

***Interactive comment on “Influence of  
hydropedology on viticulture and oenology of  
Sangiovese vine in the Chianti area (Central Italy)”  
by E. A. C. Costantini et al.***

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General comments:

1- Aim of the study. We can better specify in the final text that the main object of the paper was to test the applicability of the Lin's and Host models in the Mediterranean - a very different environment from where they have been elaborated, during the summer season - when it is supposed that subsurface flows are very limited, and for a crop that undergoes heavy soil disturbance before plantation. To our knowledge, there are not similar studies published so far. This knowledge can be very important to foster the application of the models worldwide and, in particular, to soil series for precision viti-

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culture. The use of the hydropedological approach, and in particular the Lin's and Host models, to assess subsurface flows in vineyards, can be enhanced by demonstrating that it is really relevant in terms of wine quality.

2- Use of pedological models. The Lin's model is qualitative and stresses the importance of the interaction between soil characteristics, morphological position on the slope and subsurface flow, as well as runoff. We wanted to test this assumption in condition when runoff and hydraulic conductivity are limited. We can explain this better in the final text. We can also describe briefly the semi-quantitative Host model. The use of a large quantity of data is typical of the holistic pedological approach, which is very much concerned about boundary conditions. This is especially true when you want to test the application of models, always a rough simplification of the reality, to a very complex physical and biological system, like vineyard. And especially when you are looking for the thing that matter, the quality of wine, which is so difficult to control. Any way, we have thoroughly checked the paper and we have found that active Ca CO<sub>3</sub>, water saturation, field capacity, and K sat, can be actually deleted from tables 1 and 2.

3- Use of the data to reach the objective. We can certainly follow the referee's suggestion as for the moving the data that concern the description of the soils from the results part to the material and methods part, removing unused information. We can also better focus on the relationships between TSW and the wine quality parameters, adding figures reporting the significant relationships. However, another main result of the paper is that soil salinity also plays an important role on viticultural and oenological parameters, in interaction with TSW. In fact, in the conclusion, we state that the combined modeling of water and salt movements would be particularly relevant for viticultural management.

Specific comments:

4- line 10 page 1199: soil water holding capacity and salinity are the main variables which regulate water nutrition in Mediterranean vineyards

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5- line 22 page 1199: the age of the vineyards (planting time 1991) will be mentioned in the text. It will be also added that the slopes where vineyards were planted were scalped and reshaped by bulldozing before plantation. Hence not only deep ploughing affected the soils.

6- line 30 page 1199: possible rephrasing: "In addition, the hydrological functioning of the vineyard is above all important. ...."

7- line 18 page 1200: the rootstock 420A is a hybrid between *vitis Berlandieri* and *Riparia*, which is considered to be resistant to drought and active lime, but not to salinity. (The interaction between rootstock and soil characteristics is an important boundary conditions that can explain the resulting quality of wine).

8- line 18 page 1200: OK

9- figures 1 and 2: OK

10- line 10 page 1201: the principles of Host classification will be explained. Testing the use of that classification in such a different environmental and crop condition is just one of the main aim of the work.

11- lines 15 to 25 page 1201: Host classification provides an estimation of the soil hydrological functioning on the basis of the profile characteristics. Applying Host classification to the two different soil series we obtained different estimated soil hydrological functioning. The sentence "we expected moister conditions and larger subsurface later flow in vineyard 1 than in vineyard 2" is therefore the hypothesis, which is tested in the research work.

12- lines 7 to 15 page 1201: SIS system made available a large number of maps, which were however a sort of black-box, as for the passages used to build them. Other maps were more straightforward (like that of resistivity, obtained by means of EMI) but more difficult to interpret. Therefore, we decided to use only simple data, obtained with methods that could be clearly identified, that is humidity by FDR and penetrometry. In

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the 2.7 paragraph: GIS and statistical analysis, we explained that map spatialization was obtained with the Inverse Distance Weighting method. That means that the maps were obtained by spatialization of the 21 locations. Rooting depth is the depth that can be potentially reached by roots, which corresponded in our case to the first horizon offering a resistance higher than 350 psi (2,413 kPa) to the cone penetrometer used by SIS at the time of the survey (bud bursting). Our monitoring activity was concentrated in the experimental plots and did not produce maps.

13- line 18 page 1202: we don't think that the hydrological functioning of the studied area was modified by the soil sampling because i) the surface was periodically cultivated by the farmer during the summer, to kill the weeds, interrupt capillarity and reduce evaporation, and ii) sampling outside growing season were on a monthly basis.

14- line 27 page 1202: runoff was estimated by means of the CN method.

15- line 20 page 1203: the reason is that it is assumed that vine can assume soil water at very high absolute tensions, even lower than conventional wilting point (White, 2003). Evaporation is limited by farmers through frequent cultivation.

16- line 21 page 1204: by means of the formula: (see attachment)

17- line 25 page 1204: as we have explained above, the sentence "Wilting point was the minimum soil water content recorded during the field core sampling during the whole trial" is not in contradiction. However, for the sake of clarity, we will rephrase it using the term "lowest recorded value of soil water", instead of "wilting point". To avoid any misunderstanding, the term wilting point will be only used with reference to the laboratory value obtained at -1500 kPa.

18- line 17 page 1205: we will precise in material and methods that sample depth of the undisturbed soil for making thin sections was 0.1-0.30 m and 0.40-0.70 m, as reported in figure 6

19- lines 14 to 19 page 1206: the only maps we refer in the paper are those reported

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in figs 4 and 5. The maps were used to select plots within the vineyards. The trial then was conducted in plots.

20- lines 13 to 18 page 1207 and lines 1 to 19 page 1208: OK. Ap horizon designation and limit are justified by the disturbance caused by the cultivation.

21- lines 19 to 28 page 1207: the unit of soil moisture is mm in figures and text. The maps are not directly useful for the interpretation of wine quality, as also stated in the conclusions. As said in paragraph 2.3 Plot selection, they were useful to single out plots within the vineyards.

22- Table 2: the saturated conductivity for the surface horizon which results from Rosetta is low, but we assume that the reader is aware of the limitations of the Rosetta method.

23- line 9 page 1208: in material and method it will be explained that root density was measured in the field by means of a 10x10 cm mesh.

24- line 23 page 1208: we will specify within material and methods that image analysis was conducted on vertical oriented images. Former studies demonstrated a close relationship between elongated and irregular pores and internal drainage (Costantini et al., 2006b)

25- line 26 page 1208: in plot S of San Quirico, the porosity of the lower horizon is 3.03%, which is 46.7% of the upper horizon porosity (5.68%). Figure 6 reports correctly the porosity of the studied horizons in the three different slope positions.

26- line 19 page 1209: we tried to relate IRIS discoloration to the amount of soil water, as well as soil temperature. For the sake of clarity, the sentence can be rephrased as follows: "In fact, percentage of tube discoloration was not related to mean daily soil moisture during the time in which the tubes were in place, while the relationship with daily mean soil temperature was highly significant ( $R^2=0.496$ ,  $P<0.01$ ,  $n=12$ )."

27- line 4 page 1211: You are right, we must rephrase, separating the discussion  
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about the effects of the experimental treatments (vineyard, year, slope position) from the relationships between viticultural and oenological parameters, and TSW

28- line 4 page 1211: here there is a misunderstanding. The term "qualitative evaluation" is referred to the quality of the wine, which has been evaluated quantitatively. We will rephrase it.

29- lines 8 to 20 page 1211: we will better explain that the behaviour of vineyard 1 is really "particular", because it shows the opposite than expected, that is, high soil water availability usually causes a lowering of wine quality, as it eliminates the moderate stress needed to achieve high quality wine. The explanation is that in our condition vines of vineyard 1 actually suffered from moderate stress, as demonstrated by DC13, but not because of the lack of water, but because of salinity. Soil salinity then, when it is moderate and only affects lower horizons, is a factor of wine quality. This result is an important new discovery, which leads to new research interests, especially for precision viticulture. In fact, salinity is generally considered a limitation for vine, because it has been studied in soil condition where it affected the whole profile. This paper drives the researchers' attention to moderate soil salinity in depth, and its relationships with subsurface later water flows. This research developments could be of particular interest for many hydopedologists.

30- line 21 page 1211: we can better explain that the hydopedological model of Lin stresses the importance of the interaction between soil characteristics, morphological position on the slope and subsurface flow. Our research work demonstrated that this assumption can be also true in our Mediterranean environment, as in both our vineyards, TSW increased significantly along the three positions on slope in all years, even during the very dry summer 2006. Thus soil properties can induce significant subsurface flow also in Mediterranean climate. Host classification uses soil properties to estimate major or minor subsurface flows. When applied to the studied series, it foresees a subsurface water flow in vineyard 1 greater than in vineyard 2. Our data demonstrated that TSW was actually larger in vineyard 1 than in vineyard 2. Conse-

quently the Host classification can be useful for the prevision of the moisture status also in our Mediterranean conditions.

#### References

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Faybischenko B.A.: Hydraulic behaviour of quasi-saturated soils in the presence of entrapped air: laboratory experiments. *Water Resour. Res.*, 31 (10), 2421-2435, 1995.

White R.E.:Soils for fine wines, Oxford Univ. Press, 266 p., 2003

Please also note the Supplement to this comment.

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