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Influence of Weather Factors on Population Dynamics of Armyworm, *Spodoptera litura* F. on Cauliflower, *Brassica oleracea* in Punjab

Sumaira Maqsood[1,*] Muhammad Afzal,[1] Anjum Aqeel,[1]
Abu Bakar Muhammad Raza[1] and Waqas Wakil[2,*]
[1]*Department of Agri. Entomology, University College of Agriculture, University of Sargodha, Sargodha*
[2]*Department of Entomology, University of Agriculture, Faisalabad.*

ABSTRACT

Five major cauliflower producing localities *viz*., Faisalabad, Chiniot, Sargodha, Sheikhupura and Gujranwala of Punjab, were selected to check the population fluctuation of *S. litura* larvae through regular ten days interval on cauliflower crop during 2013-14. The data were recorded at fixed schedule of Period I (22 to 31 August), Period II (01 to 10 September), Period III (11 to 20 September), Period IV (21to 30 September) and Period V (01to 10 October). During 2013 maximum larval population was recorded in Sargodha during 4th period of observation and minimum population was observed in Gujranwala during 1st period of observation *i.e.* 4.55±0.117 and 1.96±0.105 larvae/plant respectively. While during 2014 minimum population was recorded in Gujranwala (1.05±0.024 larvae/plant) during the 2nd period of observation and maximum population was observed in Sargodha during 1st period of observation *i.e.* 4.37±0.086 larvae/plant, respectively. Relative humidity and rainfall was negatively correlated with the larval population while, temperature was significant and positive correlated with larval population.

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SM and WW conceived and designed the study. SM conducted the study and analyzed data with the help of AA. All authors contributed to the preparation of manuscript.

Key words
Spodoptera litura,
Weather factors,
Cauliflower

INTRODUCTION

Cauliflower (*Brassica oleracea* var. botrytis) is an important crop grown in South and South East Asia. It is damaged by a large number of insect pests among them armyworm *Spodoptera litura* F. (Lepidoptera: Noctuidae) is the most serious pest (Zhou *et al.*, 2012) causing yield loss ranging from 31% to 100%. It invade more than 40 plant families (Lingappa *et al*., 2004). The main crops damaged by *S. litura* in Pakistan include alfalfa, barseem, brassica, cotton, groundnut, tobacco, maize, summer legumes, and vegetables like brinjal, potato, cucurbits, capsicum and sweet potato, whereas some other hosts are from weeds, ornamentals and wild plants act as alternative hosts. Based on the crop damages, it is also generally known as Indian leaf worm, tobacco caterpillar and tobacco cutworm. Severe incidence of this pest may demand wide use of insecticides to safeguard the infested crops (Carasi *et al*., 2014).

Environmental factors influence the population fluctuation of *S. litura*. It was observed that the adults of this pest appeared during late July and it remained active till the month of October, while its peak population was recorded during the 2nd fortnight of September (Punithavalli *et al*., 2014). Whereas, its moths were observed during the month of August to mid-October after that its population was sharply decreased in the month late October and its peak population was recorded during the months of September-October and maximum activity of larval population. A significant and positive correlation was recorded between population fluctuations of *S. litura* and weather parameters including rainfall, maximum temperature and wind speed (Fand *et al*., 2015).

Maximum and minimum temperature showed significant and positive correlation with population fluctuation, while rainfall and relative humidity impart significant and negative effect on population fluctuation of *S. litura* larvae (Selvaraj *et al*., 2010; Prasannakumar *et al.*, 2011; Mishra *et al*., 2013; Punithavalli *et al*., 2014; Shahzad *et al*., 2014; Fand *et al*., 2015).

During the recent decades, agriculture sector is greatly suffered due to climatic change especially increase of temperatures and unusual pattern of rainfall have been observed in Asia and the Pacific regions. Pakistan is one of them which is affected by these climatic changes (ADB, 2009). So, keeping in mind these climatic changes and their effects on insect pest population, current study "influence of weather factors on population dynamics of armyworm (*S. litura*) on cauliflower" was designed.

MATERIALS AND METHODS

Study areas

The current study was conducted in regular cauliflower growing season from August to October

* Corresponding author: sumaira.ento@yahoo.com
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during 2013 and 2014. For this purpose, an extensive plan of surveys was formulated in five different cauliflower growing localities viz. Faisalabad, Chiniot, Sargodha, Sheikhupura and Gujranwala districts.

Sampling scheme

After transplanting nursery, cauliflower fields were surveyed to check the population of larvae regularly at fixed schedule of Period I (22 to 31 August), Period II (01 to 10 September), Period III (11 to 20 September), Period IV (21to 30 September) and Period V (01to 10 October) at 10 days intervals during 2013 and 2014 in all selected districts. Data regarding larvae population were recorded from randomly selected 25 plants in each replication and calculate the number of larvae per plant. Data regarding weather factors like temperature, relative humidity and rainfall were obtained from Pakistan Meteorological Department in each district. Correlation and linear regression determined between weather factors and larval population.

Statistical analysis

Collected data were subjected to analysis of variance (ANOVA) in Minitab software (Minitab, 2002) and at the level of 5% significance means were separated by using Tukey's honestly significant difference (HSD) (Sokal and Rohlf, 1995). The relationship between larval population and weather factors *i.e.* temperature and humidity was determined by simple linear regression.

RESULTS

Larval population

Larval population per plant on cauliflower showed significant variation recorded on fixed schedule at 10 days intervals from different selected localities of Punjab during 2013 and 2014. The results presented in Table I showed that during the 1st year of study (2013), maximum population of *S. litura* larvae on per plant basis was recorded in Sargodha (2.51±0.052 larvae/plant) during first period of observation followed by Chiniot, Faisalabad and Sheikhupura (2.45±0.048, 2.17±0.058 and 2.14±0.075 larvae/plant) respectively, while minimum population was observed in Gujranwala *i.e.* 1.96±0.105 larvae/plant. During the 2nd period of observation population started to increase and minimum population was observed in Gujranwala (2.75±0.099 larvae/plant) and maximum was recorded in Sargodha (3.14±0.085 larvae/plant) followed by Chiniot, Faisalabad and Sheikhupura *i.e.* 3.07±0.078, 2.92±0.061 and 2.82±0.069 larvae/plant, respectively. During 3rd period similar trend was observed in all localities while, during 4th period maximum population was observed in all selected localities of Punjab, during this period maximum population was recorded in Sargodha (4.55±0.117 larvae/ plant) during first period of observation followed by Chiniot, Faisalabad, Sheikhupura and Gujranwala *i.e.* 4.45±0.117, 4.25±0.121, 4.20±0.132 and 4.13±0.104 larvae/plant, respectively. During 5th period of observation same trend was recorded where minimum population of *S. litura* larvae was recorded in Gujranwala (3.21±0.081 larvae/plant) and maximum was recorded in Sargodha (3.46±0.094 larvae/plant) while intermediate population was recorded in Chiniot, Faisalabad and Sheikhupura *i.e.* 3.42±0.087, 3.34±0.081 and 3.29±0.075 larvae/plant, respectively.

Overall results of current study revealed that maximum population was recorded in Sargodha during the 4th period of observation and minimum population was observed in Gujranwala during 1st period of observation *i.e.* 4.55±0.117 and 1.96±0.105 larvae/plant, respectively.

During the 2nd year of study (2014) population trend of *S. litura* larvae per plant was changed entirely in all five selected localities of Punjab due to change in weather conditions. The results presented in Table II revealed that maximum population of *S. litura* larvae on per plant basis was recorded in Sargodha (4.37±0.086 larvae/plant) during first period of observation followed by Faisalabad, Chiniot and Sheikhupura (4.32±0.115, 4.30±0.091 and 4.22±0.057 larvae/plant) respectively, while minimum population was observed in Gujranwala *i.e.* 4.04±0.070 larvae/plant, respectively. During the 2nd period of observation population *S. litura* larvae was suddenly declined and minimum population was observed in Gujranwala (1.05±0.024 larvae/plant) and maximum was recorded in Sargodha (1.33±0.037 larvae/plant) followed by Chiniot, Faisalabad and Sheikhupura *i.e.* 1.30±0.058, 1.26±0.052 and 1.13±0.048 larvae/plant, respectively. During 3rd period sudden increase in population was recorded in all selected localities, maximum population was observed in all selected localities of Punjab, during this period maximum population was recorded in Faisalabad (3.32±0.064 larvae/plant) followed by Sargodha, Chiniot, Sheikhupura *i.e.*, 3.28±0.041, 3.26±0.069, 3.17±0.035 and minimum population was recorded in Gujranwala 3.02±0.050 larvae/plant, respectively. During 4th and 5th period of observation same trend was recorded where minimum population of *S. litura* larvae was recorded in Gujranwala (3.19±0.052 and 2.93±0.037 larvae/plant) and maximum was recorded in Sargodha (3.44±0.057 and 3.19±0.067 larvae/plant), while intermediate population was recorded in Chiniot, Faisalabad and Sheikhupura *i.e.*, 3.41±0.092 and 3.14±0.074, 3.39±0.104, 3.13±0.081 and 3.36±0.03 and 3.04±0.050 larvae/plant, respectively. Overall results during 2014 revealed that minimum

Table I.- Larval population of *S. litura* on per cauliflower plant surveyed on fixed schedule at 10 days intervals in selected localities during 2013 and 2014.

Period	Faisalabad	Chiniot	Sargodha	Sheikhupura	Gujranwala
August 22 – 31, 2013	2.17±0.05 E	2.45±0.04 D	2.51±0.05 E	2.14±0.07 C	1.96±0.10 D
September 01 – 10, 2013	2.92±0.06 D	3.07±0.07 C	3.14±0.08 D	2.82±0.06 B	2.75±0.09 C
September 11 – 20, 2013	3.82±0.07 B	3.88±0.07 B	3.97±0.10 B	3.77±0.09 A	3.68±0.11 AB
September 21 – 30, 2013	4.25±0.12 A	4.45±0.11 A	4.55±0.11 A	4.20±0.13 A	4.13±0.10 A
October 01 – 10, 2013	3.34±0.08 C	3.42±0.08 C	3.46±0.09 C	3.29±0.07 B	3.21±0.08 BC
LSD value @ 5%	0.40	0.35	0.26	0.46	0.50
August 22 – 31, 2014	4.32±0.11 A	4.30±0.09 A	4.37±0.08 A	4.22±0.05 A	4.04±0.07 A
September 01 – 10, 2014	1.26±0.05 C	1.30±0.05 C	1.33±0.03 C	1.13±0.04 D	1.05±0.02 D
September 11 – 20, 2014	3.32±0.06 B	3.26±0.06 B	3.28±0.04 B	3.17±0.03 BC	3.02±0.05 BC
September 21 – 30, 2014	3.39±0.10 B	3.41±0.09 B	3.44±0.05 B	3.36±0.03 B	3.19±0.05 B
October 01 to 10)	3.13±0.08 B	3.14±0.07 B	3.19±0.06 B	3.04±0.05 C	2.93±0.03 C
LSD value @ 5%	0.37	0.33	0.25	0.18	0.25

Means sharing similar letters in each column are not different significantly (Tukey's HSD, p>0.05)

Table II.- Correlation between larval population of armyworm (*S. litura*) and weather factors on cauliflower during 2013 and 2014.

Period	Temperature (°C)	Relative humidity	Rainfall (mm)
August 22 to 31 2013	0.974*	-0.875*	-0.852 ns
September 1 to 10	0.906*	-0.929 *	-0.411 ns
September 11 to 20	0.888*	-0.891*	-0.673 ns
September 21 to 30	0.929*	-0.910*	-0.706 ns
October 01 to 10	0.883*	-0.895*	-0.749 ns
August 22 to 31, 2014	0.944**	-0.876*	-0.176 ns
September 1 to 10 2014	0.925*	-0.920*	-0.618 ns
September 11 to 20	0.907*	-0.917*	-0.598 ns
September 21 to 30	0.930*	-0.916*	-0.581 ns
October 1 to 10	0.950**	-0.910*	-0.649 ns

* = Significant at $P \leq 0.05$;
** = Significant at $P \leq 0.01$
ns = Non- Significant

population was recorded in Gujranwala (1.05±0.024 larvae/plant) during the 2nd period of observation and maximum population was observed in Sargodha during 1st period of observation *i.e.* 4.37±0.086 larvae/plant respectively.

Relationship between larval population and climatic factors

Weather factors play a vital role on the population dynamics, distribution growth and development of an insect pest (Chang *et al*., 2008). Rainfall, relative humidity and Temperature of the surrounding of the crop influence on build up and outbreak of insect pest population. Results of correlation of temperature, relative humidity and rainfall revealed that temperature show significant and positive correlation and relative humidity showed significant and negative correlation and rainfall showed negative and non-significant correlation with larval population (Table III). To understand the influence of weather factors on population of *S. litura* larvae in current study, regression equation was determined. During 1st year of study (2013), average temperature showed significant and positively correlation with larval population, with R2 = 0.94 (y = -0.017+0.294x), 0.82 (y = -0.400+0.067x), 0.78 (y = 0.224+0.316x),0.86 (y = -1.535+0.631x) and 0.77 (y = -1.894+0.673x) for the Period I (22 to 31 August), Period II (01 to 10 September), Period III (11 to 20 September), Period IV (21to 30 September) and Period V (01to 10 October), respectively. While relative humidity showed significant and negative correlation with larval population with R2 = 0.76 (y = 4.599 -0.342 x), 0.87 (y = 5.242 -0.400 x), 0.79 (y = 4.506 - 0.289 x), 0.82 (y = 8.389 - 0.750 x) and 0.80 (y = 5.845 -0.452 x) for the Period I (22 to 31 August), Period II (01 to 10 September), Period III (11 to 20 September), Period IV (21to 30 September) and Period V (01to 10 October), respectively.

Similar relation of weather factors was recorded during 2nd year of study (2014), temperature showed significant and positive correlation with population of *S. litura* larvae with R2 = 0.89 (y = 0.208+ 0.340 x),0.85 (y = -0.322+0.313x), 0.82 (y = 0.721+0.223 x), 0.86 (y = 0.681+0.226 x) and 0.90 (y = 0.925+0.179 x) for the Period I (22 to 31 August), Period II (01 to 10 September), Period III (11 to 20 September), Period IV (21to 30 September) and Period V (01to 10 October) respectively. While relative humidity showed significant and negative correlation with larval population with R2 = 0.76 (y = 5.687-0.445 x), 0.85 (y = 3.875- 0.277x), 0.84

(y = 4.184 - 0.249x), 0.83 (y = 3.676 - 0.204x) and 0.82 (y = 3.976- 0.249x) for the Period I (22 to 31 August), Period II (01 to 10 September), Period III (11 to 20 September), Period IV (21 to 30 September) and Period V (01to 10 October), respectively.

DISCUSSION

In the current study during 2013, the minimum level of plant infestation and larval population of *S. litura* was recorded during the month of August, while after that its population was increased and reach at peak during the last week of September and after that decline was started in the month of October. The main reason behind this variation of larval population and plant infestation may be geographical distribution and environmental variations among different localities. Punithavalli *et al*. (2014) reported that the larval population and egg masses were observed during the month of August and remained on the crop up to mid-October. While its peak population was recorded during the 2nd fortnight of September, which showed in confirmation with the results of present study.

The sudden increase in population of S. *litura* larvae during the month of September was in accordance with the findings of (Rao *et al.*, 2014) they concluded that during the month of September optimum temperature and relative humidity was attained which lead in abundance and flourishing population of *S. litura*. The peak population was attained in the month of September showed in conformity with (Babu *et al.*, 2015) they reported that larval population of *S. litura* was found during the month of August to mid-October after that its population was sharply decreased in the month late October. While its peak population was recorded during the months of September.

In contrast, during the study year 2014, maximum population of S. *litura* larvae was observed during the last week of August and after that sudden decrease in larval population was recorded in the first 10 days of September. During the mid-September again larval population started to increase. The main reason behind this population fluctuation is that during the last week of August optimum temperature and relative humidity were available but during the first 10 days of September heavy rainfall was recorded and temperature decreased rapidly and after that again temperature raised. In the current study temperature showed significant and positive correlation with larval population while relative humidity and rainfall showed negative correlation with larval population which is also confirmed by the previous studies (Sharma *et al.*, 2002; Monobrullah *et al*., 2007; Nadaf and Kulkarni, 2010; Selvaraj *et al.*, 2010; Nandihalli and Patil, 2012; Prasannakumar *et al*., 2012; Mishra *et al*., 2013; Rao *et al*., 2014; Roopa and Kumar, 2014; Babu *et al*., 2015) they reported that temperature showed positive correlation while rainfall and relative humidity showed negative correlation with larval population of *S. litura.*

The results of current study were contradicted with (Punithavalli *et al*., 2014) they confirmed that maximum temperature had negative correlation and relative humidity had positive correlation with *S. litura* larval population and their impact was highly significant. Rainfall was also significant and positively correlated with its abundance. This difference in results may be due to different ecological and weather conditions and growing time. Similar kinds of results were also confirmed by Shahzad *et al.* (2014) they concluded that armyworm abundance was significant and negatively correlated with maximum temperature on the other hand relative humidity was positively correlated with armyworm abundance.

Statement of conflict of interest

Authors have declared no conflict of interest.

REFERENCES

ADB, 2009. Building climate resilience in the agriculture sector in Asia and in the Pacific. Asian Development Bank, *Annual Development Report*, p. 9.

Babu, S.R., Kalyan, R.K., Ameta, G.S. and Meghwal, M.L., 2015. Analysis of outbreak of tobacco caterpillar, *Spodopteralitura*on soybean. *J. Agro. Meteorol.*, **17**: 61-66.

Carasi, R.C., Telan, I.F. and Pera, B.V., 2014. Bioecology of common cutworm (*S. litura*) of Mulberry. *Int. J. Sci. Res*., **4**: 1-8.

Chang, X.N., Gao, H.J., Chen, F.J. and Zhai, B.P., 2008. Effect of environmental moisture and precipitation on insects, *Chinese J. Ecol*., **27**: 619-625.

Fand, B.B., Sul, N.T., Bal, S.K. and Minhas, P.S., 2015. Temperature impacts the development and survival of common cutworm (*Spodoptera litura*): Simulation and visualization of potential population growth in India under warmer temperatures through life cycle modeling and spatial mapping. *PLoS One*, **10:** e0124682.

Lingappa, S., Basavanagoud, K., Kulkarni, K.A., Patil, R.S. and Kambrekar, D.N., 2004. Threat to vegetable production by diamondback moth and its management strategies. In: *Fruit and vegetable diseases* (ed. K.G. Mukerji), Springer, Netherlands, **1**: 357-396.

Minitab, 2002. Software Inc., Northempton, MA, USA.

Mishra, A., Das, D.K., Singh, J., Jain, A.K. and Singh, R., 2013. GIS based decision support system of *Spodoptera litura*

in soybean. *Indian Cartogr.,* **33**: 273-277.

Monobrullah, M., Bharti, P., Shankar, U., Gupta, R.K., Srivastava, K. and Ahmad, H., 2007. Trap catches and seasonal incidence of *Spodoptera litura* on cauliflower and tomato. *Ann. Pl. Protec. Sci*., **15**: 73-76.

Nadaf, A.M. and Kulkarni, K.A., 2006. Seasonal incidence of the fruit borers, *Helicoverpa armigera* and *Spodoptera litura* on chili in Dharwad. *Karnataka J. agric. Sci.,* **19**: 549-552.

Nandihalli, B.S. and Patil, B.V., 2012. Influence of weather parameters on population dynamics of *Spodoptera litura* (Fb.) in pheromone and light traps. *Karnataka J. agric. Sci*., **2**: 62-67.

Prasannakumar, N.R., Chakravarthy, A.K. and Naveen, A.H., 2012. Influence of weather parameters on pheromone trap catches of potato cutworm, *Spodoptera litura*. *Curr. Biot.* **5**: 508-512.

Punithavalli, M., Sharma, A.N. and Rajkumar, M.B., 2014. Seasonality of the common cutworm *Spodoptera litura* in a soybean ecosystem. *Phytoparasitica,* **42**: 213-222.

Rao, M.S., Manimanjari, D., Rao, A.C.R., Swathi, P. and Maheswari, M., 2014. Effect of climate change on *Spodoptera litura* on peanut: A life table approach. *Crop Protect.,* **66**: 98-106.

Roopa, M. and Kumar, C.T.A., 2014. Seasonal incidence of pests of capsicum in Bangalore conditions of karnataka, India. *Glob. J. Biol. Agric. Hlth. Sci.,* **3**: 203-207.

Selvaraj, S.I., Adiroubane, D., Ramesh, V. and Narayanan, A.L., 2010. Impact of ecological factors on incidence and development of tobacco cut worm, *Spodoptera litura* on cotton. *J. Biopestic*., **3**: 43-46.

Shahzad, M.S., Hameed, A., Ahmad, S., Mehmood, A., Aslam, M., Khan, N., Mehmood, K. and Fared, S., 2014. Modelling population dynamics of army worm (*Spodoptera litura* F.) in relation to meteorological factors in Multan, Punjab, Pakistan. *Int. J. Agro. Agric. Res.,* **5**: 39-45.

Sharma, H.C., Sullivanb, D.J. and Bhatnagara, V.S., 2002. Population dynamics and natural mortality factors of the Oriental armyworm, *Mythimna separata*, in South-Central India. *Crop Prot.*, **21**: 721-732.

Sokal, R.R. and Rohlf, F.J., 1995. *Biometry*: *The principles and practice of statistics in biological research.* 3rd Eds. New York, USA.

Zhou, Z.-S., Chen, Z.-P. and Xu, Z.-F., 2012. Effect of three *Spodoptera litura* control strategies on arthropod diversity and abundance in tobacco agroecosystem in south China. *Pakistan. J. Zool.*, **44**: 151-177.