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POPULATION ABUNDANCE OF LEAF-EATING CATERPILLARS OF CABBAGE

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Abstract

This study was conducted in the experimental field of Entomology Division, Bangladesh Agricultural Research Institute (BARI), Gazipur during October 2014 to April 2015 to know the population abundance of leaf-eating caterpillars, namely prodania caterpillar, *Spodoptera litura* and diamondback moth (DBM), *Plutella xylostella* attacking cabbage in Bangladesh. The lowest population of both DBM and prodania larvae per plant was found during November and January whereas the highest population per plant was recorded during September and March 2014 and 2015, respectively. The same trend were observed in case of the adult population in the sex pheromone trap catch. The adult prodania caterpillar population was the highest during October-November and March. During December population declined totally in the month of January. The highest diamondback moth (*Plutella xylostella*) population was observed during November and March. During the last week of December population again declined entirely which continued until the last week of January. *S. litura* population was always higher than that of diamondback moth (DBM). There is a positive correlation between the rise of temperature with the population buildup of both *S. litura* and *P. xylostella* in cabbage. Especially when the mean temperature declined below 15˚C then the population of both the pest became nil.

Keywords: Cabbage, *Spodoptera litura*, *Plutella xylostella*, population abundance, pheromone trap, temperature

Introduction

Cabbage, *Brassica oleracea* L., is a popular vegetable in Bangladesh. Cabbage is growing throughout the year due to introduction of heat tolerant varieties. Cabbage is attacked by a group of insect pests. However, two leaf-eating caterpillars, prodenia caterpillar, *Spodoptera litura*, (F.) (Lepidoptera: Noctuidae) and diamondback moth (DBM), *Plutella xylostella*, (L.) (Lepidoptera: Plutellidae) are the most destructive pests of cabbage (Nyambo and Pekke, 1995). High population levels of diamondback moth can cause losses in yield up to 90% (Verkerk and Wright, 1996) worldwide and for many years been considered as the most important pest of cabbages and other brassica crops

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(Shelton, 2004; Furlong *et al*., 2013), costing up to 4-5 billion US$ per year due to damage and control costs (Zalucki *et al.*, 2012). In India, Krishnamoorthy (2003) reported 52% yield loss of cabbage due to diamondback moth.

Spodoptera litura infested all cruciferous vegetables including cabbage, cauliflower, broccoli, Chinese cabbage, mustard, radish, turnip etc. in Bangladesh and *P. xylostella* has now been reported and documented at least one hundred and twenty-eight countries or territories of the world and is believed to be the most universally distributed of all lepidopterous insect pests (Sarfraz *et al.*, 2006). Shelton (2004) reported that currently, this insect pest is present all over the world wherever the crucifers exist.

The importance of climatic factors in the population dynamics of *P. xylostella* and *S.litura* have been emphasized by Vickers *et al.*, 2004. Biology and development of leaf-eating caterpillars are highly dependent on temperature and humidity (Guo and Qin, 2010). Ansari *et al*., (2010) reported that temperature is a vital factor for the development of *P. xylostella* and *S.litura*. Life table and population studies showed that besides host plants, rainfall, temperature, humidity and natural enemies greatly influence the survival and reproduction of *P. xylostella* and *S. litura* (Haseeb *et al.*, 2001).

S. litura and *P. xylostella* are a key and destructive pest around the world, but still, little attention has been paid to forecast its population dynamics (Zaluci *et al*., 2011). Forecasting population dynamics of leaf-eating caterpillars are not easy as many factors influence its abundance and fluctuation (Schellhorn *et al*., 2008; Muthuthantri *et al*., 2010). To develop a proper planning for the management of this pest, prediction of the population abundance, it is proper timing of occurrence and level (pest pressure) is highly important (Maelzer *et al*., 1996). Therefore, the present research was conducted to observe the population dynamics of *S. litura* and *P. xylostella* on cabbage and to determine the effects of temperature, relative humidity on population trend of this pest.

Materials and Methods

Study site

The population dynamics of *S. litura* and *P. xylostella* was examined under the sub-tropical climatic zone, present at the experimental field of Entomology Division, BARI, Gazipur conducted during October 2014 to April 2015. The area was situated at 24.09° North latitude and 90.26° East longitude with an elevation of 8.4 meters from the sea level.

Parameters and design of the study

Experiments were laid down in a randomised complete block design (RCBD) having an experimental unit size of 10 meters in width and 10 meters in length transplanted with 40 days old ‘Atlas-70’variety of cabbage. Each experimental

unit consisting of forty (40) cabbage plants, having five (5) rows and every row consisted of eight (8) plants. Plant to plant distance of cabbage was about 60 cm and row to row distance was 60 cm. For studying population dynamics of leaf-eating caterpillars, each experimental unit was replicated three times under the same experimental conditions. For documentation of population dynamics, standard agronomic practices, including normal weeding, irrigation practices, fertilisation and sanitation etc. except plant protection measures were followed as per recommended package of practices (Rashid, 1999) in the cabbage fields.

Data collections

The population of *S. litura* and *P. xylostella* larvae was recorded from two weeks after sowing at weekly intervals and continued until the harvest. The number of adult population of *S. litura* and *P. xylostella* recorded by sex pheromone traps. Bangladesh Agricultural Research Institute (BARI) developed water traps and Ispahani Agro Ltd. pheromone lures were used for adult population monitoring. On the other hand, mean number of larvae were examined and recorded in the field by visually counting at harvest cabbage plant. The collected data were pooled over the cropping season. The infested and healthy yield data were also recorded. Data regarding maximum and minimum temperature, relative humidity and rainfall were collected from Meteorological Department, BARI, Gazipur. Correlation of population fluctuation of prodania caterpillar and diamondback moth (DBM) was done with weather parameters.

Results and Discussion

A. Results

The mean population of both leaf-eating caterpillars varied in different months from September 2014 to March 2015. Pest appeared in the first-week after transplanting of 40 days old cabbage seedlings to the field in September. The lowest population of both *P. xylostella* and *S. litura* larvae per plant was found on November 2014 and January 2015, whereas the highest population per plant was recorded during September 2014 and March 2015, respectively (Table 1). This trend of the population increase continued during September 2014 and March 2015 and decline of population noticed during November to January, when the temperature was below 15˚C.

It is observed from the result of pheromone trap catches that *S. litura* adult population was the highest during October-November and March. During December the population declined and became nil during January (Fig. 1 & 2). The highest *P. xylostella* adult population was observed during November and March. During the last week of December the population became nil which continued till the last week of January (Fig. 1 & 2). Especially when the mean temperature declined beyond 15˚C then the population of both the pest became nil (Fig. 2). *S. litura* population was always higher than *P. xylostella* population in the study area.

Table 1. Population dynamics of both *P. xylostella* and *S. litura* larvae on cabbage plant during 2014-2015

Date (2014-2015)	Number of *P. xylostella* (Mean ±SE)	Number of *S. litura* (Mean ±SE)	Temperature ˚C (Max.)	Temperature ˚C (Min.)	RH%
28 Sep 2014	2.7±0.14	4.5±0.20	34.56	20.23	80
12 Oct 2014	2.2±0.10	3.1±0.23	34.23	24.25	75
26 Oct 2014	2.6±0.02	3.8±0.41	29.59	22.53	73
10 Nov 2014	0.6±0.02	2.7±0.13	30.45	22.24	72
24 Nov 2014	0.9±0.07	2.7±0.13	32.23	21.25	73
08 Dec 2014	1.4±0.11	2.3±0.12	30.25	19.20	80
22 Dec 2014	1.2±0.05	1.2±0.03	20.07	15.32	81
05 Jan 2015	0.7±0.05	1.3±0.17	29.22	19.23	83
19 Jan 2015	0.6±0.10	2.6±0.24	28.36	17.45	82
02 Feb 2015	1.2±0.08	2.2±0.06	29.51	15.45	78
16 Feb 2015	1.02±0.18	3.1±0.17	21.82	15.23	78
02 Mar 2015	2.2±0.09	4.3±0.29	25.98	16.24	70
16 Mar 2015	2.7±0.17	5.5±0.28	23.12	15.76	70
30 Mar 2015	2.0±0.15	4.8±0.66	26.45	16.23	65

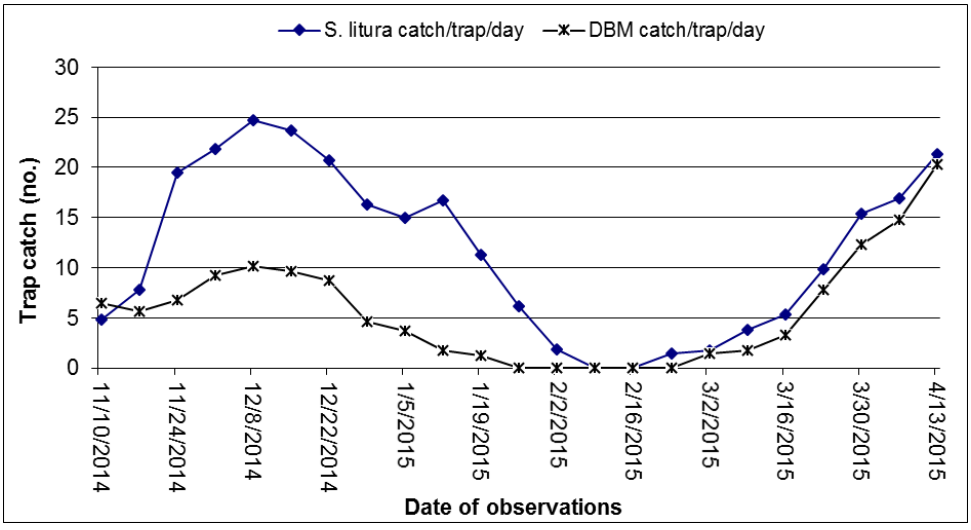

Fig. 1. Population fluctuation of *S. litura* and *P. xylostella* during the study period on the basis of pheromone trap catch.

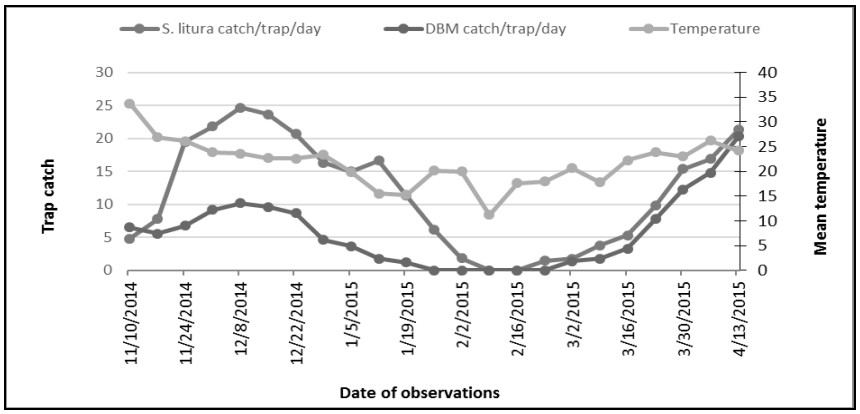

Fig. 2. Population fluctuation of *S. litura* and *P. xylostella* in relation to temperature as these leaf eating caterpillar adults caught by pheromone trap.

There is a positive correlation between temperature rise with the population buildup of both *S. litura* and *P. xylostella* in cabbage (Figure 3 & 4).

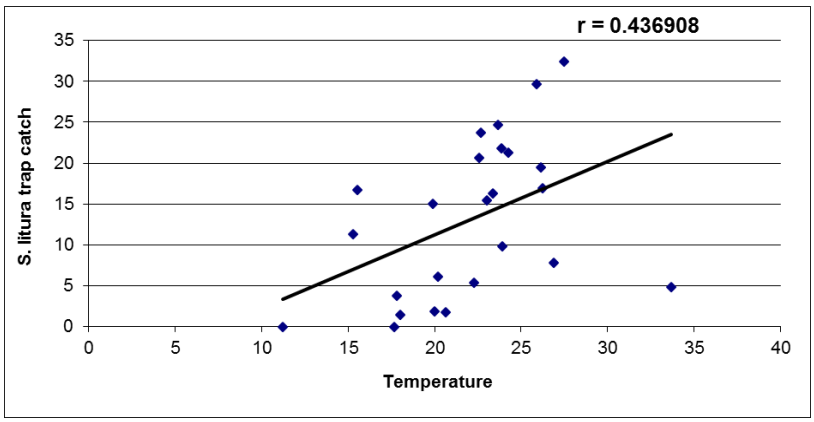

Fig. 3. Correlation between *S. litura* trap catch with the increase of temperature.

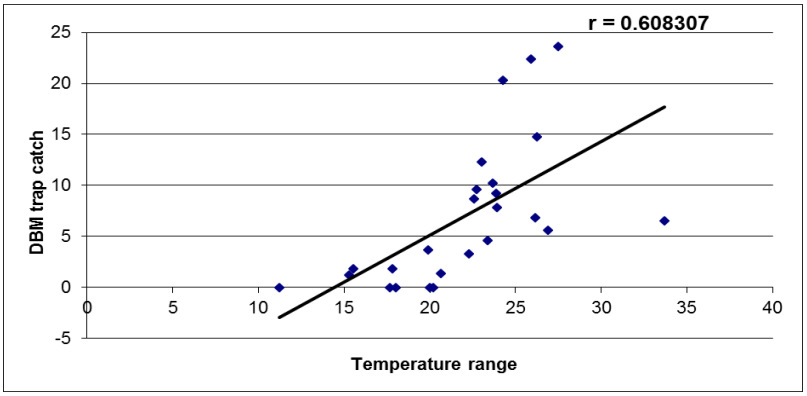

Fig. 4. Correlation between *P. xylostella* trap catch with the increased temperature.

B. Discussion

Our studies showed that the incidence of leaf-eating caterpillar *Plutella* larvae was lowest in the month of November and January and the highest population was found in the month of September and March. Similarly, Ahmed *et al*. (2015) revealed that the highest population of larvae per cauliflower plant was recorded in September and the lowest was observed in July. The population of the *P. xylostella* showed flare up in the month of August and September (Ahmed and Ansari, 2010).

Our findings were in conformity with the reports of Hasanshahi *et al*. (2013) who reported that *P. xylostella* population appears at the beginning of the cauliflower season and shortly after transplantation of the seedlings in the field. Patra *et al*. (2013) stated that *P. xylostella* attacked the crop about one month after transplanting in the field. There was a gradual increase in the population density of *S. litura* after transplantation. It was found that *P. xylostella* was available in the field from July to November (cropping season) with a mean temperature range of 37˚C (max.) in July to 7˚C (mini.) in November, thus indicating that it can survive in a wide range of temperatures (Mohammed *et al*., 2004). Liu *et al*. (2000) stated that *P. xylostella* remained active throughout the year in China at a daily minimum temperature in January below 2˚C to a daily maximum temperature in July rises above 35˚C. *P. xylostella* is distributed in the wide range of temperature from the tropics to cool regions all over the world (CAB International, 2000). Lower relative humidity, higher temperature and lower total rainfall, seem to favour *P. xylostella* population build up (Hemchandra and Singh, 2007). Thus, our result indicate that temperature showed positive correlation with population buildup of *S. litura* and *P. xylostella* in cabbage. Likewise, Venkateswarlu *et al*. (2011) reported that among different climatic tools, the maximum and minimum temperature had a significant positive correlation whereas percent relative humidity showed significant negative correlation with *P. xylostella* population.

Fund *et al*. (2015) revealed that the development rate as a function of temperature increased linearly for all the immature stages of *S. litura* until approximately 34–36°C, after which it became nonlinear. Seasonal abundance of diamondback moth recorded on cabbage in India revealed that the infestation of diamondback moth (larva) was first recorded on 31 January with an initial population of 0.20/plant. The population increased gradually in successive weekly counts and reached a peak of 12.05/plant on 27th March and thereafter (Goudegnon *et al*., 1999). They also observed that diamondback moth population attained its peak during February and March. The maximum population of diamondback moth in the month of March was also reported by Kumar *et al*. (2007), Vanlaldiki *et al*. (2013) and Venkateswarlu *et al*. (2011) which are in agreement with the present findings. Temperature is recognized as the most important environmental factor influencing development and survival of insects. The relationship between

temperature and development of *P. xylostella* has also been studied in other countries (Shirai, 2000; Liu *et al*., 2002; Mohandass and Zalucki, 2004; Golizadeh *et al*., 2008). In our studies, we also found that temperature is one of the most important factor for development of both *S. litura* and *P. xylostella* populations. The highest population of both *S. litura* and *P. xylostella* per plant was recorded during September and March and the lowest was found November and January with a mean temperature range of 34˚C in September to 15˚C in December. In addition, pheromone trap results showed that the population of leaf-eating caterpillars increased when temperature was high moreover the population declined beyond temperature 15˚C, consequently, indicates that it can persist in a wide range of temperature.

It can be concluded that the attack of both *S. litura* and *P. xylostella* in cabbage commenced during the first week after transplantation of cabbage seedling. The lowest population of both *P. xylostella* and *S. litura* larvae per plant was found on November to December whereas highest population per plant was recorded during October and March and the highest infestation was recorded from November and March. A positive correlation was observed between the populations of *P. xylostella* and *S. litura* and temperature. The influence of temperature on development and survival of the diamondback moth may affect the population dynamics of the pest.

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