Research Article

Effect of Weather on Diamond Back Moth, *Plutella xylostella* (L.) (Lepidoptera: plutilidae) in District Haripur

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Abstract | Under unprotected condition study was carried out during the months from July to November in the year 2012 and 2013 to investigate population dynamics and observe the impact of temperature, relative humidity and rainfall on population of *Plutella xylostella* (L.) in Cauliflower, *Brassica oleracea* crop at District Haripur of Khyber Pakhtunkhwa. Field studies results showed that the population of *P. xylostella* gradually increased from mid of July where the population was 2.1 and 2.0 larvae and pupae per plant in the year 2012 and 2013 respectively. The population increased in September to highest number of larvae and pupae per plant (8.25 and 8.4) were recorded in the years 2012 and 2013 respectively. Then population declined from September to November 3.5 and 3.1 larvae and pupae was recorded per plant in both years as the lowest number. In the year 2012, mean maximum and minimum temp showed non- significant negative and positive association (r=-0.32 and 0.07) with population of *P. xylostella* respectively. Similarly R.H (r=0.89) exhibited positive highly significant whereas RF (r=-0.96) showed negative highly significant relationship with *P. xylostella* during the year 2012. Likewise, during the year 2013, mean maximum temperature showed non-significant negative relation (r=-0.21) whereas mean minimum temperature showed positive non-significant association with *P. xylostella* population. Mean relative humidity (RH) also exhibited non-significant positive association (r=0.06), while the population effectively influenced by total rainfall (r=-0.82) which exhibited highly significant negative association. Regression analysis showed 87-96% (R²) variability due to weather parameters on the population dynamics of *P. xylostella* at District Haripur.

Introduction

Cauliflower, *Brassica oleracea*, belongs to family cruciferace which is a very diverse group comprises 350 genera and more than 3,500 cultivated and wild plants species (Warwick et al., 2003). Cau-

liflower is basically a cool season vegetable having a temperature requirement for growth and heading is between 15°C and 20°C. Pakistan is among the top ten producing countries of this vegetable in the world (FAO, 2008). The production of Cauliflower has been reduced by several factors including insect pests such

as Diamond back moth (DBM), *Plutella xylostella*, Aphids (*Brevicoryne brassicae*, (Innaeus) *Lipaphis erysimi* (Kaltenbach), *Myzus* persicae (Sulzur), Cabbage worms and flea beetles (*Phyllotreta* spp.), butterfly (*Pieris* spp.) and diseases such as black rot and club root (Nyambo and Pekke, 1995).

Diamond back moth (DBM) is a highly destructive insect pest of *B. oleracea* throughout the world (You and Wei, 2007) and is the most widely distributed insect pest of all Lepidopterous insects (Shelton, 2004). *P. xylostella* is an oligophagous pest as the larvae feed on a number of crucifer ace crops including cabbage, cauliflower, broccoli, radish, turnip and mustard (Thorsteinson, 1953). The DBM is available throughout the year provided that due availibility of food source for the DBM larvae (Leu and Lee, 1984) causing damage to the cruciferous plants (Chin et al., 1990). *P. xylostella* has about 21 generation per year ((Leu and Lee, 1984) but in temperate and tropical regions it has 4 to 20 generations (Vickers et al., 2004).

In Pakistan, DBM is a key pest of cauliflower (Mushtaque et al., 1995) and in most situation, cause, s about 100% loss (Abro et al., 1994) whereas Verkerk and Wright (1996) reported 90% losses of yield in Pakistan. The economic threshold level of DBM is about of 0.05/plant (Hartcoutr et al., 1957). However, no research has been conducted on population dynamics and forecasting of its outbreak. For strategic planning and tactical decision making the knowledge of pest species level of abundance, pest pressure, timing is highly important (Maelzer et al. 1996). In general pest population forecasting become a difficult task as many factors influence it (Muthuthantri et al. 2010) such as a biotic and biotic factors e.g. temperature, rainfall and relative humidity and natural enemies for a key pest all years round available, it is important to develop long term population forecasts would be particularly effective (Zalucki et al. 2009).

Keeping in view this factor an up to date knowledge of the occurrence pattern of diamondback moth cauliflower. Crop in relation with weather parameter is a prerequisite for implementation of an effective and successful management tactics against this pest. The present research was consequently conducted to observe and monitor the population dynamics of *P. xylostella* on cauliflower and determine the effects of maximum and minimum temperature, percent relative humidity and rainfall on population trend.

Materials and Methods

To study the population dynamics of *Plutella xylostella* (L.) in cauliflower, the experimental procedures of Mohamed (2004) and Kfir (1998) with some modification was used. The population dynamics of *P. xylostella* was examined in District Haripur, Khyber Pakhtunkhwa in the cropping seasons from July to November during the years 2012 and 2013 and were correlated with abiotic climatic factors including mean maximum and minimum temperature, relative humidity and rainfall.

Standard agronomic practices were used in the field of cauliflowers that were included normal weeding, irrigation practices, fertilization and sanitation etc. Experiments were laid down in a randomized complete block design (RCBD) having experimental unit size of 5m in width and 5m in length within the experimental field. Each experimental unit was consisting of Forty (40) cauliflower plants, having five (5) rows and every row was having eight (8) plants. For studying population dynamics of *P. xylostella*, each experimental unit was replicated four times within the experimental field.

Five infested plants were randomly selected from each replication and were thoroughly inspected fortnightly and the numbers of *P. xylostella* larvae and pupae were counted but not removed. The experiment was continued until harvest in both years. Population of *P. xylostella* was determined as the mean numbers of larvae and pupae per cauliflower plant. Observations were recorded for each plant and the mean maximum and minimum temperature, relative humidity and rainfall were noted. Data regarding maximum and minimum temperature, relative humidity and rainfall were taken from Meteorological Department and were correlated with the population dynamics of Diamond Back Moth, *P. xylostella*.

Statistical analysis

The data was subjected to correlation (Pearson) analysis and linear multiple regression by using Statistical Software Statistix 8.1 (Bowden and Morris, 1995).

Results and Discussion

Population dynamics of diamondback moth

Population of *Plutella xylostella* (L.) was gradually started building up after transplanted the cauliflower,

Table 1: *Population dynamics of P. xylostella (L.) taken Fortnightly with mean weather parameters on Cauliflower at District Haripur, during the year 2012 and 2013.*

2012						2013					
Date	Pop	T. Max	T. Min	RH	RF	Date	Pop	T. Max	T. Min	R.H	R.F
July 15	2.1	33.5	19.9	68	1320	July 15	2	31.3	19	72	1145
July 30	2.85	33.1	19.7	70	1060	July 30	2.15	30.3	19.5	92	987
Aug,14	4.85	31.6	19	80	870	Aug, 14	4.95	29.5	19	95	754
Aug, 29	6.65	27.2	18	87	449	Aug,29	6.5	27.7	18.8	85	653
Sep, 13	7.7	27.6	17.1	90	399	Sep, 13	6.55	27.1	16.7	81	289
Sep, 28	8.25	27.2	16.5	82	324	Sep, 28	8.4	26.5	16.1	79	329
Oct, 13	5.3	26	8	80	549	Oct, 13	5.05	25.8	9.5	80	465
Oct, 28	4.65	23	7.2	73	862	Oct, 28	4.85	23.2	7.9	72	567
Nov, 12	3.5	22.2	4	73	987	Nov, 12	3.1	21.5	5	69	578

Brassica oleracea seedlings in the experimental field and at the mid of July, population was 2.1 and 2.0 larvae and pupae per plant in the year of 2012 and 2013 respectively as depicted in Table 1. The highest numbers of larvae and pupae (8.25 and 8.4) per recorded at the end of September (Table 1) in both years of the research. From both years of the experiment it is highly obvious that peak population of *P. xylostella* persist from mid of August to mid of October as shown in the Table 1. A trend of decline in the cropping seasons from July to November was observed after the end of October in both years of the experiment and the lowest population of *P. xylostella* on cauliflower crops was recorded in the mid of November as 3.5 and 3.1 (Table 1) larvae and pupae per plant in the year 2012 and 2013 respectively.

Studying the population trends of *P. xylostella* on *B. oleracea* at district Haripur of Khyber Pakhtunkhwa from July to November in the year 2012 showed peak populations from August to October (6.65, 7.7, 8.25 and 5.3) as the highest number of larvae and pupae per plant were recorded in these months (Table 1). Likewise, during the year 2013 similar trend of *P. xylostella* population were observed as 6.5, 6.55, 8.4 and 5.05 (Table 1) larvae and pupae per plant were counted on August, 29, September 13, 28 and October 13. Ahmad and Ansari (2010) reported that the population of the DBM showed increased in the month of August and September and then gradually declined. These results are in agreement with the finding of Ahmad and Ansari (2010). Climatic conditions, including higher temperatures and decreased rainfall were cited as major factors which regulate the population dynamics of *P. xylostella* (Harcourt, 1986) while hot and dry conditions are known to be conducive for *P. xylostella* (Shelton, 2001). Similarly according to Patra et al. (2013) high temperatures favored the multiplication and development of *P. xylostella* while cold temperatures in November-February limited its population dynamics. As incidence of pest depends on host availability and climatic condition, therefore, incidence and peak infestation of pest vary from region to region. Results are similar with the study of Venkateswarlu et al. (2011) who reported that peak incidence of diamond back moth was observed during 1st week of September.

Correlation matrix of P. xylostella population dynamics with mean maximum and minimum temperature, % relative humidity (RH) and rainfall (RF) in 2012 and 2013

During the year 2012, mean maximum and minimum temperatures have non- significant negative and positive association (r=-0.32 and 0.07) as shown in table II, with the population of diamondback moth, *P. xylostella* respectively. Similarly R.H (r=0.89) exhibited positive highly significant relation with the population dynamics of *P. xylostella* whereas RF (r=-0.96) showed negative highly significant relationship with DBM population in District Haripur during the year 2012 (Table 2). Likewise, table II clearly explained that in the year 2013 of the research, the population of *P. xylostella* has influenced by the weather parameters. Mean Maximum temperature showed non-significant negative relationship (r=-0.21) whereas the mean minimum temperature has positive non-significant correlation (r=0.06) with the population of *P. xylostella*.

Population dynamics of *P. xylostella* has showed non-significant positive association (r=0.11) with

mean percent relative humidity but has greatly influenced by total rainfall (r=-0.81) which exhibited highly significant negative association (Table 2). Present findings of our research are in close conformity with the observation of Venkateswarlu et al. (2011) who reported that among different climatic factors, maximum and minimum temperature had significant positive correlation whereas percent relative humidity showed significant negative correlation with *P. xylostella* population. Hemchandra and Singh (2007) reported that higher temperature, lower relative humidity and lower total rainfall, seem to favour the pest population build up. According to Loher et al. (2007) the growth and development of *P. xylostella* are significantly influenced by the prevailing weather variables, especially temperature and rainfall in the field. Ahmad et al. (2015) further investigated that temperature has positive correlation with population dynamics of *P. xylostella*, whilst rainfall negatively affect the population build up the said pest.

Table 2: *Correlation Matrix of P. xylostella in District Haripur in the year 2012 and 013.*

Weather Parameters	Correlation coefficient for P. xylostella population at Distt. Haripur	
	2012	2013
Mean Max temp (C⁰)	-0.32	-0.21[NS]
Mean Min Temp (C⁰)	0.07	0.06
Mean R.H (%)	0.89**	0.11
Total Rainfall (mm)	-0.96**	-0.81**

NS: *Non Significant;* ***:** *Significant 0.05 level of probability;* ****:** *Highly Significant at 0.01 level of probability;* **T Max:** *Maximum Temperature C⁰;* **T Min**: *Minimum Temperature C⁰;* **R.H:** *Mean Percent Relative Humidity;* **R.F:** *Rain fall (mm).*

Table 3: *Multiple regression equation for P. xylostella in District Haripur during the years 2012 and 2013.*

Year	Multiple Regression equation	R² Value
2012	Y1= 12.95-0.22X1+0.16X2-0.002X3-0.005X4	96.36%
2013	Y2= 13.82-0.28X1+0.34X2-0.02X3-0.006X4	87.56%

Y1 and Y2: *Population of DBM;* **X1:** *Temperature maximum;* **X2:** *Temperature minimum;* **X3:** *Percent relative humidity.*

Regression equations (Table 3) of *P. xylostella* indicates that during the year 2012, 96.36% (R²) of variation in the population has influenced by weather parameters, while in the year 2013, 87.56% (R²) of the deviation in the population has caused by the weather parameters. So the total variation in the population

of the *P. xylostella* due to weather parameters in both years of studies was 87-96% (R²). These results are in close concordance with the finding of Ahmad et al. (2015) who reported that weather parameters can influenced the population dynamic of *P. xylostella* up to 90-98% (R²). Nonetheless, Zada et al. (2014) also reported that *Cydia pomonella* population has greatly influenced by weather parameters Swat Pakistan, which ranges from 68-82% (R²). This equation can be used for predicting the population dynamics and establishment of an effective Integrated Pest Management Programme (IPM) for *Plutella xylostella* on cauliflower.

Conclusions and Recommendation

1. The results of the field study revealed that the incidence of Diamondback moth (DBM), steadily increase from mid of July where the population was 2.1 and 2 larvae and pupae per plant during both the years of studies.

2. The peak population of *P. xylostella* was recorded at the end of September (8.25 and 8.4 larvae and pupae /plant) in 2012 and 2013 respectively.

3. After September in both years of the research, declined in the population has been observed and the lowest population of 3.5 and 3.1 larvae and pupae/plant were counted in the mid of November.

4. Population dynamics of *P. xylostella* has showed great affinity with the temperature, relative humidity and rainfall and therefore, influenced by the weather parameters. Mean Maximum temperature showed non-significant negative relation (r=-0.24) whereas mean minimum temperature has exhibited positive non-significant association with the *P. xylostella* population. Mean percent relative humidity proved non-significant positive association (r=0.06) while total rainfall (r=-0.81) has greatly influenced the pest population by establishing a highly significant negative association.

5. Multiple regression analysis indicated 87-96 % (R2) variability due to meteorological parameters in the population dynamics of *P. xylostella* at District Haripur.

6. This model can be used for estimating and forecasting the population dynamics index of diamondback moth for its effective management. Besides, this model will also be helpful to find out proper time for spray application and implemen-

tation of other management techniques to eliminate economic injury to the cauliflower.

Author's Contribution

Bashir Ahmad is the main researcher. Ahmad ur Rahman Saljoki supervised the research work while Muhammad Saeed co-supervised the research. Shahid Sattar did statistical designing. Toheed Iqbal helped in field work preparation and data analysis. Hayat Zada contribute in data entry research layout. Saddam Husain helped in writing the manuscript.

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