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# USING CANOPY PROXIMAL SENSORS FOR VARIABLE RATE FERTILIZATION IN A TREBBIANO ROMAGNOLO VINEYARD

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## INTRODUCTION

In the last decade, the development of remote and proximal sensing allowed to acquire detailed vigour maps that are helpful for predicting spatial variability of vine productivity and grape quality and for site-specific vineyard management (Bramley et al., 2011; Filippetti et al., 2013). The modern variable-rate fertilizer spreaders associated with increasingly precise and reliable positioning systems made it possible to supply different quantities of mineral elements on a given vineyard, in order to obtain vegetative uniformity and to reduce wastefulness of nutrients (Gatti et al., 2017 and 2018).

This study aimed to evaluate if variable rate (VR) fertilization may be usefully adopted to reduce the amount of nitrogen supplied, maintaining high-yielding performance of a vigorous Trebbiano romagnolo vineyard.

**Fig. 1. Experimental site: Trebbiano romagnolo vineyard trained to GDC.**

**Fig. 2. GreenSeeker® sensors used to acquire NDVI.**

**Fig. 3. Variable rate fertilizer spreader.**

## MATERIALS AND METHODS

The experiment was carried out in 2018 and 2019 in a 3 ha, non-irrigated vineyard of cv. Trebbiano romagnolo (*Vitis vinifera* L.), clone TR 3T grafted onto SO4, established in Tebano (Ravenna, Italy) on a flat land in the Senio valley. Vines are trained to GDC system (4m x 1m) with NE/SW oriented rows (Fig. 1).

During summer of 2018 and 2019, two quad-mounted GreenSeeker® crop sensing system (Fig. 2) measured canopy reflectance in the red ($R_{RED}$) (650±10 nm) and NIR ($R_{NIR}$) (770 ±15 nm) band and calculated NDVI according to the formula: NDVI = $(R_{NIR}-R_{RED})/(R_{NIR}+R_{RED})$. Vineyard vigour map was created with QGIS software ver. 3.4. In September 2018, vines were harvested following a pre-arranged grid (50m x 20m) in order to get georeferenced data of yield components and berry quality parameters.

Spatial Inverse Distance Weighting (IDW) interpolation of NDVI, yield and quality data was carried out using QGIS software, over a predefined 3 m grid surface. The k-means clustering analysis of the interpolated values produced the delineation of sub-field zones representative of different classes of vigour, yield, sugar concentration and titratable acidity. Based on the defined sub-field zones, a prescription map for N fertilization was elaborated with QGIS software. In March 2019, 40 kg $ha^{-1}$ of Nitrogen were uniformly applied in the vineyard with urea (46% N), while in May VR fertilization was performed with a KUHN MDS 12.1 with electronic metering system and automatic outlet control via GPS receiver STONEX S8 Plus (Fig. 3).

## RESULTS AND DISCUSSION

The preliminary results of this study showed a noticeable variability of vine vigour in 2018 (Fig. 4), nevertheless the majority of the vineyard was characterized by high NDVI values (> 0.6). The results of harvest confirmed the expected relations between the areas with highest NDVI (> 0.75) and the most productive vines (Fig. 5) with grape at low total soluble solid concentration (Fig. 6) and high acidity levels (Fig. 7). Conversely, at lower NDVI, vines were less productive and grapes reached higher sugar concentration and lower level of acidity.

Variable rate N fertilization was performed according to the prescription map (Fig. 8) with the following nutrient rates: 60 kg $ha^{-1}$ of N in the lower vigour zones, 30 kg $ha^{-1}$ in the higher vigour zones and no N application on missing vines and on plants affected by “Flavescence dorée” or “Esca desease” (NDVI < 0.30). In 2019 summer, NDVI levels resulted overall higher and more uniform compared to those of 2018 (Fig. 9). It appears that vigour variability was reduced across the vineyard but it is hard to ascribe this result to the single VR nitrogen fertilization. Considering that the experimental vineyard was not irrigated, the abundant and well distributed precipitations during 2019 growing season (260 mm from April to July) may have contributed to the increase of vigour in the lower vigour zones, enhancing the adsorption of the additional amount of nitrogen.

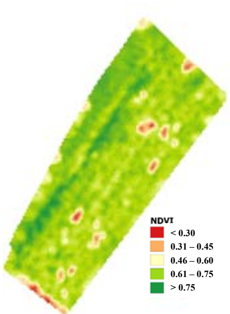


**Fig. 4. NDVI spatial variability map (summer 2018).**

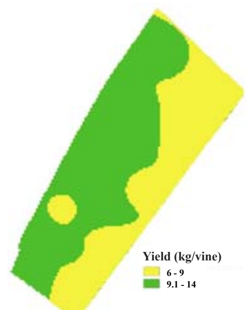


**Fig. 5. Yield spatial variability map (harvest 2018).**

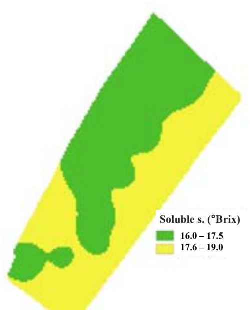


**Fig. 6. Sugar concentration spatial variability map (harvest 2018).**

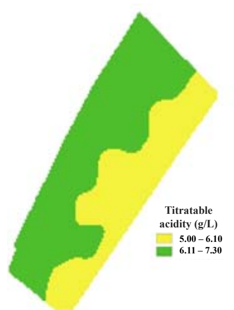


**Fig. 7. Titratable acidity spatial variability map (harvest 2018).**

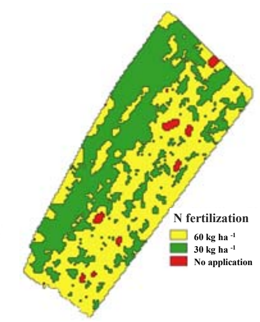


**Fig. 8. Prescription map for VR nitrogen fertilization.**

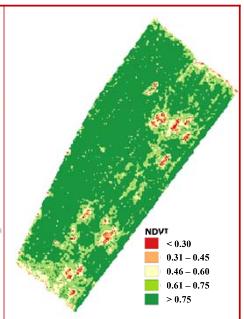


**Fig. 9. NDVI spatial variability map (summer 2019).**

## CONCLUSIONS

Variable rate fertilization is a promising technique to get the optimal vine vigour across a given vineyard but other factors, such as water availability, may contribute to the achievement of this goal. Nevertheless, in our case-study the sustainability of vineyard management was ameliorated by saving 30 kg $ha^{-1}$ of N and maintaining adequate vegetative performances across the vineyard.

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