

CORRELATION BETWEEN APPLE SCAB AND APPLE POWDERY MILDEW DEGREE OF ATTACK ON SOME APPLE VARIETIES DURING THREE YEARS OF OBSERVATIONS

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Abstract. This article discusses the study of two of the most important fungal diseases of apple trees, powdery mildew and scab. Scab, which appear annually in apple orchards, causes damage due to crop losses and reduce crop quality (Gessler C, et al, 2006, Parisi L. et al. 2004). Powdery mildew is also present annually in orchards and three nurseries, causing significant crop losses (David A, et al. 2021). The correlation of these two diseases, who is the most common and important diseases in apple orchards, gives us a broader view of the moment to apply treatments and try to synchronize them. The result of the statistical analysis is different for each variety, partly due to the differences in resistance to these diseases of each variety. The greater the correlation, the greater the simultaneous application of treatments for both diseases could be carried out simultaneously, leading to a decrease in production costs. The experiments took place between 2023 and 2025, years with a dry climate, long summers and high temperatures and intense insolation. The location of orchard was Timiș County, Urseni village, in an apple orchard covering an area of 2 hectares. The orchard was established 14 years ago, using certified planting material. The frequency and intensity of the disease were recorded annually and the degree of attack was calculated in three repetitions. The statistical calculation was done with the statistics package in the Microsoft Excel program.

Keywords: apple scab, apple powdery mildew, correlation, apple orchard

INTRODUCTION

The most significant fungal diseases of the apple species that attack both the foliage and the fruits are powdery mildew and apple scab (SIMERIA GH. ET AL., 2004; POPESCU, GH., 2005; PUJA C.E., 2006). These diseases occur annually in apple orchards, both in bearing orchards and in nurseries (SIMERIA GH., ET AL., 2006; TIMAR., 2009; JAKAB-ILYEFALVI, ZS., 2016). The fungi causing these diseases lead to major losses in apple production, both by reducing yield and by diminishing fruit quality SUMEDREA M., TEODORESCU G., 2005; MOLNAR L., 2003). It is worth noting that while the attack of powdery mildew on the fruit can often be overlooked by the consumer, the scab attack on the skin drastically reduces the appearance and, in some cases, the quality of the apples, causing the price of the affected fruit to decrease substantially.

In this study, we used apples of fairly heterogeneous origin, which are most commonly found in Romanian shops and markets. The selected varieties react very differently to the attack of these fungi due to variations in their tolerance levels (CHEVALIER M ET AL., 2004; GESSLER C, ET AL., 2006; PARISI L, ET AL., 2004; JAKAB-ILYEFALVI, ZS., 2016).

MATERIAL AND METHODS

Research took place from 2023 to 2025 in a 12-year-old private orchard (2 hectares) located in Urseni, Timiș County.

As study material, we selected five apple varieties most commonly found in shops and markets, namely Golden Delicious, Florina, Jonagold, Delicios de Voinești, and Jonathan. These varieties are preferred by consumers due to their organoleptic qualities. Although some of these varieties show high sensitivity to the fungi under study, they continue to be cultivated due to their popularity among consumers.

During the aforementioned period, the frequency and intensity of powdery mildew and apple scab attacks were determined, and their attack degree was calculated. Readings of the frequency and intensity for both diseases were performed on three trees in three replicates. The average attack degrees per tree were used to calculate correlations. Correlations were performed for each individual variety with both diseases, as well as between varieties and diseases, as shown in Table 2.

It should be mentioned that these three years were arid, with a low water regime.

RESULTS AND DISCUSSIONS

Table and Figure 1 present the 3-year averages of the attack degree for apple scab and powdery mildew, as well as the calculations performed regarding the correlation between these two diseases for each individual variety.

The data presented in the chart and table indicate that there is no correlation exceeding 0.5 between these two diseases; this demonstrates a lack of correlation across all varieties.

For the Golden Delicious variety, we have a negative correlation of -0.423, which indicates that there is almost no correlation between these two diseases. However, the calculated data shows that the Florina variety could be the most suitable for organic farming, as the attack degree for both diseases is the lowest among all studied varieties. Furthermore, the correlation between them is quite high, suggesting the possibility of performing simultaneous treatments for these diseases with a high probability of success.

In the Jonathan variety, although the correlation is the highest, the difference in attack levels between the two diseases is very large, which suggests that simultaneous treatments might not be feasible. The Jonathan variety is the most susceptible to powdery mildew, leading to significant challenges when growing this variety in organic or ecological farming.

Table 1.

The attack degree of apple scab and powdery mildew in five apple cultivars and the correlations between this two diseases

	Degree of scab attack (%)	Degree of powdery mildew attack (%)	Correlation between scab and powdery mildew
Golden delicios	19.53	18.35	-0.4230
Florina	8.95	9.45	0.2134
Jonagold	7.55	11.14	0.2912
Delicios de Voinești	16.13	5.44	0.2713
Jonathan	12.89	22.45	0.3340

We will continue to study the correlation between diseases and varieties in other plant species as well, in order to verify the theory presented in this paper.

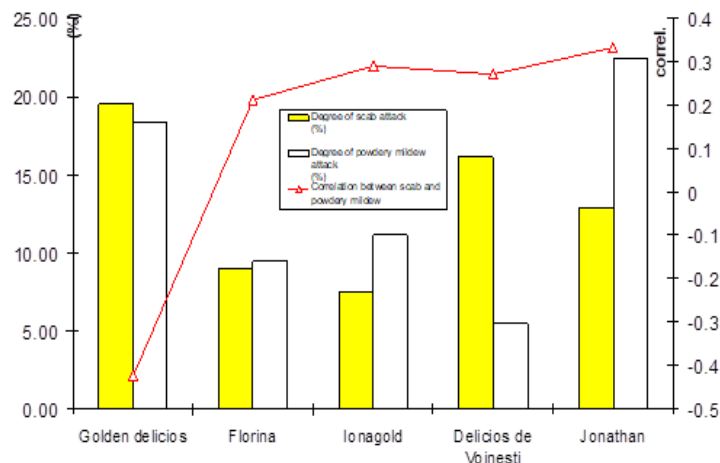


Figure 1. Graphical representation of the attack degree of apple scab and powdery mildew in five apple cultivars and the correlations between this two diseases

The statistical comparisons presented in Table and Figure 2 were based on the idea of correlating diseases across two different varieties: specifically, the scab attack level of the first variety with the powdery mildew attack level of the second, and then conversely, the powdery mildew attack level of the first variety with the scab attack level of the second. The practical utility of these correlations lies in apple breeding programs focused on tolerance or resistance to these two diseases, as well as in agricultural practice for selecting pollinators for self-sterile apple varieties.

Table 2.

The correlation between the five apple varieties and the two diseases, each with other

		Powdery mildew				
		Golden delicios	Florina	Ionagold	Delicios de Voinești	Jonathan
Apple Scab	Golden delicios	-0.4230	-0.0949	0.1871	-0.0581	0.4115
	Florina	-0.3549	0.2134	0.1715	0.2818	0.2800
	Ionagold	-0.3752	0.0701	0.2912	0.0296	0.4114
	Delicios de Voinești	-0.3103	0.3322	0.3610	0.2713	0.4439
	Jonathan	-0.2326	0.1861	0.2023	0.2137	0.3340

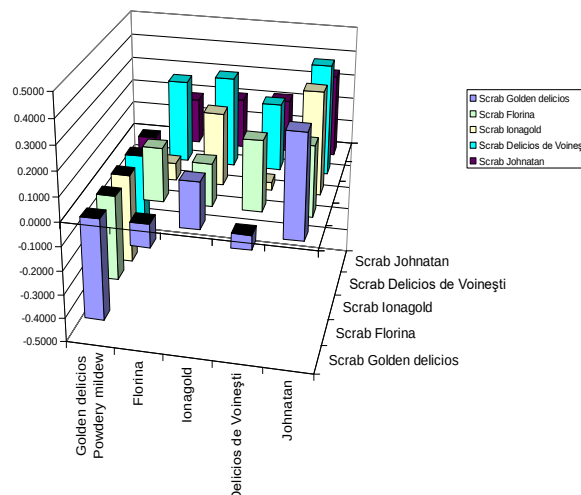


Figure 2. Graphical illustration of correlation between the five apple varieties and the two diseases, each with other

In the table, the varieties and their correlation for apple scab are listed horizontally, while the same varieties and their correlation for powdery mildew are listed vertically. The diagonal from top-left to bottom-right shows the mildew–scab correlations for the same variety; outside of this diagonal, bidirectional comparisons regarding diseases are made between pairs of different varieties.

For example, I will discuss a single example of correlation between two varieties regarding the attack of these two diseases. In an orchard where the Delicios de Voinești and Jonathan varieties are grown, it can be observed that the correlation value for apple scab on the Delicios de Voinești variety compared to powdery mildew on the Jonathan variety is 0.4439. In contrast, the correlation value between apple scab on the Jonathan variety and powdery mildew on the Delicios de Voinești variety is 0.2137.

The reason for choosing these two varieties is that Jonathan is known to be the most susceptible to powdery mildew among the varieties under study—a variety where the disease could become chronic—while Delicios de Voinești is the most sensitive to apple scab, which often causes the fruit skin to crack in the affected areas and leads to a high frequency of deformed fruits.

What can further be observed by analyzing the data in the table is that the average of the two mirrored values for the Delicios de Voinești - Jonathan pair and the powdery mildew – apple scab tandem is the highest, at 0.6576. As an example, calculating the average following the same model for the Jonagold and Florina varieties, the result is 0.2416 ($0.0701 + 0.1715$).

The difference in correlation means is 0.4160, suggesting that the cultivation of Jonagold and Florina cultivars may be more advisable than that of Jonathan and Delicious de Voinești.

For instance, in breeding, crossing the Jonagold and Florina varieties would be more auspicious than crossing Jonathan with Delicios de Voinești, as it could lead to a new variety resistant to both diseases. Conversely, crossing Jonathan with Delicios de Voinești might produce varieties with excellent flavor, but with excessive susceptibility to both diseases. Hybridization between varieties from these two distinct groups could be open to debate.

CONCLUSIONS

Based on the results and discussions in the previous chapter, the following conclusions can be drawn:

- When assessing the correlation between two diseases within the same cultivar, a strong positive correlation is desirable to facilitate synchronized chemical control. Ideally, reciprocal correlation analyses should be conducted, determining the treatment protocol based on the primary reference disease.

- The most valuable cultivars are characterized by a low degree of susceptibility to both pathogens combined with a high degree of inter-pathogenic correlation.

- In the case of cross-correlating two cultivars and two diseases, a lower mean correlation is expected; however, it is recommended that observations prioritize the specific cultivar-disease pairing that exhibits the highest correlation coefficient.

- This methodological approach warrants further investigation across a broader range of agricultural crops and their respective major pathogens.

If this work has caught your attention and you have a different line of reasoning, I look forward to receiving your suggestions.

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