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Agro-ecological zonation of leaf folder (*Cnaphalocrosis medinalis*) infestation in Haryana*

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Pest zonation is a concept, which has application for large area pest management. Pest population model can be run with requisite weather data to determine probability of severe pest epidemics at a site. The site predictions can then be extrapolated using geographic information system (GIS) to carve out zones of same epidemic potential for the pest. This has been demonstrated for tropical rice blast (Teng and Savary 1992). Coakley (1990) categorized the sites on the basis of their conduciveness to specific wheat (*Triticum* sp) disease using historical climatic data. Similarly, the risk of an environment to tomato viruses has been predicted in Arizona using geostatistics and geographic information system (Teng and Savary 1992). Keeping in view the potential applications of pest zonation in pest management, the present investigation was attempted to study agro-ecological zonation of leaf folder (*Cnaphalocrosis medinalis* Geenee) infestation in Haryana.

Data on leaf-folder infestation in rice (*Oryza sativa* L.) in Punjab and Haryana from 1972 to 1999 were collected during 2000 from Rapid Roving Survey Reports of Directorate of Plant Protection, Quarantine and Storage, Faridabad, and Annual Reports of the Punjab Agricultural University (PAU), Ludhiana, and Chaudhary Charan Singh Haryana Agricultural University (HAU), Hisar. The data were in qualitative form, indicating severity of the leaf-folder incidence in 4 classes, viz very low, low, moderate and severe. The pest incidence in an area such as Ludhiana or Karnal was arrived at by averaging the peak pest incidence of many fields at several sampling stations during the season. The weather data, viz maximum temperature, minimum temperature, relative humidity, rainfall and sunshine hours, of different years for Ludhiana, Karnal, Ambala, Gurgaon and Hisar were also collected. From daily mean, mean monthly temperature was worked out. Similarly, mean monthly values of relative humidity, rainfall and sunshine hours were derived.

Leaf-folder infestation from 1972 to 1999 at Ludhiana was analysed in relation to monthly averaged maximum temperature, minimum temperature, mean temperature, relative humidity and rainfall of September to develop leaf folder- weather model. Actually, the leaf-folder data from 1972 to 87 and 1988 to 99 were used for model development and model validation respectively. The model was also validated with pest data from Karnal. The validated model was then used for pest zonation and risk analysis for different rice-growing areas of Haryana. These areas were classified into various zones with the 'geographic information system' using Idrisi package. Rice map of Haryana was then overlaid on zoned map for locating rice-growing areas in each zone.

Pest-risk analysis was carried out for Hisar, Gurgaon, Karnal and Ambala by determining simulated levels of leaf-folder infestation on the basis of monthly mean September temperature for several preceding years and then finding out the probability of occurrence of different levels of leaf-folder incidence at these places.

The analysis of leaf-folder infestation data from 1972 to 99 in relation to weather factors at Ludhiana showed qualitative relationship between the pest incidence and monthly averaged mean September temperature. The mean September temperature from 26.5° to 28.5°C had association with low leaf-folder incidence, while temperature from 28.2 to 30.5°C was associated with moderate infestation (Table 1).

The mean September temperature remained less than 28.5°C during 1972, 1973, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1984, 1989, 1992 and 1993, whereas during other years it was more than 28.5°C. Other meteorological factors like relative humidity and rainfall did not show any clear relation with leaf-folder incidence. The leaf-folder incidence was at peak after panicle-emergence stage of the crop, around 80 days after transplanting in September (Chander and Singh 2000). The relationship between mean September temperature and leaf-folder incidence thus seems logical.

As mean September temperature between 26.5° and 28.5°C and 28.2° and 30.5°C was associated with low and moderate leaf-folder incidence, respectively, there was thus slight overlap between these temperature ranges. Therefore

*Short note

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Table 1 Leaf-folder infestation and monthly averaged mean September temperature for Ludhiana (Punjab)

Year	Leaf folder infestation	Mean temperature (°C) of September
1972	++	26.7
1973	−+	28.3
1976	++	26.5
1977	++	26.8
1978	++	27.7
1979	−++	28.2
1980	+++	28.2
1981	+++	28.4
1982	++	28.3
1983	++	29.0
1984	++	26.8
1985	++	28.5
1987	+++	30.1
1988	+++	30.3
1989	+++	27.7
1991	++	28.8
1992	++	28.2
1993	+−	27.5
1997	+−	27.9
1998	++	29.5
1999	++	28.2

++, Low infestation level; +++, moderate infestation level

The qualitative model developed on the basis of data given in Table 1 was :

Infestation level	*Mean monthly average (September temperature)*
++ (low)	26.5 28.5°C
+++ (moderate)	28.2–30.1°C

for validation purpose low infestation up to 28.5°C was accepted as true, while moderate infestation at more than 28.5°C was considered true. When the leaf folder–weather model was validated for Ludhiana, there was about 81% agreement between simulated and observed leaf-folder infestation level. Similarly, the validation of the model for Karnal revealed around 76% agreement between simulated and observed leaf-folder incidence (Table 2).

Based on the mean September temperature, viz 26.5, 26.5–28.5, 28.5–30.5 and > 30.5°C, Haryana state could be divided into 4 zones using Idrisi package of geographic information system. Rice-growing areas with low and moderate leaf-folder infestation potential could be identified. Most of the areas of the state were covered by second and third categories of temperature. None of the districts was exclusively accounted for by 26.5 to 28.5°C and 28.5 to 30.5°C range of temperature. In some districts, areas with 26.5 to 28.5°C were dominant while in others areas with 28.5 to 30.5°C were more.

The probability of moderate and leaf folder incidence was 0.85 and 0.15, 0.64 and 0.36, 0.35 and 0.65, and 0.24 and 0.76 at Hisar, Gurgaon, Karnal and Ambala respectively. Therefore, more likelihood of moderate infestation of leaf-

Table 2 Validation of leaf folder–weather model with data from Ludhiana and Karnal

Place	Mean September temperature (°C)	Observed infestation	Simulated infestation	Right or wrong	Accuracy
Ludhiana	30.3	+++	+++	R	
	27.7	−+	++	R	
	28.8	−+	+++	W	
	28.2	++	+−	R	6/8*100=75%
	27.5	++	++	R	
	27.9	++	++	R	
	29.5	++	+++	W	
	28.2	++	++	R	
Karnal	28.5	++	++	R	
	27.5	++	++	R	
	27.5	++−	++	W	
	27.5	++	−+	R	
	27.0	+−	−+	R	13/17*100=76%
	28.2	+−	++	R	
	26.5	+−	++	R	
	26.7	+−	++	R	
	28.7	+++	+++	R	
	30.0	+++	++−	R	
	28.7	+++	+++	R	
	28.0	+++	++	W	
	28.0	−+	++	R	
	27.1	+++	++	W	
	27.8	++	++	R	
	26.2	++	+−	R	
	28.3	+++	++	W	

++, low; +++, moderate

folder was observed at Hisar and Gurgaon compared with Karnal and Ambala (Fig 1).

Knowledge about probable pest infestation level in a zone would be helpful in adopting timely and appropriate management practices such as selection of resistant cultivars, application of fertilizers and procurement of recommended

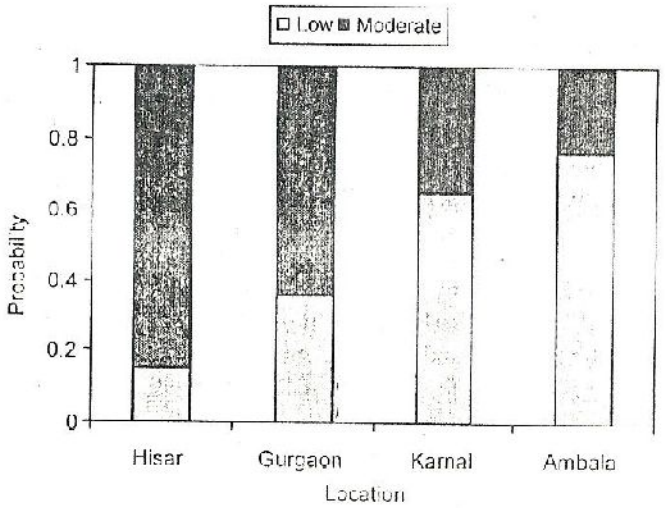

Fig 1 Probability of leaf-folder infestation in rice in Haryana

pesticides. Resistant cultivars effective under low infestation level may not be useful under high infestation of the pest. Durability of the resistant cultivars may be assessed approximately based on pest prevalence in the area as more variation within pest population may lead to development of pest biotypes. Pest zonation would also help in delineation of pest hot spots where breeding programmes for pest-resistant cultivars can be carried out effectively. In pest-prone area the inputs such as nitrogen should be used judiciously as leaf-folder incidence intensifies with nitrogen (Chander and Garg 1999). Based on changes in weather factors over a period of time, changes in pest status can be predicted and chances of pest spread to new areas can also be evaluated.

SUMMARY

Data on leaf-folder (*Cnaphalocrosis medinalis* Guenee) incidence on rice (*Oryza sativa* L.) in Punjab and Haryana from 1971 to 1999 were collected from different sources during 2000. The analysis of leaf-folder infestation data in relation to weather factors at Ludhiana revealed a qualitative relationship between pest incidence and mean September temperature. The mean September temperature from 26.5–28.5°C was observed to be associated with low leaf-folder incidence, while temperature of 28.2–30.5°C was associated with moderate incidence. The data from 1988 to 1999 were used for validation of the pest–weather relationship. The relationship could be validated for Ludhiana and Karnal with about 80% agreement between observed and simulated leaf-folder incidence level. On the basis of the mean September temperature prevalent in Haryana, viz 26.5, 26.5–28.5, 28.5–30.5 and > 30.5°C the state could be divided into 4 zones using Idrisi package of geographic information system. Rice areas with low and moderate leaf-folder incidence potential could thus be identified.

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