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Plant Pathology

Evaluation of the Resistance of Georgian Grapevine Germplasm towards Powdery Mildew (*Erysiphe necator* Schwein) under Controlled Conditions

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Grape powdery mildew, caused by *Erysiphe necator* Schwein, poses a significant threat to widely cultivated *Vitis vinifera* L., leading to environmental and health concerns due to the prevalent use of fungicides. To address this, researchers are exploring the development of resistant grapevine varieties through crossbreeding with American Vitaceae. However, historical attempts resulted in hybrids with undesirable wine qualities inherited from American species. The recent focus on identifying resistance genes in the Ren family within the *V. vinifera* gene pool has gained traction since 2006, recognizing its potential. Georgian and European studies have identified *E. necator*-resistant grapevine varieties. Georgian grapevine germplasm, boasting 525 cultivars with high genetic variability, is considered prospective for finding resistant genotypes. This study specifically examines untreated 80 grapevine varieties showing high resistance in field conditions, sourced from Shumi, Jighaura, and Mukhrani collections. Using the OIV455 descriptor, powdery mildew development on grapevine leaves is evaluated in greenhouse conditions. Results indicate varying resistance levels, with some varieties exhibiting stable resistance (score 7-9) and others displaying unstable resistance (score 1-5, 1-7, 3-5, etc.). The study underscores the necessity for ongoing research to comprehensively understand the identified resistant varieties under greenhouse conditions. This emphasizes the potential for further contributions to sustainable grape cultivation practices. Notably, the results are based on one year, highlighting the need for additional years to conduct a comprehensive study. © *2024 Bull. Georg. Natl. Acad. Sci.*

disease, *Erysiphe necator*, germplasm, susceptibility

Erysiphe necator Schwein is a fungus that causes powdery mildew of grapes. It is a common pathogen of Vitis species, including the wine grape, *Vitis vinifera* L., which is the most cultivated grapevine species worldwide. In certain weather conditions, the pathogenic fungus infects all green parts of the plant causing partial or complete losses in grape yield. The control of downy mildew on grapevine requires regular application of fungicides. However, it has to be mentioned that intensive use of chemicals harms the environment and human health [1]. As an alternative, cultivation of the resistant grapevine varieties, holding the resistant genes of *Ren* family is a good method for reducing damage due to powdery mildew. In the 19th century, it was imitated breeding programs by crossing *V. vinifera* with resistant Vitis species, particularly of American origin, that co-evolved with the pathogen. However, the obtained hybrids were unsuitable for the production of high-quality wines, due to their mediocre quality including unpleasant foxy aromas coming from the American species of the genus Vitis [2].

It was believed that *V. vinifera* has no or little genetic resistance against *E. necator*. However, the observation of Georgian researchers [3] years ago and recent European studies revealed some varieties resistant to the powdery mildew causing by fungus [4]. Among others, some Georgian *V. vinifera* accessions have been reported to be resistant to *E. necator* and to have no genetic relationship to the known sources of resistance to powdery mildew: the varieties ‘Shavtsitska’ and ‘Tskhvedianis Tetra’ from Western Georgia showed strong partial resistance to *E. necator* which segregated into two cross populations. The resistant genotypes delayed and limited the pathogen mycelium growth, sporulation intensity, and a number of conidia generated [4].

Georgia in the South Caucasian region is considered one of the most important primary centers of domestication of cultivated grapevine, where the first viticulture emerged, towards the middle of the VI millennium BC [5]. The region is rich in grapevine diversity and wild grapevines are widely present in the area [6]. Georgian grapevine germplasm consists of about 525 to 607 cultivars [7,8] and is distinguished with high genetic variability [9] and various ampelographic characteristics, agronomical traits, and phenological diversity [6,10].

Preliminary studies in 2022 of the Georgian germplasm revealed several varieties that showed field resistance in different grapevine collections but were treated with fungicides by the conventional system [11, 12]. Because of that evaluation of the Georgian grapevine germplasm for future evaluation and usage in breeding is extremely important.

The aim of this study was the phenotyping of the selected, untreated, Georgian grapevine varieties for susceptibility to Powdery mildew under greenhouse conditions.

Materials and Methods

Plant materials. To create a collection of untreated vines in a greenhouse. There were selected the varieties demonstrated resistance to powdery mildew in the field conditions of Shumi (GEO 036), Jighaura (GEO 038), and Mukhrani (GEO 031) grapevine collections treated by the conventional scheme of plant protection [12]. Dormant woody cuttings of 80 Georgian varieties were planted in 1L pots and placed in a greenhouse in 2023. During the vegetative season, the grapevine leaves were naturally infected in May-June under the greenhouse conditions of the Georgian Agricultural University. The plants were kept untreated with a temperature range of 22-27°C and humidity of 50-90%, suitable for optimal development of the fungus.

Phenotyping of the grapevine leaves by the OIV455 descriptor. Evaluation of the Powdery mildew development on the leaves was carried out according to the OIV455 descriptor [13]. Leaf

damage by the pathogenic fungus was assessed on all leaves of 4-6 plants of each cultivar. The disease was scored from 1 to 9 corresponding: 1 score stands for very susceptible, 3 – susceptible, 5 – moderately resistant, 7 – resistant, and 9 – very resistant. Disease development was observed 3 times per year.

Results and Discussion

Evaluation of 80 varieties during the 2023 vegetative season showed different types of resistance in the greenhouse condition (Figure). The grapevines of the following varieties were found to be: v*ery susceptible (1-score)*: Aleksandrouli, Ansapzj, Bandzura, Danakharuli, Vertkvichalis Shavi, Kuprashviliseuli, Mauris Tetri, Mgaloblishvili, Onoura, Partala, Samarkhi, Tkupkvirta, Ghrubela Kakhuri, Kvira, Kornistvala, Tsolikouri, Tskhvedianis Tetra, Dziganidzis Shavi, Sachkheris Shavi, Tsvrimala, Khushia. *Susceptible varieties (score-3)* were: Beglaris Kurdzeni, Budeshuris Tetri, Budeshuri Tsiteli, Institutis Grdzelmtevana, and Kartnula. *Moderate resistance (score-5)* was revealed by the following varieties: Goruli Mtsvane, Tavkveri, Kundza Imeruli, Mkhargrdzeli, Natsara, Rkatsiteli cl. 4, Tsnoris Tetri, Tskobila, Chrogha Kakhuri, Jani Bukistsi-khis. *Resistance (score-7)* was shown by the following varieties – Kakhuri Mtsvane, Saphena. *Very high resistance (score-9)* was shown by the following varieties: Buera, Kurkena, and Rkatsiteli clone 48.

Among genotypes that showed very high resistance: Buera and Rkatsiteli cl. 48 are representatives of the East Georgia gene pool and Kurkena – is from the Western Georgia gene pool. Buera is recognized to be a table grape and two others are wine grape varieties. If positive resistance of tree-positive genotypes is confirmed in the next steps of the study we could say that these three varieties have the potential to be involved in the breeding programs for resistance to obtaine new wine or table grape varieties for eastern or western Georgian viticulture.

Observation shows that some varieties demonstrated stable levels of resistance, but others were not stable. Unstable resistance was shown by the following varieties: 1-3 scores – Aladasturi, Akhmetis Shavi, Vardispera, Tavkveri, Tamaris Kurdzeni, Tqvara, Kamuri Shavi, Kapistoni, Muju-retuli, Sapena, Seura, Chekobari, Tsivchkhavera, Jani Nakashidzis 1-5 scores – Adanasuri, Tavkveri Patalaanteuli, Kamuri Tetri, Rkatsiteli, Kharistvala Shavi; 1-7 scores – Mkhargrdzeli Kviteli; 3-5 scores – Ikaltos Tsiteli, Labiladzis Tetri, Machkvaturi, Mskviltvala Tetri, Nakutvneuli, Saperavi Atenis, Chitiskvertskha Meskhuri; 3-7 scores – Ubakluri, Chitiskvertskha Bodburi, Chitiskvertskha Kakhuri/Bodburi; 3-9 scores – Donghlabis Tetri; 5-7 scores – Adreula Shavi, Lekuri, Kurdzeni, Shavtita.

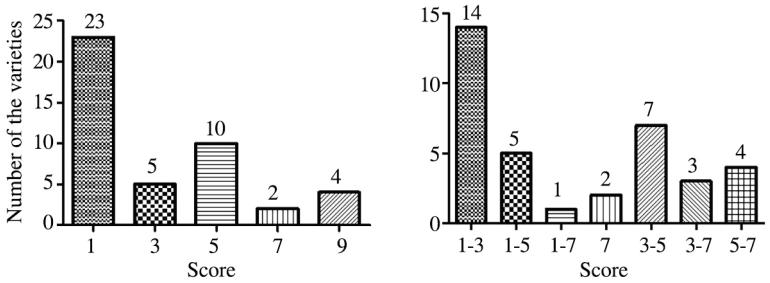

Fig. Stable and unstable resistance revealed by grape varieties during their evaluation based on the OIV455 descriptor*.
*Note: Level of expression of *E. Necator*: *1 – very susceptible, 3 – susceptible, 5 – moderately resistant, 7 – resistant, 9 – very resistant.*

According to the results of the study, the varieties that were resistant in the field conditions regularly treated by fungicides had no opportunity to demonstrate their resistance there. But in the greenhouse conditions, they revealed different degrees of resistance to Powdery mildew. These results give us the motivation to continue the research to study the resistant varieties in more detail, which is very positive even if we speak about 3 positive genotypes – the study should be continued in the same greenhouse conditions for successive vegetative seasons, but also with usage of DNA array for confirmation of this resistance and for looking out of resistance *Ren* genes.

Another motivation to continue this research comes from the controversial results of Rkatsiteli and Rkatsiteli cl.48: the first variety is recognized to be susceptible and the second – resistant. Clone 48 was selected from Rkatsiteli based on its high productivity and usually, the clones do not have a very high shift of variations concerning the mother variety. For sure – if further research confirms the high resistance of Rkatsiteli clone 48 – it should be a great achievement for Georgian viticulture and winemaking, but the producers need to have the highest confirmation of this conclusion to reduce their risks if they will start planting new vineyards with this clonal variation of Rkatsiteli.

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მცენარეთა პათოლოგია

ქართული ვაზის გერმპლაზმის გამძლეობის შეფასება ვაზის ნაცრის მიმართ (*Erysiphe necator* Schwein) კონტროლირებად პირობებში

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ყურძნის ნაცარი დაავადებაა, რომელსაც იწვევს მცენარეთა პათოგენი სოკო *Erysiphe necator* Schwein. ეს დაავადება კონტროლდება ფუნგიციდებით, რაც საფრთხეს უქმნის გარემოს და ადამიანის ჯანმრთელობას. არსებული პრობლემის გადაჭრის მიზნით, მე-19 საუკუნეში ხდებოდა ვაზის გამძლე ჯიშების შეჯვარება ამერიკულ ჯიშებთან. თუმცა, ამ მეთოდის გამოყენებით შექმნილმა ჰიბრიდებმა ამერიკული სახეობებიდან მემკვიდრეობით მიიღო ღვინისთვის არასასურველი სპეციფიკური არომატი. ამის გამო, 2006 წლიდან მეცნიერებმა გამძლეობის გენების მოძიება და შესწავლა დაიწყეს *V. vinifera*-ს გენოფონდში, რაც უფრო და უფრო საინტერესო თემა ხდება მკვლევრებისთვის. ქართულმა და ევროპულმა კვლევებმა ვაზის ნაცრის მიმართ შედარებით გამძლე ვაზის ჯიშები გამოავლინა. ქართული გერმპლაზმა მოიცავს მაღალი გენეტიკური ცვალებადობის 525 ჯიშს და პერსპექტიულია გამძლე გენოტიპების მოსაძიებლად. წინამდებარე კვლევის მიზანია საველე გამძლეობით გამორჩეული ვაზის 80 ჯიშის შესწავლა OIV455 დესკრიპტორის გამოყენებით. დაკვირვება ხორციელდებოდა შეუწამლავ ვაზზე, სათბურის პირობებში. გამოვლინდა გამძლეობის სხვადასხვა სახე: ზოგიერთი სახეობა ხასიათდებოდა სტაბილური გამძლეობით (ქულა 7-9), ზოგი კი არასტაბილური გამძლეობით (ქულა 1-5, 1-7, 3-5 და ა.შ.). წინამდებარე კვლევა ეფუძნება ერთი წლის მონაცემებს და ადასტურებს მიმდინარე კვლევების გაგრძელების აუცილებლობას გამოვლენილი, შედარებით გამძლე ჯიშების უკეთ შესწავლის მიზნით.

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