

## GREFFADAPT: A RELEVANT EXPERIMENTAL VINEYARD TO SPEED UP THE SELECTION OF GRAPEVINE ROOTSTOCKS

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### Abstract:

**Context and purpose of the study** - Grapevine is grown as a grafted plant since the end of the 19<sup>th</sup> century. The large majority of rootstocks were selected at this period. Among the large diversity of existing rootstocks, few of them are commercially used in the vineyard. However, rootstocks could be considered as a relevant way of adaptation to climate change context because they have no major impact on wine typicality unlike the changes of scion varieties. Rootstock selection is a long term process. Consequently, in addition of the selection of new bred genotypes, characterizing existing rootstocks already used in foreign countries or available in germplasm collections, is a complementary strategy to allow a faster enlargement of the rootstock range available for winegrowers.

**Material and methods** - GreffAdapt is an experimental vineyard created to get and update the agronomical characteristics of 55 rootstocks. These rootstocks were grafted with 5 scions in 3 blocks of 5 vines each. Blocks were defined according to soil resistivity measurements and the statistical power of the experimental designed was calculated. Before planting, the genetic identity of each genotype was checked with 20 microsatellites markers and their sanitary status was analyzed with ELISA assays. Planting occurred in 2015, 2016 and completed in 2017. The fresh weight of each plant was determined at grafting and the pruning weight of each vine has been recorded annually since the plantation.

**Results** - Phenotypic data were analyzed according to the parentage with the three main genetic background (*V. riparia*, *V. rupestris*, *V. berlandieri*). The weight of each plant at the grafting time and the pruning weight since the plantation were assessed. The significant relation between these variables was discussed taking into account annual data sets. The first results showed that the range of conferred vigor among the rootstock panel was large enough to identify the required diversity, necessary to fit different production objectives in the French vineyard.

Overall, GreffAdapt is a very unique experimental facility to speed up the selection of rootstocks and to analyze the relationship between conferred vigor and drought tolerance, two major selection criteria for rootstocks.

**Keywords:** rootstock, rootstock × scion interaction, conferred vigor, *Vitis berlandieri*, drought tolerance

### 1. Introduction

In the context of major issues as climate change, the decrease of the use of plant protection inputs and the competition in the use of farmlands (food production and urbanization), it is crucial to set up innovative systems to maintain the profitability of vine and wine industry, to reduce its environmental impact and to emphasize its ability to use soils with low fertility, less adapted for food production. Among the technical innovations, plant material, particularly rootstocks, could be a relevant way to adapt.

In Europe, grapevine is grown as a grafted plant since the end of the 19<sup>th</sup> century. The large majority of rootstocks were selected at this period. Among the large diversity of existing rootstocks, few of them are used commercially (Figure 1). Rootstocks offer an excellent opportunity to adapt grapevine to climate change without causing major modifications of wine typicality, unlike the change of scion varieties. Rootstock selection is a long term process. Consequently, in addition of the selection of newly bred genotypes, characterizing existing rootstocks, already used worldwide or available in germplasm collections, is a complementary strategy to rapidly accelerate the range of rootstocks available for vine

growers. GreffAdapt, an experimental vineyard, was designed to comprehensively study a large panel of 55 rootstocks for drought tolerance and rootstock conferred vigour when grafted with 5 different scion varieties. The objective of this project is to identify rootstocks conferring traits of interest that could be used to expand the range of rootstocks registered for use in France.

## **2. Material and methods**

### **2.1. Experimental design set up**

Fifty-five rootstocks were chosen for their known drought tolerance and their large range of vigor conferred (Figure 2). This panel includes 30 rootstocks already registered for use in France (Grézot 1 was excluded because of its medium phylloxera resistance), and 25 rootstocks used in other countries selected for relevant characteristics about lime-induced iron deficiency chlorosis, drought and vigor conferred. All these rootstocks are grafted with 5 scions (Cabernet Sauvignon clone 169, Grenache clone 362, Pinot noir clone 113, Syrah clone 524, Ugni blanc clone 481) selected to emphasize the genetic diversity at the scion (Lacombe, personal communication) and in the same time to get varieties that could represent the main vine growing area in France for their surface and their economic value. Consequently, GreffAdapt is a plot with 275 rootstock/ scion combinations. It is located in the vineyard of Unité expérimentale Vigne et Vin Bordeaux Grande Ferrade (44.790658, -0.573954, France), with 3 blocks of 5 vines per combination, *i.e.* 15 vines per combination, distributed randomly within each block (Figure 3). The soil resistivity and pedological characteristics were studied and allowed us to locate the block position taking into account the soil variability (Figure 4). The statistical power of the experimental design was calculated from the datasets of two other experiments (one with a pedigree population and one with a large range of *Vitis spp.*). The plot was planted with a density of 6 666 vines/ha and is pruned in Guyot simple.

### **2.2. Plant material checking**

Taking into account the problem to get the plant material, in addition to Domaine de Vassal, French and Italian nurseries and European universities were also involved in the project. A first grafting campaign was carried out in 2014, a second one in 2015. The plants obtained were planted at the end of June 2015. Two other grafting campaigns occurred in 2016 and 2017 with plantation at the end of June. Sanitary tests were carried out to check if the plant material was free of viruses GFLV, ArMV, GLRaV 1 to 9 and GFkV, what is required to register a rootstock to the French catalogue. The genetic identity of all accessions from external sources was also checked. These two points were carried out by the UMT Génovigne (Montpellier). Each plant was weighted just after grafting to take into account the heterogeneity of the reserves of each plant (Lecourt, 2013). Now, the experimental design is well set up.

### **2.3. Traits measured**

All the traits already measured are presented in Table 1.

## **3. Results and discussion**

The rootstocks were chosen according to a large range of vigor conferred. It was well confirmed at the juvenile stage, with the cane pruning weight in 2015, 2016 and 2017 (Figure 5). Above the significant effect of rootstock on the cane pruning weight, rootstocks could be discriminated with their genetic background.

The first results collected for phenology with the mid-burst, mid flowering and mid-veraison dates showed no significant effect of the rootstock on the scion phenology. When the effect was significant, the differences between rootstocks were very reduced. These results confirmed those got in pot experiments with QTL approaches. These results need to be confirmed a second year at juvenile stage.

The rootstock/ scion interactions were high and allowed us to identify very plastic rootstocks depending on the scion and others with very stable responses whatever the scion they were grafted with.

## **4. Conclusions**

This very original and unique experimental vineyard will allow us to characterize a large panel of rootstocks grafted with 5 scions in order to better take into account the rootstock/ scion interactions with a meticulous protocol (statistical power, sanitary test and genetic identity checked). Since 2015, a large range of vigor conferred has been observed. The first measurements showed a very low

rootstock effect on phenology. Some measurements need to be confirmed one year more. Another characterization will be done when the root system is adult. This work is completed by pot experiments to evaluate water deficit responses and lime-induced iron deficiency chlorosis with the same rootstock panel. This experimental design will allow us to plan new rootstocks registrations in approximately a decade.

**5. Acknowledgments**

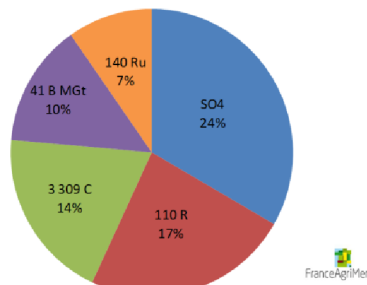
We would like to thank all the people invested directly or indirectly in the setup of GreffAdapt experimental vineyard, for the technical support (staff from Unité Expérimentale Vigne Vin Bordeaux for ensuring the maintenance of the vineyard and technical staff from UMR EGFV: Bernard Douens, Cyril Hévin, Nicolas Hocquard, Jean-Pierre Petit, Jean-Paul. Robert, for ensuring the plant material production and colleagues from UMT Génovigne invested in genetic analyses and sanitary tests: Isabelle Beccavin, Delphine Legrand et Marilyn Roques), for the scientific discussions (Laurent Audeguin, Louis Bordenave, Jean Michel Boursiquot, Jean Michel Desperrier, Vincent Dumas, Timothée Flutre, Sébastien Juillard, Thierry Lacombe, Cécile Marchal, Didier Viguier). We do not forget the colleagues from European universities that provided us plant material: Geisenheim university, the Institute for Grapevine Breeding Geilweilerhof (Germany), Madrid university, the collection from Rancho de la Merced (Spain), Milan university (Italy), Pannonia university (Hungary).

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**6. Literature cited**

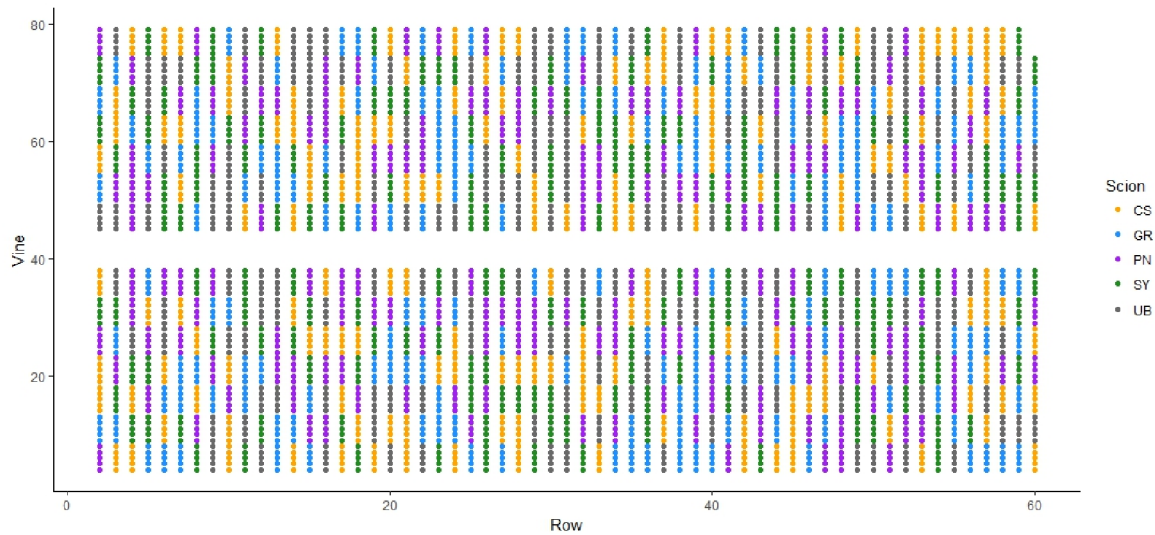
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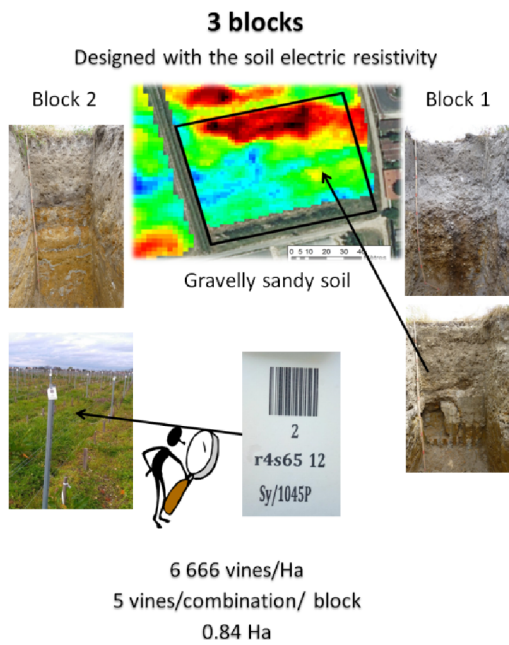
**Figure 1:** Percentage of vine areas planted with 5 rootstocks among the 31 registered in the French catalogue, that represented nearly 75% in the French vineyard (data come from France Agrimer).

Rootstocks from the French catalogue		Rootstocks used in other countries	
101-14MGt	44-53M	1045P	Evex 13-3
110R	99R	106-8 MGt	Evex 13-5
1 103P	BC2	125-1 MGt	Freedom
140Ru	Fercal	150-15M	Georgikon 28
1447P	Gravesac	157-11C	Georgikon 121
161-49C	125AA	225Ru	Georgikon 251
1616 C	5 BB	57R	Harmony
196-17Cl	Nemadex AB	775P	M1
216-3Cl	RSB1	779P	M3
3309C	RGM	Binova	M4
333EM	Rupestris du Lot	Börner	Ramsey
34EM	SO4	Dog Ridge	Scharzmann
4010Cl	5C		V15
41B	8B		
420A	Violla		

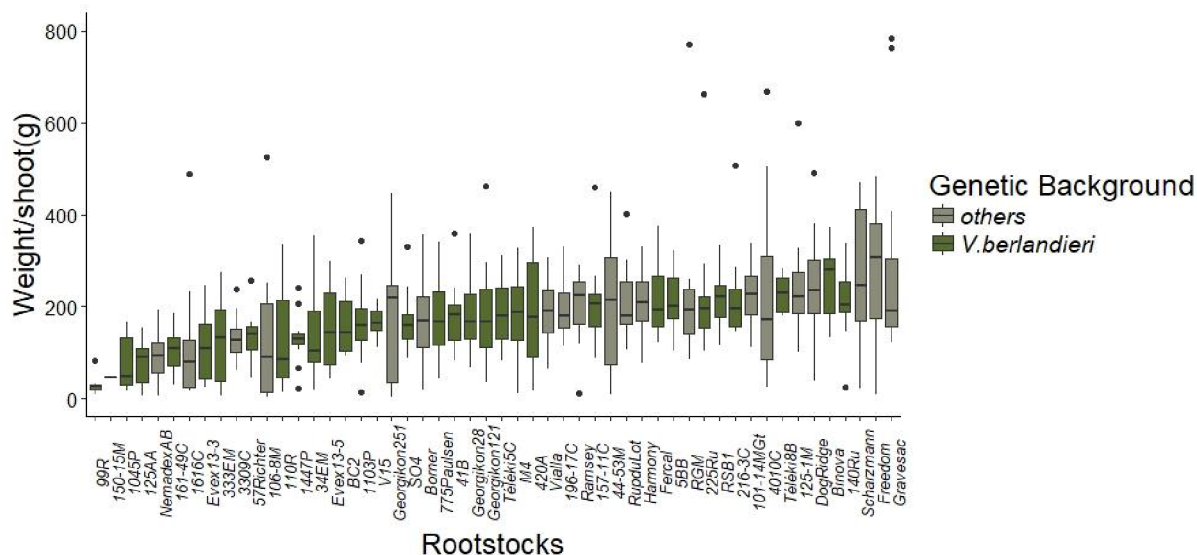
**Figure 2:** List of rootstock used in the experimental vineyard GreffAdapt.



**Figure 3:** Rootstocks/ scion combination repartition in the experimental vineyard GreffAdapt. CS, GR, PN, SY, UB respectively mean Cabernet-Sauvignon, Grenache, Pinot noir, Syrah and Ugni blanc.



**Figure 4:** Soil resistivity map (0-1.7meter depth) and soil pits of the three blocks of the experimental vineyard GreffAdapt



**Figure 5:** Cane pruning weight per shoot in 2017 with Cabernet-Sauvignon as scion.

**Table1:** Traits already measured in the experimental vineyard GreffAdapt since 2015.

\* In 2017, the five scions varieties were harvested in the same time, the weight of the bunches was not measured at the same maturity level for each of them.

Traits	Years when phenotyping occurred	Parts of the experimental vineyard concerned	Sampling/ replicates
Cane pruning weight	2015 ; 2016 ; 2017 ; 2018	The whole plot	per vine
Visual observations for the intensity of defoliation	2016 ; 2018	The whole plot	per 5 vines
Visual observations for the intensity of Magnesium deficiency	2016 ; 2018	The whole plot	per 5 vines
Weight of bunches	(2017)* ; 2018	The whole plot	per vine
Number of bunches	(2017)* ; 2018	The whole plot	per vine
Mid-bud burst date	2018	The whole plot	per vine
Mid-flowering date	2018	The whole plot except Grenache vines	per vine
Mid-veraison date	2018	9 vines from the 15 of each combination and vines of Grenache removed	per vine