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EFFECTIVENESS OF PREVENTIVE FUNGICIDE TREATMENTS IN CONTROLLING *PLASMOPARA VITICOLA* OUTBREAKS

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Introduction

Viticulture is one of the primary forms of fruit crop cultivation worldwide, and its global diffusion significantly contributes to human nutrition. However, *P. viticola* is a crucial causal agent of agro-economic losses in grape production, particularly at the beginning of the annual production cycle. Therefore, a survey of the efficacy of fungicides was conducted.Experimental grapevine plots in Smilica, Kavadarci, Republic of Macedonia (41°42'71.4" N, 22°0'10.75" E), planted with the Vranec variety, were utilized to test the effectiveness of preventive fungicide treatments in controlling outbreaks of *Plasmopara viticola* (Berk. & M.A. Curtis) Berl. & De Toni during the spring-summer of 2023.

Material and methods

Two variants were implemented: (i) a control plot and (ii) a plot with a preventative fungicide treatment. At the experimental vineyard, six chemical treatments were conducted. The control variant was treated solely with the active ingredient folpet. Meanwhile, in plot with preventative fungicide sprays, the following fungicidal substances were applied: (i) 50% Fosetil-Al + 25% Folpet + 4% Iprovalicarb; (ii) 25% Mandipropamid + 24% Zoxamide; (iii) 25% Copper oxychloride + 24% Copper hydroxide (iv) 3% Oksatiapiprolin + 25% Mandipropamid; (v) 10% Metalaxyl + 40% Folpet; (vi) 6% Valifenalate + 48% Folpet. The Climate Forecast System Reanalysis (CFSR) is a climate dataset used for intraday climate predictions of rainy weather, where chemical treatments were carried out immediately before the onset of precipitation as a necessary measure for plant protection. This forecasting model was enhanced by incorporating data from experimental vineyard plots on disease incidence and fungicide efficacy, in addition to weather data.

Disease assessment

Between the last week of May and the third of July, the experimental vineyard plot was monitored twice a week to identify the initial symptoms of downy mildew. The severity of the disease was determined by evaluating a random sample of 100 leaves and 100 bunches at three separate growth stages: (i) when the inflorescences were clearly visible (growth stage BBCH 53), (ii) during fruit set (growth stage BBCH 71), and (iii) when the majority of berries were touching (growth stage BBCH 79). The incidence of *P. viticola* on vines was evaluated using ImageJ software, which calculates the ratio between infected and healthy tissue. In this context, ImageJ software applies a threshold color segmentation method for calculating the areas of infected and healthy tissue(Figure 1).

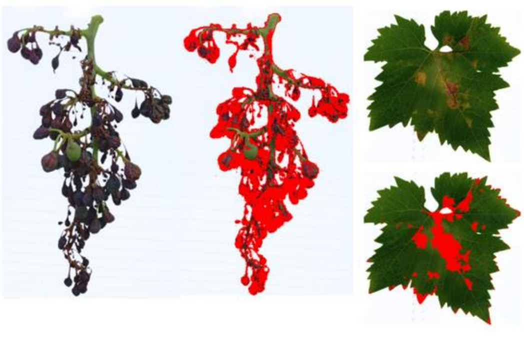

Figure 1. The original images that were segmented using the threshold color segmentation method

Data analysis

The efficacy of fungicide treatments wasdetermined based on mean disease incidence on leaves and bunches using the formula $E = 100 - [(\frac{Yb}{Yl}) \times 100]$, where E is the efficacy of the treatment and Yb and Yl are disease incidence on bunches or leaves in control plot and plot with a preventative fungicide treatment. Analyzed using ANOVA, the disease incidence data acquired from experimental plots aimed to evaluate the statistical significance of fungicides efficacy.

Results and discussion

Chemical treatments were applied before rainfall, using a CFSR climate data set for prediction (Figure 2).

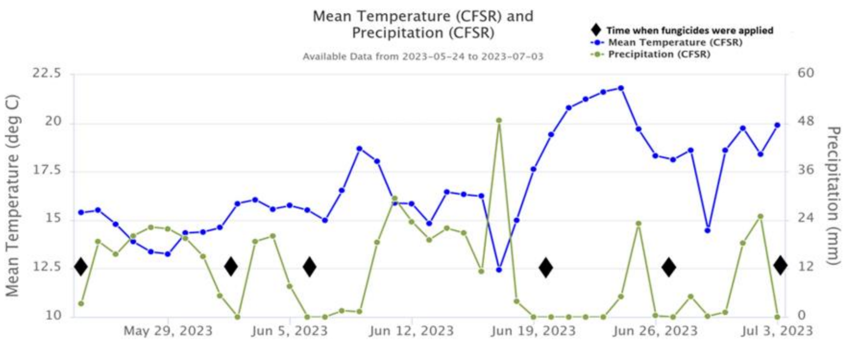

Figure 2. An overview of CFSR climate data is provided for the research period from 05/24/2023 to 07/03/2023, during which the application period of the fungicides is indicated

Six applications were carried out based on the field analysis results using ImageJ software. The incidence of disease in the variant with preventive treatments was recorded as follows: (i) 8.3%; (ii) 4.28%; (iii) 9.2%; (iv) 16.6%; (v) 10.14%; and (vi) 3.9%.In the control variant, the following incidence rate of the disease in the vineyard was observed: (i) 18.75% ; (ii) 19.17% ; (iii) 31.34%; (iv) 51.13%; (v) 71.91%; and (vi) 77.42%. ANOVA analysis of data on the efficacy of fungicides from both experimental plots showed statistical significance ($P < 0.007$), (Table 1).

Table 1. ANOVA Analysis Results: Fungicide Efficacy

Anova: Single Factor						
SUMMARY						
Groups	*Count*	*Sum*	*Average*	*Variance*		
Preventative chemical treatments	6	547,19	91,19833	21,78842		
Control	6	330,24	55,04	671,098		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	3922,275	1	3922,275	11,32155	0,007185	4,964603
Within Groups	3464,432	10	346,4432			
Total	7386,707	11				

Conclusion

Due to the repeated use of the same active ingredient six times in a row in the control variant, the efficiency of the fungicide constantly decreased. Conversely, in the vineyard plot with preventative fungicide treatment, the development of the disease was under control due to the increased efficacy of the fungicides, which was not the case in the control variant (Figure 3).

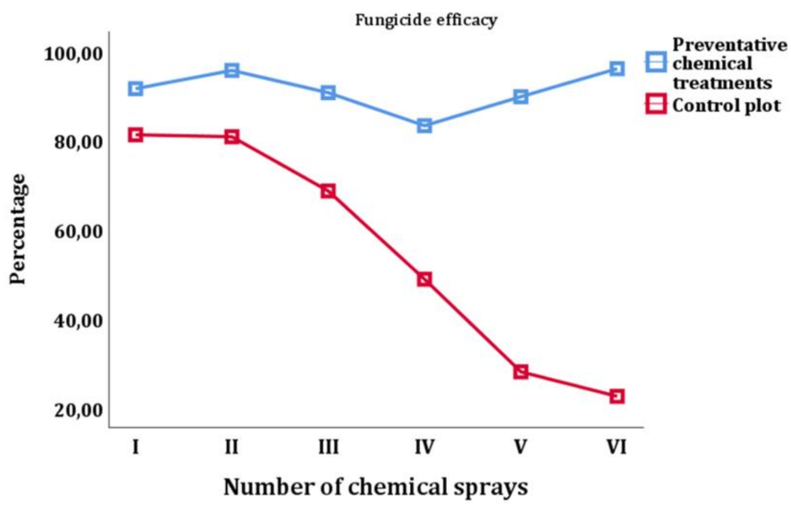

Figure 3. Overview of fungicide efficacy in both variants