Rootstock regulation of scion phenotypes: the relationship between rootstock parentage and petiole mineral concentration

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Introduction

Grapevine is grown grafted since the end of the 19th century. Rootstocks not only provide tolerance to Phylloxera but also ensure the supply of water and mineral nutrients to the scion. Rootstocks are an important means of adaptation to environmental conditions, because the scion controls the typical features of the grapes and wine. However, among the large diversity of rootstocks worldwide, few of them are commercially used in the vineyard. The aim of this study was to investigate the extent to which rootstocks modify the mineral composition of the petioles of the scion.

Materials & methods

Vitis vinifera cvs. Cabernet-Sauvignon, Pinot noir, Syrah and Ugni blanc were grafted onto 55 different rootstock genotypes and planted in a vineyard in three blocks of 5 vines. Petioles were collected in the cluster zone with 6 replicates per combination. Petiolar concentrations of 13 mineral elements (N, P, K, S, Mg, Ca, Na, B, Zn, Mn, Fe, Cu, Al) at veraison were determined. To study the effect of rootstock parentage on mineral concentration, rootstocks are grouped by their genetic backgrounds (Julius Kühn-Institut, 2022. Riaz et al., 2019). The parentage was assigned when at least 50% of a genetic background is present. The values of 5 mineral contents were classed by the status : excess, optimum and deficiency (Delas, 2010). A Chi² test of frequency was done to determine whether a independence between the genetic background and the mineral status exists. To describe this relation, we studied standardized residuals which are based on the difference between theoretical and expected values.

② Effect of genetic backgrounds on mineral content

Petiole mineral status is significantly dependent on rootstock genetic background for all the elements except N. The strongest relationship occured for P and Mg.

Table 2: P-value of Chi² test for the 2 years

	P-value	
	2020	2021
N	0.07	0.7
P	5e-07	4e-13
K	0.05	9e-04
Mg	9e-14	3e-11
Ca	1e-06	0.03

Phosphorus

Figure 2: Stacked bar chart of the P status in function of genetic backgrounds in 2021

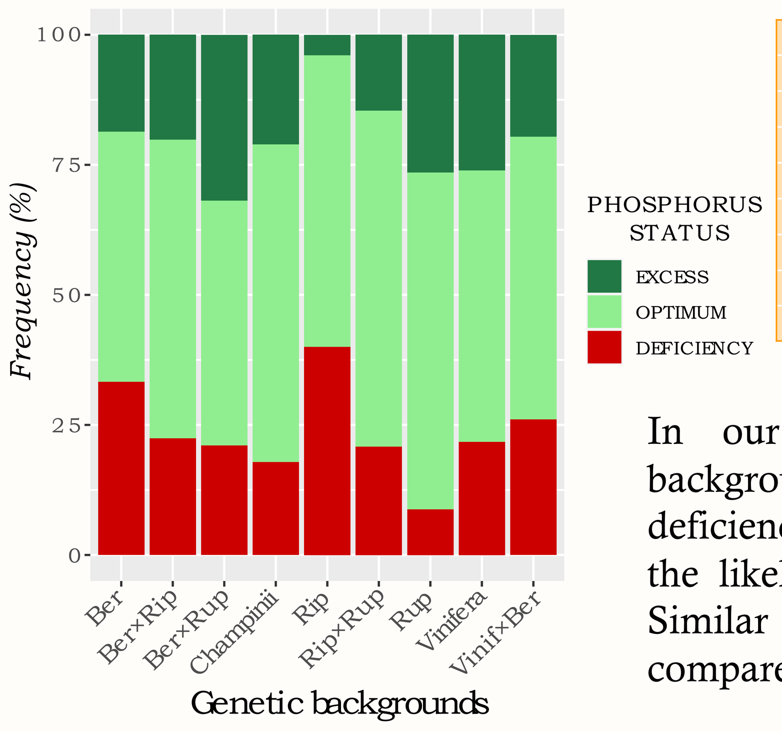


Table 3: Standardized residuals , sign and significativity of the relation between genetic backgrounds and P status (Chi²) in 2021

	DEFICIENCY	OPTIMUM	EXCESS
Ber	1.77	-1.5	-0.07
Ber×Rip	-1.51	0.86	0.59
Ber×Rup	-1.77	-2.55*	5.23***
Champinii	-1.88	1.22	0.56
Rip	5.80***	0.36	-6.95***
Rip×Rup	-0.83	1.35	-0.78
Rup	-3.33***	1.64	1.65
Vinifera	-0.67	-0.41	1.27
Vinif×Ber	0.01	-0.11	0.12

In our conditions rootstocks with a *V. riparia* background decreased P excess and conferred P deficiency whereas rootstocks with a *V. rupestris* reduced the likelihood of deficiency.
Similar results occur in 2020 for *V. riparia* and *rupestris* compared to 2021.

Magnesium

Figure 3: Stacked bar chart of the Mg status in function of genetic backgrounds in 2021

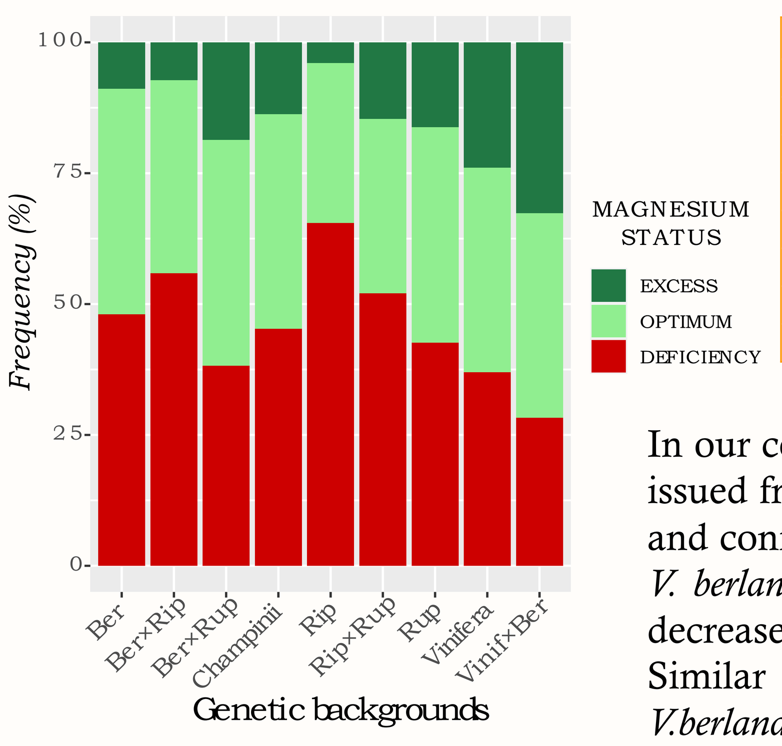


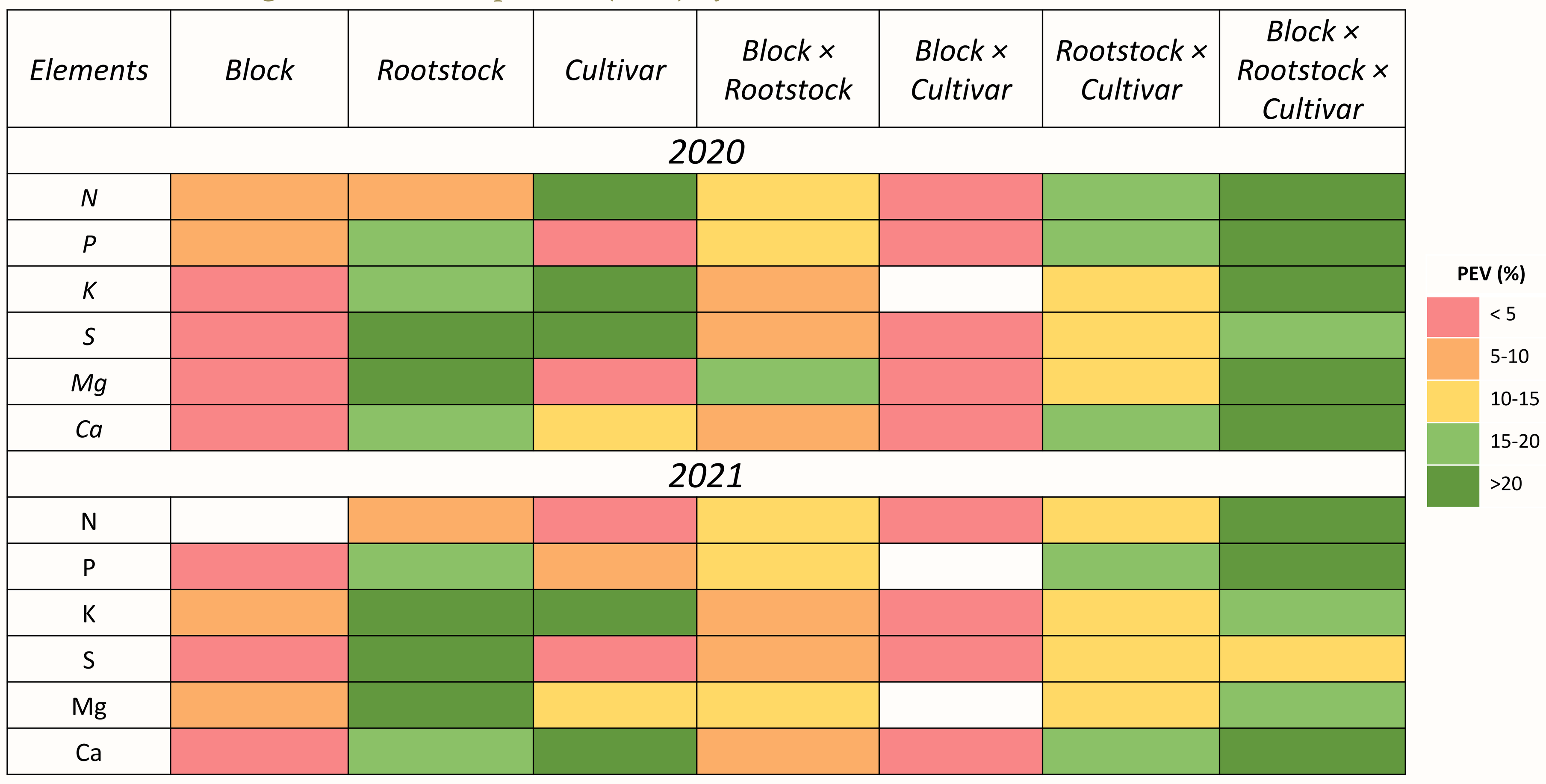
Table 4: Standardized residuals , sign and significativity of the relation between genetic backgrounds and Mg status (Chi²) in 2021

	DEFICIENCY	OPTIMUM	EXCESS
Ber	-0.5	1.17	-0.98
Ber×Rip	2.04*	-0.35	-2.63**
Ber×Rup	-3.84***	1.74	3.34***
Champinii	-1.05	0.68	0.59
Rip	5.48***	-2.70**	-4.43***
Rip×Rup	0.24	-0.65	0.61
Rup	-1.32	0.59	1.15
Vinifera	-1.86	0.19	2.60**
Vinif×Ber	-3.07**	0.19	4.47***

In our conditions rootstocks with a *V. riparia* and hybrids issued from *V. berlandieri* × *V. riparia* decreased Mg excess and conferred Mg deficiency whereas hybrids issued from *V. berlandieri* × *V. ruspestris* and *V. vinifera* × *V. berlandieri* decreased Mg deficiency and increased Mg excess.
Similar results are observed in 2020 for *V. riparia*, *V.berlandieri* × *V. rupestris* and *vinifera* × *berlandieri*

① Ranking of factors affecting petiole mineral composition

Table 1: Pourcentage of variance explained (PEV) by factor for each macroelement



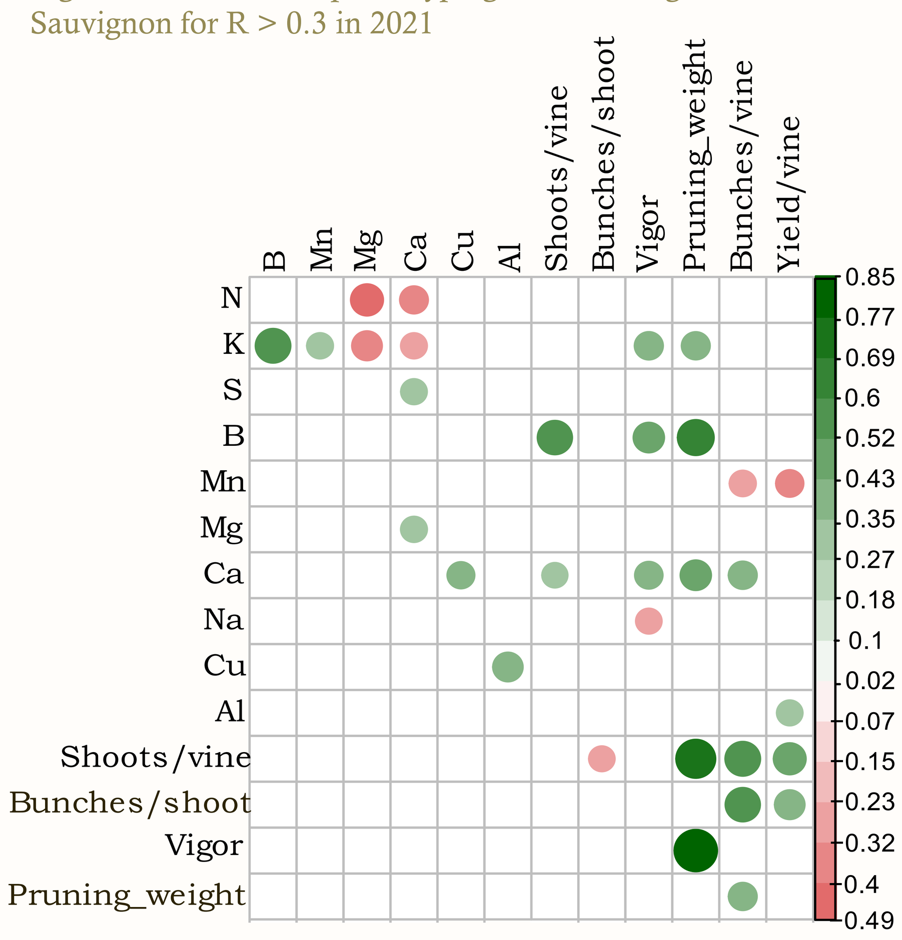
Rootstock effect explained from 7 % for N to 25 % for S of the variance in 2020 and from 9 % for N to 45 % for S of the variance in 2021.

Figure 1: Comparison of PEV by rootstock and cultivar for mineral elements with a PEV by rootstock > 15 %

Rootstock genotype affects significantly the petiole mineral composition. Except for S, the ranking of the factors rootstock and cultivar is stable from year to year.

③ Correlation between biomass and mineral composition

Figure 4: Mineral and phenotyping data correlogram of Cabernet-Sauvignon for R > 0.3 in 2021



- Petiole B & K concentrations correlated with vegetative development
- There is no other strong correlation between mineral content and phenotyping data for both years

Conclusion & discussion :

Thanks to a highly powerful design, it is the first time that such a large panel of rootstocks grafted with 4 scions has been studied. Rootstock genotype showed a strong influence on some petiole mineral elements: the effect of the rootstock can be equivalent to the cultivar. In a non limiting soil we observed differences on scion mineral status between rootstocks with different genetic backgrounds. The genetic background *V.riparia* seems to increase the probability of P or Mg deficiency : these results confirm some observations in Gautier et al 2020.

- Delas, J., 2010. *Fertilisation de la vigne.* 2e éd. Bordeaux: Féret
- Gautier, A. *et al.* (2020) 'Influence of the three main genetic backgrounds of grapevine rootstocks on petiolar nutrient concentrations of the scion, with a focus on phosphorus', *OENO One*, 54(1), pp. 1–13. doi:10.20870/oeno-one.2020.54.1.2458.
- Julius Kühn-Institut, 2022. *Vitis International Variety Catalogue VIVC.* [Online] Available at: https://www.vivc.de/
- Riaz, S. *et al.* (2019) 'Genetic diversity and parentage analysis of grape rootstocks', *Theoretical and Applied Genetics*, 132(6), pp. 1847–1860. doi:10.1007/s00122-019-03320-5.

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