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REACTION OF SOME PLUM CULTIVARS TO NATURAL INFECTION WITH *Taphrina pruni* (Fuck.) Tul., *Fusicladium Pruni* DUCOMET AND *Tranzschelia pruni-spinosae* PERSOON DIETEL

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Abstract. The response to the attack of *Taphrina pruni* (Fuck.) Tul., *Fusicladium pruni* Ducomet and *Tranzschelia pruni-spinosae* Persoon Dietel , in natural conditions of infection of 13 plum cultivars were evaluated, during three years, in a commercial orchard located at Calacea, Salaj county, Romania, in 2012-2014. The cultivars taken into study were 'Topfirst', 'Nectarina rosie', 'Tuleu timpuriu', 'Hangata', 'Toptaste', 'Tuleu gras', 'Vinete de Italia', 'Stanley', 'Vinete romanesti', 'Tophit', 'Jojo','Anna Spath', 'Topend'. The highest degree of attack of *Taphrina pruni*, on fruits in 'Vinete romanesti' 'Stanley' and 'Vinete de Italia' was recorded and the most resistant cultivars were 'Topend', 'Jojo', 'Tophit', 'Tuleu timpuriu'and 'Topfirst'.The most resistant cultivars regarding the attack of *Fusicladium pruni* Ducomet proved to be 'Topfirst', 'Topend', 'Jojo', 'Tophit', 'Hangata' followed by 'Anna Späth', 'Toptaste', 'Vinete romanesti' and 'Stanley' respectively the highest degree of attack on 'Tuleu gras', 'Nectarina rosie', 'Tuleu timpuriu' and 'Vinete de Italia' , was observed. Regarding the plum rust (*Tranzschelia pruni-spinosae* Persoon Dietel) the cultivars having the lowest degree of attack were 'Jojo', 'Tophit', 'Topend', 'Anna Späth', 'Toptaste', 'Tuleu gras' and 'Nectarina rosie. The most sensitive cultivars to Plum Rust proved to be 'Vinete romanesti' and 'Tuleu timpuriu' followed by 'Nectarina rosie', 'Vinete de Italia' and 'Stanley'. The low level of infections in some cultivars represents an element that recommends them in breeding programs on resistance to these diseases of plum.

Keywords: breeding, plum pockets, rust disease,stone fruits

INTRODUCTION

Plum is the most widespread fruit tree species in Roamnia. Regarding the plums production, Romania holds the 4th place worldwide after China, Serbia and USA and the 2nd one in Europe after Serbia (Coman et all., 2010). The biggest losses in plum production, as to the other tree species are due to diseases and pests. Improving resistance to diseases is a primary goal for plum breeders. Plum diseases that commonly occur year after year in both commercial and backyard plantings of plum in Romania are brown rot, red spots and shot-hole (Mitre et al 2015). Besides these diseases other pathogens like *Taphrina pruni* (Fuck.) Tul., *Fusicladium pruni* Ducomet and *Tranzschelia pruni-spinosae* Persoon Dietel. cause serious damages in the comercial plum orchards.

Taphrina pruni infects *Prunus domesticus* (Plum) and *Prunus spinosus* (Blackthorn or Sloe) fruits to form pocket plums. It also infects the shoots of Blackthorn to cause stunted or swollen distortions. Infected fruits tend to become elongated, often more on one side than the other, which leads to to pocket-like shapes (Elis, 1997). *Fusicladium pruni Ducomet* Scab (sometimes called "black spot" or "freckles") attacks peaches, cherries, plum, and apricot. It affects most stone fruit, including plums. Rust is caused by the pathogenic fungus *Tranzschelia pruni-spinose* Persoon Dietel. Small,

yellow, irregular spots appear on the upper and lower surfaces of leaves. Those on the lower surface later turn rusty brown. Leaves with numerous lesions turn yellow and fall. Therefore it is necessary to obtain new varieties with tolerance or resistance to these diseases. Creating resistance involves selection and propagation genotipes with genetic resistance to these diseases .

Genetic forms of control will become more important as pesticide resistance, declining access to registered chemicals and consumer demand for pesticide-free fruit will combine to remove current chemical solutions (Bruce *et al.*, 1992). Conservation of genetic resources has received increasing attention over the last decades. Therefore, the estimation of the diversity and its nature and magnitude are beneficial or even crucial to a breeding Program (Rakonjac *et al.*,2014). The availability and informative value of plant germplasm are becoming more and more important for the future preservation and sustainable use of genetic resources (Lacis *et al*., 2010). Summaries of resistant cultivars (Ramming and Cociu, 1991) and genetics of resistance (Okie and Weinberger, 1996) are available for the economically important diseases and pests. Hartmann and Neumuller, (2009) present the steps in breeding resistant cultivars as follows: first of all, genetically fixed differences in the behaviour of single genotypes of the respective species against the pathogen must be detected.

The more genotypes can be tested, the higher is the probability of finding resistance and/or tolerance.National gene banks can be used for obtaining a broad spectrum of different genotypes. For this kind of large-scale testing, a reliable resistance test has to be developed. Resistant genotypes must be selected in order to use them as a crossing partner. In advance or in parallel to a resistance breeding programme, the life cycle of the pathogen and the kind of reaction of the plant against it must be investigated. Before releasing a new variety, the respective genotype has to be tested under natural inoculation conditions on different sites for several years (Mitre et al., 2015)

The aims of this investigation were to study the response of 13 plum cultivars regarding the some fungus diseases of plum (*Taphrina pruni* (Fuck.) Tul., *Fusicladium pruni* Ducomet and *Tranzschelia pruni-spinosae* Persoon Dietel) under conditions of natural infection, in Transylvanian area. The results will be useful in choosing of good parents in order to obtain resistant new cultivars to these diseases.

MATERIALS AND METHODS

The research has been carried out at SC Lunca Farm, Calacea, Sălaj, county, Romania, in a commercial orchard in 2012-2014. Biological material of the experiment, was represented by the following plum cultivars: 'Topfirst', 'Nectarina rosie', 'Tuleu timpuriu', 'Hangata', 'Toptaste', 'Tuleu gras', 'Vinete de italia', 'Stanley', 'Vinete romanesti', 'Tophit', 'Jojo','Anna Spath', 'Topend'. The orchard had a density of 1000 trees/ha. A complete randomized experimental design with five replicates (trees) was used for sampling trees. *Taphrina pruni* (Fuck.) Tul. was evaluated, each year, 8 weeks after bud break, counting the 'pocket plums'appeared on the twigs. In the case of Plum Scab caused by *Fusicladium pruni* Ducomet, infections on fruits were evaluated first and then infections appeared on leaf and twigs, as sooty or olive blotches on the underside of leaves, and as dark lesions running along the mid-rib and petiole. *Tranzschelia pruni-spinosae* Persoon Dietel was followed in the end of june each year.Visual observation was the method used to identify a disease based on signs and symptoms shown by infected plants. The level of attack was determined by Frequency (F%) and Intensity (I%) attack,

in the natural conditions of infections. Thus, the Attack Degree (AD%) was calculated with the formula: AD%=(F% x I%)/100 (Cociu and Oprea, 1989), representing expressly the extension of the attack seriousness, as a mean for the tree years in question. The Frequency of attack (F%) was determined by dividing the number of organs (leaves, twigs or fruits) affected by disease (n) by the total number of organs analysed (N), the formula being: F% = n / N x 100. The Intensity of attack (I%) was a percentage assessed for every tree, with the formula: I% = _(i x f) / b, where 'i' represented the percentage of coverage with symptoms per organs, 'f' was the number of cases with symptoms framed incertain percentage and 'b' was the number of disease affected organs.

The observations on the intensity and frequency of attack were made on leaves, twigs and fruits. Interpretation of results was done by analysis of variance (ANOVA test). Climatic data from Salaj Water Management System were provided.

RESULTS AND DISCUSSION

The climatic conditions of the experimental field, in the three years of study, can be considered as normal ones compared to the multi-annual average, even if temperatures increased year by year. In June and July the value of temperature became higher and higher year by year (Fig.1.).

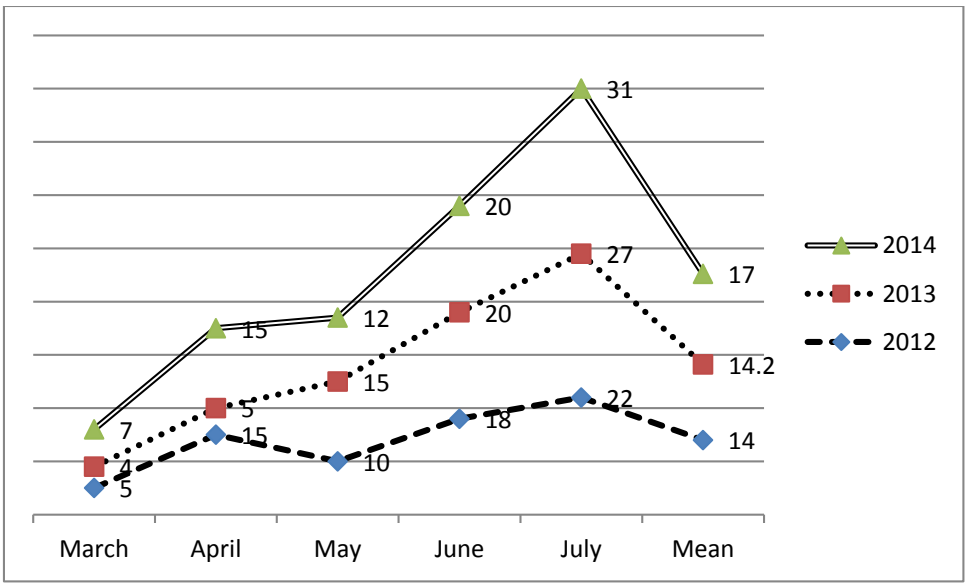

Fig.1. Mean monthly temperatures in the experimental years (^{0}C)(Salaj Water Management System)

In 2012 and 2014 temperature mean values were high and similarly in April, period when the conidia started to germinate and grow. The temperature value created good conditions for evoulution of the studied fungus.

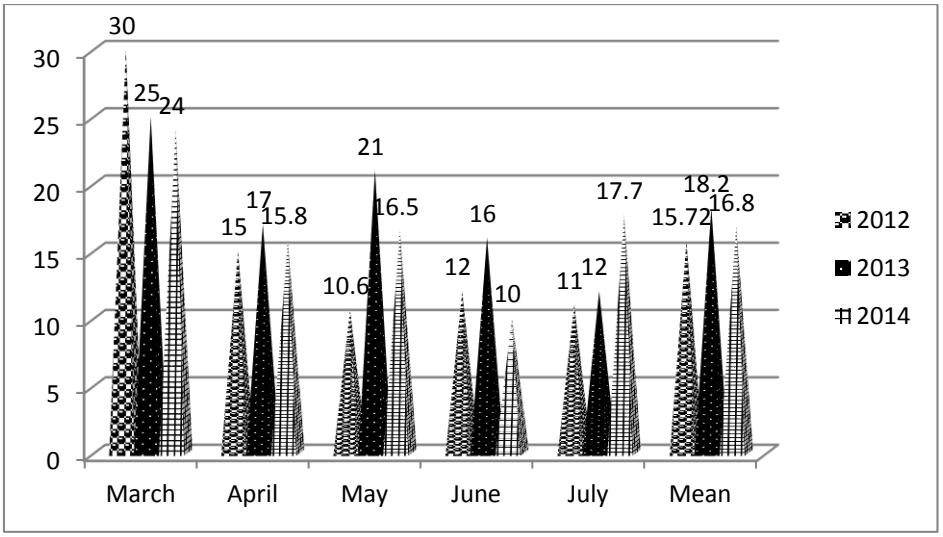

Fig.2. Mean monthly precipitations in the experimental years (mm)(Salaj Water Management System)

The average monthly precipitation decreased every year (Fig.2.). Anyway the umidity conditions needs of fungus development was favorable. Plum Pockets, caused by the fungus *Taphrina pruni (Fuck.) Tul*, appeared shortly after fertilization, deforming newly formed fruit. After infection, attacked fruits had became dried and fell in June each year. The attack of Plum Pockets on the fruits is presented in Table 1. The highest degree of attack on 'Vinete romanesti' 'Stanley' and 'Vinete de Italia' was registered, with very significant respectively distinct significant differences as to the control (mean of experiment). A part of the results are confirmed by Minoiu (1997).

Table 1

The response of plum cultivar to Plum Pockets (*Taphrina pruni (Fuck.) Tul.*) attack on fruits, in Calacea, Sălaj, county, Romania, in 2012-2014

Cultivar	Degree of attack (%)	Degree of attack as to control (%)	Differences as to control (%)	Significance of difference
Topfirst	1.0	10.8	-8.3	00
Nectarina rosie	2.7	28.8	-6.6	0
Tuleu timpuriu	0.5	5.4	-8.8	00
Hangata	2.0	21.6	-7.3	0
Toptaste	3.3	36.0	-5.9	-
Tuleu gras	5.8	62.3	-3.5	-
Vinete de Italia	18.0	194.6	8.7	**
Stanley	21.7	234.2	12.4	***
Vinete romanesti	54.0	583.7	44.7	***
Tophit	0.0	0.0	-9.3	00
Jojo	0.0	0.0	-9.3	00
Anna Spath	11.3	122.5	2.1	-
Topend	0.0	0.0	-9.3	00
Mean of experiment	9.3	100		
	DL 5% = 6.1	DL 1 % = 8.3	DL 0.1 % = 11.1	

These cultivars proves to be very sensitive to *Taphrina pruni*, thats why, they are not recommended as parent for improvement resistance to Plum Pockets. The most resistant cultivars were 'Topend', 'Jojo', 'Tophit', 'Tuleu timpuriu'and 'Topfirst' registering distinct significant negativ differences as to the control, followed by 'Hangata' and 'Nectarina rosie', with significant differences. No differences statistically assured as to the control also in 'Anna Späth', 'Tuleu gras' and 'Toptaste' was registered. All these cultivars could be considered as good genitors for improvement resistance to Plum Pockets, caused by the fungus *Taphrina pruni (Fuck.) Tul*.

Regarding the black spot caused by *Fusicladium pruni Ducomet* attack on fruits, the cultivars having the lowest degree of attack were 'Topfirst', 'Topend', 'Tophit', 'Jojo', 'Hangata', 'Anna Spath','Toptaste' (Tab.2.). The differences registered as to the control were very significant so, these cultivars could be recomanded in improving resistance to black spot caused by *Fusicladium pruni Ducomet* attack. The cultivar 'Vinete romanesti' also registered differences statistically assured as to the control.The highest degree of attack on 'Tuleu gras', 'Nectarina rosie', 'Tuleu timpuriu', 'Vinete de Italia', was observed, registering very significant differences as to the control. These cultivars prove to be very sensitive to black spot in natural conditions of infections of the experiment.

Table 2

The response of plum cultivars to black spot (*Fusicladium pruni Ducomet*) attack, on fruits, in Calacea, Sălaj county, Romania, 2012-2014

Cultivar	Degree of attack (%)	Degree of attack as to control (%)	Differences as to control (%)	Significance of difference
Topfirst	0.0	0.0	-9.0	000
Nectarina rosie	28.3	314.8	19.3	***
Tuleu timpuriu	21.0	233.3	12.0	***
Hangata	0.7	7.4	-8.3	000
Toptaste	2.0	22.2	-7.0	000
Tuleu gras	35.3	392.6	26.3	***
Vinete de Italia	18.0	200.0	9.0	***
Stanley	4.3	48.1	-4.7	00
Vinete romanesti	5.7	63.0	-3.3	0
Tophit	0.0	0.0	-9.0	000
Jojo	0.0	0.0	-9.0	000
Anna Spath	1.7	18.5	-7.3	000
Topend	0.0	0.0	-9.0	000
Mean of experiment	9.0	100		
	DL 5% = 3.2	DL 1 % = 4.4	DL 0.1 % = 5.9	

The degrees attack of black spot caused by *Fusicladium pruni* Ducomet on twigs and leaves are presented in the Table 3. Data inside of the table show that there are differences statistically assured as to the control between cultivars. The highest degree of

attack on fruits was recorded in the following varieties: 'Tuleu gras','Nectarina rosie' , 'Tuleu timpuriu' and 'Vinete de Italia'. These cultivars prove to be very sensitive to black spot on fruits in natural conditions of infections in the experiment and are not recommended as parents in plum breeding resistance against Fusicladium pruni Ducomet on twigs and leaves. Both in the attack on the leaves and branches, as well as the attack on the fruit have been shown to be sensitive, respectively resistant the same cultivars. Good genitors for inducing rezistance to black spot caused by *Fusicladium pruni* Ducomet prove to be 'Topfirst', 'Topend', 'Jojo', 'Tophit', 'Hangata' followed by 'Anna Späth', 'Toptaste', 'Vinete romanesti' and 'Stanley'. Nasrollah and Mahmudi (2010) found similar results with some local plum cultivars particularly Santeroza, Ghatretala, Shablon with significant differences between them.

Table 3

The response of plum cultivars to black spot (*Fusicladium pruni Ducomet*) attack, on twigs and leaves, in Calacea, Sălaj county, Romania, 2012-2014

Cultivar	Degree of attack (%)	Degree of attack as to control (%)	Differences as to control (%)	Significance of difference
Topfirst	0.0	0.0	-7.1	000
Nectarina rosie	21.0	296.7	13.9	***
Tuleu timpuriu	20.3	287.3	13.3	***
Hangata	0.0	0.0	-7.1	000
Toptaste	2.0	28.3	-5.1	000
Tuleu gras	29.7	419.2	22.6	***
Vinete de Italia	13.3	188.4	6.3	***
Stanley	3.0	42.4	-4.1	000
Vinete romanesti	2.0	28.3	-5.1	000
Tophit	0.0	0.0	-7.1	000
Jojo	0.0	0.0	-7.1	000
Anna Spath	0.7	9.4	-6.4	000
Topend	0.0	0.0	-7.1	000
Mean of experiment	7.1	100		
	DL 5% = 1.7	DL 1 % = 2.3	DL 0.1 % = 3.1	

Another diseases taken into study was Plum Rust caused by *Tranzschelia pruni-spinosae* Persoon Dietel. The Table 4, shows the results regarding the degree of attack on the leaves. The response regarding the infections was depending to the cultivar.

The most sensitive cultivars to Plum Rust were 'Vinete romanesti'and 'Tuleu timpuriu' registering very significant differences as to the control, followed by 'Nectarina rosie', 'Vinete de Italia'and 'Stanley' with distinct significant differences. The best results regarding low infections with Plum Rust in 'Jojo', 'Tophit', 'Topend', 'Anna Späth', 'Toptaste', 'Tuleu gras'and 'Nectarina rosie were obtained.

Table 4

The response of plum cultivar to Plum Rust (*Tranzschelia pruni-spinosae*.) attack on leaves, in Calacea, Sălaj, county, Romania, in 2012-2014

Cultivar	Degree of attack (%)	Degree of attack as to control (%)	Differences as to control (%)	Significance of difference
Topfirst	1.7	14.3	-10.0	00
Nectarina rosie	21.0	179.6	9.3	*
Tuleu timpuriu	31.3	268.0	19.6	***
Hangata	2.0	17.1	-9.7	0
Toptaste	1.3	11.4	-10.4	00
Tuleu gras	21.7	185.3	10.0	00
Vinete de Italia	20.3	173.9	8.6	*
Stanley	19.0	162.5	7.3	*
Vinete romanesti	33.0	282.2	21.3	***
Tophit	0.0	0.0	-11.7	00
Jojo	0.0	0.0	-11.7	00
Anna Spath	0.7	5.7	-11.0	00
Topend	0.0	0.0	-11.7	00
Mean of experiment	11.7	100		
	DL 5% = 7.3	DL 1 % = 10.0	DL 0.1 % = 13.3	

Castejón *et al*.,(2012) obtained simillar results but using other cultivars and organic production. García-Galavís (2009) obtained highest levels of infection in some japanesse cultivars: ‘Showtime’, ‘Santa Rosa’, ‘Friar’, and ‘Larry Ann’. The low infection of the noted cultivars with Plum rust on leaves recommend them in breeding resistance against this disease of plum.

CONCLUSION

In the climatic conditions of the Salaj region, Transylvania the diseases caused by *Taphrina pruni (Fuck.) Tul., Fusicladium pruni Ducomet* and *Tranzschelia pruni-spinosae* Persoon Dietel in natural conditions of infection produced significant losses.

The most resistant cultivars to attack of *Taphrina pruni* were ‘Topend’, ‘Jojo’, ‘Tophit’, ‘Tuleu timpuriu’and ‘Topfirst’.

The cultivars having the lowest degree of attack of black spot cased by *Fusicladium pruni* Ducomet were ‘Topfirst’, ‘Topend’, ‘Tophit’, ‘Jojo’, ‘Hangata’ , ‘Anna Spath’,‘Toptaste’.

The cultivars ‘Jojo’, ‘Top Hit’, ‘Topend’, ‘Anna Späth’, ‘Top Taste’, ‘Tuleu gras’and ‘Nectarina rosie were very little attacked by Plum Rust.

Obtaining new varieties tolerant or resistant to these diseases is a permanent goal in plum breeding activity. Thus the study of reaction of the plum germplasm to these diseases is one of the ways of finding genetic sources for breeding.

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