Grapevine and apple replant disease in Hungary

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Summary: Field experiment was conducted to study the replant problems of grapevine and apple. Plantings were in three different fields: on virgin soil, on apple replant soil and on vine replant soil. Each field was planted with 60 pieces of grafted vine (variety Bianca on rootstock Berl. X Rip. T.K. 5BB) and 60 pieces of grafted apple (variety Gloster on rootstock MM. 106). Fungicide (BUVICID K with 50 % captan agent, 0.5 g/1 l soil) and nematocide (VYDATE 10 G with 10 % oxamil agent, 0.03 g/1 l soil) treatments were used in the soil in order to identify the causal factor of the problem.

Biological soil test was conducted to test 17 soil samples of 11 wine districts and vine growing fields in plastic pots, under shading net. No root pieces were left in the soil. Two bud-cuttings of the Berl. X Rip. T 5C rootstock varieties were used as test plants. In each case, samples were taken from the vineyard and from the virgin soil. One fourth of the soil from the vineyard was left untreated and the other three part was treated with nematocide, fungicide or heat.

The results of the field experiment suggest that there was no problem growing grapevine after apple and apple after grapevine, but both species had been inhibited growing after itself. The fungicide and nematocide treatments did not succeed in determining the casual factor of the problem. Heat treatment of replant soil (in pot test) was useful in AS and VNS soils.

Results of biological soil test suggest, that grapevine replant problem do not occur in every vineyard. In fifty percent of soils, no significant differences between the treatments for shoot length, weight of cane, length, diameter and wood:ratio of the fourth internode were observed. In one case, difference was not found in any of the measured characters. However, fruiting bodies of *Roesleria pallida (Pers.)Sacc.* and the mycelium of *Rosellinia necatrix Prill.* were observed in this sample. In other samples, there was no significant difference between the treatments, but nematode and fungus infection appeared to be involved in increased shoot growth in nematocide and fungicide treated plants (mycelium of *Rosellinia necatrix* was detected). In other samples, the fungus infection caused significant difference between the virgin, untreated and fungicide treated soils and infection of *Rosellinia necatrix* was observed.

Key words: apple, grapevine, nematodes, replant problem, root rot fungi

Abbreviations: AS = apple replant soil, VNS = vine replant soil, VS = virgin soil

Introduction

Replant problems are very important to deal with in fruit orchards and vineyards. The phenomenon can be caused by biotic and abiotic factors *(Utkhede,* 1994). Biotic factors are equal to replant diseases (such as nematodes, fungi, bacteria etc.) and the abiotic factors are phytotoxins, accumulation of chemicals, lack of phosphorus, low or high pH, lack of moisture etc.

In Hungary, the structure of viticulture and oenology has changed since 1990. Most of the big integrators have been eliminated (co-operatives, state-owned farms). Lots of new vineyards and wineries have been formed with new owners. The features of vine growing land influence the quality and quantity of wine in our country than in other countries, because Hungary is situated on the northern border of viticulture. The number and size of the best lands are limited, so we have to grow on the same land in order to get the best quality. Sometimes, even crop rotation can not be followed and replantation is unavoidable.

Naturally, replant problems do not occur in every replant situation, but if they do, it can cause big economic damage and loss of time. It is very important to know, if the land to be planted is healthy or infected. Investigations were already made with fruit species by *Hoestra* (1968) & *Magyar* (1984), but we wanted to know the right way of it in case of vine.

Studies were carried out in field to examine the possible causes of grapevine replant problems and its effect of replantation on vine and apple species. Our goal was also to develop a biological soil test method, which could help the growers to make a decision, if a certain land is suitable for replanting or not.

Material and method

Field experiment was set up in 1994 on the Experimental Farm of the Faculty of Horticulture, in Szigetcsép. Plantings were on three different fields: on virgin soil (VS), on apple replant soil (AS) and on vine replant soil (VNS) *(Table 1).* Each field was planted with 60 pieces of grafted vine (variety Bianca on rootstock Berl. X Rip. T.K. 5BB) and 60 pieces of grafted apple (variety Gloster on rootstock MM. 106). A quarter of the planting holes (15 pieces) were left untreated,

Table 1 Chemical and physical properties of the soils used in the experiments

Soils	Depth	Org. matter (%)	pH (H_2O)	P_2O_5 (mg/kg)	K_2O (mg/kg)	Ratio of the parts < 0.01 mm (%)
VS	0–20 cm	0.52	8.0	162	115	19
	20–40 cm	0.70	7.8	158	117	19
	40–60 cm	0.05	8.0	108	150	20
AS	0–20 cm	1.32	8.1	..80	405	67
	20–40 cm	1.47	8.1	..77	338	64
	40–60 cm	1.45	8.3	..19	236	70
VNS	0–20 cm	0.66	8.0	230	202	16
	20–40 cm	0.64	8.0	139	150	16
	40–60 cm	0.52	8.0	..78	154	20
1	Virgin soil	0.68	8.3	..27	203	19
	Vineyard soil	0.76	8.1	213	200	19
2	Virgin soil	0.98	7.7	..18	192	88
	Vineyard soil	0.75	5.7	130	306	73
3	Virgin soil	0.61	7.9	160	116	65
	Vineyard soil	1.41	8.2	..59	326	65
4	Virgin soil	0.45	8.2	..55	259	65
	Vineyard soil	0.05	8.3	..41	..98	74

while the remaining 45 pieces were distributed among three treatments. The treatments used were: Treatment 1 (BUVICID K with 50% captan, 0.5 g/l soil), Treatment 2 (VYDATE 10 G with 10% oxamil, 0.03 g/l soil) and Treatment 3 (BUVICID K with 50% captan, 0.5 g/l soil + VYDATE 10 G with 10% oxamil, 0.03 g/l soil). Two shoots of vine and three shoots of apple were allowed to grow for measurement. During vegetation all of the plantations received the same treatment. Growth of the shoots were measured monthly, altogether five times and we studied the weight of cane of each plant individually of both species. For grapevine, we measured the length, diameter and wood:ratio of the fourth internode of cane.

The biological soil test method was carried out to test 17 soil samples of 11 wine districts and vine growing fields in plastic pots, under shading net. No root pieces were left in the soil. As test plants, two bud-cuttings of the Berl. X Rip. T 5C rootstock varieties were used. In each case, samples were taken from the vineyard and from the virgin soil.

One fourth of the soil from the vineyard was left untreated and the other three part was treated with nematocide (VYDATE 10 G with 10% oxamil, 0.03 g/l soil), fungicide (BUVICID K with 50% captan, 0.5 g/l soil) and heat (100 °C, for 1 hour) to determine the specific replant disease. Each treatment had 10 replications. The plants were grown in pots sized 2000 cm^3 with one shoot, two irrigation per day. We measured the shoot growth monthly and incubated the roots of the test plants that were collected in the previous year to identify a possible fungus infection. The nematode infection can be proved by the modified Cobb's decanting sieving technique *(Flegg,* 1967). The length, diameter and wood:ratio of the fourth internode of cane was also measured.

All statistical analyses were carried out using the MiniStat procedure *(Vargha,* 1995). Tukey-Kramer pairwise comparison at 1, 5 and 10% level of significance was used to compare the means.

Results

Field Experiment

Shoot growth of grapevine planted on VS and on AS did not significantly differ from each other except in the beginning and end of vegetation period *(Figure 1)*. During vegetation, vine planted on VNS had 25–54 per cent less growth, than vine on VS. This difference increased to 58 per cent by the end of vegetation. No significant difference between any of the treatments was found, growth of plants chemically treated did not surpass the growth of untreated plants. Average weight of cane, length and diameter of fourth internode *(Table 2)* were significantly less for VNS plants compared to VS plants (79,37 and 30 per cent retardation, respectively). Difference in wood:ratio was caused only by the better nitrogen – supply of AS plants. Apple growth on VS and VNS soils was always similar, however, VNS plants showed 25–48 per cent less growth compared with AS plants *(Figure 2)*. In cane weight 20–32 per cent less *(Table 2)* was found on AS compared to the two other soils. *Rosellinia necatrix* was detected in roots of plants grown in AS and VNS soils.

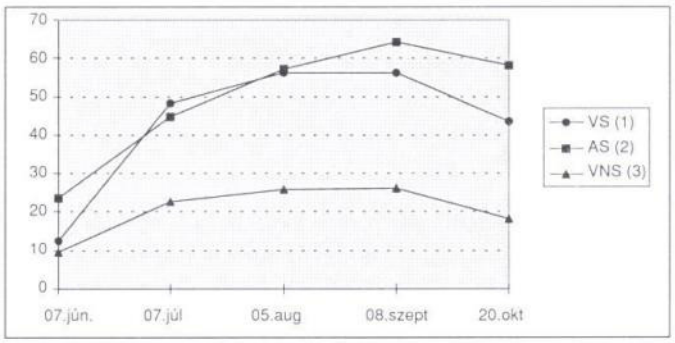

Figure 1 Shoot growth of grapevine after different vegetations in 1995

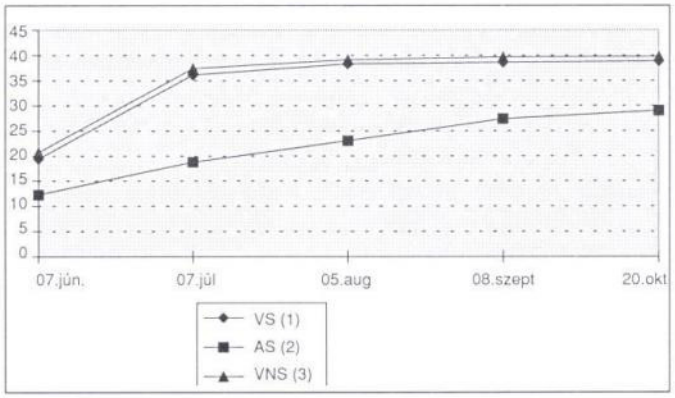

Figure 2 Shoot growth of apple after different vegetations in 1995

Table 2 Morphological characters of grapevine and apple after different vegetation in 1995 in average of treatments

Name of field	Grapevine								Apple	
	Weight of cane per stock		Length of the fourth internode of cane		Diameter		Wood:rato		weight of cane per tree	
	(g)	(%)	(cm)	(%)	(mm)	(%)		(%)	(g)	(%)
		100 % = VS		100 % = VS		100 % = VS		100 % = VS		100 % = VS
VS (1)	15.8	100	5.7	100	6.18	100	1.068	100	17.2	100
AS (2)	21.2	134	3.2	56	5.55	90	1.465	137	13.8	80
VNS (3)	3.3	21	3.6	63	4.34	70	1.047	98	19.3	112

Tukey-Kramer pairwise comparison of means, correction used for the unequal population variances
Significant differences between the fields, in pairs (LSD:*:p < .10 ; **: p < .05 ; ***: p < .01):

T(1,3)= 9.9***	T(1,2)= 10.5***	T(1,3)= 9.4***	T(1,2)= 7.81***	–
T(2,3)= 8.0***	T(1,3)= 8.7***	T(2,3)= 4.9***	T(2,3)= 7.89***	–

Biological Soil Test Method

The treatments resulted in a wide range of data according to the different types of soils. Four typical soil types were involved in our investigation.

1. Half of the collected soil samples did not show any significant differences between the treatments for shoot length, weight of cane, length, diameter and wood:ratio of the fourth internode *(Figure 3 & Table 3*, soil No. 1).

2. Significant differences were not found for any of the measured characters *(Figure 3 & Table 3*, soil No. 2), however, we observed the fruiting bodies of *Roesleria pallida (Pers.)Sacc. (Ascomycotina, Discomycetes, Caliciales)*. This was the first time of getting these fruiting bodies from the soil and not from infected root pieces. White root rot (*Rosellinia necatrix Prill., Ascomycotina, Pyrenomycetes, Xylariales)* is more frequent in Hungary, the mycelium was found in 7 samples. There were some cases where we found the mycelium, but it did not affect the shoot growth.

3. In soil No. 3 *(Figure 3)* there were no significant differences between the treatments (just a small tendency was able to be recognized), but nematode or fungus infection appeared. We found strong mycelium development on the infected root pieces.

4. In this case, the fungus infection caused significant differences between the virgin, untreated and fungicide treated plants *(Figure 3*, soil No. 4) and we observed the mycelium of *Rosellinia necatrix*. Data on weight of cane *(Table 3)* also support the data of shoot growth measurements, but for the other characters (length, diameter and wood:ratio) we could not find any significant difference. A root sample originated from the same wine district, but from another vineyard, an obligatory *Trichoderma sp.* was discovered on *Rosellinia necatrix*. Plants of the heat treatment did not differ significantly from the untreated ones.

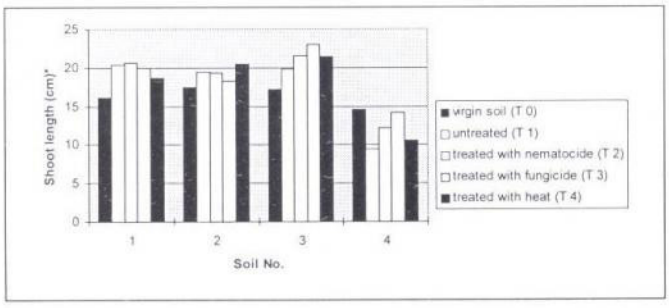

Figure 3 Shoot growth of the test plants in healthy and variously infected soils

Discussion

Fungi and nematodes play main role in non-specific replant disease of grapevine *(Jenser* et al., 1977). Role of fungi in replant disease depends on the climate and the parameters of the soil. *Guillaumin* et al. (1982) reported, that in French vineyards having replant problem 43 of the 47 root samples were infected with *Armillariella mellea (Vahl) Karst*, 3 with *Rosellinia necatrix* and 1 with *Roesleria pallida*. The samples were collected from Bordeaux and the Cotes-du-Rhone. *Utkhede & Li* (1988) showed that *Pythium ultimum Trow* was the most commonly isolated from grapevines that showed symptoms of decline in British Columbia, Canada. In Hungary, mainly two pathogenic fungal species (*Rosellinia necatrix and Roesleria pallida*) cause problems in vineyard soils *(Véghelyi,* 1987). The young vines infected by any of them should be destroyed. The fungi keep the ability to infect living roots for a long time, but can also survive on dead root pieces for years (6–8 years) *(Véghelyi,* 1977). Thus, the

Table 3 Morphological characters of the grapevine test plantson four different type of soil in 1995.

Soil No.	Treatment	Weight of cane per stock		Length		Diameter		Wood:ratio	
				of the fourth internode of cane					
			(g)	LSD	(mm)	LSD	(mm)	LSD	LSD
1	0	0.78	–	20.3	–	3.1	–	0.771	–
	1	0.80		23.4		3.0		0.812	
	2	0.84		18.8		3.2		0.851	
	3	0.98		21.9		3.1		0.867	
	4	0.96		22.3		3.3		0.925	
2	0	0.98	–	20.1	–	2.3	–	1.073	–
	1	0.99		19.6		3.1		0.868	
	2	1.15		20.6		3.2		0.901	
	3	0.91		20.6		3.2		0.911	
	4	0.99		23.1		3.1		0.802	
3	0	1.10	–	22.8	–	3.5	–	0.865	–
	1	0.97		25.4		3.2		0.753	
	2	1.42		26.2		3.5		0.976	
	3	1.55		22.9		3.5		0.907	
	4	1.07		25.2		3.4		0.802	
4	0	0.31	T(0,1)=4.9**	21.0	–	2.5	–	0.878	–
	1	0.08	T(0,2)=4.1*	22.9		2.2		0.778	
	2	0.12	T(1,3)=5.9***	23.5		2.4		0.485	
	3	0.36	T(2,3)=5.1*	20.5		2.4		0.830	
	4	0.16		19.0		2.4		0.838	

Tukey-Kramer pairwise comparison of means, correction used for the unequal population variances.
LSD: significant differences between the treatments,
in pairs (*:p < .10 ; **: p < .05 ; ***: p < .01).

Treatments: 0 – virgin soil
1 – vineyard soil, untreated
2 – vineyard soil, treated with nematocide
3 – vineyard soil, treated with fungicide
4 – vineyard soil, treated with heat

damage caused by root rot fungi can be very serious in replanted vineyards.

Most frequent nematodes of Hungarian vineyards are *Xiphinema sp. (Jenser,* 1977) and *Meloidogyne hapla Chitwood* (Andrássy and Farkas, 1988).

Grapevine replant disease is not well studied. *Brinker & Creasy* (1988) tried to determine whether grape (*Vitis rupestris Scheele* and *Vitis riparia Michx.)* specific replant disease might be an example of autotoxicity. They concluded that grape roots appear to be the source of at least one compound that is toxic to plants and accumulates in the soil in which grapes are grown. The toxic substance has not been identified.

The results of the field experiment showed that there was no problem growing grapevine after apple or apple after grapevine, but both species had been inhibited growing after itself. The fungicide and nematocide treatments did not succeed in determining the casual factor of the problem. Data of the pot test of AS and VNS soils showed a non significant fungus and nematode infection, but it does not explain the phenomenon.

The results of biological soil test showed, that grapevine replant problems do not occur in every vineyard in Hungary. *Véghelyi* et al. (1995) investigated 451 root samples of Hungarian grapevine nurseries from young, old and former vineyards. They had shown, that the most frequently appearing (71.6% of the studied roots) root pathogen fungus in Hungary was *Rosellinia necatrix*. The other species, *Roesleria pallida* was found sporadically (8.3% of the studied roots). The apothecium is very important for the identification, which develops after 6–10 months. Our studies correspond to this statement, because 41% of the investigated samples were infected with *Rosellinia necatrix* and 6% with *Roesleria pallida*. The serious infection appeared already during vegetation in shoot growth and was observable with incubation.

Lower infection did not always give significant differences, but the incubation helped to decide the infectional status of roots. The measurements and the incubation can give reliable results. Isolation and identification of the nematodes are in progress.

References

Andrássy I. & Farkas K. (1988): Kertészeti növények fonálféreg kártevői. Mezőgazdasági Kiadó, Budapest, 243.

Brinker, A. M. & Creasy, L. L. (1988): Inhibitors as a possible basis for grape replant problem. J. Amer. Soc. Hort. Sci. 113(3): 304–309.

Flegg, J. J. M. (1967): Extraction of *Xiphinema* and *Longidorus* species from soil by a modification of Cobb's decanting sieving technique. Ann. appl. Biol. 60: 429.

Guillaumin, J. J., Mercier, S. & Dubos, B. (1982): Root-rot caused by *Armillariella* and *Rosellinia* in France on vine, orchard trees and flower crops. I. Etiology and symptoms. Agronomie 2(1): 71–80.

Hoestra, H. (1968): Replant diseases of apple in the Netherlands. Department of Nematology, Agricultural University, Wageningen, 39–45.

Jenser, G. (1977): Szabadon élő külső parazita fonálférgek. [Pages 24–25 in A gyümölcsösök újratelepítésének növényvédelmi problémái Herpay, B., (ed.)] Mezőgazdasági Kiadó, Budapest

Magyar, K. (1984): A gyümölcstermő növények talajuntsága. [Pages 338–346 in Gyümölcsfák védelme. Jenser, G.,(ed.)] Mezőgazdasági Kiadó, Budapest

Utkhede, R. S. & Li, T. S. C. (1988): Determining the occurrence of replant disease in British Columbia orchard and vineyard soils by pasteurization. Canadian Plant Disease Survey 68(2): 149–151

Utkhede, R. S. & Smith, E. M. (1994): Biotic and abiotic causes of replant problems of fruit trees. Acta Horticulturae 363: 25–32.

Vargha A. (1995): MiniStat. Felhasználói füzet, Budapest

Véghelyi K. (1977): A gyümölcsfák gyökereinek parazita gombái. [Pages 16–19 in A gyümölcsösök újratelepítésének növényvédelmi problémái. Herpay, B., (ed.)] Mezőgazdasági Kiadó, Budapest

Véghelyi K. (1987): Establishment of the pathogenicity of the root parasitic fungi of fruit trees *Rosellinia necatrix Prill. and Roesleria pallida (Pers.)Sacc.* Kertgazdaság 19(6): 13–23.

Véghelyi K., Balogh I. & Polyák D. (1995): Root rot fungi on grapevine in Hungary. Horticultural Science. 28(1-2): 48–53.