Scientific Papers. Series B, Horticulture. Vol. LXVI, No. 1, 2022
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

THE RESISTANCE OF PEACH TO THE ATTACK OF SOME PATHOGENS IN CLIMATE CHANGE CONDITIONS

Cristina MOALE[1], Leinar SEPTAR[1], Corina GAVĂT[1], Ion CAPLAN[1], Alexandru OPRIȚĂ[1], Gheorghe LĂMUREANU[1], Florin OANCEA[2], Marius GHIUREA[2], Mălina DESLIU-AVRAM[2]

[1]Research Station for Fruit Growing Constanta, 25 Pepinierei Street, 907300, Valu lui Traian, Constanta, Romania
[2]National Institute for Research & Development in Chemistry and Petrochemistry-ICECHIM, 202 Splaiul Independentei, Sector 6, 060021 Bucharest, Romania

Corresponding author email: moalecristina@yahoo.com

Abstract

The studies were carried out over a period of four years (2018-2021) in a plot at the Research Station for Fruit Growing (RSFG) Constanta. This paper presents the manner in which the ten peach tree cultivars reacted to the climate changes and the attack of pathogen agents: Taphrina deformans Berk et Tull, Cytospora cincta Sacc, Monilinia laxa and Monilinia fructigena Aderh Ruhl Honey. The cultivars with resistance, tolerant (T) to Taphrina deformans (without attack), in the studied period were 'Mimi', 'Catherine Sel.1' and 'Raluca'. The 'Filip' cultivar showed sensitivity (S) towards the Monilinia laxa in 2019 and 2020. As far as for the Cytospora cincta pathogen the cultivars tolerant (T) were 'Collins' in all studied years and 'Filip' in 2018 and 2019. The obtained results demonstrate the importance of choosing the assortment of cultivars, taking into account the favourability of the area, as well as the climate and soil conditions.

Key words*: Cytospora cincta, Monilinia laxa, climate changes, natural infection.*

INTRODUCTION

The southeastern part of Romania is the area that offers the most favorable ecoclimatic conditions for peach cultivation. Unfortunately, this area is also favorable for the development of particularly harmful pathogens such as the fungus *Taphrina deformans* Berk et Tull, *Cytospora cincta* Sacc, *Monilinia laxa* and *Monilinia fructigena* Aderh Ruhl Honey. The territory of the RSFG Constanta is influenced, from a climatic point of view, both by the Black Sea as well as the Danube, which means that spring arrives later, summers are droughty and autumns are long and warm. The introduction within cultures of peach tree cultivars which are more resistant to the attack of the most harmful pathogen agents offers numerous economic advantages and is consistent with the protection of the environment. Therefore, the fruit practice on the one hand and especially the peach breeding program from the Research Station for Fruit Growing Constanța, set up as a priority objective, the promotion of cultivars and the identification of possible genitors with genetic resistance to *Taphrina deformans* fungus attack.

Cytospora was first introduced by Ehrenberg (1818), which is one of the most important pathogenic fungi of hardwoods and coniferous trees in the world (Adams et al., 2005; Fan et al., 2020).

About 150 species epithets of *Cytospora* are associated with dieback and stem canker on over 130 species of woody hosts (Spielman, 1985; Adams et al., 2005; Kirk et al., 2008; Fan et al., 2020). Trandafirescu (1998, 2007) has studied the resistance to the *Taphrina deformans* within the peach tree and nectarine tree species, detailing the research for each cultivar from the national peach tree collection which was planted in 1981.

According to the estimations of the weather forecasts, there have been presented in the frame of the 4th report of the International Committee for Climatic Changes in the year 2007, the whole Europe and implicit Romania will be confronted in future with a process of global warming, characterized by increasing of temperatures with 0.5 - 1.5°C for the period

2020- 2029 and with 2- 5°C for the period 2029 -2099. In the period 2090-2099 Romania will confront with pronounced drought during the time of summer. Researches from many countries, in the frame of climatic research methodology have the approached aspects regarding climatic changes effects on growth and development of some fruit tree species (Chmielewski and Rotzer et al., 2002; Olensen and Bindi, 2002; Sunley et al., 2006, Chitu et al., 2010).

The introduction within cultures of peach tree cultivars which are more resistant to the attack of the most harmful pathogen agents offers numerous economic advantages (the reduction of production losses, the diminishing of expenses regarding pesticides, the fuel and energy required for the application of treatments, the prolonging of the culture's exploitation period) and is consistent with the protection of the environment(the reduction of the soil's ramming due to the fact that the tractor crosses the orchard a smaller number of times, the reconstruction of the soil's structure, the reduction of the pollutionof the environment and of the fruit, as well as the protection of the consumers' health).

The purpose of this paper is to show the manner in which certain peach tree cultivars reacted to to the attack of pathogens and to recommend said cultivars for extension in production, given the fact that in our country as well as worldwide the main objective is not only the obtainingof fruit of a higher quality, with an elevated yet constant productivity of the trees, but which are also resistant and/or tolerant to the main disease of the species.

MATERIALS AND METHODS

The experimental plot is situated within the RSFG Constanța, with its headquarters in the village of Valu lui Traian, Constanța county, Dobrogea region, Romania. The geographical coordinates are: 44°10' North, 28°29' East, 70-72 m altitude.

During the period of 2018-2021, 10 peach tree genotypes were studied, organised in a demonstrative plot that was created in 2011. The plot has 20 trees per row, with a planting distance of 4 m × 4 m (625 trees/ha), with the canopy shape a vase and the rootstock a wild Tomis 1. Among the studied cultivars there, as well as cultivars promoted in the regional and national assortment, these are: 'Purpuriu', 'Mimi', 'Catherine Sel.1', 'Springold', 'Raluca', 'Cardinal', 'Collins', 'Redhaven', 'Florin' and 'Filip'. The system used for the soil management system was with cultivated strips both between the rows as well as in the row. The soil is a calcareous chernozem (CZka), with a loamy texture and a high, alkaline pH (8.2) in its entire profile. All in all, the climatic conditions were favourable to the growth and fructification of the peach trees.

The study focused on how certain peach tree cultivars reacted to the change in climatic conditions in the winters of the above-mentioned years. The conclusion was that the resistance of the peach tree cultivars differs from year to year because of the climatic changes that have occurred throughout the past few years and that depends on the severity of climatic accidents. During the studied period 2018-2021 the climatic data were recorded with the aid of an automatic meteorological station type WatchDog and were processed as daily averages.

Observations were carried out concerning the behaviour of certain peach tree cultivars towards the attack of the main pathogen agents: *Taphrina deformans* Berk et Tull*, Cytospora cincta* Sacc*, Monilinia laxa* and *Monilinia fructigena* Aderh Ruhl Honey. *Taphrina deformans* causes the blistering of the peach tree's leaves (Figure 1).

Figure 1. The blistering of the leaves -*Taphrina deformans:*
a) Symptoms on the leaves; b) Symptoms on the fruit

The most characteristic symptoms can be noticed on the leaves, although the branches, flowers and fruit can also be attacked. The leaves of the attacked trees become thicker and creased (blistered), the attack being more evident on younger leaves at the tip of the sprouts. The attacked leaves are twice as long and wide (Figure 1a) than the healthy ones and they fall earlier, thus defoliating the tree, which

means that the development and the maturing of the branches is disturbed. The fruit also have a weak development and they fall before becoming ripe; sometimes white-yellowish spots can be observed, slightly prominent and with irregular contours (Figure 1b). The young sprouts which are infected stop growing; they remain short, thicker at the base and with leaves only at the tip.

Cytospora cincta, which causesthe perennial cancer of the sprouts is generalised in peach tree crops which have suffered injuries on the bark of the sprouts as a result of other pathogen agents' attacks, such as *Taphrina deformans* or fusicoccum, the attack of insects orhits caused by hail. *Cytospora* installs itself on the already existent wounds and continues its attack on the branches; subsequently, the bark and the wood becomes dry and in some cases ulcerations occur. *Monilinia laxa*, which causes moniliosis or the monilinial drying of the branches manifests itself during spring on all aerial organs of trees of all ages through the withering of the flowers and the drying of the vegetative buds and the sprouts, being accompanied by gumma leakages (Figure 2).

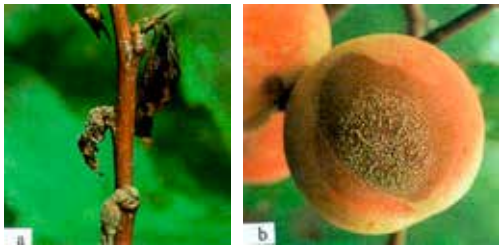

Figure 2. *Monilinia:*
a) Monilinia laxa - the monilinial drying of the branches; b) Monilinia fructigena - fruit moniliosis

On multi-annual branches we can notice the defoliation and the necrosis of the wood. Upon a weaker attack the trees are able to recover, while upon a stronger one they manifest typical decaysymptoms and, in time, they die. *Monilinia fructigena* causes the moniliosis of the fruit during the period in which the latter begin ripening, the result being that the latter fall androt. In dry weather they remain on the tree, becoming the source of infection for the following year.

From a technological point of view, 8-10 treatments with insecticides and fungicides have been applied each year in the experimental plots, so as to protect against diseases and pests. The attack of these pathogen agents has serious consequences both on the fruit production, as well as on the physiological balance of trees, leading to their debilitation.

These observations were focused on the evolution of the diseases on the leaves, fruit and shoots following. The climatic conditions in this area are favourable to the peach tree culture. Due to its geographic position, Dobrogea is part of the agro-climatic area I, which is warm and droughty and characterised by the most generous thermal resources and the lowest amount of precipitations in comparison to other regions of the country. The behaviour of peach tree cultivars towards the attack of the pathogen agents *Taphrina deformans* Berk et Tull*, Cytospora cincta* Sacc*, Monilinia laxa* and *Monilinia fructigena* Aderh Ruhl Honey - was studied under conditions of natural infections, according to the test created by Crossa Raynaud (1969). The evaluation technique consisted in writing down the frequency of the attacked organs and the intensity with which the symptoms manifested themselves and these two aspects were utilised in assessing the behaviour of the cultivars. The field observations were centred on the calculation of the pathogens' frequency (F %) and intensity (I) on different tree organs such as: leaves, flowers, shoots, branches and fruits. For the intensity of the diseases marks were granted on a scale from 0 to 4.

Depending on the frequency and intensity of the disease, the studied cultivars and hybrids were categorised into 4 classes and 8 groups of resistance according to the following scale (Table 1).

Table 1. Cultivar Categorisation into Classes and Groups of Resistance

Resistance class	Resistance group	Frequency (F%)	Intensity (I%)
1 = tolerant (T)	1	0	0
2 = medium resistance (MR)	2	0.1-11.0	+
	3	11.1-25.0	+
3 = sensitive (S)	4	25.1-34.0	++
	5	34.1-50.0	++
4 = very sensitive (VS)	6	50.1-59.0	+++
	7	59.1-75.0	+++
	8	75.1-100	++++

WA = cultivars without attack (F%= 0 and I= 0); T = tolerant cultivars (F%= 0.1-5% and I= +); WeA = weakly attacked cultivars (F%= 5.1% - 10% and I= +); MA = moderately resistant cultivars (F%= 10.1% - 25% and I= +); S= sensitive cultivars (F%= 25.1 – 50% and I= ++++); VS = highly sensitive cultivars (F%= 50.1% - 100%, I= ++++)

RESULTS AND DISCUSSIONS

The comeback frosts in March-April, which occur after a relatively warm period are more dangerous than those that occur during the obligatory resting period in December-January. Nevertheless, the major climatic changes that have taken place over the past few years have had a significant negative influence on the onset of flowering and fruit setting and implicitly, on the peach tree production.

Analysis was carried out in order to determine the loss of flowering buds caused by temperature variations during winter and the low temperatures during the day.

In 2021 the Springold cultivar recorded the greatest losses caused by frost – 61%; though the trees apparently blossomed abundantly, the pistils were blackened (due to frosts) and there was no fruit setting. Though some of the flowers did indeed show fruit setting, upon careful inspection the core ovary was also blackened. The Cardinal cultivar recorded 54% losses in 2021, while the smallest percentage of affected fruit occurred in the Catherine Sel.1 cultivar - 12% in 2021 (Figure 3).

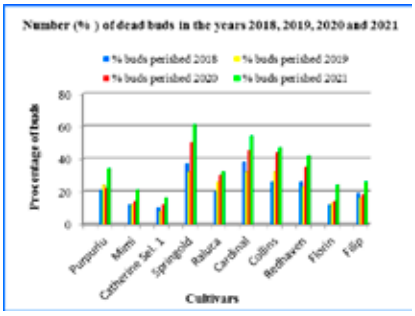

Figure 3. Procentage of peach tree flowering buds perished due to frosts during the winter of 2018, 2019, 2020 and 2021 at Valu lui Traian, Constanța

The peach tree cultivars showed a good resistance to frost during the winters of the four studied years, as follows: Catherine Sel. 1 - 12%, Mimi - 15%, Florin - 16% and Filip - 20%, (Figure 4).

Table 2 presents the relative sensitivity of the ten cultivars from the demonstrative plot created within the laboratory responsible with improving the peach tree concerning the attack of the pathogens: *Taphrina deformans* Berk et Tull, *Cytospora cincta* Sacc, *Monilinia laxa* and *Monilinia fructigena* Aderh Ruhl Honey under natural conditions of infection.

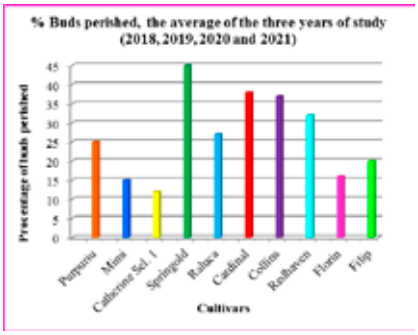

Figure 4. Procentage of peach tree flowering buds perished because of frosts (average over the three years), Valu lui Traian

The analysis of the data in this table highlights a variation in the peach tree cultivars' behaviour towards a pathogen or another. The observations that were carried out under conditions of natural infection with *Taphrina deformans* Berk et Tull for the ten peach tree cultivars displayed the different degrees of resistance.

Table 2. The behaviour of peach tree cultivars towards the attack of the main pathogens in the period 2018, 2019, 2020 and 2021

No.	Cultivar	Year	Intensity of attack (note)			
			Taphrina deformans	*Cytospora cincta*	*Monilinia laxa*	*Monilinia fructigena*
1.	Purpuriu	2018	MR	S	T	T
		2019	MR	S	MR	T
		2020	MR	MR	T	T
		2021	MR	MR	MR	T
2.	Mimi	2018	T	S	T	T
		2019	T	T	T	T
		2020	T	T	T	T
		2021	T	T	T	T
3.	Catherine Sel.1	2018	T	S	T	T
		2019	T	T	T	T
		2020	T	T	T	T
		2021	T	T	T	T
4.	Springold	2018	S	MR	S	S
		2019	S	S	S	S
		2020	MR	MR	MR	MR
		2021	MR	S	MR	MR
5.	Raluca	2018	T	S	T	T
		2019	T	T	T	T
		2020	T	T	MR	MR
		2021	T	T	MR	MR
6.	Cardinal	2018	MR	MR	MR	MR
		2019	T	MR	MR	MR
		2020	MR	T	MR	MR
		2021	T	MR	MR	MR
7.	Collins	2018	MR	T	S	S
		2019	MR	T	S	S
		2020	MR	T	S	S
		2021	MR	T	S	S

8.	Redhaven	2018	S	MR	MR	MR
		2019	S	MR	T	T
		2020	MR	MR	T	T
		2021	MR	T	T	T
9.	Florin	2018	S	MR	MR	MR
		2019	S	MR	MR	MR
		2020	MR	MR	MR	MR
		2021	MR	MR	MR	MR
10.	Filip	2018	S	T	T	T
		2019	S	T	S	T
		2020	S	S	S	T
		2021	S	S	T	T

The Mimi, Catherine Sel.1 and Raluca cultivar was Tolerant (T) in the studied years 2018, 2019, 2020 and 2021 towards *Taphrina deformans*. Purpuriu and Collins displayed a Medium Rezistance (MR) in the studied years 2018, 2019, 2020 and 2021. Redhaven and Florin displayed a Medium Rezistance (MR) in the studied years 2020 and 2021. None of the studied cultivars could be introduced in the classes Very Sensitive (VS).

The Collins cultivar was Tolerant (T) in the studied years 2018, 2019, 2020 and 2021 towards *Cytospora cincta*. The Mimi, Catherine Sel .1 and Raluca cultivars, manifested a good resistance towards *Cytospora cincta* in the studied years 2019, 2020 and 2021. None of the studied cultivars could be introduced in the classes Very Sensitive (VS).

In the studied period 2018-2021 both Mimi and Catherine Sel.1 manifested a good resistance towards *Monilinia laxa*, being basically in the class Tolerant (T). The two studied cultivars displayed an increased resistance towards the attack of *Taphrina deformans* in all studied years.

That is why fruit-growing practices on the one hand and especially the RSFG Constanta programme for improving the peach tree on the other highlighted as main objective for researches the promoting of cultivars and the identification possible genitors with genetic resistance towards the attack of the pathogens *Taphrina deformans* Berk et Tull, *Cytospora cincta* Sacc, *Monilinia laxa and Monilinia fructigena* Aderh Ruhl Honey.

CONCLUSIONS

The results show that the frosts in the winters of 2018, 2019, 2020 and 2021 affected the peach tree species in variable percentages according to the cultivar (approx. 12-45%).

The greatest losses as far as flowering buds are concerned were recorded by he Springold cultivar in 2021 (61%), while the smalles were recorded by 'Catherine Sel.1' in 2019 (8%).

Concerning the attack of the the *Taphrina deformans* the following cultivars were comprised in the class Tolerant (T): 'Mimi', 'Catherine Sel.1' and 'Raluca' cultivar in the studied years 2018, 2019, 2020 and 2021. The three studied cultivars ('Mimi', 'Catherine Sel.1' and 'Raluca') manifested an increased resistance towards the attack of *Taphrina deformans.*

Concerning the attack of the the *Cytospora cincta* the Collins cultivar was Tolerant (T) in the studied years 2018, 2019, 2020 and 2021.

In the studied period 2018-2021 both 'Mimi' and 'Catherine Sel.1' manifested a good resistance towards *Monilinia laxa*, being basically in the class Tolerant (T).

When choosing the assortment of cultivars, one must take into account the favourability of the area for the setting up of fruit-growing plantations.

ACKNOWLEDGEMENTS

The authors thank financial support from Romanian Ministry of Agriculture and Rural Development (The projects: ADER 7.3.9. Research on the biological activity of nanomaterial products on major pesticides in fruit growing and assessment of their ecotoxic-cological impact on useful entomofauna) and Romanian Academy of Agricultural and Forestry Sciences "Gheorghe Ionescu Sisesti" (The project no. 4580, Maintenance of fruit - trees multiplication material from superior biological categories).

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