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POPULATION FLUCTUATIONS OF RICE LEAF FOLDER, *CNAPHALOCROCIS MEDINALIS* GUENÉE (LEPIDOPTERA: PYRALIDAE) IN RELATION TO THE METEOROLOGICAL FACTORS

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ABSTRACT

Rice leaf folder, *Cnaphalocrocis medinalis* Guenée has emerged as a major pest in all the rice cultivated areas of Punjab, Pakistan. The herein reported experiment was conducted to observe the population trends and the impact of abiotic factors on *C. medinalis* infestations in rice crop during Kharif season (August to October) of 2015 and 2016. The observations were made for its infestation and population dynamics at weekly intervals from first week of August to second week of October on rice crop. During 2015, the population peak of *C. medinalis* (1.96/plant) was observed during fourth week of September. In 2016, the population peak of *C. medinalis* (2.46/plant) was recorded during 2^{nd} week of September. Regression analysis revealed that the average temperature has negative and relative humidity and rainfall have positive impact on incidence of *C. medinalis.* During 2015, the abiotic factors average temperature, relative humidity and rainfall contributed 15.69% in rice leaf folder infestation. While, during 2016, these factors contributed 43.61% in rice leaf folder infestation. This knowledge about the population dynamics of *C. medinalis* is much important for determining its abundance in the field and to develop a timely management strategy. This information can be helpful as a key component for implementation of integrated management of rice leaf folder.

Keywords: Population dynamics, Rice leaf folder, Infestation, Temperature, Relative humidity, Rainfall

INTRODUCTION

Rice leaf folder, *Cnaphalocrocis medinalis* Guenée is a widely distributed Lepidopteran pest in all rice growing countries of Asia and its severe infestation may cause yield losses up to 63-80 percent (Muragesan and Chellish, 1987; Karim and Riazuddin, 1999). In Pakistan, *C. medinalis* has caused severe yield losses due to its outbreak in 1989 (Rehman *et al*., 2003). The larvae damage the rice leaves by scraping off the green mesophyll tissues and therefore resulting in as longitudinal, pale white stripes. The damaged leaves act as entrance points for entry and development of fungal and bacterial infections (Park *et al*., 2014). In case of considerable infestation, every attacked rice plant displays numerous folded leaves (Salim *et al*., 1991; Bashir *et al*., 2004). The photosynthetic ability and general vigor of an infested plant is badly affected and ultimately yield is reduced (Karim and Riazuddin, 1999; Nathan *et al*., 2004; Padmavathi *et al*., 2013). Rice is the most favorable host plant of *C. mednalis* among wide variety of other host plants such as corn, sugarcane, wheat, sorghum and certain graminaceous weeds (Joshi *et al.*, 1987; Khan *et al*., 1996). However, rice is the most preferable host plant (Yadava *et al*., 1972; Khan *et al*., 1988). Among different rice varieties, *C. medinalis* preference ranges from fine grain and aromatic varieties to the short, medium duration and non-aromatic varieties (Dhaliwal *et al*., 1979). The high yielding susceptible rice varieties are most favorable host for its survival and development. *C. medinalis* faces difficulty to feed, grow, survive and reproduce sufficiently on resistant rice plants (Khan *et al*., 1989; Sexana and Khan, 1991). The incidence of folded leaves has been recorded more on rice varieties with longer

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and broader leaves (ChalapathiRao *et al*., 2002).

Ecologists have found the population dynamics of insect pests as one of the important study in assessing the population of the target insect pest (Soleimani and Madadi, 2015). Numerous studies have reported the incidence and abundance of C. medinalis in different seasons, crop growing periods and varietal preference (Khan *et al*., 1989; Alvi *et al*., 2003; Akhter *et al*., 2015)

The abundance of insect pest populations in crops is greatly affected by the local micro climate. Prolonged periods of low/high temperature, rainfall and humidity levels, either, increase or decrease the population of insect pests (Dale, 1994; Iqbal *et al*., 2010; Supawan and Chongrattanameteekul, 2017; Bodlah *et al*., 2019).

Among meteorological factors, mostly temperature and moisture, can either augment insect population growth or may cause populations to decrease. The damage due to insect pests depends upon their population development and abundance in the field which, in turn, depend on upon their dynamics of the physical factors of their close environment (Isard, 2004; Boopathi *et al*. 2018).The understanding about the role of abiotic factors in the insect pest occurrence may not only help in forecasting the insect pest losses to the crop, but also help in their avoidance through some timely pest management approaches (Aasman, 2001; Boopathi *et al*., 2018).

The thorough understanding of interaction between abiotic factors and insect pest dynamics is pre-requisite for weather-based pest forecasting model (Boopathi *et al*., 2018). Hence, the present study was undertaken to determine the population trends as well as to know the impact of abiotic factors on the population of *C. medinalis* on rice crop.

MATERIALS AND METHODS

The experiment was carried out at farmer field at Shorkot, District Jhang ("30.76°N, 72.03°E") during the Kharif season (August to October) of 2015 and 2016. The rice nurseries (super basmati) were sown on well prepared raised beds in the first week of June during the year 2015 and 2016. Thirty days after sowing, the rice seedlings were uprooted and transplanted two seedlings per hill in the field at 9 inch spacing in Randomized Complete Block Design (RCBD). The total area (0.40 ha) was divided into four equal segments and each was considered as a replication. All the advised agronomic practices (Fertilizer, irrigation) were performed in raising the crop. No plant protection measures were practiced throughout the duration of the crop season. Plant protection measures were not applied during the crop season.

The rice field was observed for the infestation of *C. medinalis* at weekly intervals starting from first week of Augusts to mid of October. Pest scouting of *C. medinalis* was performed in zigzag manner With Quadrat (1.0 m x 1.0 m) at four different randomly selected places in each experimental replication. The data was taken by counting the number of folded leaves per quadrat (1.0 m × 1.0 m) to evaluate the average number of leaf folders/ plant.

Meteorological data regarding daily mean temperature, relative humidity and rainfall were acquired from the meteorological observatory of Pakistan Meteorological department at sub-station Jhang, Punjab, Pakistan. The effect of weather data on the population of *C. medinalis* was also analyzed using multiple linear regression.

Statistical analysis

The data was analyzed using Statistix 8.1 version. The means values of *C. medinalis* infestation were compared by Tukey's HSD *test* at $P \leq 0.05$. The association among the population of rice leaf folder and meteorological factors was worked through processing the data for multiple linear regression analysis.

RESULTS AND DISCUSSION

The recorded population of *C. medanils* during 2015 and 2016 is shown in Figure.1. During 2015, the infestation of *C. medinalis* (0.42/ plant) started from 2nd week of September and attained the peak (1.96/ plant) during 4th week of September and gradually declined to zero in 2nd week of October (Fig. 1). While, during the year 2016, the infestation of *C. medinalis* (0.59/plant) started from 2nd week of August and attained the peak (2.46/ plant) during 2nd week of September and and gradually declined to zero in 2nd week of October (Fig. 1). These results are in accordance with previous studies that reported the same infestation trends including highest infestation during September (Garg, 1984; Khan *et al*., 1989; Rashid, 1994; Kraker *et al*., 1999; Alvi *et al*., 2003; Sulagitti *et al*., 2017 and Boopathi *et al*., 2018). Though, these results differ than studies of Devendra *et al*. (2018) that reports high population of *C. medinalis* in 4th week of October. Bhatnagar and Saxena (1999) reported highest population in 4th week of October. Previous scientists Islam *et al*. (1996) and Kalita *et al*. (2015) concluded that the maximum abundance of *C. medinalis* population occurs during September to November. These differences in population might be due to differences in climatic conditions and sampling methods

Table-1 shows the results regarding multivariate regression models of *C. medinalis* folded leaves per plant and meteorological factors including the coefficient of determination (R^2) values in 2015.The average temperature affected negatively on the incidence and abundance of *C. medinalis* and average temperature alone contributed 11.8% in infestation of *C. medinalis*. When the other factor, relative humidity, was added, then R^2 value increased to 15.42% and its impact was positive. Likewise, this value (R^2) increased (15.69%), when the effect of another factor rainfall was also included and rainfall also affected positively. As a result, the coefficient of determination (R^2) value of 15.69% was attained when these meteorological factors were calculated collectively (Table-1).

Table-2 shows the results concerning multivariate regression models of *C. medinalis* infestation per plant and meteorological factors together with R^2values in year 2016. Average temperature alone contributed 2.7% in infestation of *C. medinalis* having negative impact on population incidence and abundance (Table-2). The inclusion of relative humidity in the model enlarged the R^2 value to 23.42% contributing positively. In the same way, this contribution was augmented when the factor rainfall was included. The rainfall also showed positive influence on *C. medinalis*. Consequently, the R^2 value of 0.4361 was achieved when all these meteorological factors were collectively calculated (Table-2). In current study, the average temperature has negative and relative humidity and rainfall have positive impact on incidence of *C. medinalis*. These results are partially in accordance to those reported by Boopathi *et al*. (2018) who described all these factors have positive impact on incidence of *C. medinalis*. Similar trend was reported by Calora and Ferino (1968) and Devendra *et al*. (2018). Our current results regarding impact of rainfall on *C. medinalis* infestations are similar to those reported by Gangwar, (2015) and Boopathi *et al*. (2018) who witnessed that the *C. medinalis* generally was most abundant during the rainy season. Sabir *et al*. (2006), Boopathi *et al*. (2012) and Boopathi *et al*. (2018) also reported positive role of meteorological factors on incidence and abundance of rice insect pests. The results regarding impact of Relative humidity are similar with Chakraborty and Deb (2011) but opposite to results described by Emura and Kojima (1974) have negative impact of relative humidity on abundance of *C. medinalis* infestations. Therefore, this issue necessitates much wide-range, thorough and well organized trials involving diverse agro-ecological rice growing areas.

Authors' contributions

AR, MY and SZ designed the study and wrote the manuscript with input from all authors. MY, HH, MS and SU analyzed the data. MH, MS, RAA, MBA, FA, MI and MAS gave their suggestions for improvement in the manuscript. All authors read and approved the final manuscript.

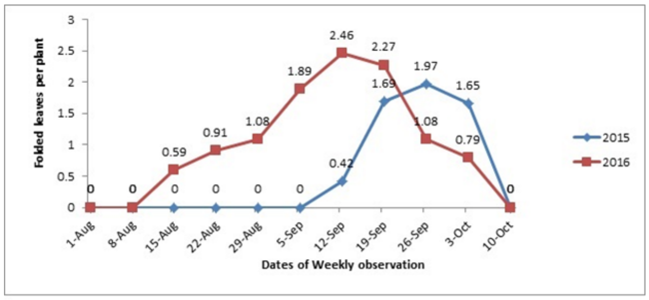

Fig. 1
Population dynamics of rice leaf folder per plant during 2015 and 2016.

Table 1
A Multiple Regression Model showing the influence of various abiotic factors on folded leaves per plant of rice leaf folder, during 2015.

Regression Model for 2015	R^2	$100R^2$	% contribution
Ý = 1.75 - 0.0418⁇1	0.118	11.8	11.8
Ý = 1.34 - 0.0637⁇1 + 0.0188⁇2	0.1542	15.42	3.62
Ý = 1.60 - 0.0706⁇1 + 0.0173⁇2 + 0.030⁇3	0.1569	15.69	0.27

Where, Y= Folded leaves per plant; X1 = Mean Temperature; X2 = Relative Humidity (%); X3 = Rainfall (mm); R2 = Coefficient of Determination

Table 2
A Multiple Regression Model showing the influence of various abiotic factors on folded leaves per plant of rice leaf folder during 2016.

Regression Model for 2016	R^2	$100R^2$	% contribution
Ý = - 0.40 - 0.0435⁇1	0.027	2.7	2.7
Ý = - 0.78 + 0.046⁇1 + 0.0051⁇2	0.1234	23.42	20.72
Ý = 3.95 + 0.0230⁇1 - 0.0660⁇2 + 0.226⁇3	0.436	43.61	20.19

Where, Y= Folded leaves per plant; X1 = Mean Temperature; X2 = Relative Humidity (%); X3 = Rainfall (mm); R2 = Coefficient of Determination

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