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**The Thesis Submitted for the Degree of Ph.D.
(in the Field of Plant Pathology)**

Epidemiology of Grapevine Powdery Mildew in Sistan Region

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June 2020

Abstract

Grape powdery mildew is caused by *Erysiphe necator* (syn: *Uncinula necator* (Schwein.) Burrill, 1834) and is one of the most important grape diseases. The aim of this study was to investigate different epidemiological aspects of this disease in Sistan region. For this purpose, three county including Zabol, Zahak and Hamoon were selected and data of the disease incidence and severity, with regular and weekly visits to vineyards in all three county (10 vineyards in each county), during the two crop years, 2017 and 2018 were recorded. Results showed that based on highest disease incidence in combined two years, Zabol and Zahak (57.6%, 57.2%) had the highest and lowest percent of disease incidence. Based on leaf and fruit disease severity, there were significant differences between counties and two years ($P < 0.001$) and in combined two years Hamoon and Zahak (23.1%, 20.6%) had the highest and lowest percent of infection in leaves, and based on the fruit disease severity, Zabol and Zahak (25.4%, 21.8%) had the highest and lowest percent of infection in fruits respectively. Based on area under disease progress curves, there were no significant differences between years, counties and vineyards in disease incidence but in leaf and fruit disease severity, there were significant differences between years and counties ($P < 0.001$) and in combined two years Hamoon and Zabol (696.9 and 680.3) had the highest area under of disease progress curves of leaf and fruit infections respectively. Study of disease progress curves at regional level showed that based on R^2 , all models were able to describe disease progress to a high degree but based on regression statistics especially adjusted R^2 (aR^2) and standard error of estimates (SEE), revealed that the best and strongest description of the disease epidemic over time was provided by the Monomolecular model. The results showed that in combined two years for three variables of disease including disease incidence, leaf disease severity and fruit disease severity, the Monomolecular model was fitted with 100, 100 and 98.33% of studied epidemics respectively. Also means R^2 of this model for three disease variable, calculated 91.64%, 89.60% and 90.27% respectively. In total of two years, rate of increase (r_m) per unit of disease in the vineyards for three disease variable were 0.016, 0.004 and 0.005 respectively. Based on relationship between incidence (I) with leaf and fruit disease severity (S), all three model including linear, allometric and square root models were highly fitted to the data, but based on such statistics as high coefficient of determination (R^2), low standard error of estimates (SEE) and residual plots, in the relationship between disease incidence (I) and leaf disease severity (S), allometric model (with R^2 of 91.17 to 96.25%) and for disease incidence (I) with fruit disease severity (S), the square root model (with R^2 of 89.56 to 96.40%) were selected as the best models in describing these relationships at the county level. Total results in discussion of yield loss assessment and determine of threshold of economic losses in vineyards showed that the three model including single-point, integral (AUDPC) and response surface models had acceptable fit with the sum of variables studied in two years. The results of analysis of variance of disease loss data separated by year showed that there was no significant difference between the counties and vineyards in the first and the second years but in total, between the two years there was a significant difference ($P < 0.01$) and no significant difference was observed between counties and vineyards. Accordingly, the average loss to vineyard yield in the first and second year was 42.87% and 27.28%, respectively. Determination of economic loss thresholds of disease using single-point model results showed that for one percent increase in disease incidence, leaf disease severity and fruit disease severity, the vineyard yields was declined by 2.04%, 3.96% and 1.65%, respectively. The total results of the study of climate and agricultural factors affecting on the probability of disease epidemic outbreak showed that among the climate factors, the factor highest of moisture percent and among the agronomic factors five factors including presence or absence of spraying in the previous year, The presence or absence of winter spraying in the current year, the presence or absence of spraying in mid-April, the presence or absence of spraying in early May and the time of onset of disease symptoms, have the highest level of significance and correlation with disease variables and therefore were selected as the most effective climatic and agronomic factors to predict the probability of grape powdery mildew disease outbreak in Sistan region.

Keywords: Epidemiology, Powdery Midew, Grapeavine, Forecasting, *Erysiphe(Uncinula) necator*