PREDICTING PEANUT LEAF SPOT DISEASE FROM WEATHER CONDITIONS IN CORDOBA, ARGENTINA

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ABSTRACT

A model for predicting peanut leaf spot was developed using data of the disease incidence in the field and weather related variables. Predictions of the disease incidence from the model have shown good agreement with the observed data. The model explained 92 % of the disease incidence using independent variables. RMSE between observed and predicted disease incidence for the tested crop seasons were less than 20 %.

Key words: peanut, leaf spot, disease prediction

INTRODUCTION

Peanut is one of the main crops in the south central area of the province of Cordoba in Argentina. During the crop season, several environmental factors may reduce yield and production. Early and late peanut leaf spot caused by *Cercospora arachidicola* S. Hori and *Cercosporidium personatum* (Berk, & M. A. Curtis) Deighton, are responsible for major losses in the peanut crops (*Arachis hypogaea* L.) (Johnson et al. 1986). The threat posed by the diseases depends significantly on temperature and humidity within the crop canopy and the presence of free water on the leaves (Jensen and Boyle 1966; Klingauf 1981; Wu et al. 1996; Phipps et al. 1997). Local environmental conditions that favor the diseases were also associated to air temperature and relative humidity measured at the canopy level in specific experiments (March et al. 1993; March and Marinelli 1995). Regional and reliable disease predictions can reduce the number of fungicide applications increasing profit in the peanut production. The main objective of this research is to develop, test and validate a peanut leaf spot disease prediction model. Partial findings are presented in this paper.

MATERIALS AND METHODS

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Biological data were obtained from commercial peanut crops close to Río Cuarto, Córdoba-Argentina (33° 07’ S, 64° 14’ W) and from experiments at the University of Rio Cuarto (UNRC) Agricultural Experimental Station. Measurements were done by technicians from the Plant Pathology area of the UNRC whom gently made them available for this research. Five consecutive peanut crop seasons (1986/87 to 1990/91) were used. For each of the crop seasons, crops were planted during the last week of November. Disease incidence (DI, %) was a measure of the total infection in percentage (Jensen and Boyle, 1965). Disease appearance was assumed to occur when infection reached 10 %. Weeks were coded as week 1 from the first week of July to week 52 for the last week of June of the next year. Lesions of early and late leaf spot were not differentiated and computed as the total infection. Observations were done on randomly selected plants (Marinelli et al. 1991), in runner-type cultivars. Weather data were collected from the closest conventional stations to the experimental fields and from the weather station of the UNRC. Daily data values were processed into weekly values. Weekly weather variables derived from maximum and minimum temperature, relative humidity, sunshine, total of rainfall, number of days with precipitation, growing degree days were generated (Table 1), and accumulated throughout the crop cycle. A Stepwise procedure was applied to identify variables which contributed significantly to the disease progress. The selected variables were used in regression analysis for the model development. Independent data from several crop seasons were used for model testing and validation but, only 1988/89 and 1989/90 are shown in this paper.

RESULTS AND DISCUSSION

Inter-annual weather variability was present during all the analyzed years. This variability affected disease appearance and the rate of development. Disease appearance happened in different dates for each of the crop seasons. However, in four seasons out of the five, the disease appearance occurred during January. The average date of appearance was January 18th with an standard deviation (St.Dev.) of 20.3 days.

After appearance, disease incidence was different among seasons and also, the rate of the disease progress changed within the season. Severe drought for almost the whole season occurred in 1988/89 while favorable rainy weather was the condition during 1987/88. Disease incidence for each of the crop seasons is the result of the interaction between the plant factors, the pathogen and the weather conditions, being difficult to identify in the field the partial contribution of each component. No other extreme weather condition was detected during the remaining years of experiments.

Table 1. Disease incidence and biometeorological variables derived from the weather variables measured during the crop growing seasons.

Variable	Units	Variable description
DI	%	Weekly disease incidence
DPCP	Days	Weekly total of rainy days; cumulative during the crop season
PCP	mm	Weekly total precipitation; cumulative during the crop season
SPDUS	mm	Total precipitation during last two weeks; cumulative during the crop season
SPTUS	mm	Total precipitation during last three weeks; cumulative during the crop season
NHT16	Hours	Weekly total of hours with temperature ≥ 16 ºC; cumulative during the crop season
NHT18	Hours	Weekly total of hours with temperature ≥ 18 ºC; cumulative during the crop season
NHT20	Hours	Weekly total of hours with temperature ≥ 20 ºC; cumulative during the crop season
PST16	Hours	Weekly average of hours with temperature ≥ 16 ºC; cumulative during the crop season
PST18	Hours	Weekly average of hours with temperature ≥ 18 ºC; cumulative during the crop season
PST20	Hours	Weekly average of hours with temperature ≥ 20 ºC; cumulative during the crop season
TMAX	ºC	Weekly mean maximum temperature
TMED	ºC	Weekly mean temperature
TMIN	ºC	Weekly mean minimum temperature
TB16A	ºC	Weekly accumulation of degree days (Tb=16 ºC) during the crop season
TB16B	ºC	Two weeks accumulation of degree days (Tb=16 ºC) during the crop season
TB16C	ºC	Three weeks accumulation of degree days (Tb=16 ºC) during the crop season
HR80	Hours	Weekly total of hours with relative humidity ≥ a 80 %; cumulative during the crop season
HR95	Hours	Weekly total of hours with relative humidity ≥ a 95 %; cumulative during the crop season
HFR	%	Weekly average of relative sunshine

The Stepwise procedure selected the weekly precipitation (PCP, mm), the weekly average of minimum temperature (TMIN, ºC) and the weekly number of days with precipitation (DPCP, days), all of them accumulated during the crop season. The overall model explained 92% of the DI variability. The developed model was as follows:

$$DI = - 44.88 + 0.134 * PCP + 0.117 * TMIN + 0.988 * DPCP$$

where R^2: 0.925; St.Dev.: 8.49 and F was significant at the 0.00 level.

The model capabilities were tested for different seasons by omitting at random from the entire data set one season at a time, recalculating the model coefficients and predicting the disease incidence for each of the excluded season. Figure 1 showed the relationships between observed and predicted values of the disease incidence and the statistical significance for the 1988/89 and 1989/90 crop seasons. These seasons were selected to test the model performance as they represented extreme weather conditions. The model overpredicted disease infection under drought conditions and showed good estimates during normal weather conditions. Preliminary conclusions showed that the identified weather variables have statistical and biological significance to be included in a peanut leaf spot disease prediction model. The prediction model is simple to apply and has good predictive capability. However, more extensive testing and validation is needed in the region.

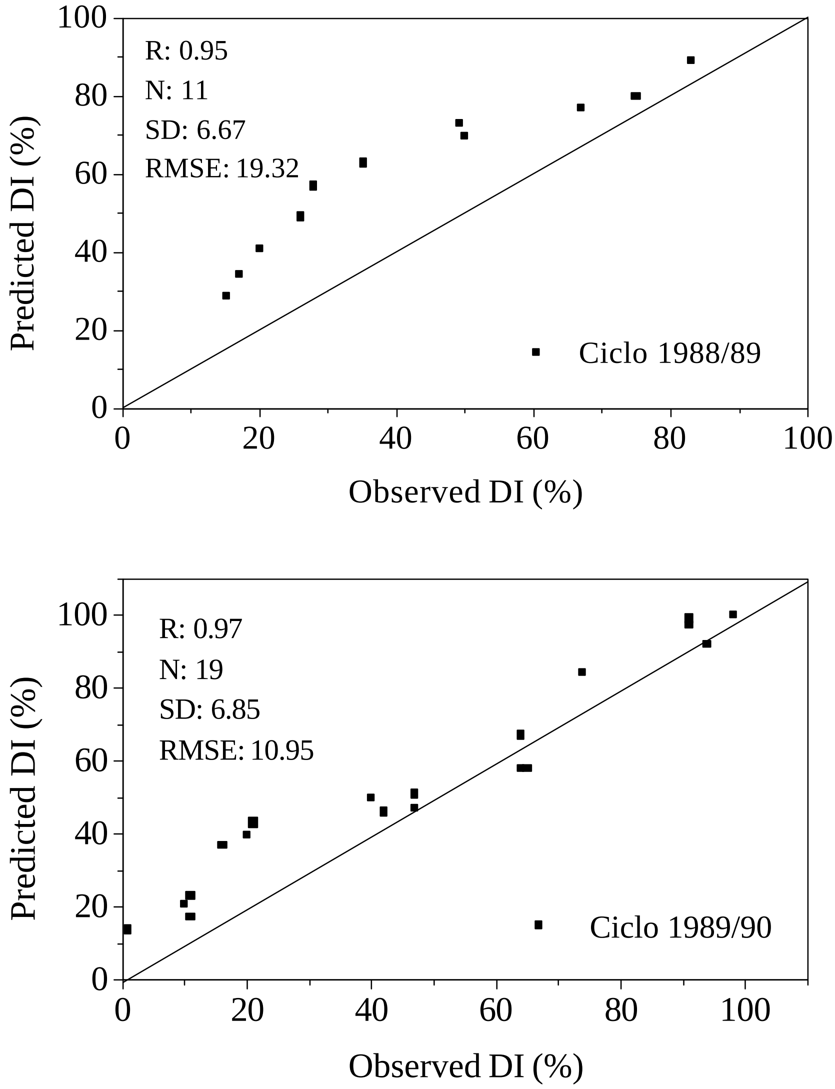

Figure 1. Relations between predicted and observed values of disease incidence for the 1988/89 and 1989/90 crop seasons.

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