academicJournals

Vol. 8(38), pp. 4740-4747, 3 October, 2013
DOI:10.5897/AJAR2013.7423
ISSN 1991-637X ©2013 Academic Journals
http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Prediction of population development of melon fruit fly (*Bactrocera cucurbitae* Coq.) on pointed gourd (*Trichosanthes dioica* Roxb.)

P. Barma[1]*, S. Jha and S. Banerjee[2]

[1]Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India.
[2]Department of Agricultural Meteorology and Physics, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India.

Accepted 11 September, 2013

Study on melon fruit fly, *Bactrocera cucurbitae* Coq. was taken up during 2007 to 2008, 2008 to 2009 and 2009 to 2010 at Central Research Farm, Bidhan Chandra Krishi Viswavidyalaya, India on pointed gourd. To forewarn the fruit fly population, the data of first two years were used for the formation of predictive equation and that of last year were used for validation purpose. The maggot population was found to be having significant positive correlations with atmospheric temperature (r = 0.386 for maximun temperature and 0.501 for minimum temperature) and soil temperature (r = 0.555). This study also revealed significant negative relation (r = -0.451) with morning RH but it had no significant positive relation (r = +0.284) with evening RH. Rainfall could not influence the population of this internal feeding maggot. The maggot population showed almost neutral relationship with bright sun shine hours (r = +0.103). While fitting the predictive model the maggot population was slightly under predicted. The root mean square error value was found to be 4.45, indicating the developed equation can well be used to predict the maggot population in pointed gourd.

Key words: Pointed gourd, fruit fly, maggot population, correlation, predictive model.

INTRODUCTION

For cucurbits, especially pointed gourd, *Trichosanthes dioica* Roxb., the melon fruit fly, *Bactrocera cucurbitae* Coq., damage is the major limiting factor in obtaining good quality fruits and high yield (Gupta and Verma, 1992; Dhillon et al., 2005a, b, c; Shooker et al., 2006). This polyphagous insect is infesting alone more than 125 plant species (Batra, 1953; Weems, 1964; Syed, 1971; Kapoor and Agarwal, 1983). Very few reports on infestation of the pest attacking pointed gourd in West Bengal had been found (Chintha et al., 2002). Jha et al. (2007) observed infestation of fruit fly to the tune of 17% on the crop in the district of Malda, Murshidabad and Nadia. The fruit fly activity varies a lot depending mostly on the prevailing climatic conditions and the diversity of other hosts in a particular agro-ecosystem. For this reason, it is imperative to study the influence of abiotic factors on fruit fly activity for development and proper implementation of fruit fly management programmes. The present experiment was undertaken to study the population fluctuation in relation to various abiotic factors designing for monitoring fruit fly of pointed gourd.

MATERIALS AND METHODS

The experiment was conducted at Central Research Farm, Bidhan

*Corresponding author. E-mail: pranab.barma@gmail.com.

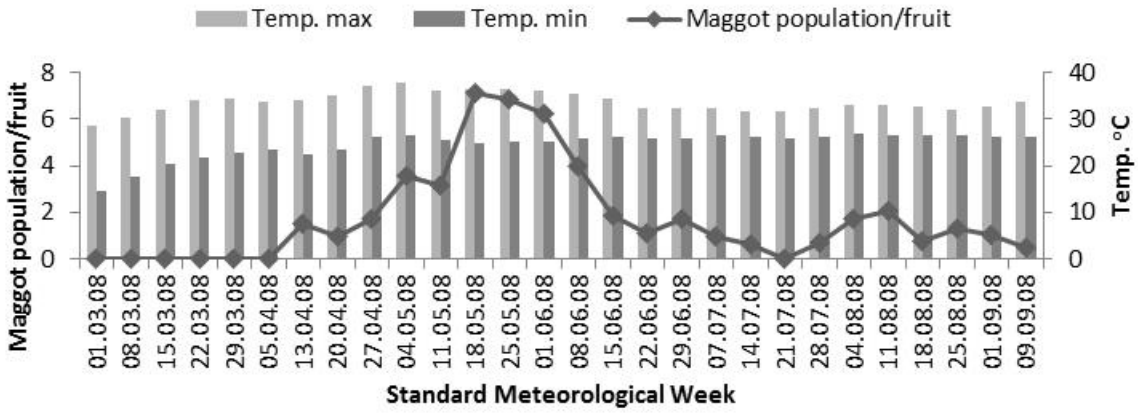

Figure 1. Influence of temperature on fruit fly maggot population during 2008.

Chandra Krishi Viswavidyalaya, Gayeshpur, Nadia, West Bengal (23°N latitude, 89°E longitude and 9.75 m above sea level) in three successive crop growing seasons from 2007 to 2008 to 2009 to 2010. The soil was a typical alluvial soil (Entisol) with a sandy clay loam texture with good drainage, slightly acidic pH and moderate fertility.

Experiments were replicated three times having a plot size of 3 × 2 m with a spacing of 135 × 100 cm. Mature root cuttings were collected from the farmer's field early in the morning of the planting day. Six female root cuttings with one male per plot were planted in pits. FYM @ 150 q/ha and N, P and K were applied @ 90, 80 and 70 kg/ha respectively.

The incidence of fruit fly was recorded on the basis of number of fruits damaged by the pest. The maggots per infested fruits were counted. These data were later converted to maggot population per fruit with the following formula (Gupta and Verma, 1992).

$$\text{Maggot population per fruit} = \frac{\text{No. of infested fruits} \times \text{No. of maggots per infested fruit}}{\text{Total no. of fruits sampled}}$$

The weekly meteorological data on maximum temperature (°C), minimum temperature (°C), morning relative humidity (%), evening relative humidity (%), rainfall (mm), soil temperature (°C) and bright sun shine hours were obtained from the Department of Agricultural Meteorology and Physics, Bidhan Chandra Krishi Viswavidyalaya. Through establishing correlation with the weather parameters mentioned above, predictive models on the population development of the pest had been worked out.

RESULTS AND DISCUSSION

Fruit fly population and weather factors

Fruit fly (*B. cucurbitae* Coq.) on pointed gourd was found to infest from mid, April to mid, September in 2008, third week of April to mid, September in 2009 and first week of May to second week of September in 2010 in the experimental field. Variation in the infestation levels of the insect could be noted which could have been influenced by fruit availability along with its growth stages and also by the weather factors. In the present study the impact of weather factors on the population build up and development of predictive models thereof have been tried.

Relationship between fruit fly population and temperature

Highest average maggot population per fruit (7.09) could be recorded during third week of May 2008 which occurred a week later during same month of 2009 when the average weekly maximum temperature was 36°C and 34°C, respectively (Figures 1 and 2). Occurrence of low maggot population could be due to the weekly average maximum temperature during April and July being lower than 35°C.

With respect to relationship between minimum temperature and maggot population, the highest average found in May during both years coinciding average minimum weekly temperature at 25°C (Figures 1 and 2). However, low population incidence did not follow any relation with fluctuating average minimum temperature.

Inspite of the fact revealed by general consideration of temperature factors with average temperatures, it was curious to find significant positive correlations (r = 0.386 for maximum temperature and 0.501 for minimum temperature) when pooled data of two years' observation were subjected to calculation.

Relationship between fruit fly population and relative humidity

Occurrence of highest average maximum population of maggot was observed during May in both 2008 and 2009 when morning RH was on an average 85 and 89%, respectively. It can clearly be seen (Figures 3 and 4) that heightened occurrence of larval population showed clear relation with morning RH in 2008. But from the data of

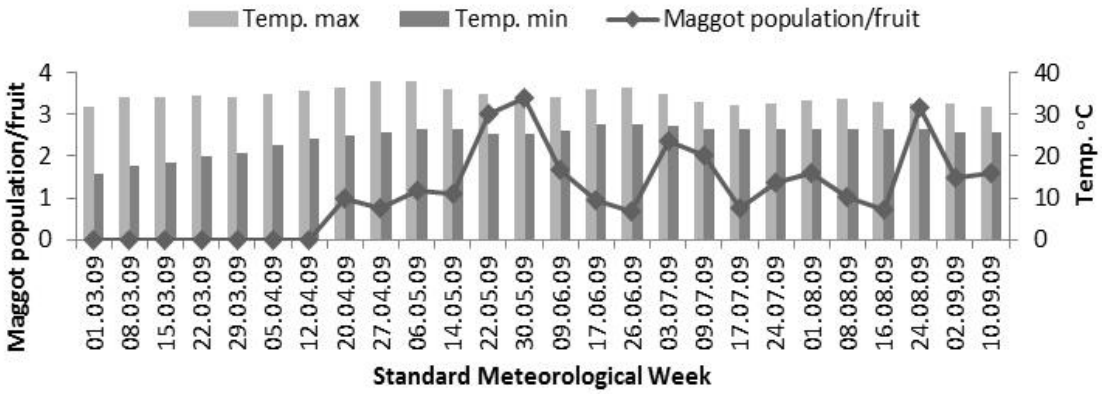

Figure 2. Influence of temperature fruit fly maggot population during 2009.

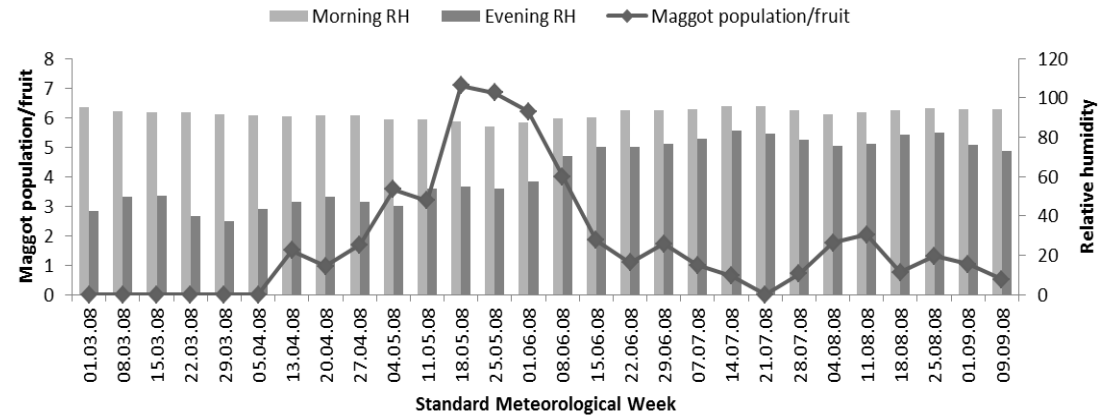

Figure 3. Influence of relative humidity on the fruit fly maggot population during 2008.

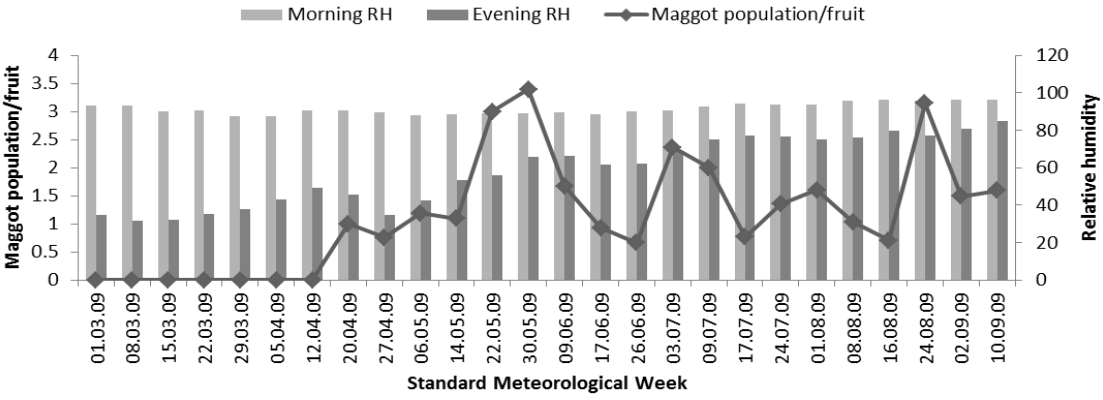

Figure 4. Influence of relative humidity on fruit fly maggot population during 2009.

2009, same inference could not be drawn. Interesting situation has also been presented when relation of maggot population with that of evening minimum RH (Figures 3 and 4) was attempted and both the dependent and independent factors behaved indifferently with one another.

Simple correlation of the pooled data of two years' observation revealed significant negative relation

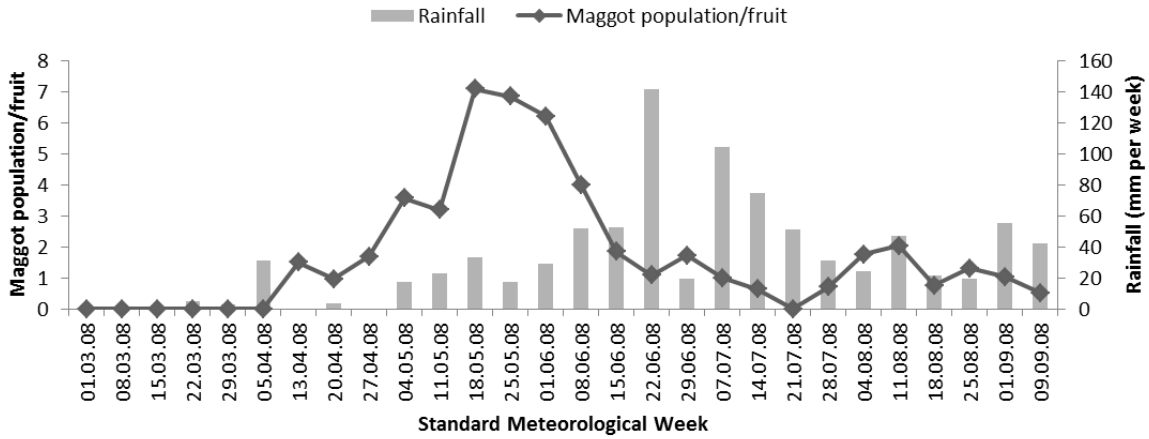

Figure 5. Influence of rainfall on fruit fly maggot population during 2008.

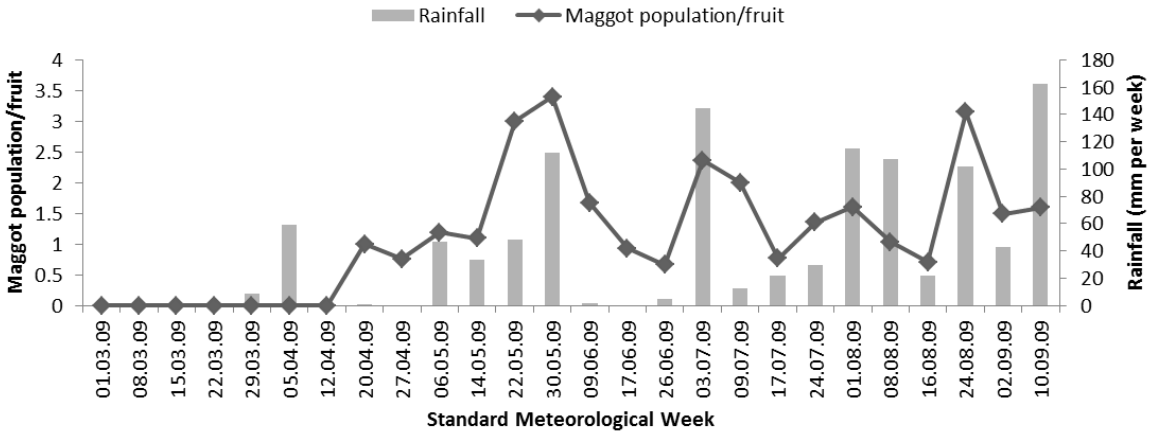

Figure 6. Influence of rainfall on fruit fly maggot population during 2009.

(r = -0.451) with morning RH but it had no significant positive relation (r = +0.284) with evening RH.

Relationship between fruit fly population and rainfall

Distribution of rainfall during both the years of study differed much between the years. Rainfall above 30 mm occurred seven times and high rainfall above 100 mm occurred only twice with the highest precipitation of about 140 mm was recorded during fourth week of June 2008 (Figure 5). Rainfall of more than 30 mm per week occurred twelve times and higher precipitation of more than 100 mm could be recorded during last week of May, first week of July, first, second and fourth week of August and second week of September. The highest precipitation of 160 mm could be recorded during second week of September during 2009 (Figure 6). Higher level of maggot population could be recorded during three consecutive weeks starting from third week of May 2008 when precipitation was low (round about 15 mm). If the population of three maggots/fruit be considered as lower limit of high incidence then it could be encountered twice during the last week of May and again during fourth week of August, 2009. From perusal of the incidence intensity and pattern, it could be found that there was substantial difference in peak of population of little above seven per fruit in 2008 that was double to that of 2009 (3.5 larvae/fruit). Even statistically, the pooled data correlation value +0.195 were feeble and non-significant. From this, it can be inferred that rainfall could not influence the population of this internal feeding maggot. Activities of the free living adult fruit flies could be influenced by rainfall which depends upon the mating and oviposition. The hatching of eggs at a later day would, therefore, reflect the population of maggot. Thus, frequency of rainy days and intensity, when related with adult population activities would be a more reasonable analysis of the maggot population of days following intensified activities of its web.

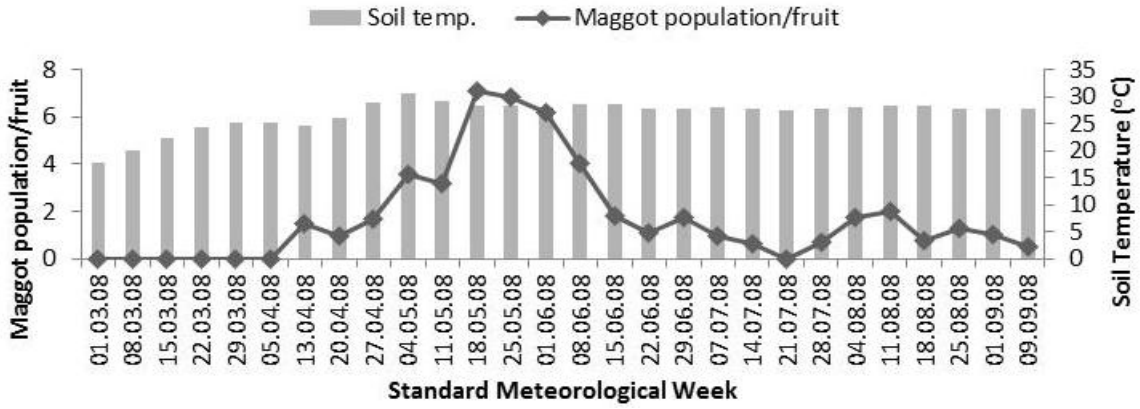

Figure 7. Influence of soil temperature on fruit fly maggot population during 2008.

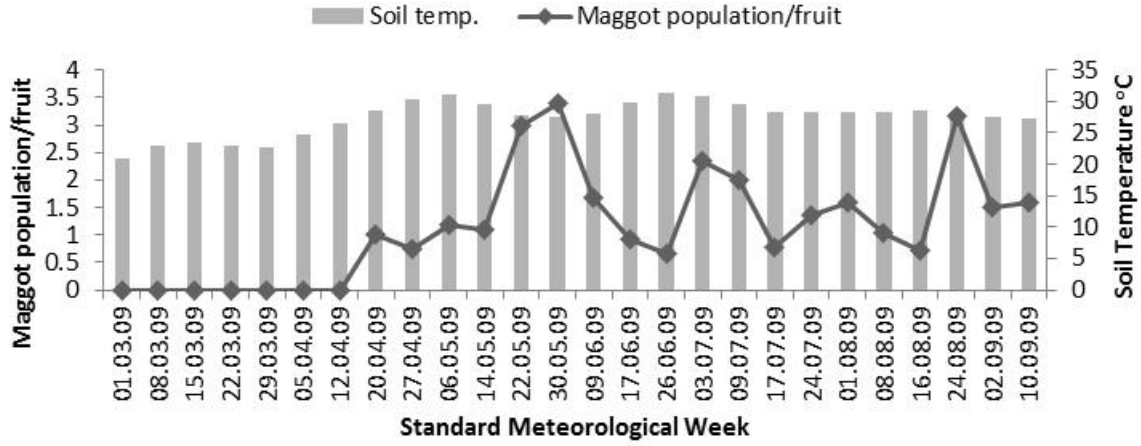

Figure 8. Influence of soil temperature on fruit fly maggot population during 2009.

Relationship between fruit fly population and soil temperature

It could be seen (Figure 7) that upto early April, the soil temperature during 2008 remained below 22°C when there was no incidence of maggots in the fruits. It started appearing from the second week of the same month whence forth the maggot appeared, started to increase to reach peak during third week of May and remained high upto first week of June. Then onwards upto last observation (09.09.2008) the population started declining sharply to become absent during fourth week of July. Then again the population gradually increased to a low high (02/ fruit) during second week of August showing an almost declining population till the last day (09.09.2008), of its existence. It could be noted that during the period that followed the highest population, the soil temperature remained more or less 27.5°C. During 2009, there was no maggot incidence in fruits upto second week of April (Figure 8). Then as temperature reached 25°C (third week of April) inception of incidence could be recorded. Then temperature rose to about 30°C in the first week of May and from then it fluctuated between 27°C and 30°C upto last observation (10th September). The highest maggot population in fruit (3.4/ fruit) occurred twice, once during fourth week of May and then during fourth week of August at temperature of about 27.5°C. Between this period and beyond the last peak the population fluctuated low level. Correlation of pooled data of these two years showed a significant and positive relationship (r = 0.555) with soil temperature.

Relationship between fruit fly population and bright sun shine hour

Bright sunshine prevailed with some fluctuation upto about middle of June during both 2008 and 2009 (Figures 9 and 10). After this period, normally rainy season sets in. Maggots in fruit could be recorded from second week

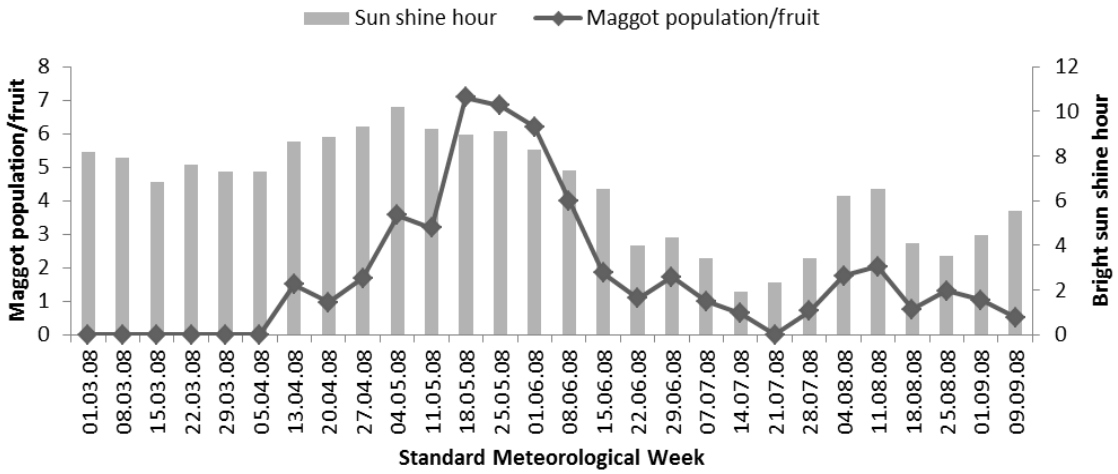

Figure 9. Influence of sun shine hour on fruit fly maggot population during 2008.

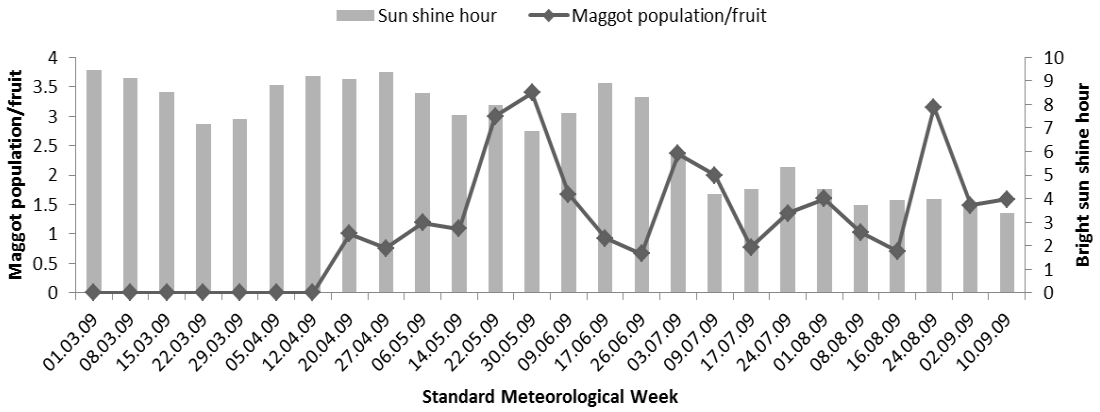

Figure 10. Influence of sun shine hour on fruit fly maggot population during 2009.

(2008) and third week of 2009. During 2008, after attaining peak incidence of maggots in fruits, the population decline followed more or less identical trend. During 2009, the population peak could be found during longer bright sun hours but later population after declining deep during fourth week of June when sun shine was of long duration which was followed by drastic decrease in duration with population existence of maggots in fruits erratically high and low with last high population of about the same level of first peak during third week of August.

The aforesaid characteristic of population has been reflected in correlation coefficient (r = +0.103) that was too feeble to indicate almost neutral effect of sun shine hours.

Development of predictive equation to forewarn fruit fly population

The population dynamics of fruit fly influenced by different weather parameters, as discussed in the previous section, were used to develop forewarning system. The data of first two years (that is, 2008 and 2009) were used for formation of predictive equation and the last year data were used for validation purpose.

As per the discussion on fruit fly-weather relationship done in the previous section, minimum temperature, morning relative humidity and soil temperature were considered for development of predictive equation. The equation developed in this study was as follows:

$$Y = 19.16 + 0.275X_1 – 0.248X_2 + 0.062X_3$$
$$R^2 = 0.463$$

Where: Y, Mean number of maggot/fruit; X_1, Minimum temperature; X_2, Morning RH; X_3, Soil temperature.

If all the parameters under study would have been considered, then the following equation may be used for prediction of the said insect pest.

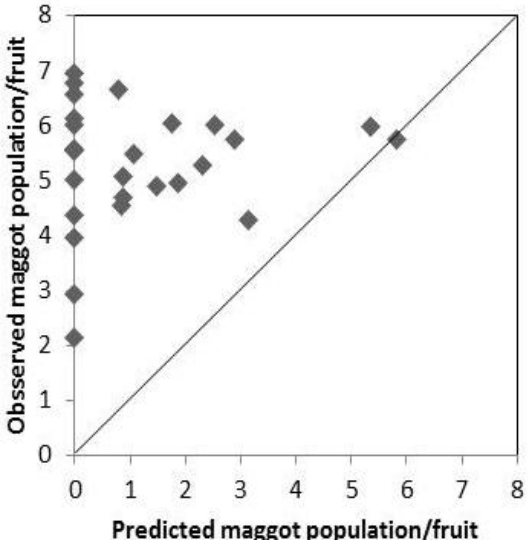

Figure 11. Comparison between observed and predicted fruit fly maggot population per fruit.

$Y = 28.85 + 0.298X_1 – 0.333X_2 – 0.443X_3 + 0.157X_4 - 0.001X_5 – 0.007X_6 + 0.311X_7$
$R^2 = 0.762$

Where: Y, Mean number of maggot/fruit; X_1, Maximum temperature; X_2, Minimum temperature; X_3, Morning relative humidity; X_4, Evening relative humidity; X_5, Rainfall; X_6, Soil temperature;
X_7, Bright sun shine hour.

Comparison between observed and predicted fruit fly maggot population

The predicted and observed maggot population per fruit was done through 1:1 line. It was observed that most of the data points were along with 1:1 line and from the figure it was apparent that the maggot population was slightly under predicted (Figure 11). The root mean square error value was 4.45, indicating the developed equation can be used safely to predict the maggot population in pointed gourd.
Thus the maggot population was very much closely related with minimum temperature, morning relative humidity and soil temperature. The predictive equation thus formed through the present investigation can form the basis of forewarning system towards better production of pointed gourd.

DISCUSSION

Abiotic factors affect the population fluctuation of the insect pests. In the present study, impact of minimum and maximum temperature was found to have significantly positive correlation with *Bactrocera cucurbitae* incidence. The maximum relative humidity had the negative and minimum RH had positive impact on the pest build up. Rainfall also showed positive impact though it was at insignificant level. The result was more or less in conformity with Laskar and Chatterjee (2010) barring the bright sun shine hour which in the present study was positively (insignificantly) correlated and that of the authors referred were negatively correlated. The number of fruit flies captured with cuelure baited traps correlated positively with all three abiotic factors, that is, temperature, humidity and rainfall (Hasyim et al., 2008). In a study conducted in Pakistan, fly population peak of the genus *Bactrocera* appeared in July to August and decline was observed in October depending on the host fruit maturity, temperature and rainfall (Mahmood and Mishkatullah, 2007). Similar observation with regard to influence of meteorological parameters on the incidence of melon fly was also recorded earlier by several workers (Mahmood et al., 2002; Gupta and Bhatia, 2000; Shukla and Prasad, 1985; Su, 1984).

Conclusion

So, it indicated that contribution of soil, maximum and minimum temperature exerted positive effect on population buildup and moisture increase of ambient atmosphere during morning hours were not congenial for population activities of fruit fly. The development of predictive models for fruit fly in pointed gourd had been done for the first time and this pioneering work would be useful for timely application of management measures.

ACKNOWLEDGEMENT

The authors are indebted to the Department of Agricultural Entomology, BCKV for the infrastructural supports extended for the study.

REFERENCES

Batra HN (1953). Aphids infesting peach and their control. Indian J. Entomol. 15(1):45-51.
Chintha RM, Das RK, Mandal SK (2002). Pests and beneficial arthropods occurring on pointed gourd, *Trichosanthes dioica* Roxb. (Cucurbitaceae). J. Interacadem. 6(2):174-179.
Dhillon MK, Naresh JS, Singh R, Sharma NK (2005a). Evaluation of bitter gourd (*Momordica charantia* L.) genotypes for resistance tomelon fruit fly, *Bactrocera cucurbitae*. Indian J. Plant Prot. 33(1):55-59.
Dhillon MK, Naresh JS, Singh R, Sharma NK (2005b). Influence of physico-chemical traits of bitter gourd, *Momordica charantia* L. on larval density and resistance to melon fruit fly, *Bactrocera cucurbitae* (Coquillett). J. Appl. Entomol. 129(7):393-399.
Dhillon MK, Singh R, Naresh JS, Sharma HC (2005c). The melon fruit fly, *B. cucurbitae*: A review of its biology and management. J. Insect Sci. 5:40-60.

Gupta D, Bhatia R (2000). Population fluctuation of *Bactrocera* spp. in sub-mountainous mango and guava orchards. J. Appl. Hort. 1(2):101-102.

Gupta D, Verma AK (1992). Population fluctuations of the maggots of fruit flies *Dacus cucurbitae* Coquillett and *D. tau* (Walker) infesting cucurbitaceous crops. Adv. Plant Sci. 5:518-523.

Hasyim A, Muryati, De Kogel WJ (2008). Population fluctuation of the adult males of the fruit fly, *Bactrocera tau* Walker (Diptera: Tephritidae) in passion fruit orchards in relation to abiotic factors and sanitation. Indones. J. Agric. Sci. 9(1):29-33.

Jha S, Khan MR, Sahoo S, Das S (2007). Infestation of fruit fly (*Bactrocera cucurbitae*) on pointed gourd (*Trichosanthes dioica*). Sashya Surakhya 4:12-13.

Kapoor VC, Agarwal ML (1983). Fruit flies of Economic importance, In: Fruit Flies and Their Increasing Host Plant in India (ed. R. Cavalloro), Proceedings of the CEC/ 10BC. International Symposium, Athens, 1982. Balkema, Rotterdam. pp. 252-257.

Laskar N, Chatterjee H (2010). The effect of meteorological factors on the population dynamics of Melon fly, *Bactrocera cucurbitae* (Coq.) (Diptera: Tephritidae) in the foot hills of Himalaya. J. Appl. Sci. Environ. Manage. 14(3):53-58.

Mahmood K, Mishkatullah (2007). Population dynamics of three species of *Bactrocera* (Diptera: Tephritidae: Dacinae) in BARI, Chakwal (Punjab). Pak. J. Zool. 39(2):123-126.

Mahmood T, Hussain SI, Khokhar KM, Hidayatullah MA (2002). Studies on methyl eugenol as a sex attractant for fruit fly, *Dacus zonatus* (Saund) in relation to abiotic factors in peach orchard. Asian J. Plant Sci. 4:401-402.

Shooker P, Khayrattee F, Permalloo S (2006). Use of maize as a trap crops for the control of melon fly, *B. cucurbitae* (Diptera:Tephritidae) with GF-120. Bio-control and other control methods [http\\www.fcla.edu/FlaEnt/fe87 p354.pdf.].

Shukla RP, Prasad VG (1985). Population fluctuation of the oriental fruit fly, *Dacus dorsalis* Hendel in relation to host and abiotic factors. Trop. Pest Manage. 31:273-275.

Su CY (1984). The study on the relationship between seasonal succession of male adult of melon fly, *D. cucurbitae* and the meteorological factors. J. Agric. For. 32:105-109.

Syed RA (1971). Studies on tephritids and their natural enemies in Pakistan. *V. Dacus* (Strumete) *Cucurbita* Coq. Tech. Bulletin Commonwealth Inst. Biol. Control 14:63-75.

Weems HV (1964). Melonfly *(Dacus cucurbitae* Coq.) (Diptera: Tephritidae). Entomology circular, Div. of PI. Industry, Florida Dept. Agric. Consum. Serv. 16:1-2.