MAUSAM, 52, 4 (October 2001), 691-696

551.5 : 63

Abiotic control on the incidence of pod borer on red gram [*Cajanus cajan* (L.) *Millsp.*]

N. CHATTOPADHYAY, R.P. SAMUI and P. S. RAVINDRA

Meteorological Office, Pune-411005, India

(*Received 24 July 2000, Modified 21 November 2000*)

सार - इस शोध-पत्र में अरहर की फसल में लगने वाले फली छेदक कीट के प्रयोग के संबंध में मौसम विज्ञान के प्राचलों की भूमिका का पता लगाने का प्रयास किया गया है। इस बात का पता चला है कि न्यूनतम तापमान और आपेक्षिक आर्द्रता (प्रातःकाल और अपराह्न दोनों समयों में) इस कीट के लिए प्रतिकूल है। जबकि पूर्व के सप्ताहों की तेज धूप फली छेदक कीट की संख्या में बढ़ोतरी के अनुकूल पाई गई है। साफ आकाश के समय न्यूनतम तापमान में कमी (12° से. या इससे अधिक) तथा प्रातःकालीन और अपराह्न की आपेक्षिक आर्द्रता (80 प्रतिशत या इससे अधिक और 45 प्रतिशत या इससे अधिक) की स्थितियाँ कीटों की संख्या में बढ़ोतरी और उनकी वृद्धि के अनुकूल पाई गई हैं। इस अध्ययन में तैयार किए गए मौसम पर आधारित दिशा-निर्देशों का प्रयोग अरहर की फसल में फली छेदक कीट पर फसल संरक्षण हेतु किया जा सकता है।

ABSTRACT. An attempt has been made in this study to work out the role of meteorological parameters on the incidence of pod borer on red gram. Minimum temperature and relative humidity (both morning and afternoon) were found to be negatively correlated while bright hours of sunshine in the preceding weeks was positively correlated with the pod borer population. Decrease in minimum temperature ($\leq 12°C$), morning and afternoon relative humidity ($\leq 80\%$ and $\leq 45\%$ respectively) under clear skies favoured the multiplication and growth of the pest. Weather based guidelines generated in this study could be used for the operational crop protection of pod borer on red gram.

Key words – Pigeon pea, Heliothis armigera, Meteorological parameters, Forewarning guidelines.

1. Introduction

Pigeon pea or red gram is one of the most widely cultivated pulse crops in the country. The yield of the crop is severely damaged by the number of species of insect. Gram pod borer (*Heliothis armigera*) has been reported to cause severe loss to the gram (chickpea), arhar (pigeon pea), cotton and sorghum during the last few decades in the country (Srivastava and Singh 1973, Singh and Singh 1974, Saharia and Dutta 1975). Though the pod borer enjoys all India distribution, it appears occasionally in epidemic form in certain districts of the principle gram growing states namely Madhya Pradesh, Uttar Pradesh, Haryana and Maharashtra. A major epidemic outbreak of this pest in Madhya Pradesh was reported during 1967-68 *rabi* season. Late maturing pigeon pea extensively grown in Uttar Pradesh was also severely damaged by the pod borer (Lal 1981, Lal *et al.* 1981). In a large-scale field survey conducted by ICRISAT throughout India during 1975-81, found that the total pod damage due to lepidopteran borer ranged from 13.2 to 36.4 per cent (Bhatnagar *et al.* 1982). Large scale cultivation of unrecommended susceptible varieties, choice of wrong insecticides, longer spell interval and indiscriminate and excessive use of some insecticides especially synthetic pyrethroids were some of the reasons for the outbreak of the pest (Dhaliwal and Arora 1998).

Amongst the several methods used in monitoring pests, pheromone traps are widely accepted as a supplement to or a replacement for traditional monitoring methods for spray timing (Batiste *et al.* 1970, Madsen and Vakenti, 1972, Mani *et al.* 1972). Glenn (1922) predicted the incidence of the first appearance of the various life stages of pest over the season based on degree-days. This solely based on temperature gave satisfactory results for spray timing (Headlee 1931). The weather factors like temperature, relative humidity, photo-period, rainfall etc. play an important role in the build up of pod borer population suddenly to a greater extent (Riper and George 1965, Singh and Singh 1978, Wu *et al.* 1978, Vaishampayan and Veda 1980, Patil *et al.* 1992, Tadas *et al.* 1994, Prasad *et al.* 1985, Kadu *et al.* 1987). In the present study a field study was conducted to record gram

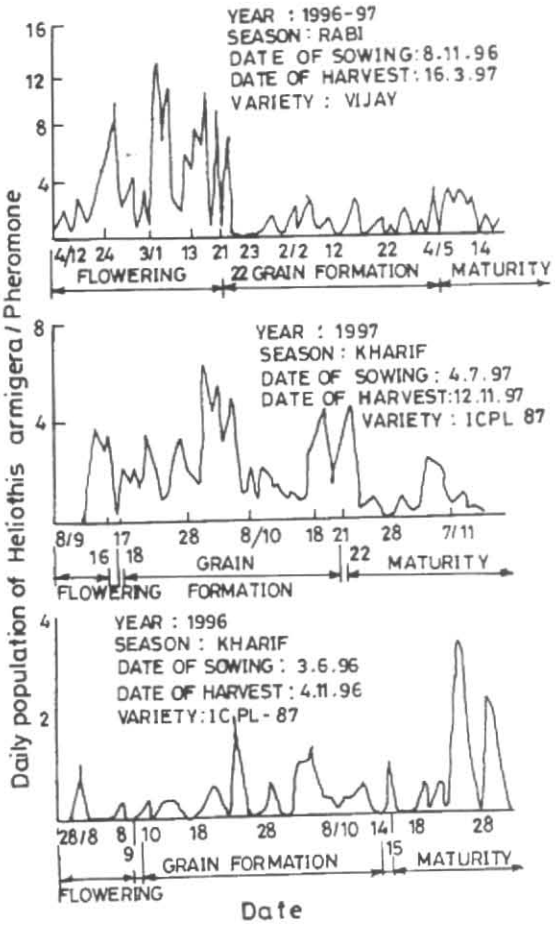

Fig. 1. Daily population of *Heliothis armigera* on red gram in different seasons

pod borer with respect to the prevailing weather parameters. The objective of the study was to establish the relationship between the population of the gram pod borer with meteorological parameters and also to establish a workable forecasting system which could be easily incorporated in a pest management programme for red gram.

2. Data and methodology

Field experiments were conducted during two consecutive years *i.e.* 1996 and 1997 for three crop seasons (two *kharif* and one *rabi*) growing two varieties of crops (ICPL – 87 in *kharif* & Vijay in *rabi* seasons) at the experimental field plots of the Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri (19°24′ N, 74°30′ E), Maharashtra. Adult pod borer observation (three replications) was recorded in the untreated plot throughout the entire crop season by using specially designed plastic trap (Catch-A-Moth) that uses biosense lure to attract moths into a trap from which they are unable to escape. Catch-A-Moth consists of a green plastic disc, yellow plastic cover, white bottom and wire hangers. Catch-A-Moths were hung at a height approximately 4 ft above the ground for the best performance. Lures were replaced at an interval of one month. The daily meteorological parameters-maximum temperature (T_{max}), minimum temperature (T_{min}), humidity both at 0730 IST (Rh_1) and 1730 IST (Rh_2), rainfall (R/F) and sunshine hours (Ssh) recorded in the observatory of the University were used.

Both statistical tools and graphical superimposition techniques were used to work out the inter-relationships between the pest population and meteorological variables. Using Sigma Statistical Software Version 2.0 for Windows- 95 - developed by Jandal Scientific Software, USA, statistical studies were made. Using Pearson's method simple correlation were worked out between population of the pest and meteorological parameters in the preceding period (1 to 6 weeks before) on the incidence of pest. '*t*' test was applied to test the significance of these correlations at 5 per cent level. Graphical superimposition of daily data of pest and meteorological parameters were also made to workout critical values of the latter conducive for the increased population of the pest.

3. Result and discussion

In all the crop seasons under study the pod borer appeared either in flowering or grain formation stage of the crop (Fig. 1.) This observation is in consonance with the findings of Shekar *et al.* (1991) and Singh and Singh (1991) who reported that pigeon pea has really been attacked by *Heliothis armigera* only during flowering and fruiting stages of the crop. It was observed that the population of the pest was relatively higher in *rabi* season than *kharif*. Average weekly population reached upto six-adults/pheromone trap in *rabi* season. In this season maximum daily adult population in trap was recorded upto 13. In the *kharif* season, the pod borer population was mainly confined between 38th to 46th standard week *i.e.* 17th September to 18th November. According to Bilapate *et al.* (1988) usually the massive attack by *Heliothis armigera* develops on pigeon pea from October in Marathwada region of Maharashtra. Tadas *et al.* (1994) observed the maximum pheromone catches of the *Heliothis armigera* on cotton field at Akola, Maharashtra from middle of August to end of September. In *rabi* season though the pest population was recorded upto 11th week (18th March) of the succeeding year, the population was maximum in the month of January. Singh and Singh (1991) recorded the population densities of some major insect pests on 14 late maturing cultivars of pigeon pea sown as *kharif* and *rabi*

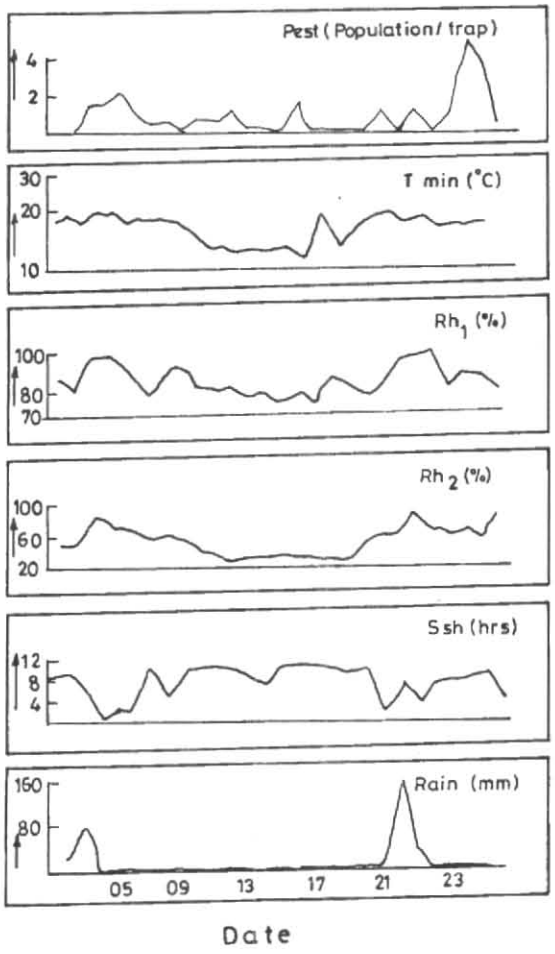

Fig. 2. Variations of different meteorological parameters during and before the incidence of *Heliothis armigera* in *Kharif* season (1996)

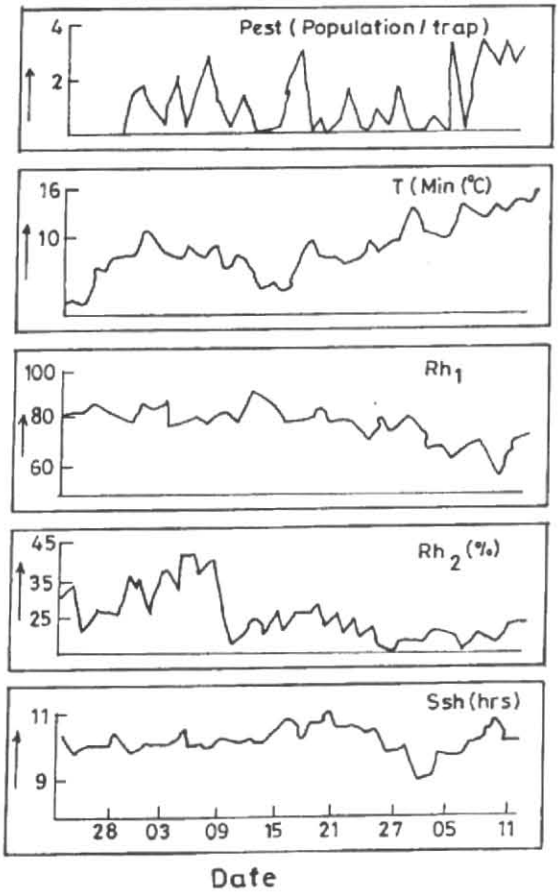

Fig. 3. Variations of different meteorological parameters during and before the incidence of *Heliothis armigera* in *Rabi* season (1996-97)

crops during 1981 – 82 and 1982 – 83. The authors observed that the mean larval population *of Heliothis armigera* was maximum during the *rabi* season in both the years.

Total life cycle of the pod borer is about 40 days. The approximate duration of egg, larvae, pupa and adult stages is 1,3, 1, 1 weeks respectively (Atwal 1986, Nair 1986). Thus the total period required from egg to adult stage is around 5 weeks. ETL of the pest is one larva per one to two plants or 5 to 10 per cent damages (DPR 1990). The larva stage causes maximum damage to this crop. Fluctuations in the population of any of the stages affect the adult population. Thus in this paper, studies were made to find out the role of meteorological parameters in the preceding six weeks on the stage wise development of gram pod borer.

All the stages of the life cycle particularly the larva stage was affected most by the decrease in minimum temperature. In *kharif* 1996 pest population was more than 2 larvae on 26th and 27th October. During this season minimum temperature started decreasing from 20.6° C on 7th October to 12.2° C on 17th October (Fig. 2). Similar observations were also reported in other two seasons (Fig. 3). Correlation studies indicate that there was a negative correlation between minimum temperature for all the preceding weeks (1 – 6) and the pest population (Fig. 4). In *kharif* 1996, the pest population and minimum temperature at 2, 3 and 5 weeks before were significantly correlated with the pest population (r – values were in the range of – 0.6 to – 0.90). Negative correlation of *Heliothis armigera* with minimum temperature was also reported by Singh and Singh (1978) who reported that

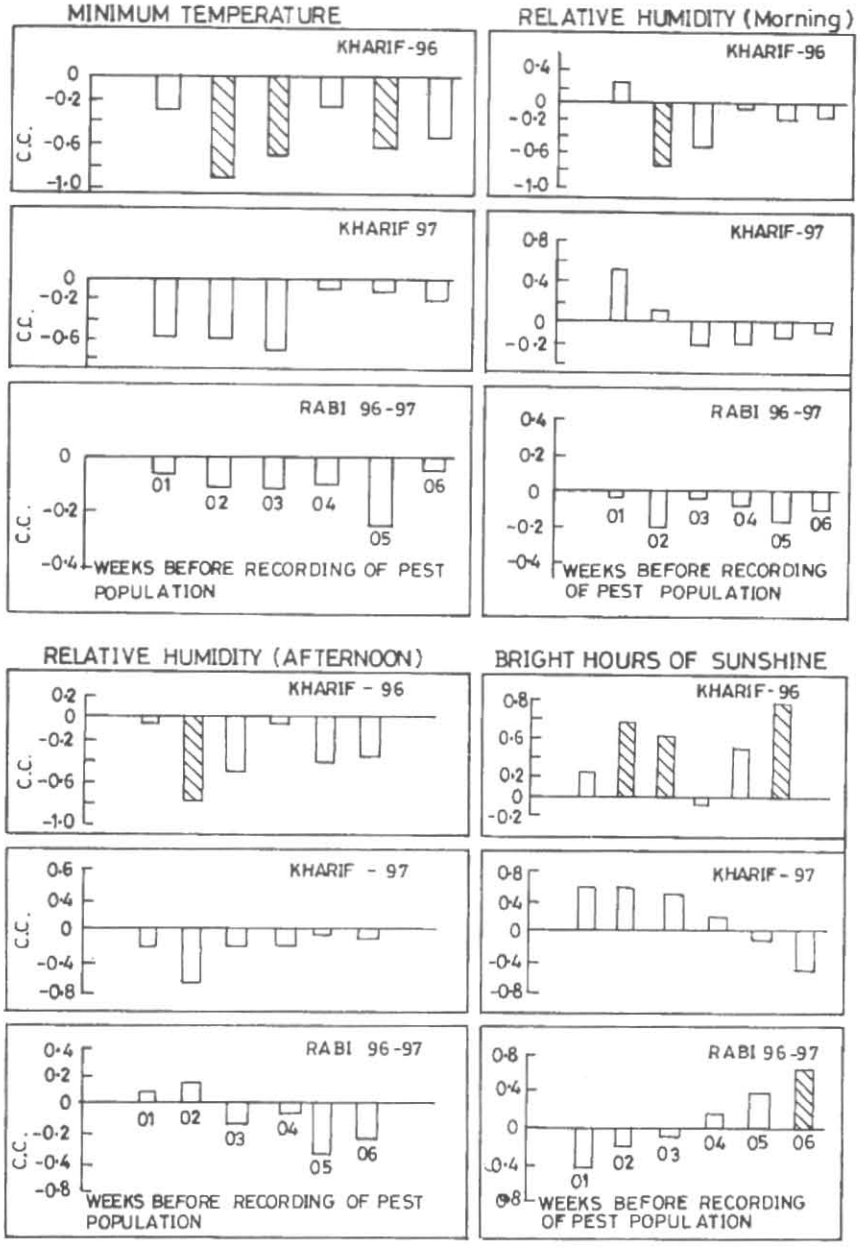

Fig. 4. Correlation coefficient between the population of *Heliothis armigera* and minimum temperature, relative humidity (both morning and afternoon) and bright hours of sunshine

decline in temperature below 17° C favoured the multiplication of the pest.

Both morning and afternoon relative humidity before 2 to 6 weeks were negatively correlated with the pest population in all the crop season (Fig.4). In *kharif* 1996, morning and afternoon relative humidity 2 weeks before were significantly negatively correlated with the pest population. Correlation coefficient values were of the order of –0.8. Singh and Singh (1978) Vaishampayan and Veda (1980) and Tadas *et al.* (1994) also reported that relative humidity were negatively correlated with the pod borer population. In *kharif* 1996, both morning and evening relative humidity started decreasing from 9th

October from 93 and 59 % to 75% and 30% respectively on 17th October. The pest population was high on 26th and 27th October [2.3 to 3.3 adult/pheromone per day]. Similar decrease in humidity with corresponding high pest population was also observed in other seasons.

Except for the *rabi* season, in general, sunshine hours in most of the preceding weeks were positively correlated with the pest population. In *kharif* 1996 sunshine hours at 2, 3, and 6 days before was significantly positively correlated with the pest population. In the entire crop seasons' sunshine hours was relatively high (>6.6 hours) at least 2 weeks before the incidence of high population of pest. The finding of Singh and Singh (1978) and Tadas *et al.* (1994) supports this observation. No consistent relationship was observed between rainfall and pest population in the crop seasons under study.

4. Conclusion

The results of the study are summarized below:

(*i*) The population of the pod borer was relatively higher in *rabi* than in *kharif* season during flowering to pod formation stages of the crop.

(*ii*) Minimum temperature for all the preceding weeks (1 to 6) was negatively correlated with the pest population. Lower minimum temperature below 12° C was favourable for pest development.

(*iii*) Both morning and afternoon relative humidity before 2 to 6 weeks were also negatively correlated with the pest population. Decrease in morning and afternoon relative humidity respectively below 80% and 45% were found to be favourable for the outbreak of the pest.

(*iv*) Bright hours of sunshine were positively correlated with the pest population. In all the crop seasons the hours of bright sunshine (>6.6 hours) at least two weeks before was favourable for the incidence of high population of the pest.

(*v*) By monitoring the real time meteorological data recorded in the nearby observatory during flowering and pod formation maturity stage of the crop, it would be possible to control/minimize the pod borer damages by forewarning the incidences of the pest.

It may be mentioned that the reliability of the result obtained in the study could be improved if pheromone traps data of the pest are collected for more number of stations over a longer period.

Acknowledgements

The authors are thankful to Shri. S.K. Shaha Deputy Director General of Meteorology (Agrimet) for encouraging and providing full facilities for carrying out the work. They are thankful to Shri. K.C. Mate, Shri. M.D. Dharamadhikari and Shri. M.C. Dethe, AET, Rahuri and Department of Entomology, MPKV, Rahuri for rendering help in pest data collection and also to Smt. S.N. Wadekar for data analysis.

References

Atwal, A. S., 1986, "Agricultural Pests of India and South – East Asia ", Kalyani Publishers, New Delhi.

Batiste, W. C., Berlowitz, A. and Oloon, W. H. , 1970, "Evaluation of insecticides for control of codling moth on pears in California and their usefulness in an integrated control programme", *J.Econ. Ent.*, **63**, 1457 – 1462.

Bhatnagar, V. S., Lateef, S. S., Sithananthan, S., Pawar, C.S. and Reed, W., 1982, "Research on *Heliothis* at ICRISAT (in) Proceedings of the International Workshop on *Heliothis* Management", held during 15 – 20 November 1981 at ICRISAT Centre, India , 385 –396.

Bilapate, G.G., Raoded, A.K. and Pawar, V.M. ,1988., "Investigation of borer *Heliothis armigera* (Hubner) in Marathwada – VII. Growth with reference to progression factors for successive instars on pigeon pea", *Indian J. Ent.*, **50**, 462-467.

Dhaliwal, G.S. and Arora, R., 1998, "Principles of Insect Pest Management", Kalyani Publishers, New Delhi, India.

DPR (Director of Pulse Research), 1990, "Recommendation of the First National Workshop on Heliothis Management: Current Status and Future Strategies", August 30-31, 1990, Kanpur. (Compiled by J. N. Sachan and Gururaj Katti).

Glenn. P.A., 1922, " Relation of temperature to development of codling moth", *J. Econ. Ent.*, **15**, 193–198.

Headlee, T. J., 1931, "Performance of the thermal constant as an indicator of the time to apply spraying for codling moth", *J. Econ. Ent.*, **24**, 291-296.

Kadu, N. R., Radke, S. G. and Borle, M. N., 1987, "Effect of temperature on the development of *Heliothis armigera* (Hubner)", *Indian J. Ent.*, **49** , 535-543.

Lal, S. S., 1981, "Needs and priorities for developing integrated pest management for pigeon pea pests", Pulse Crop Newsletter, **1**, 48– 49.

Lal, S. S., Yadava, C. P. and Dias, C. A. R, 1981, "Major pest problem of pigeon pea in Uttar Pradesh, India", International Pigeon pea Newsletter, **1** , 30–31.

Madsen, H. F. and Vakenti, J. M., 1972, "Codling moths: female – baited and synthetic pheromone catch population indicators", *Environ. Ent.*, **1**, 554 – 557.

Mani, E., Wildbolz, Th. and Riggenbach, W., 1972, "Die Mannchenfalle, eine nenue Prognosemephode fur den. Apfelwickler; Resultate, 1969 – 71", Schweiz. Z. Obst- u. Weinb, **108**, 337–344.

Nair, M. R. G. K., 1986, "Insects and Mites of Crops in India", Indian Council of Agricultural Research, New Delhi.

Patil, B. V., Nandihalli, B.S., Hugar, P. and Somesekhar., 1992, "Influence of weather parameters on pheromone trap catches of cotton bollworms", *Karnataka J. Agric. Sci.*, **5**, 346-350.

Prasad, Devendra, Premechand, Srivastva, G. P. and Pashupalak, S.N., 1985, "Possibility of integrated control of pod *borer Heliothis armigera* (Hubner) in pigeon pea", *Indian J.Ent.*, **47**, 215-219.

Riper, W. E. and George, L., 1965, "*Heliothis* Bollworm – Chapter 17 in Cotton pests of Sudan", Blackwell Sci. Pub., Oxford.

Saharia, D. and Dutta, B., 1975, " *Helioverpa armigera* serious pest of arhar in Assam", *Pesticides*, **9**, 34 –35.

Sekhar, J.C., Singh, K.M., Singh, R.N. and Singh, Y., 1991, "Succession of insect pest on pigeon pea Cajanus cajan (L.) Millsp. cultivors of different maturity", *Indian J. Ent.*, **53**, 316 – 319.

Singh, H. and Singh, G.,1974, "Gram podborer, *Helioverpa armigera* (Hubner) (Lepidoptera: noctuida)", *Agro. Indust. J.*, February, 1-9.

Singh, R.N. and Singh, K.M., 1978, " Incidence of insect – pest in early varieties of red gram,Cajanus cajan(L.) Millsp", *Indian J. Ent.*, **40**, 229 –244 .

Singh, H. K. and Singh, H. N., 1991, "Some major pest incidence on certain late cultivors of pigeon pea CAJANUS CAJAN. L.during half pod formation stage", *Indian J. Ent.*, **53**, 298 – 301.

Srivastava, A.S. and Singh, Y. P.,1973, " Control of *H. armigera* on sorghum", *Curr. Sci.*, **42**, 865 –866.

Tadas, P. L., Sarnaik, D.N., Kene, H.K. and Satpute, U. S., 1994, "Effect of weather parameters on monitoring of cotton bollworm with pheromone trap", *PKV- Research Journal*, **18**, 87-90.

Vaishampayan, S.M. and Veda, O.P., 1980, "Population dynamics of gram pod borer", *Helicoverpa armigera* (Hurbner) and its outbreak situation on gram, *Cicer arietinum* L. at Jabalpur, *Indian J.Ent.*, **42**, 453-459.

Wu, K. C., Chen, Y. P. and Li, M. H., 1978, "Tables for experimental populations of cotton bollworms", *Heliothis armigera* (Hubner), at different temperature, "Acta Entomologica Sinica", **21**, 385–392.