

Development of weather based prediction model for leaf roller population of Sesame in Bundelkhand zone of Madhya Pradesh

M. P. GUPTA, A. K. SRIVASTAVA* and M. K. NAYAK

JNKVV, College of Agriculture, Tikamgarh (M. P.) – 472 001, India

(Received 20 March 2008, Modified 16 September 2009)

*e mail : ajay_weather@yahoo.com

सार – क्षेत्रीय कृषि अनुसंधान केन्द्र, टीकमगढ़ में वर्ष 1995 से 2006 तक के लगातार 12 वर्षों के खरीफ के मौसम के दौरान तिल की पत्ती मोड़क कीट की सक्रियता पर क्षेत्रीय परीक्षण किया गया है जिसमें तिल के जे. टी.-7 किस्म को परीक्षण के लिए चुना गया। आँकड़ों के विश्लेषण से यह पता चला है कि तिल की पत्ती मोड़क कीट की सक्रियता तिल की फसल पर 30वें मानक सप्ताह से 40वें मानक सप्ताह तक रहती है। तिल की पत्ती मोड़क इल्ली की संख्या को मौसम के आँकड़ों और सहसंबंध गुणांक के साथ संबद्ध किया गया है एवं मौसम के आधार पर प्रागुक्ति निदर्श विकसित करने के लिए समाश्रयण समीकरण तैयार किए गए। अधिकतम और माध्य तापमान (अधिकतम, न्यूनतम) के साथ महत्वपूर्ण सकारात्मक सहसंबंध और वर्षा के साथ इसके नकारात्मक संबंधों का पता चला है। पूरे 12 वर्षों के आँकड़ों के आधार पर एक पॉलिनामियल निदर्श विकसित किया गया जो कि मौसम प्राचलों के कारण 60 से 90 प्रतिशत तक कीड़े की विविधता को दर्शाता है। इल्ली की संख्या और मौसम के आँकड़ों का सिर्फ अनुकूल सप्ताह में बल्कि पहले के सप्ताह में भी उपयोग करते हुए प्रागुक्ति निदर्शों को विकसित करने के लिए बहुसमाश्रयण तकनीक का उपयोग किया गया है। पत्ती मोड़क के लिए प्रागुक्ति निदर्श इल्ली की संख्या का 88 प्रतिशत परिवर्तनशीलता दर्शाता है। इल्ली की चरम संख्या के प्रागुक्ति निदर्श प्रेक्षित किए गए जो इल्ली की चरम संख्या के अनुरूप हैं।

ABSTRACT. Field experiment was conducted during twelve consecutive Kharif seasons from 1995 to 2006 at Zonal Agricultural Research Station, Tikamgarh to find out the impact of weather parameters on the incidence and activity of *Antigastra catalaunalis* (Dupnocbel) in Sesame cv JT-7. The analysis revealed that the pest activity started to buildup from 30th standard meteorological week and remained up to 40th standard meteorological weeks (SMW). Larval population has been correlated with weather data and correlation coefficient, regression equations were worked out for development of weather based prediction model. Significant positive correlation with maximum and mean temperature (maximum, minimum) and negative relationships with rainfall was observed. Best fitted polynomial models were developed using the whole season data which explained 60 to 90 per cent variability due to weather parameters. The multiple regression technique has been used for developing predictive model using larval population and weather data not only for the corresponding week but also for preceding weeks. The prediction model for leaf roller explained 88% variability of the pest population. The model predicted peak larval population was in good agreement with observed peak larval population.

Key words – Leafroller, Sesame, Temperature, Rainfall, Correlation, Regression model.

1. Introduction

India is the largest producer of Sesame and ranks first in acreage in the world (Anonymous, 2003). Out of 67 insect pests damaging Sesame crop (Kumar and Goel, 1994) leaf roller *Antigastra catalaunalis* is the most damaging pest infesting the crop at leaf, flower and capsule stage causing yield losses up to 68.2 per cent (Ahuja, 1990). Bundelkhand region is one of the endemic areas of Sesame leaf roller and hence it is important to develop a model for estimation of leaf roller population build up for Bundelkhand zone, which may help in formulating ecological pest management programme. The

present investigations were undertaken to study the association of various weather parameters and build up of leaf roller pest over a longer period with a view to predict the outbreak under congenial weather conditions.

2. Data and methodology

The experiment was conducted at Zonal Agricultural Research Station, Tikamgarh (24° 40' North Latitude, 77° 80' East Longitude and 324 meter height above msl) during kharif season of 1995 to 2006. Variety, JT-7 was sown (30 × 10 cm distance) in the first fortnight of July during each kharif season in an isolated area of 200 m²

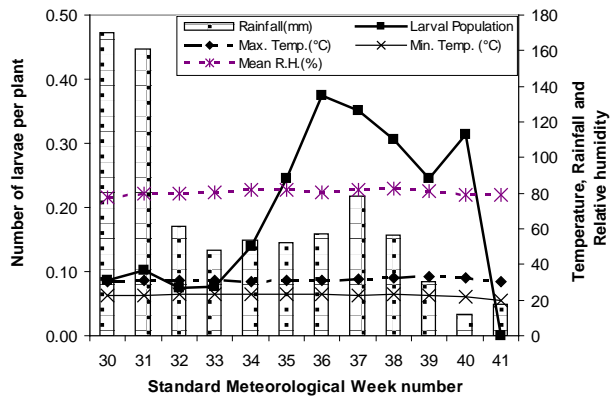


Fig. 1. Weekly mean larval population and weather parameters during kharif at Tikamgarh of Bundelkhand zone

with recommended doses of fertilizer 60 kg N, 40 kg P₂O₅ and 20 kg K₂O/ha. Weekly observation of larval population of *Antigastra catalaunalis* were recorded after two-three week of sowing on 100 plants selected randomly and mean larval population per plant was computed. Pest infestation on plants, flower and capsule were also recorded at 30, 55 DAS and at harvest respectively. Meteorological observation of daily rainfall, minimum, maximum temperatures and relative humidity were collected from IMD meteorological station (located at Tikamgarh District HQ within 4 km from crop field), and weekly values are computed. The data were processed statistically and correlations and regression between larval population and weather parameters were established. Simple and multiple regression equations using least square method were worked out using highly correlated weather parameters. Significance of R² of the equation was tested following F test.

3. Result and discussion

3.1. Seasonal incidence of leaf roller

Mean weekly population was calculated after pooling the 12 years weekly data and presented in Fig. 1. The data revealed that in general lowest population was recorded in early weeks during 30-34th Standard Meteorological Week (SMW). The peak activity of insect population reached between 36th and 37th SMW. The years 1998 and from 2003 to 2006 was recorded lower pest population, which may be attributed to the influence of high rainfall towards the end of August and early September (Fig. 1).

The weekly values of the weather data have been calculated and their weekly pattern has been presented in Fig. 1. The pest population build up occurred over wide

range of weather parameters, viz., maximum temperature range (11° C), minimum temperature range (6° C) and mean temperature range (7° C).

3.2. Leaf roller infestation and damage of plant parts

The leaf infestation was maximum in 37th SMW during 1998 whereas the flower damage was maximum in 2001 during 35th and 36th SMW. The highest infestation on capsule was during 2002 in 38th SMW. The lowest infestation on plant, flower and capsule were observed in the years 1995, 2003 and 2006 respectively.

3.3. Pest population and weather parameters

The trend line polynomial type (3 orders) was used and the trend line with its regression equations and weekly pattern are shown in [Figs. 2(a-d)]. The weather parameters accounted for 60-90 per cent variation of larval population [Figs. 2(a-d)]. In case of temperature the value of maximum above 30° C and minimum around 25° C was found critical for multiplication of population of leaf roller at Tikamgarh.

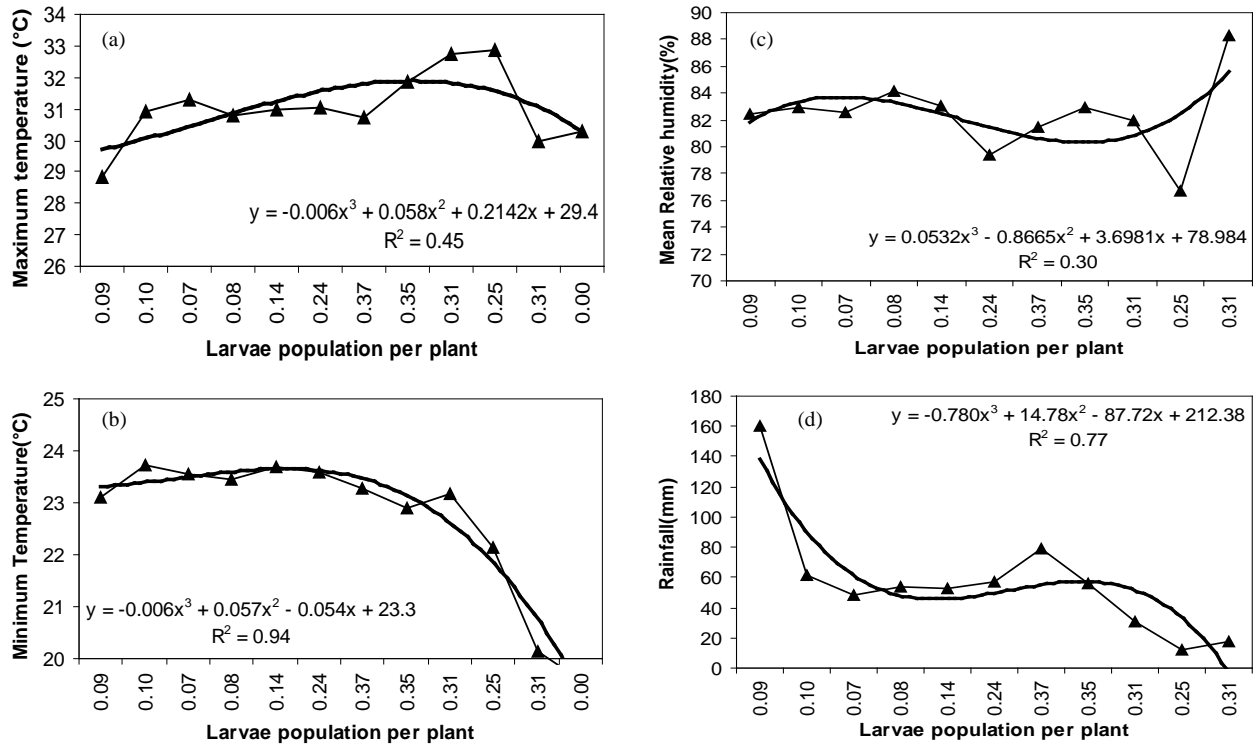
3.4. Correlation between peak pest population and weather parameters

It was noticed that the corresponding as well as previous week weather parameters have influenced the peak pest population in many years. The correlation coefficients between peak pest population periods (35-39th SMW) with corresponding week (35-39th SMW) weather parameters were calculated. The correlation coefficient values

Maximum temp. (Tmax) : + 0.38*, Mean Temp. (Tmean) : + 0.35*, Rainfall : -0.66** and Temperature difference (Tdiff) : + 0.36

(*Significant at 5% level, **Significant at 1 % level)

The above analysis shows that maximum and minimum temperatures are positively associated with pest population, while the rainfall is negatively associated. The significant positive correlation of larval population with maximum temperature and mean temperature is in conformity with the finding of Ghorpade and Thakur (1995), whereas negative correlation with rainfall confirms the finding of Ahuja (1989). The association between rainfall and peak pest population is very high. Desai and Patel (1965) reported that leaf roller population did not reach higher proportion during July and August due to reasonably high rainfall under Gujarat conditions in India.



Figs. 2(a-d). Relationship between larvae population and (a) maximum temperature (b) minimum temperature (c) mean relative humidity and (d) rainfall at Tikamgarh of Bundelkhand zone

3.5. Correlation between peak pest population period and preceding week weather parameters

Correlation coefficient between peak larval population (35-39th SMW) and previous week weather parameters (30-34th SMW) were also worked out and are

Maximum temp. (*T*_{max}) : + 0.59**, Mean Temp. (*T*_{mean}) : + 0.63**, Rainfall : -0.53** and Temp. difference (*T*_{diff}) : + 0.44*

(*Significant at 5% level, **Significant at 1 % level)

As compared to corresponding week, impact of maximum temperature and mean temperature of preceding week (30-34 SMW) is quite higher (+ 0.59 vs + 0.38) and (+ 0.63 vs + 0.35) whereas, rainfall of preceding week had significant negative correlation (-0.66 vs -0.53). Ghorpade and Thakur (1995) has worked out the relationship between leaf roller larvae and weather variables and reported moderately significant correlation with maximum temperature (- 0.55) and relative humidity (+ 0.55), while the relationship was negative with sunshine hours and minimum temperature (- 0.52).

All India Coordinated project on Sesame and Niger Annual Report (2006-2007) reported that incidence of *Antigastra catalaunalis* at Tikamgarh was at peak during 35th to 38th SMW. It is pointed out that dry weather conditions with maximum temperature (31-36° C) during preceding week coupled with low rainfall (0-33 mm/week) are found to be congenial condition for the multiplication of the leaf roller. Ahuja and Bakheta, 1995 also reported the similar findings.

3.6. Prediction model

The cumulative effects of different weather parameters on the infestation and activity of pest were obtained using stepwise techniques. The peak infestation was recorded during 35-39th SMW and highly correlated weather factors especially, mean and maximum temperatures during 30-34th SMW and rainfall of peak infestation period (35-40th SMW) were taken into consideration for working out the predictive model after pooling the data. The equation for the prediction model is:

$$Y = - 0.750 + 0.084 X_1 - 0.058 X_2 + 0.002 X_3$$

$$R^2 = 0.88^* \quad \text{Standard Error} = 0.028$$

* Significant at 5 % level

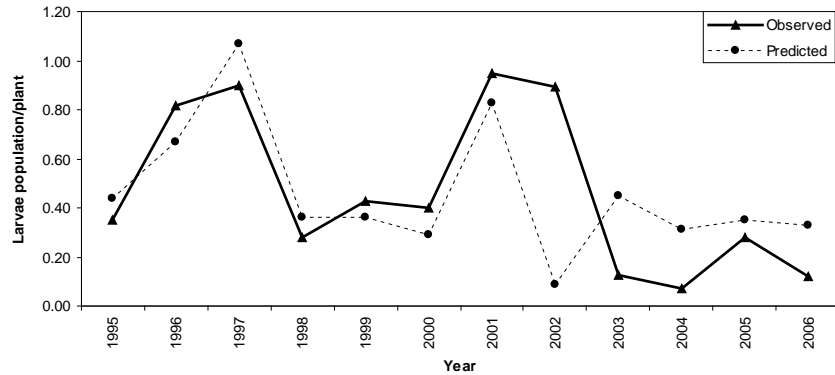


Fig. 3. Observed and predicted peak larvae population of leaf roller in sesame crop at Tikamgarh

Where

Y = Leaf roller larvae population

X_1 = Weekly maximum temperature of preceding weeks (30-34th SMW)

X_2 = Weekly mean temperature of preceding weeks (30-34th SMW)

X_3 = Weekly total rainfall during peak period (35-39th SMW)

The coefficient of determination (R^2) is 0.88 thereby showing a good account of variability by various factors during preceding week and peak period of incidence. The observed peak larval population and predicted peak larval population through predictive equation was shown in Fig. 3. The mean deviation (MD) between observed and predicted peak larval population is 0.003 which indicates that there is good agreement between observed and predicted peak larval population. Thus, the above equation can be useful for estimations of peak larval population of leaf roller in Sesame crop using mean weekly weather data. Vishva Dhar *et al.*, (2007) have been reported the weather based regression model for pod-borer infestation prediction in Central U.P.

4. Conclusions

Leaf roller larval population may be estimated through predictive equation at Tikamgarh area of Bundelkhand zone. Thus, it may be concluded that weather parameters during previous week as well as during the peak population period, play an important role in pest population build up in Bundelkhand zone. This information could be used as a tool to frame timely pest

management strategies in sesame. The predictive model may be utilized in operational and tactical measures to alter the calendar based spraying and spot the judicious application of pesticide for controlling of leaf roller incidence in Bundelkhand zone.

References

- Annual report, 2006-2007, "All India Coordinated Research Project on Sesame and Niger", ICAR (JNKVV Campus, Jabalpur), 132-133.
- Anonymous, 2003, FAO Production Year book, 44-114.
- Ahuja, D. B., 1989, "Seasonal incidence of insect pests in *Sesamum indicum* Linn.", *J. Ent. Res.*, **13**, 116-120.
- Ahuja, D. B., 1990, "Assessment of loss in seed yield due to leaf webber and capsule borer (*Antigastra catalaunalis*) in different varieties of sesame (*Sesamum indicum*)", *Indian J. Agric. Sci.*, **61**, 147-149.
- Ahuja, D. B. and Bakheta, D. R. C., 1995, "Bioecology and management of insect pests of sesame - A review", *J. Insect Sci.*, **8**, 1, 1-19.
- Desai, M. T. and Patel, R. M., 1965, "Studies on sesame leaf roller *Antigastra catalaunalis* (Duponchel) in Gujarat", *Indian oilseed J.*, **9**, 109-112.
- Ghorpade, S. A. and Thakur, S. G., 1995, "Management of major insect pests of sesame in India", *J. Insect Sci.*, **8**, 1, 43-47.
- Kumar, S. and Goel, S. C., 1994, "A great ancient oilseed sesamum", *Farmers and Parliament*, **29**, 15-16, 27-28.
- Vishva Dhar, Singh, S. K., Kumar, M., Agrawal, R. and Kumar, Amrender, 2007, "Prediction of Pod-borer (*H. armigera*) infestation in short duration pigeonpea (*Cajanus cajan*) in Central U.P.", *Indian J. of Agric. Science*, **77**, 10, 701-704.