PhD THESIS

The Study of the Health Status and Yield in Grapevine in Climatic Context of Geoagiu Depression

SUMMARY OF THE Ph.D THESIS

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CONTENTS

1. The grapevine culture

Vine culture is a complex process that involves several aspects, from the choice of varieties and the right land to the care and harvesting of the vines. A first step in grapevine culture is choosing the right variety according to local conditions and the winegrower's preferences (CISMAȘU ȘI COLAB., 2024b). Factors such as climate, soil and altitude influence the choice of vine variety to be grown (CISMAȘU ȘI COLAB., 2023; CISMAȘU ȘI COLAB., 2024a). Temperature, humidity, sun exposure and the risk of frost can directly influence the development and production of the grapevine crop (BERGQVIST ET AL., 2001; LEE ET AL., 2007).

2. The grapevine diseases

Among the most important fungal agents that cause diseases in grapevine are: Plasmopara viticola (Berk&M.A. Curtis) Berl.&De Toni (1888), Uncinula necator (Schwein.) Burrill, Botrytis cinerea Pers. (1794). Plasmopara viticola has a complex life cycle that begins with the release of spores from pustules on infected leaves. The spores then spread to other plants, favoring the development of the disease (KENNELY ET AL., 2004; KOLEDENKOVA ET AL., 2022). The life cycle of the mealybug begins with the release of spores that are carried by the wind and deposited on the leaves and other parts of the plant (SREE ET AL., 2024). Grapevine gray rot can affect all parts of the grapevine plant, including leaves, shoots, bunches and grape berries (ALTIERI ET AL., 2023).

3. Research objectives

The following objectives were taken into account in order to develop the doctoral thesis:

- the study of the effectiveness of phytosanitary treatments on the pathogens monitored in the vines in specific climatic conditions
- the study of the interrelation between the attacks of downy mildew, powdery mildew and gray rot pathogens on grapevines
- the study of the influence of climatic factors on the attack of pathogens monitored in grapevines in specific climatic conditions
- the study of the productivity of the vine and its qualitative characteristics in an experimental context
- the comparative study of the attack of downy mildew, powdery mildew and gray rot pathogens on grapevines.

4. Environmental peculiarities of the experimental site

The experimental part of this doctoral thesis took place in a private wine farm, located in the bordering area of the city of Geoagiu (45°55'12''N, 23°12'0''E), Hunedoara County, West Development Region. The area is well known for its productive potential in the wine field. An area equal to 2200 m2 cultivated with vines, of the Fetească regală and Fetească albă varieties, was used for the installation of the experimental field.

5. Material and Method

In order to carry out research on the study of the state of health and productivity of the grapevine in the climatic context of the Geogiu Depression, field experiments were implemented that allow both the study of the attack of the main pathogenic agents of the grapevine, as well as on that of productivity, for a period of two years, namely the year 2021 and the year 2022. A trifactorial experiment (2 x 3 x 2) was implemented, in randomized blocks, with different gradations, the factors being represented by the variety with the two gradations of its, respectively Fetească regală and Fetească albă, the phytosanitary treatment scheme with the 3 graduations, represented by the untreated control experimental variant and the experimental variants II and III treated according to different schemes and factor 3, the year, with 2 graduations represented by the years 2021 and 2022 (Fig. 5.1). Three repetitions were performed for each experimental variant. For each experimental variant, 8 treatments were applied. The experimental area of 3600 m2 was divided into plots (1200 m2 each plot), corresponding to the 3 experimental variants:

- Variant 1 - untreated control;
- Experimental variant 2 – treatment in accordance with Phytosanitary Treatment Scheme I;
- Experimental variant 3 – treatment in accordance with the Phytosanitary Treatment Scheme II;

On each plot (40 m x 30 m), the distance between the hubs is equal to 1 m (1.5 m on the edge), and between the rows 1.5 m. On each of the 26 rows (1.25 m on the edge) row there are 28 cones, of which, on average, 24 cones per fruit. The degrees of attack (GA%) of downy mildew, powdery mildew and grape gray rot pathogens will be monitored, by recording twice a week both the intensity of the attack and its frequency, for each pathogen considered (OROIAN , 2008). In order to quantify the effects of climatic factors on the manifestation of the studied pathogens, the following climatic parameters were recorded in the experimental field with the help of the Waldbeck WTH3-Huygens portable weather station: air temperature and humidity, wind speed and rainfall regime.

2021

Fetească regală

R1	V1	V2	V3
R2	V3	V1	V2
R3	V2	V3	V1

Fetească albă

R1	V2	V3	V1
R2	V1	V2	V3
R3	V3	V1	V2

2022

Fetească regală

R1	V3	V1	V2
R2	V2	V3	V1
R3	V1	V2	V3

Fetească albă

R1	V1	V2	V3
R2	V3	V1	V2
R3	V2	V3	V1

R –Repetition; V - Experimental variant; **1** – Control, Experimental variant I – Untreated control; **2** –Experimental variant II – Experimental pattern I; **3** – Experimental variant III – Experimental pattern III.

Fig. 5.2. The experimental pattern 2021 – 2022

Through observations made twice a week for each experimental variant, the frequencies and intensities of the attack of the pathogens under study were monitored. The determination of sugars in grapes was carried out with the help of the Refractometer RF.5635, EUROMEX. 3 grapes were harvested. 2 drops of each grain were placed on the prism of the refractometer, after which the contents were pressed with the transparent slide. The reading was done on the graduated scale of the refractometer. Because the readings are taken in Brix, it was necessary to convert the results to g/L, taking into account that 1 Brix = 10.04 g/l sugars at 20°C. The acidity was determined volumetrically, by titration with NaOH 0.1n, in the presence of phenolphthalein, and the results are expressed in g/L H_2SO_4. In order to statistically process the raw data, the program STATISTICA v.8.0 for Windows was used.

6. Results and discussions

Over the entire experimental period, 2021 – 2022, it can be seen that the highest averages of attack degrees are recorded for the gray rot pathogen, Botrytis cinerea Pers. (1794), respectively 31.72% for the control version; 11.94% for experimental variant II and 15.80% for experimental variant III (Table 6.3).

Table 6.3

The basic statistics for the attack degrees of analyzed pathogens in Fetească regală variety, when different phytosanitary patterns are applied, during 2021 – 2022 (%)

Experimental variant	N	X	Minimum	Maximum	s	CV
			$GA/AD_{Plasmopara\ viticola}$			
I	96	22.48^{d}	19.00	26.00	2.65	11.79
II	96	9.28^{dc}	4.00	14.00	2.22	23.92
III	96	13.79^{dc}	7.00	21.00	2.11	15.30
			$GA/AD_{Uncinula\ necator}$			
I	96	6.12^{c}	3.00	9.00	1.13	18.46
II	96	1.36^{ca}	0.50	3.00	0.25	18.38
III	96	2.80^{ca}	1.00	5.00	0.71	25.36
			$GA/AD_{Botrytis\ cinerea}$			
I	96	31.72^{d}	26.00	35.00	3.80	11.98
II	96	11.94^{db}	7.00	17.00	3.12	26.13
III	96	15.80^{db}	11.00	20.00	2.49	15.76
			GA/AD_{total}			
I	96	60.36^{d}	3.00	35.00	5.92	9.81
II	96	22.57^{d}	0.50	17.00	5.36	23.75
III	96	32.39^{d}	1.00	20.00	8.21	25.35

I – untreated control; II – treatment scheme I; III – treatment scheme I; GA – degree of attack; X – average (%); s – standard deviation (%); CV – coefficient of variation (%); different letters mean significant differences at the 5% significance level.

For the Fetească regală variety, compared to the entire experimental period 2021 – 2022, the average productivity, the average sugar content and the average acidity are presented in the tables Table 6.28, Table 6.13 and Table 6.15.

It can be seen that, over the entire experimental period between 2021 and 2022, Phytosanitary Treatment Scheme I, corresponding to Experimental Variant II, has a superior effectiveness, obtaining the lowest average levels of attack, both for each pathogen studied , as well as for the degree of total attack, which, in this case, is equal to 26.35% (Table 6.19).

Table 6.12

The basic statistics for the yield recorded in Fetească regală vine variety, when different phytosanitary patterns are applied, during 2021 – 2022 (kg/vine stump - kg/ha)

Varianta experimentală/ Experimental variant	N	X	Minimum	Maximum	s	CV (%)
I	20	1.13ca	0.60	1.80	0.29	25.45
II	20	1.78ca	1.35	2.50	0.38	21.52
III	20	1.44a	0.80	2.10	0.40	27,78

I – untreated control; II – treatment scheme I; III – treatment scheme I; GA – degree of attack; X – average (%); s – standard deviation (%); CV – coefficient of variation (%); different letters mean significant differences at the 5% significance level.

Table 6.13

The basic statistics for the sugar content recorded in Fetească regală grapes variety, when different phytosanitary patterns are applied, during 2021 – 2022 (g sugar/L)

Experimental variant	N	X	Minimum	Maximum	s	CV
I	20	177.75a	160.00	184.00	6.27	3.53
II	20	195.25b	170.20	205.00	4.79	2.45
III	20	184.64c	173.00	2004.10	8.83	4.78

I – untreated control; II – treatment scheme I; III – treatment scheme I; GA – degree of attack; X – average (%); s – standard deviation (%); CV – coefficient of variation (%); different letters mean significant differences at the 5% significance level.

Table 6.16

The basic statistics for the acidity recorded in Fetească regală grapes variety, when different phytosanitary patterns are applied, during 2021 – 2022 (g/L)

Experimental variant	N	X	Minimum	Maximum	s	CV
I	20	5.77da	5.30	6.30	0.32	5.55
II	20	6.29dc	5.80	6.95	0.34	5.38
III	20	5.94ac	5.60	6.35	0.22	3.71

I – untreated control; II – treatment scheme I; III – treatment scheme I; GA – degree of attack; X – average (%); s – standard deviation (%); CV – coefficient of variation (%); different letters mean significant differences at the 5% significance level.

Table 6.19

The basic statistics for the attack degrees of analyzed pathogens Fetească albă grapes variety, when different phytosanitary patterns are applied, during 2021 – 2022 (%)

Experimental variant	N	X	Minimum	Maximum	s	CV
GA/AD*Plasmopara viticola*						
I	96	25.24^{d}	21.50	29.70	3.24	12.82
II	96	14.13^{da}	10.90	17.00	2.43	17.17
III	96	16.75^{da}	13.50	20.00	2.74	16.35
GA/AD*Uncinula necator*						
I	96	5.03^{ba}	4.10	6.20	0.59	11.63
II	96	2.14^{ba}	1.10	3.10	0.67	31.50
III	96	3.80^{ba}	2.70	5.10	0.81	21.35
GA/AD*Botrytis cinerea*						
I	96	30.52^{d}	28.20	32.90	1.68	5.50
II	96	10.09^{db}	6.10	14.10	3.58	35.50
III	96	14.48^{db}	9.10	20.00	5.04	34.80
GA/AD*total*						
I	96	60.80^{d}	54.10	66.70	5.24	8.62
II	96	26.35^{d}	18.30	33.90	6.57	24.93
III	96	35.03^{d}	26.30	44.50	8.46	24.15

I – untreated control; II – treatment scheme I; III – treatment scheme I; GA – degree of attack; X – average (%); s – standard deviation (%); CV – coefficient of variation (%); different letters mean significant differences at the 5% significance level.

Compared to the entire experimental period 2021 – 2022, the average productivity, the average sugar content and the average acidity of the Fetească albă variety are presented in the tables Table 6.28, Table 6.29 and Table 6.32.

Table 6.28

The basic statistics for the yield recorded in Fetească albă grapes variety, when different phytosanitary patterns are applied, during 2021 – 2022 (kg/vine stump)

Experimental variant	N	X	Minimum	Maximum	s	CV
I	20	0.76[ba]	0.43	1.05	0.11	13,92
II	20	1.10[b]	0.61	1.61	0.31	28,18
III	20	0,80[ab]	0.95	1.50	0.17	27,67

I – untreated control; II – treatment scheme I; III – treatment scheme I; GA – degree of attack; X – average (%); s – standard deviation (%); CV – coefficient of variation (%); different letters mean significant differences at the 5% significance level.

Table 6.29

The basic statistics for the sugar content recorded in Fetească albă grapes variety, when different phytosanitary patterns are applied, during 2021 – 2022 (g sugar/L)

Experimental variant	N	X	Minimum	Maximum	s	CV
I	20	162.01[a]	153.40	169.00	6.50	4.01
II	20	171.38[a]	163.00	179.00	7.34	4.28
III	20	164.78[a]	158.60	171.00	5.68	3.45

I – untreated control; II – treatment scheme I; III – treatment scheme I; GA – degree of attack; X – average (%); s – standard deviation (%); CV – coefficient of variation (%); different letters mean significant differences at the 5% significance level.

Table 6.32

The basic statistics for the acidity recorded in Fetească albă grapes variety, when different phytosanitary patterns are applied, during 2021 – 2022 (g/L)

Varianta experimentală/ Experimental variant	N	X	Minimum	Maximum	s	CV
I	20	3.39[ba]	0.39	4.70	0.84	24,78
II	20	4.37[ba]	3.60	5.10	0.45	10.35
III	20	3.98[a]	2.90	5.00	0.68	17.13

I – untreated control; II – treatment scheme I; III – treatment scheme I; GA – degree of attack; X – average (%); s – standard deviation (%); CV – coefficient of variation (%); different letters mean significant differences at the 5% significance level.

8. Conclusions and recommendations

Following the study carried out on the composition of the volatile oils from the three species of plants with potential in combating the attack of Phytophthora infestans (Mont.) by Barry on tomato, it appears that the optimal method of obtaining is the hydrodistillation of the aqueous extracts and consequently, in experiments to combat the pathogen, non-conventional treatments consisted of the use of aqueous solutions of volatile oils of lavender, thyme and rosemary.

The analysis of the evolution of the attack of the pathogen Phytophthora infestans (Mont.) by Barry on the Roxana tomato cultivar, depending on the level of fertilization, highlights specific particularities. In the case of the unfertilized control experimental variant, the highest average attack degree is reported, as expected, in the absence of any phytosanitary treatment (GA = 44.55%). The most effective are the conventional (GA = 22.65%) and non-conventional (GA = 24.70%) treatments with a mixture of lavender extracts 5%, thyme 1% and rosemary 5% (40:30:30, v/v / c).

According to the cluster analysis, regardless of the phytosanitary treatment variant applied, taking into account the average attack degrees of Phytophthora infestans (Mont.) de Bary, two main clusters result. According to Cestora, it follows that the application of soil and foliar fertilization accompanied by the use of conventional and/or non-conventional treatment with a mixture of lavender extracts 5%, thyme 1% and rosemary 5% (40:30:30, v/v/ v, %) leads to a much superior result of combating the pathogen, compared to the situation of the other fertilization options.

The study of the intensity of the multiple correlations between the production and the main morpho-productive characteristics of the tomatoes of the cultivar Ruxandra, highlights the fact that they are positive and present a variable intensity, from the average ($R = 0.429$, $R2 = 0.184$, the experimental variant foliar fertilized, untreated phytosanitary) to strong ($R = 0.782$, $R2 = 0.612$, foliar fertilized experimental variant, non-conventional phytosanitary treatment). According to the regression lines, regardless of the experimental variant, it is found that the leaf surface and, to a greater extent, the dry matter content of the fruit have the greatest contribution to tomato production.

Taking into account the research carried out in the framework of the doctoral thesis, we consider it appropriate to formulate some recommendations, respectively: ▸ the use of water as a unique extraction system in order to obtain extracts intended for non-conventional phytosanitary treatments; ▸ considering as a sustainable, environmentally friendly alternative and using the mixture of aqueous extracts of lavender 5%, thyme 1% and rosemary 5% (40:30:30, v/v/v); ▸ maintaining an appropriate level of fertilization to increase the effectiveness of phytosanitary treatments; ▸ careful monitoring and management of phytosanitary treatments in the context of the climatic regime specific to the cultivation area to ensure adequate protection of tomato crops; ▸ careful management of fertilization to achieve quality tomato production.

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