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Comparison of soil pH measurement in a non tilled vineyard: conventional laboratory values vs. 3100 Veris soil pH sensor readings

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Abstract

This work pretends to compare the soil pH measured by the 3100 Veris sensor with the conventional soil sampling in a specific soil condition of a non tilled vineyard. Whereas high density data was obtained with the soil pH sensor, which were used to delineate a pH surface using a geostatistical algorithm, conventional laboratory values were divided in two sets, depending on their location in a 3 or a 12 years non tilled vineyards. Comparison leads to some differences, but varibility was minor when the area not mobilized for 12 years was considered.

Keywords: soil pH, vineyard, proximal sensing.

1 Introduction

Some physical and chemical soil properties, as pH or organic matter content, can have an important influence on the vegetative development of crops. These properties can affect grapevine root system; a decrease in soil acidity, combined with a low water infiltration and an increase of bulk density, can cause a reduction in the root density (Morlat et al., 1993). Thus, the soil acidity is a basic property in the dynamic of biochemical balance and, if the soil is far from the neutrality, the vegetative growth of plants can be limited. In general, the range of soil pH in vineyards presents different values, finding productive crops on soils with pH from 4.5 to 8.5, as in calcareous soils (Ribérau-Gayon, 1982).

Soil pH affects decisively the vineyard nutrition, so it is important to know its spatial variation. Effects of a low pH on the soil lead to a lower availability of basic nutrients, such as phosphorous or potassium, and an increase in zinc, iron, and aluminium toxicity, among others, in addition to a less availability of organic matter due to a lower decomposition rate. Contrarily, a high soil pH can lead to similar effects in the availability of nutrients and toxicity, and is able to modify the structural stability and increase the organic matter consumption due to the higher microbiological activity (Hidalgo-Togores, 2006).

Precision agriculture utilizes rapidly evolving electronic information technologies to modify land management in a site-specific manner as conditions change spatially and temporally. During the last years, a diversity of several soil sensors has become an invaluable tool for identifying soil physicochemical properties influencing crop yield. Nevertheless, one must be aware that in some particular conditions these types of sensors must be tested and their data must be validated. Thus, the objective of this case study is compare, in non tilled vineyards, the soil pH on-the-go readings measured by the 3100 Veris sensor with the soil pH data obtained by standard methods of soil pH assessment.

2 Material and methods

The field research was conducted at a farm called Herdade de Pinheiros, in the proximity of Évora city, Portugal. The study area is approximately 66 ha and soil pH was sampled using two different methodologies: i) 1627 measurements were taken with the 3100 Veris pH sensor Manager (Veris Technologies Inc., Salina, KS, USA), and ii) 58 samples were taken from the top layer (0-20 cm) using a stratified sampling scheme (17 and 41 samples from a 3 and a 12 years non-tilled vineyard area respectively). Conventional soil sampling occurred in 2011 spring and Veris pH sensor sampling occurred in 2012 autumn. The 66 ha site is occupied with a non-tilled vineyard and, consequently, in the top layer there was a high concentration of vineyard roots. The 3100 Veris sensor works on-the-go mode. Sampled lines are 15 m average spaced and the Veris soil samples, in each line, are 20 m averaged spaced. Each sample is collected by a device located in the rear of the platform, which is raised and get in contact with two antimony pH electrodes. The pH values are obtained considering the average voltage outputs of the two electrodes. Each measurement is followed by an electrodes wash cycle.

3 Results and discussion

After the sampling process, the 3100 Veris pH values were 10 m grid interpolated, using the ordinary kriging algorithm, and a pH surface was obtained. To compare the two methodologies (low density conventional pH sampling and high density 3100 Veris pH sampling), a database was constructed considering the 58 conventional soil pH values and, for the same positions, 58 pH values obtained through pH surface. The last values were computed considering the averaged pH of a 60 m diameter circle centered in the 58 conventional soil sampling positions (Fig 1).

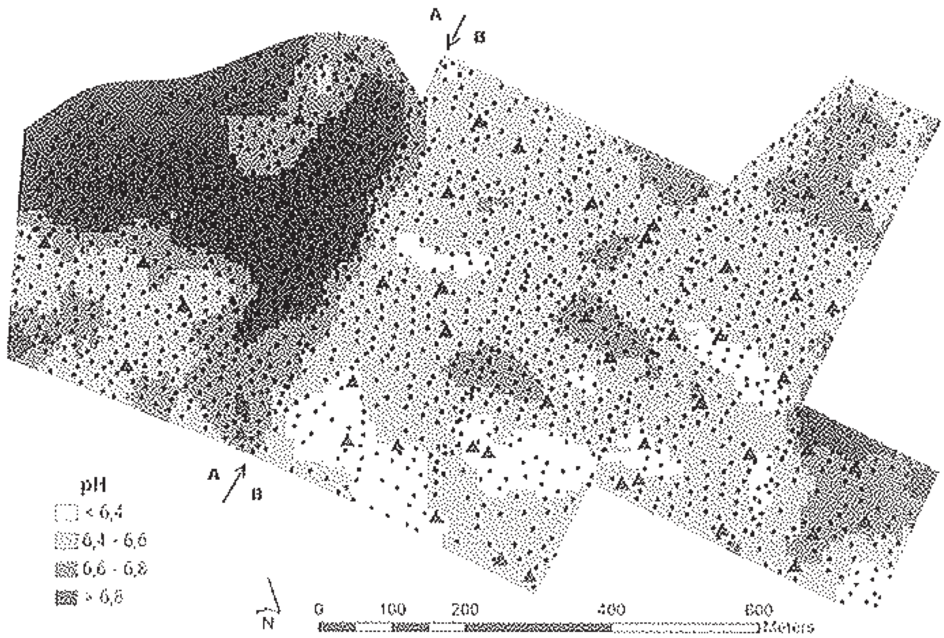

Figure 1. Soil pH samples (triangles) and 3100 Veris pH sensor readings (dots) in the vineyard not mobilized for 3 years (A) and the vineyard not mobilized for 12 years (B). Kriged surface from soil pH sensor data is also shown.

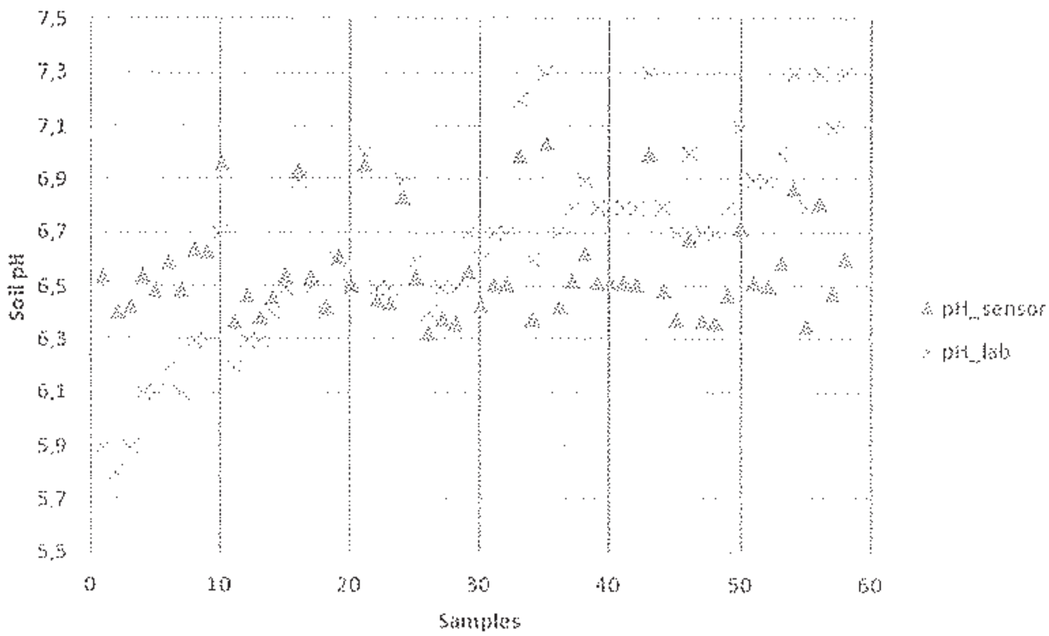

Figure 2. pH values measured by standard laboratory methods (pH_lab) and by 3100 Veris pH sensor (pH_sensor) at the same sampling location.

Some differences (|~10%|) in the pH measurement behaviour for the two used methodologies were obtained. In some cases, the Veris measurements when compared

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with analytical laboratory pH values overestimate or underestimate the soil pH value (Fig. 2). It was also found that there are areas in the experimental field where the pH spatial variability is greater than others (Fig. 1). The pH variability measured by Veris sensor is usually minor in the areas that were not mobilized for 12 years when compared to the areas that were not mobilized for 3 years. Apparently the number of years that the soil was not mobilized influences the local pH spatial stability measured by the Veris platform and this may be related to the organic matter content in the soil.

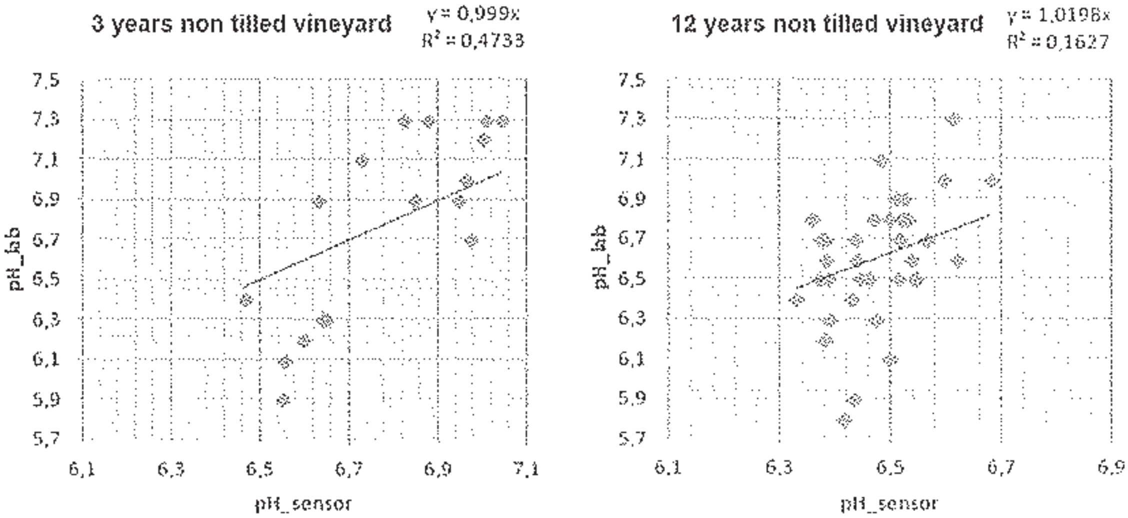

Figure 3. Scatter plot of pH values measured by standard laboratory methods (pH_lab) and by 3100 Veris pH sensor (pH_sensor) for the 3 years non tilled vineyard and for the 12 years non tilled vineyard. The regression model is also shown.

Fig. 3 shows the relationships between pH values obtained in laboratory and average values from pH surface. Higher coefficient of determination was computed when the 3 years non tilled vineyard data were considered, whereas a very low correlation was apparent for the 12 years non tilled vineyard data. In both cases, correlations were lower that those reported in other works (e.g., Schirrmann et al., 2011).

Given the obtained results the questions that can be raised are whether the observed maladjustment are due to a misbehaviour with the Veris pH sensor, problems with the laboratory measurements, or the difficulties in the comparison itself, because, although we are analyzing nearby sites, we cannot compare low density conventional pH sampling, not sensible to pH spatial variation, with high density 3100 Veris pH sampling, sensible to pH spatial variation.

4 Conclusions

Soil pH mapping using high density data provided by the 3100 Veris soil pH sensor is necessary to accurately delineate the spatial pattern of this key variable in vineyards.

However, data must be validated. Thus, apparently, there are pH values measured in the laboratory that are confirmed by the Veris sensor in the field but, however, others do not coincide. Such variability should be examined and the discrepancy between the two measuring methods should be confirmed, or if the pH local variability, undetected by point method, is responsible for the found differences.

Further research is necessary to clarify the error level of soil pH on-the-go readings in non-tilled soils, particularly in those not mobilized for a long time, and to improve the calibration using additional information as soil apparent electrical conductivity, which is simultaneously measured with the device located on the same platform.

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References

Hidalgo-Togores, J. 2006. La calidad del vino desde el viñedo. Ed. Mundi-Prensa Libros. Madrid.

Morlat, R., Jacquet, A., Asselin, C. 1993. Principaux effets de l'enherbement permanent contrôlé du sol, dans un essai de longue durée en Anjou. Progr. Agric. Vitic., 110 406-410.

Ribéreau-Gayon, Y. 1982. Ciencia y técnicas de la viña. Tomo 2º: Biología de la viña. Suelos de viñedo. Ed. Hemisferio Sur S.A. Buenos Aires.

Schirrmann, M., Gebbers, R., Kramer, E., Seidel, J. 2011. Soil pH Mapping with an On-The-Go Sensor. Sensors, 11 573-598.