IS IT POSSIBLE TO RETURN TO THE PROPAGATION OF NOBLE GRAPEVINES BY STEM CUTTINGS ?

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Abstract

Our ancestors propagated vines by stem cuttings. This custom lasted until the introduction of phylloxera, an insect from the aphid family, to Europe, which decimated noble vines. The first measures were desperate, including placing a toad at the root of the vine, treating it with sulfur, growing it on beach sand, or flooding it. The hybridization of noble vines with American wild vines in bloom led to the emergence of direct-producing hybrids; these produced inferior wine. Grafting European noble vines onto phylloxera-tolerant rootstocks was the accepted method worldwide. After 100 years, phylloxera disappeared because it had nowhere to live. Can we return to propagation by cuttings? This article invites a debate.

Key words: phyloxera, vitis vinifera, vitis labrusca, stem cuttings

INTRODUCTION

Plasmopara viticola, also known as grape downy mildew, is considered to be the most devastating disease of grapevines in climates with relatively warm and humid summers. It was first observed in 1834 by Schweinitz on Vitis aestivalis in the southeastern United States.

Shortly after this first observation, the pathogen was introduced to European countries where it played a devastating role in the yield and production of their grapes, and consequently their wine.

The "rule of thumb", 10:10:24, refers to the required environmental condition for primary infection. At least 10 mm rainfall (or irrigation) is needed while the temperature should be 10 °C or more over 24 hours. Under favorable conditions, oospores would germinate. The European cultivar is most susceptible to the pathogen, as it lacks evolutionary resistance that the American varieties have, because the pathogen originated in the Americas and was later transmitted into Europe. North American species are also susceptible but varies from high susceptibility to resistance. In the regions with high annual rainfall, the grapevines may suffer more from this disease (https://en.wikipedia.org/wiki/Plasmopara_viticola).

Erysiphe necator, synonym Uncinula necator is a fungus that causes powdery mildew of grape. It is a common pathogen of Vitis species, including the wine grape, Vitis vinifera.

The fungus is believed to have originated in North America.

European varieties of Vitis vinifera are more or less susceptible to this fungus (https://en.wikipedia.org/wiki/Erysiphe_necator).

Coarna neagră is resistant to Erysiphe necator, Plasmopara viticola, Botritys cyneraea and Guignardia bidwellii. Muscat de hamburg is the most susceptible to this fungus.

Grape black rot is a fungal disease caused by an ascomycetous fungus, Guignardia bidwellii, that attacks grape vines during hot and humid weather.

The disease "originated in eastern North America, but now occurs in portions of Europe, South America, and Asia.
It can cause complete crop loss in warm, humid climates, but is virtually unknown in regions with arid summers."The name comes from the black fringe that borders growing brown patches on the leaves. The disease also attacks other parts of the plant, "all green parts of the vine: the shoots, leaf and fruit stems, tendrils, and fruit. The most damaging effect is to the fruit“ (https://en.wikipedia.org/wiki/Black_rot_(grape_disease).
Copper does not control the disease. Strobilurins should be applied immediately after flowering. Once the berries have accumulated at least 5% sugar, they can no longer be attacked. This happens 5 weeks after flowering.

Phylloxera is a worldwide insect pest of grapevines, originally native to eastern North America. Phylloxera (Daktulosphaira vitifoliae (Fitch 1855) belongs to the family Phylloxeridae, order Hemiptera, aphids); originally described in France as Phylloxera vastatrix; equated with the previously described Daktulosphaera vitifoliae, Phylloxera vitifoliae.
These nearly microscopic (0.5-1mm), pale yellow, sap-sucking insects are related to aphids, feeding on the roots and leaves of grapevines (depending on the genetic strain of phylloxera). On Vitis vinifera, the resulting root deformities ("nodules" and "tuberosities") and secondary fungal infections can dry out the roots, gradually cutting off the flow of nutrients and water to the vine.

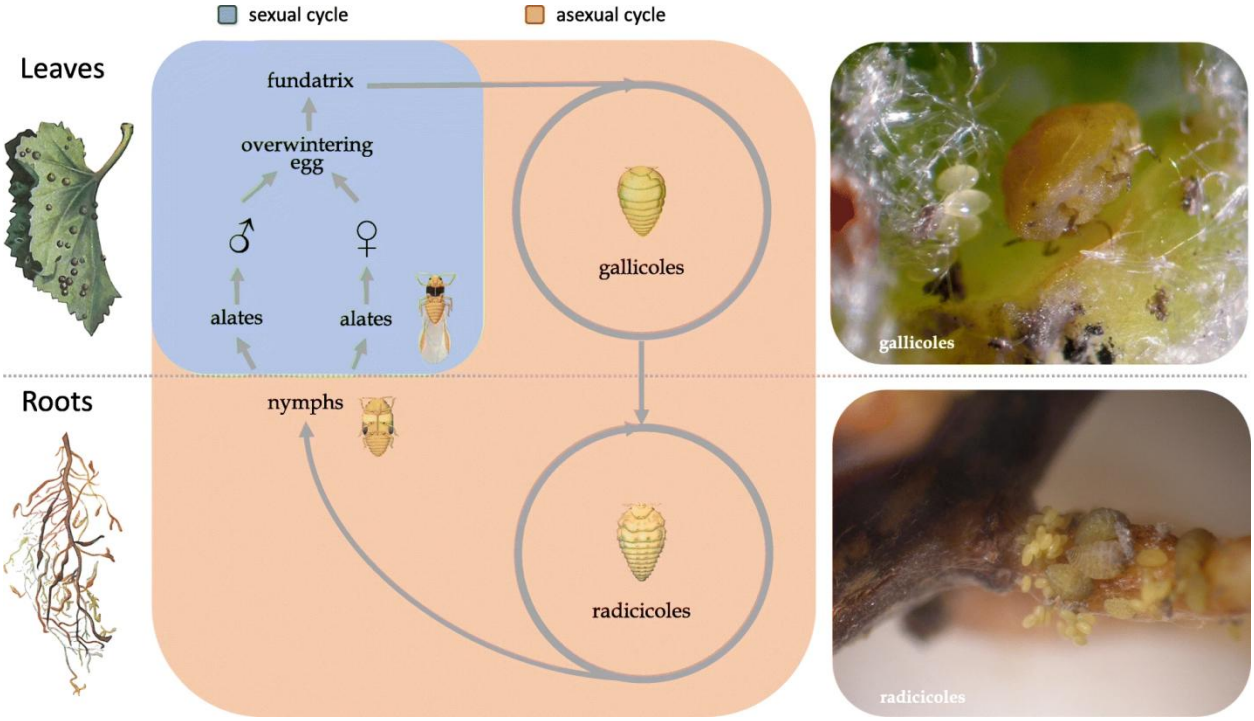

Figure 1. Lifecycle of phyloxera insect
Source: https://en.wikipedia.org/wiki/Phylloxera

Nymphs also form protective galls on the undersides of vine leaves of some Vitis species and overwinter under bark or on vine roots; these leaf galls are usually found only on the leaves of American vines.

American vine species (such as Vitis labrusca) have evolved to have more natural defenses against phylloxera. The roots of American vines exude a sticky sap that repels the nymph form by clogging its mouthparts when it attempts to feed on the vine. If the nymph succeeds in creating a feeding wound on the root, the American vine responds by forming a protective layer of tissue to cover the wound and protect it from secondary bacterial or fungal infections.

Figure 2. Phyloxera galls on the underside and mites galls on the upper side of the leaf.
Source: https://en.wikipedia.org/wiki/Phylloxera

This egg develops on the leaves. This nymph, the fundatrix, climbs onto a leaf and lays eggs parthenogenetically in a gall on the leaf that it creates by injecting saliva into the leaf. The nymphs that hatch from these eggs may move to other leaves or move to the roots where they begin new infections on the root. In this form they bore into the root to find food, infecting the root with a poisonous secretion that stops it from healing. This poison eventually kills the vine. This nymph reproduces by laying eggs for seven more generations (which can also reproduce parthenogenetically) each summer. These offspring spread to other vine roots or to the roots of other vines through cracks in the soil. The generation of nymphs that hatch in the fall hibernates in the roots and emerges the following spring when the sap begins to flow. In humid areas, the nymphs develop into winged forms, otherwise they perform the same role without wings. These nymphs begin the cycle again by either remaining on the vine to lay male and female eggs on the underside of young vine leaves, or by flying to an uninfected vine to do the same.

Note that they are mainly drifted by wind because they have not well developed muscle necessary to fly. Many attempts have been made to interrupt this life cycle to eradicate phylloxera, but it has proven to be extremely adaptable, as no stage of the life cycle is exclusively dependent on another for the propagation of the species.

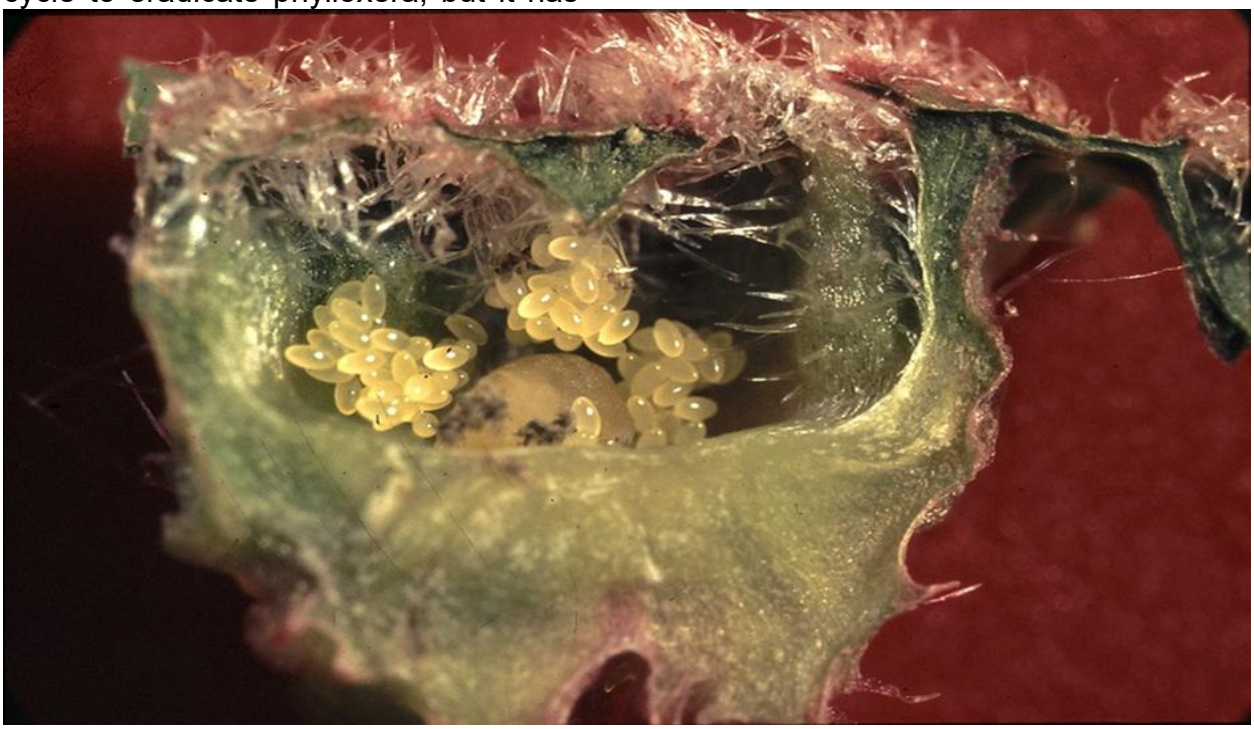

Figure 3. Phylloxera eggs inside a leaf gall
Source: https://en.wikipedia.org/wiki/Phylloxera

MATERIALS AND METHODS

The purpose of the research was to search for unconventional, yet untested methods of cultivating vines through cuttings. This was initiated by the great breeder of the faculty, Mr. Prof. univ. dr. Zăvoi Aurel, who obtained two varieties of wine vines, Pandur and Haiduc, as well as a line of Muscat de Hamburg without the need for pollination. Mr. Professor, Zăvoi initiated the cultivation of vines through cuttings, because:

- the propagation of vines has been done, in the last 80 years, only by planting grafted vines on resistant rootstock, so the insect had no host plant;
- the cutting of roots from the graft, was seldom applied;
- systemic or soil insecticides were not used, experimentally;
- intercropping methods, or irrigation, were not considered, to prevent the creation of cracks in the soil.

Experiments were organized in order to use the cultivated land as efficiently as possible, given that the vines were planted at a distance of 1.5 m between rows and, in the first experiment, with the Muscat de Hamburg variety, a variety of medium vigor, planted, in rows, at 1 m and in the second experiment, the Afuz Ali variety, a variety of very high vigor, at a distance of 3 m per row. The distance between the rows was established depending on the method of tillage, namely, with the rotary tiller that has a working width of 80 cm and a power of 7 HP.

The following varieties were planted:

- Muscat de Hamburg, Riesling italian, Fetească albă, Fetească regală, Sauvignon blanc, Tămâioasă românească, Afuz Ali, Regina viilor, Coarnă neagră.

Few grafted plants of Muscat Ottonel, Victoria and Perla de Csaba were bought. These vines have not had their roots cut from the graft.

RESULTS AND DISCUSSION

The introduction to Europe was aided by the use of steamships which reduced the transfer from America from weeks to days.

The damage caused by phylloxera ranged from 40 to 80% in French vineyards. This led to the transformation of France from the largest wine exporter to the largest wine importer because the French were used to drinking wine and Spain, Italy and Portugal were not yet infected. Later, some areas of Portugal or the islands of this country or the islands of Spain were not infested at all.

The initial methods of control were even worthy of a tabloid and showed the desperation of the growers:

- burying a dead toad at the root of each vine;
- treating each vine with sulfur by injection;
- bringing sand to each vine, because on sandy lands, the insect did not attack;
- growing on beaches, on sand, for the same reason;
- silkworm droppings;
- manure and slurry;
- crab extract;
- scraping of the bark;
- planting hemp or valeriana;
- beating the soil to drive the insect into the sea;
- electricity;
- dousing the plant with white wine.

Another method was hybridization. This consisted of hybridizing, in flower, between the pollen of the European noble vine and the American wild vine. Direct-producing hybrids are resistant to phylloxera and can be planted directly, by cutting. This way of propagating the vine was banned because of the low quality of the wine. The direct-producing hybrid Concord was disseminated in North America and Europe due to the special aroma generated by this grape. It was obtained by Ephraim Wales Bull, in his garden, in 1850 from 22,000 hybridized plants.

The substance that gives the Concord variety its distinctive flavor was chemically synthesized Methyl anthranilate, and is used worldwide in the production of jellies, juices, even by globally renowned companies with the "grape flavor" logo.

Fig. 3. Ephraim Wales Bull, in his garden, in 1850

Source: https://en.wikipedia.org/wiki/Ephraim_Wales_Bull#/media/File:Ephraim_Bull_Concord_Grape_Original_Vine.jpg

However, the most widely used method remained grafting onto wild rootstock, resistant, but not immune, to phylloxera.
The use of a resistant or tolerant rootstock, developed by Charles Valentine Riley in collaboration with J. E. Planchon and promoted by T. V. Munson, involved grafting a scion of Vitis vinifera onto the roots of a resistant Vitis aestivalis or other native American species. This is the preferred method today because the rootstock does not interfere with the development of the wine grapes (more technically, the genes responsible for the grapes are not in the rootstock but in the stock) and, in addition, allows the rootstock to be customized to the soil and weather conditions, as well as the desired vigor.
Important aspects related to grafting:
-it is a laborious operation, requiring specialization, nurseries equipped with specific equipment and land areas where the grafted plants are grown, in optimal phytosanitary conditions. This causes the price of a grafted vine to reach 2-3 euros.
-the choice of rootstock must take into account local soil and climate conditions.
- phylloxera has evolved for thousands of years in the American continent together with the wild vines here. That is why some have acquired resistance. This resistance is based on a delayed response of the plant to the insect's saliva and the formation of a porous layer that prevents the gall from breaking on the root.
- nowadays there are insecticides, both with systemic action, which are applied to the leaves and migrate to the root, and insecticides that are applied to the soil. European noble vines do not form galls on the leaves. No research has been done in this regard.
- no other technological methods have been tried to avoid the insect from entering the soil, such as irrigation, maintaining a layer of plant debris or applying large amounts of manure.
- in some countries, such as Chile, it is cultivated only on its own roots because the soil is not allowed to crack by applying irrigation.
- in the 90s a genetic mutation appeared in a population of phylloxera in the California area that attacked thousands of hectares; this shows us that no method of fighting this insect can be applied indefinitely and we must constantly look for new means of control.
Advantages of propagating by stem cuttings:
-they are cheap and eliminate the manual work of cutting the roots that grow from the scion;
-the preferences of various varieties for soil and climate are well known

Figure 4. Grafting.
Source: https://www.lakecountywinegrape.org/novavine-grafts-6-million-vines-per-year/

Two planting methods were investigated, namely, using stem cuttings rooted in the nursery and unrooted cuttings.
Stem cuttings were planted in two soil tillage situations:
- plowed soil at 40 cm
- harrowed soil at 15 cm

In both situations, drip irrigation was used. The results showed that planting in deep plowed soil resulted in 80% of the planted cuttings growing, while harrowing resulted in only 5%. This shows the need for deep tillage to ensure cutting growth, even if irrigated.

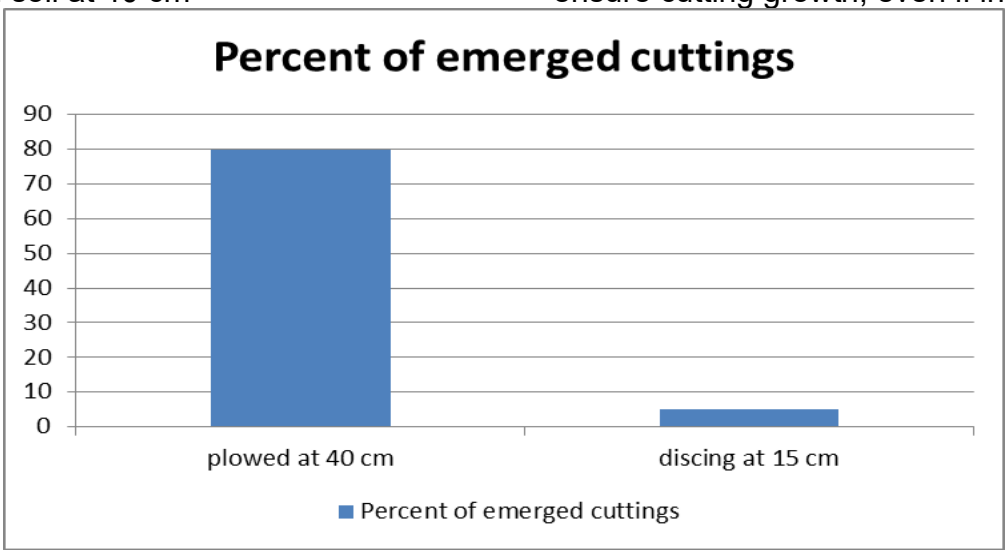

Figure 5. The percent of emerged cuttings.

Figure 6. Large amounts of manure applied (200 t/ha).

Figure 7. Drip irrigation from a gravitational source.

Figure 8. Muscat de Hamburg.

Figure 9. Afuz Ali.

CONCLUSIONS

- The best method of controlling phylloxera, so far, is grafting.
- Because grafted plants are expensive and because the insect is genetically modified through mutations, we must research chemical or technological methods to be able to cultivate vines through stem cuttings.
- Mutations and adaptation to possible insecticides make the fight against this insect endless.

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