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Prediction of Pink Bollworm (*Pectinophora gossypiella* (Saunders) Population Cycles in Cotton by Accumulating Thermal Units in the Agro-Climate of Faisalabad

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Abstract.- Studies on forecasting population fluctuations of pink bollworm (PBW) of cotton, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae), were conducted on the basis of accumulation of degree-days (DD). Pheromone trap PBW moth catches per trap per night and the field infestation showed cyclic peaks at the intervals of 323 Celsius DD's. The predicted and observed moth population peaks largely conformed to three years of study. These results indicate that DD can help to detect periods of high risk for moth activity and thus can be used for a management of this pest throughout the crop season. Based on results, different factors responsible for PBW moth population peaks are discussed.

Key words: Degree days, pink bollworm, *Pectinophora gossypiella,* prediction model.

INTRODUCTION

The pink bollworm has been recorded in nearly all the cotton growing countries of the world (Anonymous, 1990) and is considered as a key pest in many of these areas. The infestation of pink bollworm in Pakistan on annual basis was 39.6, 15.5 and 32.9% during 1978, 1979 and 1980, respectively (Nasir, 1986). To overcome losses, a number of insecticides are being used throughout the cotton growing areas. But the extensive use of pesticides since 1982 changed the pest complex and bollworms, jassids and whiteflies began to appear as major pests of cotton (Inayatullah and Haseeb, 1996; Ahmad, 2000). Despite an increasing number of applications per year, resistance has developed against these pesticides (Attique, 1992). Pheromone trapping can be used to detect early infestations of an insect pest, monitor established populations and assist in the timing of pesticide applications in relation to the build-up of populations to dangerous levels (Jutsum and Gordon, 1989). Toscano *et al*. (1974) reported significant reductions in the number and cost of insecticide applications when treatments for pink bollworm control were based on male moth trap catches as compared to automatic five to seven day insecticide spray schedules.

Proper timings for area wide applications of insecticides, based on cyclic periodicity of bollworm population, can improve economic results and reduce the need for subsequent cotton treatments. The degree-day (DD) approach has been successfully used in the past for several economic pests, such as *Lygus* bugs (Sevacherian *et al*., 1977a), codling moth (Johnson, 1988) and peach tree borer (Johnson, 1989). The method of heat accumulation reported by Sevacherian *et al*. (1977b) was used to predict the pattern of spring emergence of pink bollworm by recording daily maximum and minimum temperatures and summing up the DD's. Because of variable agro-climate, population densities of the pests differ considerably between areas. Therefore, control programmes made through DD's for specific cotton production areas may be the most viable option (Naranjo *et al*., 2001). The knowledge of field temperatures and DDs can be used successfully to monitor, predict and control pest outbreaks be specific in district Faisalabad is the main aim of the present study.

MATERIALS AND METHODS

Studies on infestation of pink bollworm (PBW) in cotton varieties (NIAB Karishma, NIAB-86 and NIAB-78) were conducted at experimental farm of Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad along with five other

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Table I.- **Comparison of actual observed and predicted dates of pink bollworm population peaks by accumulating degree days and monitoring sex-lure trap catches in district Faisalabad, Pakistan.**

Year	Generation	Observed		Predicted	
		Date	Degree Days	Date	Degree Days
1998	First	August 11	2170	August 10	2163
	Second	September 01	2504	August 31	2486
	Third	September 22	2815	September 21	2809
	Fourth	October 06	3015	October 15	3132
		SE = ± 185		SE = ± 208	
1999	First	August 04	2155	August 05	2163
	Second	August 25	2477	August 26	2486
	Third	September 22	2908	September 05	2809
	Fourth	-	-	October 08	3132
		SE = ± 218			
2000	First	-	-	August 08	2163
	Second	September 01	2556	August 28	2486
	Third	September 29	2965	September 18	2809
	Fourth	-	-	04 October	3132
		SE = ± 204			

locations (Chak Nos. 28 J.B., 243 R.B., 273 R.B., 276 R.B. and 149 G.B.) for three years *i.e.*, 1998, 1999 and 2000. Cotton varieties were sown during first fortnight of May in 4.5 ha fields in three replicates and the crop was raised using normal practices of fertilizer and insecticides applications. In another field at NIAB farm, no insecticides were sprayed on cotton and PBW larvae density was recorded weekly from July through October. While on other sites pheromone traps of PBW were installed in cotton fields @ two traps ha^{-1} and moths captured per trap per week were recorded. Daily minimum and maximum temperatures from January to December were collected from Ayub Agriculture Research Institute (AARI), Faisalabad to compute degree days (DD's) above low threshold development temperature, 12.6^{o}C according to Hamed (2005). The data on insect infestation (%) and pheromone trap moth catches were subjected to analysis of variance (Steel and Torrie, 1984) and the significant means were compared using Duncan new multiple range test. The means of observations were transformed to graphics for comparison between insect infestation, moth population trapped, accumulated DD's and the years. The actual/ observed peaks of PBW moths monitored by pheromones traps on different dates were compared with that of predicted dates by cumulative DD's during three years of the study.

RESULTS AND DISCUSSION

The results on PBW moths captured per trap per week at NIAB and farmer's field during three years (Fig. 1a, b, c) showed similar population trend and the correlations between moth populations at NIAB farm and farmers field were significant. (r = 0.571*, 0.777** and 0.961**). Likewise the correlation between PBW moths captured per trap per night and percent infestation in cotton under unsprayed conditions at NIAB (Fig. 2) were positive and significant (r =0.525*, 0.819** and 0.974**) during the three study years. The relationship between PBW moths captured per trap per night and percent infestation against DD's in unsprayed cotton fields at NIAB farm were also positive during the study years (Fig. 3). The peak populations observed/ monitored by pheromone traps and predicted by accumulated DD's over three years of study are presented in table 1. The results indicated that predicted PBW moth peaks occurred after 323 DD's during activity period whereas moth peaks observed by pheromones traps took approximately 321 DD's. Therefore, the predicted and observed moth population peaks showed conformity during the study period with a few days variations. The first

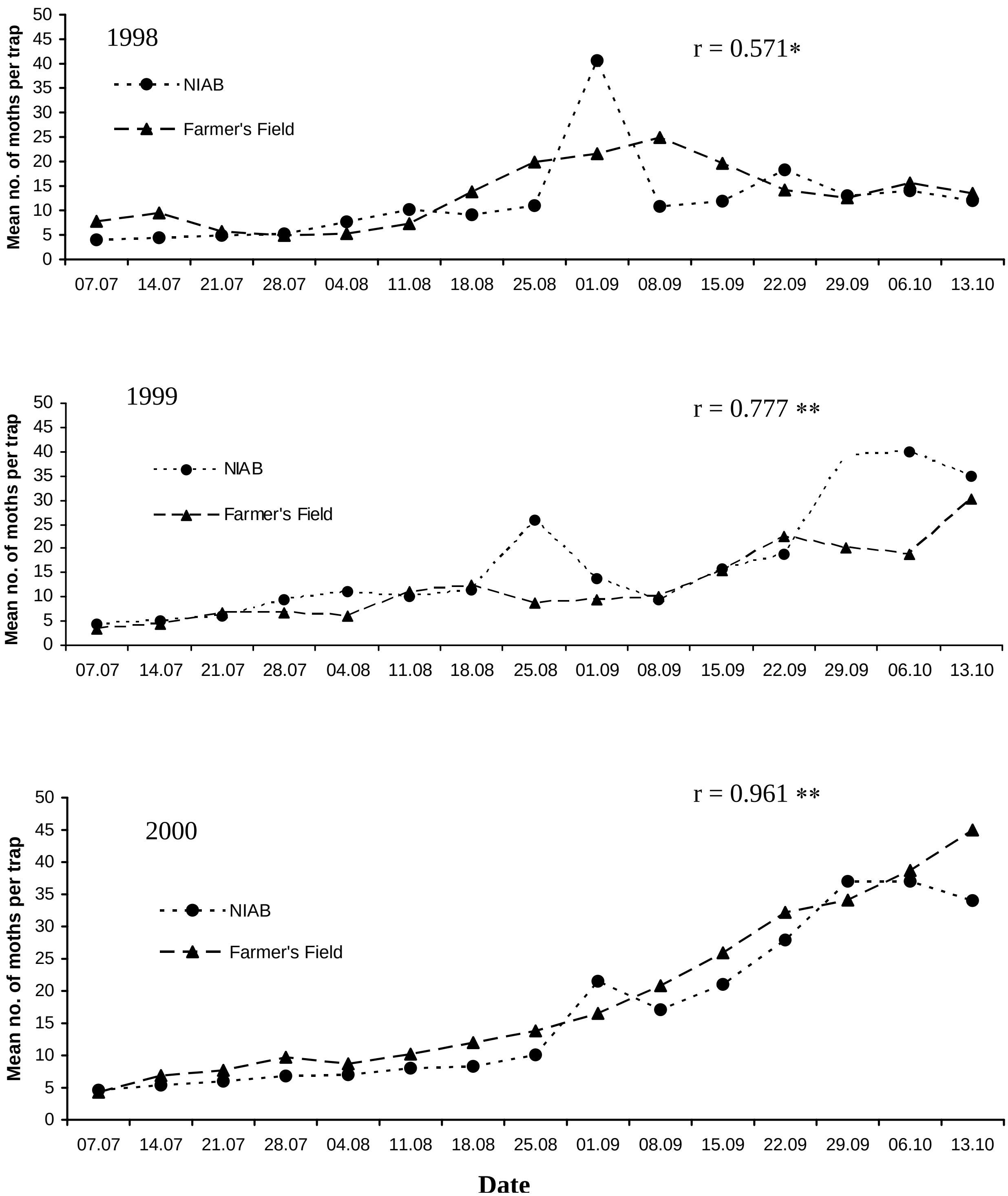

Fig. 1. Comparison of pink bollworm moths per trap per week at NIAB in un-sprayed cotton and at farmer's field in sprayed cotton in district Faisalabad over three years.

population peak appeared during 2nd week of August, whereas the last one during 1st week of October during 1998. There was minimum difference of one day and maximum of 9 days between observed and predicted moth population peaks. The highest difference (17 days) in observed and predicted moth population peak was recorded in the 3rd peak during 1999.

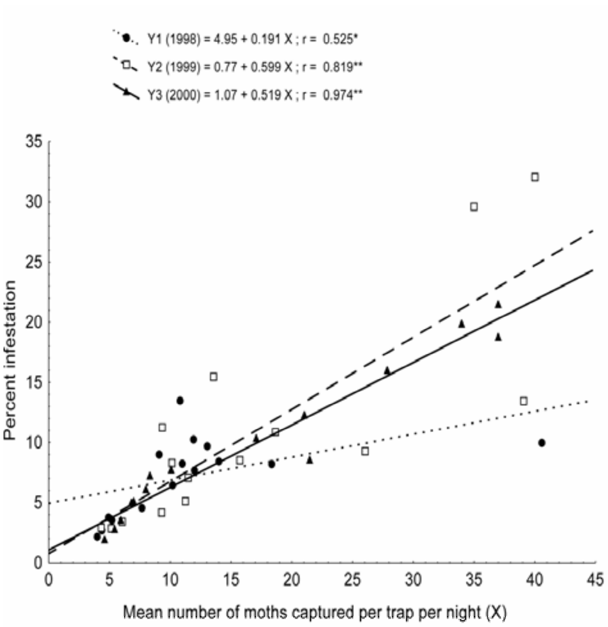

Fig. 2. Correlation between pink bollworm moths captured per trap per night and percent infestation under unsprayed conditions at NIAB.

Many workers (Naranjo and Martin, 1993; Toscano *et al.*, 1979) conducted studies on DD's for the prediction of PBW life stages in cotton crop. However, our findings do not agree exactly with that of the previous workers. The reason might be the difference in locality, temperature and strains of the test insects. We observed four generations of PBW in cotton crop with moth peaks in the months of August, September and October. In previous findings it was concluded that PBW moths activity initiated during July/August, increased steadily and remained active to end of October/mid November (Guirguis *et al.*, 1991; Taneja and Jayaswal, 1986; Singh and Lather, 1989; Yang and Li, 1986; Dhawan and Sidhu, 1987; Gupta and Katiyar, 1990).

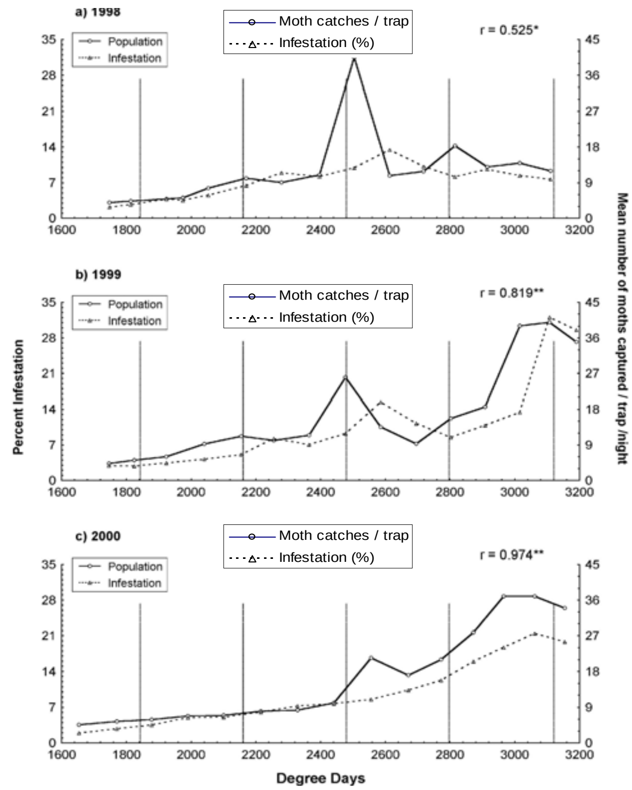

Fig. 3. Comparison between pink bollworm moths captured per trap per night and percent infestation against degree days in unsprayed conditions at NIAB from 1998 to 2000.

Negative correlation existed between trap catches and temperature (Patil *et al.*, 1992; Qureshi *et al.*, 1994; Korat and Lingappa, 1995), whereas direct relationship occurred between trap catches and field infestation (Muthukrishnan and Balasubramanian, 1992). It is inferred from the results that DD's can help to know the periods of high alert for effective integrated pest management of PBW of cotton through out the crop season.

REFERENCES

AHMAD, Z., 2000. Integrated pest management in Pakistan. *The News*, August 01, Lahore.

ANONYMOUS, 1990. *Pectinophora gossypiella* (Saunders). CAB International Institute of Entomology. Distribution Maps of Pests, Series A (Agricultural) Map No13, 3rd Rev.

ATTIQUE, M.R., 1992. Use of sex pheromones for the control of bollworms as part of IPM programme in Pakistan. *The Pakistan Cotton*, **36**: 47-56.

DHAWAN, A.K. AND SIDHU, A.S., 1987. Monitoring the seasonal occurrence and distribution of pink bollworm, *Pectinophora gossypiella* (Saunders) with gossyplure traps for control strategy. *Ind. J. Pl. Protect.*, **15**: 124-130.

GUIRGUIS, M.W., EL-FESHWI, A.A., WATSON, W.M. AND NASSEF, M.A., 1991. Occurrence and seasonal abundance of the pink bollworm, *Pectinophora gossypiella* Saund infesting cotton. *Egyptian J. agric. Res*., **69**: 63-72.

GUPTA, G.P. AND KATIYAR, K.N., 1990. Behaviour of male pink bollworm (*Pectinophora gossypiella*) towards gossyplure and its relationship with larval population and weather condition. *Ind. J. agric. Sci.*, **60**: 411-416.

HAMED, M., 2005. *Formation of prediction models for bollworms complex in cotton of district Faisalabad*. Ph.D. thesis, University of the Punjab, Pakistan, pp. 225.

INAYATULLAH, C. AND HASEEB, M., 1996. Poisoning by pesticides. *Pakistan J. med. Res*., **35**: 57-58

JOHNSON, D.T., 1988. The codling moth model is available. *Proc. Ark. St. Hort. Soc*., **109**: 113-117.

JOHNSON, D.T., 1989. Peach scouting in Arkansas and control of peach tree borers. *Proc. Ark. St. Hort. Soc.*, pp. 235.

JUTSUM. A.R. AND GORDON, R.F.S., 1989. *Insect pheromones in plant protection*. John Wiley and Sons Ltd. New York, pp. 369.

KORAT, D.M. AND LINGAPPA, S., 1995. Influence of weather factors on the pheromone trap catches of cotton bollworm moth. *Ind. J. Pl. Protect.*, **23**: 188-190.

MUTHUKRISHNAN, N. AND BALASUBRAMANIAN, M., 1992. Relationship between the pheromone trap catches of *Pectinophora gossypiella* and *Spodoptera litura*, their field infestation and larval population. *Madras J. Agric.*, **6**: 321-326.

NARANJO, S.E., BUTLER, G.D. JR. AND HENNEBERRY, T.J., 2001. *A bibliography of the pink bollworm*, Pectinophora gossypiella *(Saunders)*. USDA, ARS, Bibliographies and Literature of Agriculture, pp. 136.

NARANJO, S.E. AND MARTIN, J.M., 1993. Comparative development, reproduction, and oviposition of pink bollworm (Lepidoptera: Gelechiidae) on a resistant okra-leaf cotton and commercial upland and Pima cultivars. *J. econ. Ent*., **86**: 1094-1103.

NASIR, M., 1986. *Studies on the population dynamics of spotted bollworms (*Earias *spp.)* M.Sc. (Hons) Agri. thesis, University of Agriculture, Faisalabad, pp. 6-8.

PATIL, S.V., NANDIHALLI, B.S., HUGAR, P. AND SOMASEKHAR, P., 1992. Influence of weather parameters on pheromone trap catches of cotton bollworms. *Karnataka J. agric. Sci.*, **5**: 346-350.

QURESHI, Z.A., AHMAD, N. HUSSAIN, T. AND SHAKOORI, A.R., 1994. Pheromone trap catches of pink bollworm as influenced by crop phenology and climatic factors. *Proceedings of 12th Pak. Congr. of Zool. Govt. College, Lahore*, pp. 43-47.

SEVACHERIAN, V., STERN V.M. AND MUELLER, A.J., 1977a. Heat accumulation for timing *Lygus* control, Safflower-cotton complex. *J. econ. Ent.*, **70**: 399-402.

SEVACHERIAN, V., TOSCANO, N.C., VAN STEENWYK, R.A., SHARMA, R.K. AND SANDERS, R.R., 1977b. Forecasting pink bollworm emergence by thermal summation. *Environ. Ent*., **6**: 545-546.

SINGH, J.P. AND LATHER, B.P.S., 1989. Monitoring of pink bollworm moths and larvae. *Ind. J. Pl. Protect*., **17**: 199-204.

STEEL, R.G.D. AND TORRIE, J.H., 1984. *Principles and procedures of statistics*. McGraw Hill Book Co. Inc., New York, USA. pp. 172-177.

TANEJA, S.L. AND JAYASWAL, A.P., 1986. Population dynamics of pink bollworm, *Pectinophora gossypiella* (Saunders) on upland cotton. *Insect Sci. Applic.*, **7**: 569-573.

TOSCANO, N.C., MUELLER, A.J., SEVACHERIAN, V., SHARMA, R.K., NIILUS, T. AND REYNOLDS, H.T., 1974. Insecticide applications based on hexalure trap catches versus automatic schedule treatments for pink bollworm moth control. *J. econ. Ent*., **67**: 522-524.

TOSCANO, N.C., VAN STEENWYK, R.A., SEVACHERIAN, V. AND REYNOLDS, H.T., 1979. Predicting population cycles of the pink bollworm on some varieties of cotton in Haryana. *Ind. J. Ent*., **46**: 340-345.

YANG, Z.F. AND LI, X.J., 1986. Interaction between cotton fruits and pink bollworm, *Pectinophora gossypiella* (Saunder). *Acta Phytophylac. Sin.*, **13**: 175-178.

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