oregon State; but lowest in the rainy season; which was mainly due to insect damage. Navarro *et al*. (2002) and Sandhu and Batthal (1987) studied the seasonal fluctuations of dipteran flies in mushroom and reported the highest incidence of flies during rainy season; while lowest during winter. These reports support our findings. Since oyster mushroom is cultivated under a shed; the minimum temperature, maximum temperature and relative humidity are three important factors; which have significant impact on pest populations. Therefore, these three parameters were recorded during the experimental period i.e. 2013 and 2014. The data on average monthly temperature (maximum and minimum in °C) and relative humidity (%) inside the mushroom house were presented in figures 6 and figure 7. Population of two major pest species *viz*. *Triplax* spp. and *Bradysia* spp. was statistically correlated (at the 5% level of significance) with abiotic factors. A significant positive correlation was observed between the population of beetle, *Triplax* spp. and maximum temperature (r=0.430), minimum temperature (r=0.425) and relative humidity (r=0.352). As significant positive correlation was also found between population of sciarid flies and maximum temperature (r=0.541) as well as relative humidity (r=0.371). Clift and Larsson (1987) observed the significant positive correlation between the population of *Staphylinus* spp. and maximum temperature. Similar findings were observed by Sato (2003) in case of mushroom erotylid beetle, *Dacne picta*; who noted that the developmental time of the beetle was shortened with an increase in temperature, leading to production of large beetle populations and indicating a positive correlation with temperature and relative humidity. Several reports are available indicating relationship between the sciarid pest population and temperature as well as humidity (Wang 1994; Clift and Larsson 1987; Feng Huiqing 1987; Wilkinson and Daugherty 1970). Wang (1994) recorded that, higher the temperature, shorter was the larval period of sciarid flies and also observed that a high relative humidity was required for their survival. Feng Huiqing (1987) showed that as the temperature increased, each larval instar period of *Bradysia* spp. became shorter and thus produced many generations. Navarro *et al*. (2002) have also reported that the highest number of the sciarid flies was observed in spring, autumn while minimum during winter. This strongly indicated that, with an increase in temperature and relative humidity, the number of flies also increased and vice versa. The present study has studied and documented 10 arthropod pests which feeds on oyster mushroom in northeast region of India. *Triplax* spp. and *Bradysia* spp. are the major and most destructive pests which causes maximum damage during May to August. Both temperature and humidity have significant positive correlation with pest damage and pest population. This study would have immense importance for understanding the pest complex; which ultimately would be helpful in formulating management strategies against major pests of oyster mushroom.

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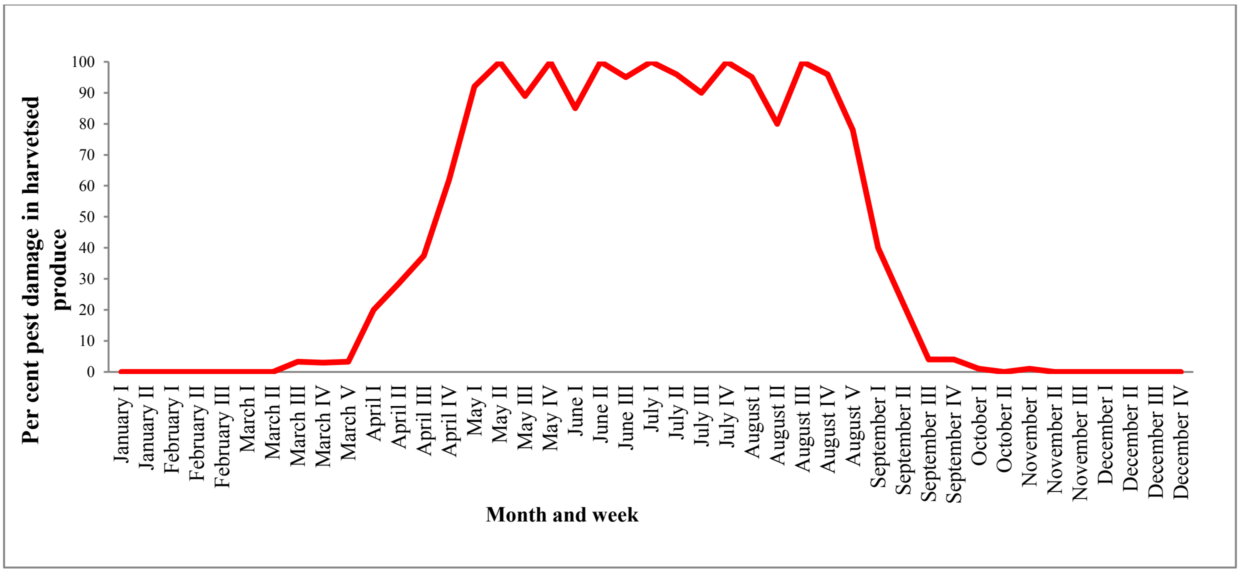

Figure 1. Losses caused by insect pests of oyster mushroom in different months during 2013 and 2014 at Umiam

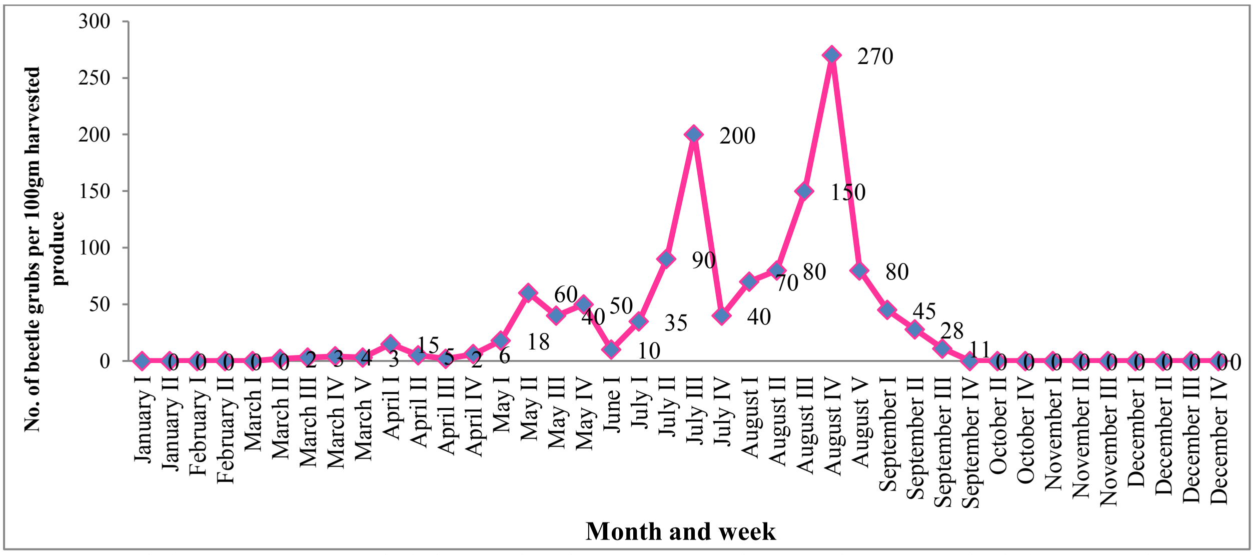

Figure 2. Population of *Triplax* spp. grubs in harvested produce of oyster mushroom in different months during 2013 and 2014 at Umiam

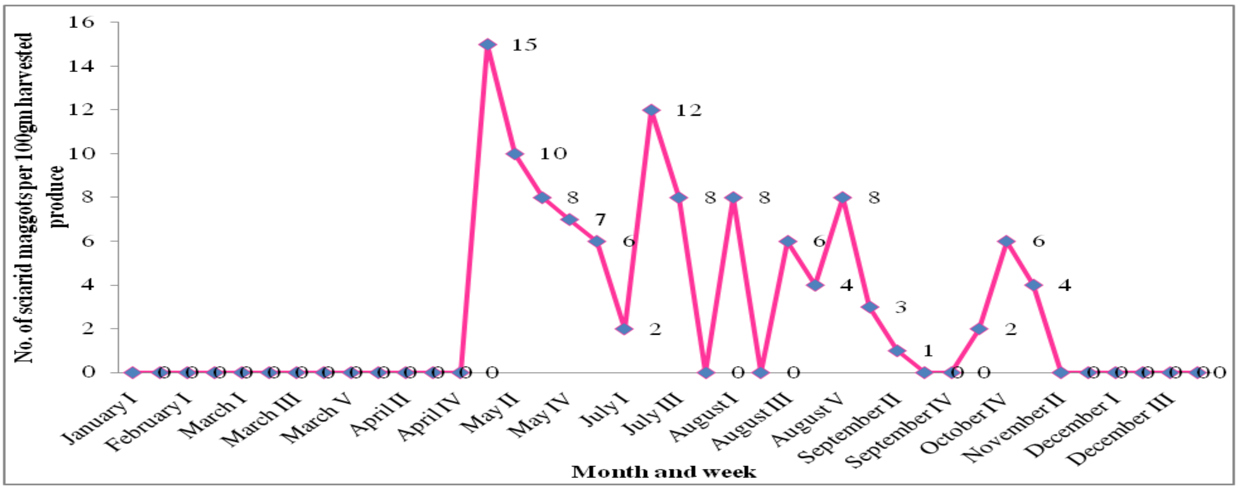

Figure 3. Population of sciarid fly (*Bradysia* spp.) maggots in harvested produce of oyster mushroom in different months during 2013 and 2014 at Umiam

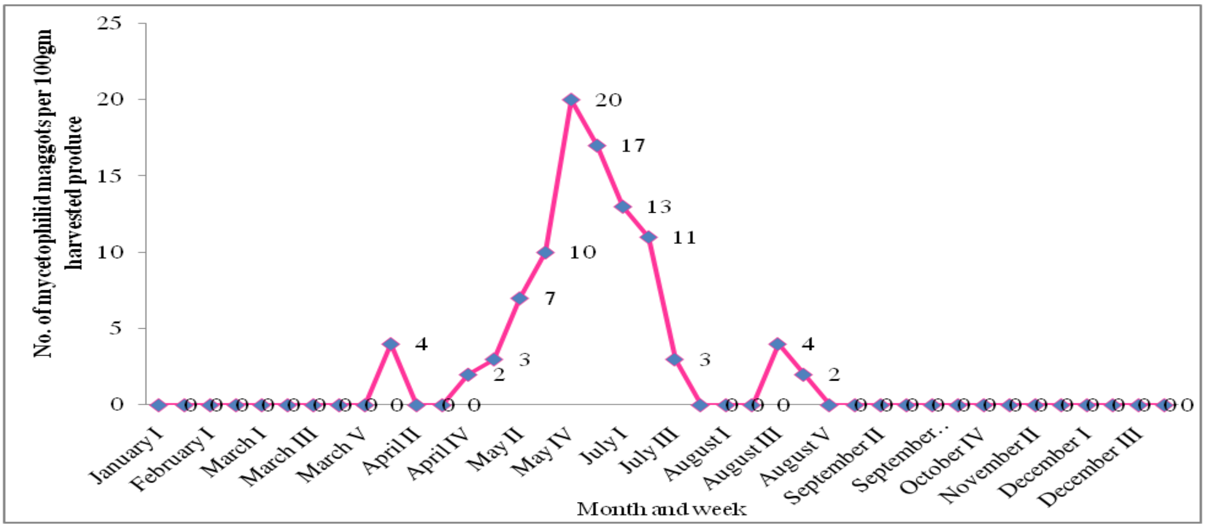

Figure 4. Population of mycetophilid fly (*Allactoneura*spp.) maggots in harvested produce of oyster mushroom in different months during 2013 and 2014 at Umiam

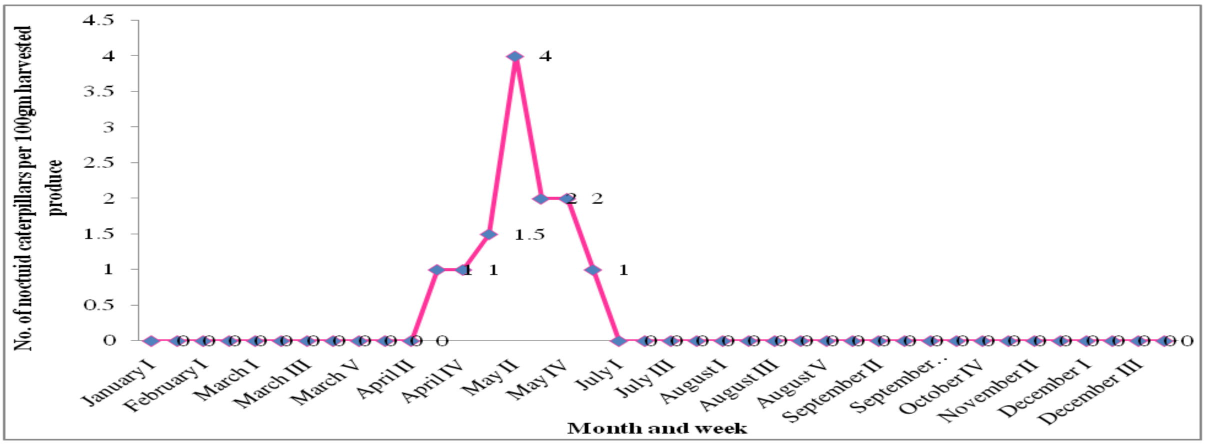

Figure 5. Population of noctuid caterpillars in harvested produce of oyster mushroom in different months during 2013 and 2014 at Umiam

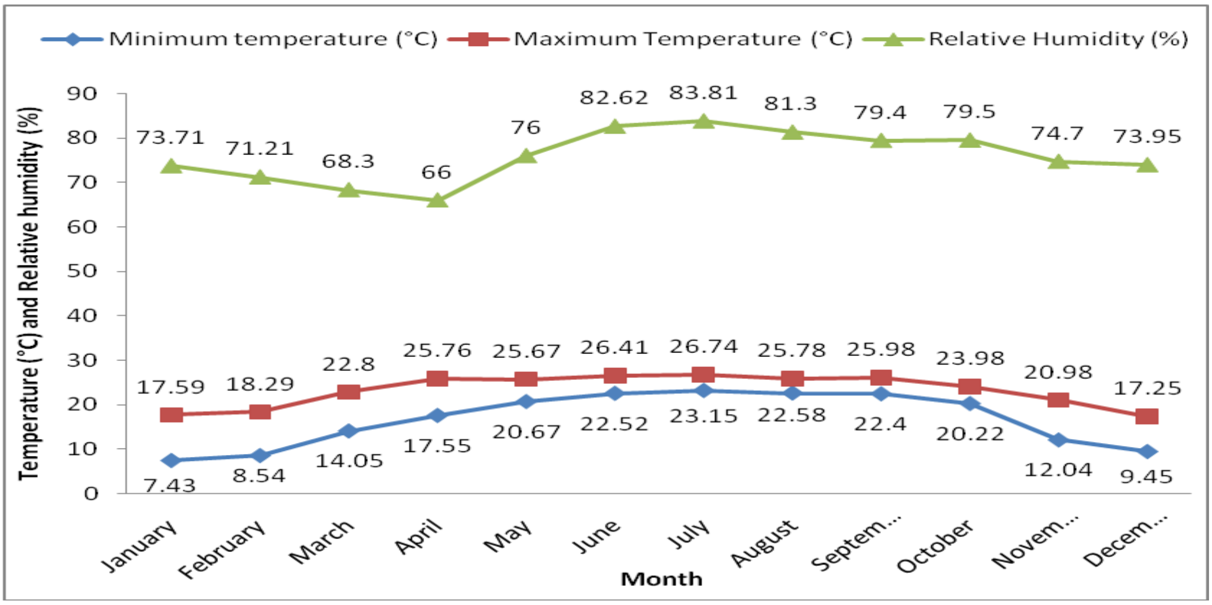

Figure 6. Mean monthly temperatures (minimum and maximum) and relative humidity (%) inside the mushroom house during 2013

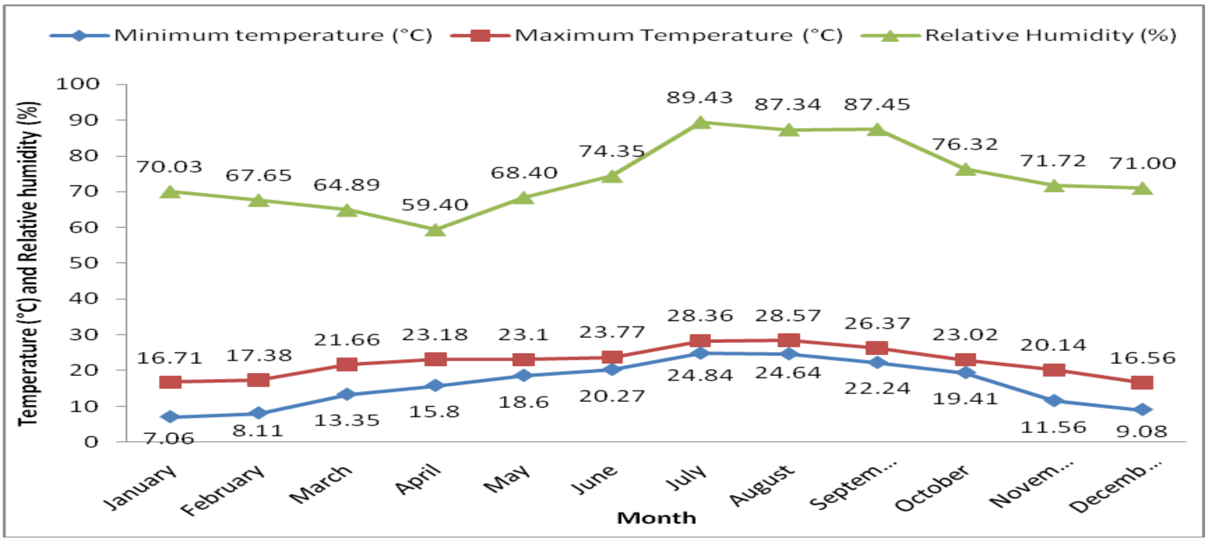

Figure 7. Mean monthly temperatures (minimum and maximum) and relative humidity (%) inside the mushroom house during 2014

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