

Propagation material borne fungus pathogens causing early stock decay in vineyards

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Summary: A decline, a slow or sudden decay of vine trunks can occur in any phase of trunk life. In senescent or old plantages the increase in trunk decay is quite common but it is unacceptable in young plantage in their best production years. All over the world as well as in Hungary, a drastic decay of young trunks in nurseries and new plantages have caused panic in the past decades. From among the numerous fungal pathogens which are responsible for considerable financial and yield losses and threaten stock vigour Petri disease, esca and Black foot are the most important. In young decaying plants the fungal species *Phaeoconiella chlamydospora*, *Phaeoacremonium* spp. and *Cylindrocarpon* spp. were the most frequent while other fungi causing different trunk diseases, cancer or decay, like *Eutypa lata*, *Botryosphaeria* spp. and *Fomitiporia mediterranea* were also found. The most important infection source is the infected propagation material. Infection is systematic, the disease process is latent, diseased plants cannot be cured, thus, prevention is the only answer to the challenge.

Keywords: decay of young trunks, young esca, Petri-disease, esca, esca proper, black foot disease

Esca is a complex disease caused by the joint or successive effects of biotic and abiotic factors considering trunk decay these factors can have *predisposing* (e.g. virus infection, senescence, climatic changes), *eliciting* (e.g. drought, precipitation, frost) or *aggravating* effects (e.g. cancer pathogens, virus infection, wood tissue diseases) (Vajna, 1998; Bruccini et al., 2008).

Scientists agree that esca – though known for a long time – has turned out to be a *new kind Phylloxera-like epidemic* (Morton, 1995; Acheck et al., 1998; Graniti et al., 2000; Wait & Morton, 2007). Esca is present in old and young bearing vineyards, in rootstocks and scions alike. In Hungary the number of stocks with symptoms has increased since 2000 (Apponyi et al., 1999; Mikulás & Lázár, 2001; Dula, 2003; Mikulás et al., 2004; Dula, 2004, 2007) (Fig. 1–2).

Of the 3 fungi responsible for esca *Phaeoconiella chlamydospora* (*Pch*) and *Phaeoacremonium aleophilum* (*Pal*) causing tracheomycosis are the most important (Mugnai et al., 1999; Surico et al., 2008). These two pathogens are responsible for the syndrome of brown stripe diseases, Petri-disease (of Black goo) and young esca in rooted canes and grafts.

On plants grown in nurseries no external symptoms can be observed, only changes in the internal tissue reveal infection. In the vertical section of rootstocks and scions long, brownish-black stripes start from the bottom or place of grafting, in the cross-section tiny black spots, frequency in ring form and rubber-like, dark secretion appear round the pith (Photos 1, 2, 3). In the spread of the disease the latently infected base material plays an important part (Acheck et

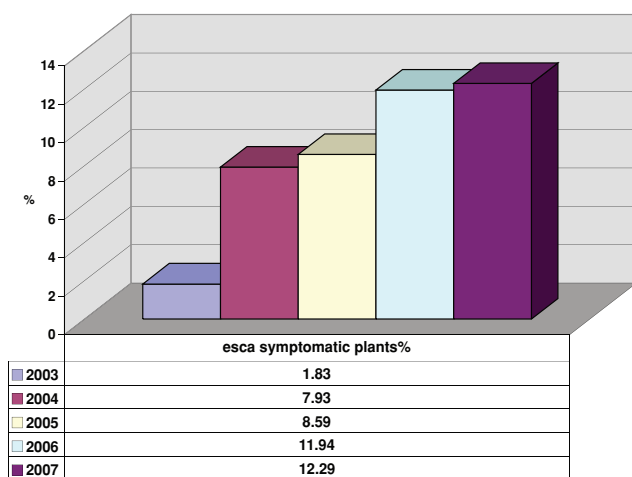


Fig. 1. Frequency of esca symptomatic plants Hungary 2003–2007

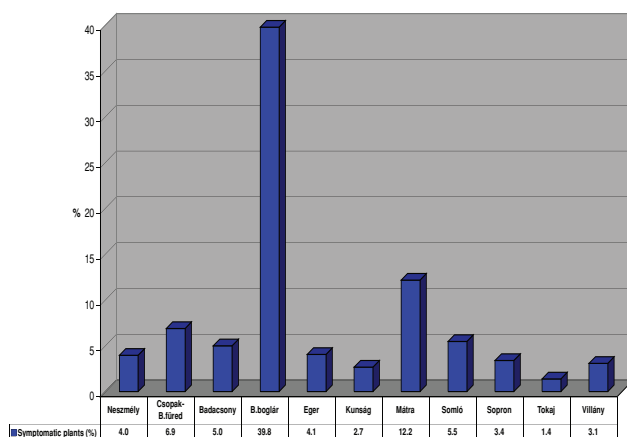


Fig. 2. Frequency of esca symptomatic plants on the wineregions in Hungary Average of three years (2003–2005)



Photo 1. Brown tissue streaking in rootstock vascular system



Photo 2. Gum-like, dark exudate in the vascular system

al., 1998; Aroca et al., 2010; Graniti et al., 2000; Morton, 1995; Mugnai et al., 1999; Surico et al., 2008; White & Morton, 2007; Whiteman et al., 2007).

Petri-disease appears in very young, 1-8-years-old plantages (Ferreira et al., 1999; Morton, 1995; Mugnai et al., 1999; Pascoe & Cottral, 2000; Scheck et al., 1998). Stunted growth, slightly chlorotic leaves are typical external symptoms with dark pith tissue, black spots or ring round the pith and rubber-like dark secretion in the inner tissue (Photo 3).



Photo 3. Petri-disease: streaking and gum-like, dark exudate

The vascular “**young esca**” disease, newly named as **vine leaf streaking** (Surico, 2009), is caused by *P. chlamidospora* and often also by *P. aleophilum* (Mugnai et al., 1998; Surico et al., 2008). Young esca can appear in 2–4-years-old vineyards. Tiny chlorotic spots are visible in the internodes and later typical tiger stripes can form (Photo 4). Leaf symptoms are caused by the phytotoxins produced by the fungi (Evidente et al., 2000; Sparapano et al., 2000, Abou Mansour et al., 2004). Symptoms in the wood tissue are similar to those found in grafts and the Petri-disease but here the brownish-red wood tissue necrosis can have a larger extent (Photo 5).

In connection to the esca complex another fungus must be mentioned though it does not infect through propagation material. *Fomitiporia mediterranea* (Fmed) is a Basidiomycetes species including white decay in the vine



Photo 4. Young esca leaf symptoms in 4-years-old Furmint stock



Photo 5. Pch infection symptom in 4-years-old Furmint

trunk. It has numerous other host plants. In Europe trunk decay is mostly due to *Fmed* but in other districts some other species causing decay could also be isolated (Fischer, 2006; White et al., 2010; Véghelyi et al., 2001). In very young, 2-4-years-old trunks white rot can appear alone. In these stocks spots, esca symptoms are never found (Edwards et al., 2001) but according to the extent of wood tissue rot, the foliage has a pale colour (Dula, non published). The pathogen often invades the stock through wounding. The infected wood tissue is yellowish-white, spongy, a dark border separates it from the healthy tissue (Larignon & Dubos, 1997) (Photo 6).

In the traditional sense the name “esca” means white decay. We speak of “proper esca” when leaf symptoms caused by the two vascular pathogens and by white rot are found in the same stock. This syndrome is mostly observed in older rootstocks in production (Photos 7, 8, 9). In the



Photo 6. White decay (*Fmed*) in 4-years-old Furmint



Photo 7. Typical esca tiger-stripe symptom

diseased plants the pathogens of the two vascular diseases and those of white rot are present. It is important to stress that the pathogens of the vascular disease are propagated exclusively through the propagation material, while spore of the white rot fungus infect plants through wounding.

In stocks infected by vascular disease pathogens *Pch*, *Pal* some other pathogens damaging wood tissue could be found: *Botryosphaeriaceae* spp., *Diatrypaceae* species (like *Eutypa lata*), *Phomopsis viticola* (Lehoczky, 1972, Lehoczky & Moller, 1979). Recently *Botryosphaeriaceae* species could be isolated from nursery material (Spagnola et al., 2011).

Pch has only been detected in vine but it is quite common in vine regions of the world (Gramaje et al., 2011). Of different host plants 34 *Pheoacremonium* species have been isolated of which 25 species from vine with or without symptoms (Mostert et al., 2006). In a global survey in 2007 numerous new *Phaeo* species were found, also a *Phaeoacremonium hungaricum* (Essakhi et al., 2008) in Tokajhegyalja, Hungary. At present *Pal* is the most common in vineyards. While the sexual form of *Pch* is still unknown, the sexual form of *Pal*, *Togninia minima*, was found in



Photo 8. T 5C rootstock with esca symptom



Photo 9. White decay in T 5C rootstock

several places (Monstert *et al.*, 2003; Pascoe *et al.*, 2004; Eskalen *et al.*, 2005). Infectious spores of both species are found on the surface rootstocks and scions. They invade the xylem through wounding in the bottom part caused by disbudding and grafting. Infection can occur in any phase of the grafting operation as wounds cannot be avoided, but the most vulnerable phases are soaking and grafting of the rootstocks and scions (Fourie & Halleen, 2002, 2003; Edwards *et al.*, 2004; Aroca *et al.*, 2009a). Though *Pch* can be detected from infected plant residues in the soil the infectivity of pathogens isolated from naturally infected soil has not been proved yet (Roonay *et al.*, 2001; Fourie *et al.*, 2004; Tello & Gonzalez, 2010). The disease causes considerable loss in rooting in nurseries. In rooted propagation material the infection is latent, symptoms appear 1–2 years later (Edward *et al.*, 2001, 2004; Zanzotto *et al.*, 2001; Di Marco & Osti, 2007). Growth is weak, the numerous missing stocks must be replaced. In later years repeated yield losses and increased stock death aggravate the financial situation of growers.

Black foot disease: *Cylindrocarpon* (anamorf *Neonectria*) species are responsible for the black foot disease of the vine (Grasso, 1984; Rego *et al.*, 1998, Maluta & Larignon, 1991; Rego *et al.*, 2001, 2006; Halleen *et al.*,



Photo 12. Severe, early stock decay in 4-years-old merlot



Photo 10. *Cyl* infection symptoms in the bottom part of rootstock



Photo 11. *Cyl* symptom in rootstock

2006; Alaniz *et al.*, 2007; Scheck *et al.*, 1998). According to recent research it is caused by the joint infection of several species. The primary pathogens are: *Cylindrocarpon* (*Cyl. liriodendri* MacDon & Butler), *Cyl. destructans* (Zins.) Scholten and *Cyl. macrodidymum* (Schroers, Halleen & Crous) as well as *Campylocarpon* (*Campyl. fasciculare* and *Campyl. pseudofasciculare* (Alaniz *et al.*, 2007, 2009; Halleen *et al.*, 2006b).

These species are present in the most important vine regions of the world. They can often be isolated in nurseries from rooted canes and grafts (Rego *et al.*, 2000; Fourie & Halleen, 2001). Infection is initiated from the soil. Micro- and macro-conidia, clamydospores or mycelium fragments can also infect roots (Halleen *et al.*, 2003; Probst *et al.*, 2009).

Principal symptoms: necrotic rot of the root crown, sunken spots on the root, root decay, longitudinal black necrosis and streaking starting from the bottom of the xylem (Photos 10–11), slow growth, short internodes, stunted shoots, small leaves, chlorosis and necrosis between veins (Photo 12). In vineyards planted with infected nursery material considerable stock decay can occur in a short time. Replacement costs burden growers heavily. The widely used glyphosate herbicide aggravates the situation in watery, wet places visibly (Whitelaw-Weckert, 2010).

Prevention of fungal infections

It is generally accepted that the drastic increase in fungal diseases causing early decay in stocks is due to the insufficient hygienic conditions during the production of the propagation material. There are no effective chemical

treatments against latent pathogens. Tests were to treat diseased stocks with symptoms with fungicides injected into trunk during dormancy. The failure proved that diseased plants cannot be cured (Di Marco *et al.*, 1997; Darrieutort & Lecompte, 2007; Dula *et al.*, 2007). Thus, prevention is of primary importance. In general opinion high quality, healthy, pathogen-free propagation material must be available. In the first step rootstocks and basic vineyards must be controlled, diseased plants marked, removed and annihilated (Lehoczky, 1984). In the next step rootstocks and shoots collected for rooting and grafting must be disinfected on the surface as infectious spores adhere to the surface. Numerous biological substances and fungicides have been tested to kill the spores on the surface of canes during the development of the propagation material. Some reliable results could be obtained by hot water (HWT), *Trichoderma* spp. and some chemicals. Hot water treatment (at 50 °C for 30–45 minutes) was tested by several workers with variable success (Crous *et al.*, 2001; Edwards *et al.*, 2004b; Fourie & Halleen, 2004; Gramaje *et al.*, 2009a; Retief *et al.*, 2005; Rooney & Gubler, 2001; Waite, 1998; Whiting *et al.*, 2001). Hot water weakens the vitality of the pathogens efficiently in dormant canes. The methods is economical as large quantities of material (rootstock, spurs) can be treated. It is advisable to use it prior to the cold storage of canes. After the heat treatment canes should be recooled gradually to avoid sudden heat stress and bud damage. The individual heat sensitivity of varieties should also be considered. Pinot noir is the most sensitive, Chardonnay, merlot and Riesling are moderately sensitive while Cabernet sauvignon is the most tolerant to heat treatment (Waite *et al.*, 2001; Crocker *et al.*, 2002; Waite & May, 2005; Waite & Morton, 2007). The effect of heat treatment is of short duration. The treated plants can be infected readily in the field by *Cyl* or *Pch*. It should be combined with fungicides (e.g. cyrocozanol followed by HWT) for lasting effect.

The antagonistic fungus *Trichoderma* is a widely used biological tool to fight tracheomicosis pathogens (Hunt, 2001; Howell, 2003). *Tr.* has several advantages: by colonizing the root sphere it prevents root infection due to its antagonistic and competitive effect, increases stress tolerance and resistance in stocks and increases the root mass (Fourie *et al.*, 2001; Hunt *et al.*, 2001; Di Marco *et al.*, 2004; Di Marco & Osti, 2007). *Trichoderma* is most effective in its natural sphere, in soil treatment. Rooted canes and grafts should be soaked or thoroughly watered when planted in nurseries or plantages.

Of the chemicals, benomyl, thiophanat methyl, thiramot with a broad active spectrum and absorption proved to be best in controlling *Pch*, *Pal* and *Cyl* (Fourie & Halleen, 2004, 2005; Eskalen *et al.*, 2007; Gramaje *et al.*, 2009b; Tello & Gonzales, 2010; Alaniz *et al.*, 2011).

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