Can precision agriculture be used in the management of a Fe and Zn biofortification workflow in organic tomatoes (*Lycopersicum esculentum* L.)?

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Abstract: Is expected that the population worldwide might exceed the 9 billion by 2050, being therefore imperative to increase food production. As such, the development of smart farming technology is an important key food production issue. In fact, through the use of UAVs (Unmanned Aerial Vehicles), it's possible to create normalized difference vegetation index (NDVI) maps, that can indicate, namely, health and vegetation vigor. In this context, this study aimed to assess the state of three tomato varieties (beef heart, "chucha" and apple) in the framework of a biofortification workflow with Fe and Zn, following an organic production mode. In a tomato experimental production field (GPS coordinates - 39° 41′ 48,517′′ N; 8°35′ 45,524′′W), six foliar spraying were carried out during the production cycle, with a mix of Zitrilon (15%) (0.40 and 1.20 kg.ha^{-1}) and Maxiblend (1 and 4 kg.ha-1). NDVI was determined 7 days before the first foliar spraying and showed a maximum of 0.86 (on a scale from -1 to 1). After the 3rd foliar spraying, no changes were detected in the color of freshly harvest tomatoes (assessed through spectrophotometric colorimeter), but an increase of Fe and Zn content was found in the leaves and of Zn in tomatoes (except in "chucha" variety). The use of precision agriculture techniques in correlation with the other analysis is discussed.

Keywords: Biofortification; Iron; *Lycopersicum esculen*tum L.; NVDI; Organic tomato production; Zinc.

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Materials and Methods

- Biofortification Itinerary – Foliar spraying with two concentration with a mix of two products (Zitrilon 15% and Maxiblend) - Treatment 1 (0.40 $kg.ha^{-1}$ Zitrilon (15%) and 1 $kg.ha^{-1}$ Maxiblend) and treatment 2 (1.20 $kg.ha^{-1}$ Ziltrilon (15%) and 4 $kg.ha^{-1}$ Maxiblend)
- NDVI of the experimental field (through the data obtained by UAV)
- Iron and Zinc content in leaves and Zn concent in tomatões (through XRF analyzer)
- Colorimetric parameters (using a scanning spectrophotometric colorimeter)
- Data analysis

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Results and Discussion

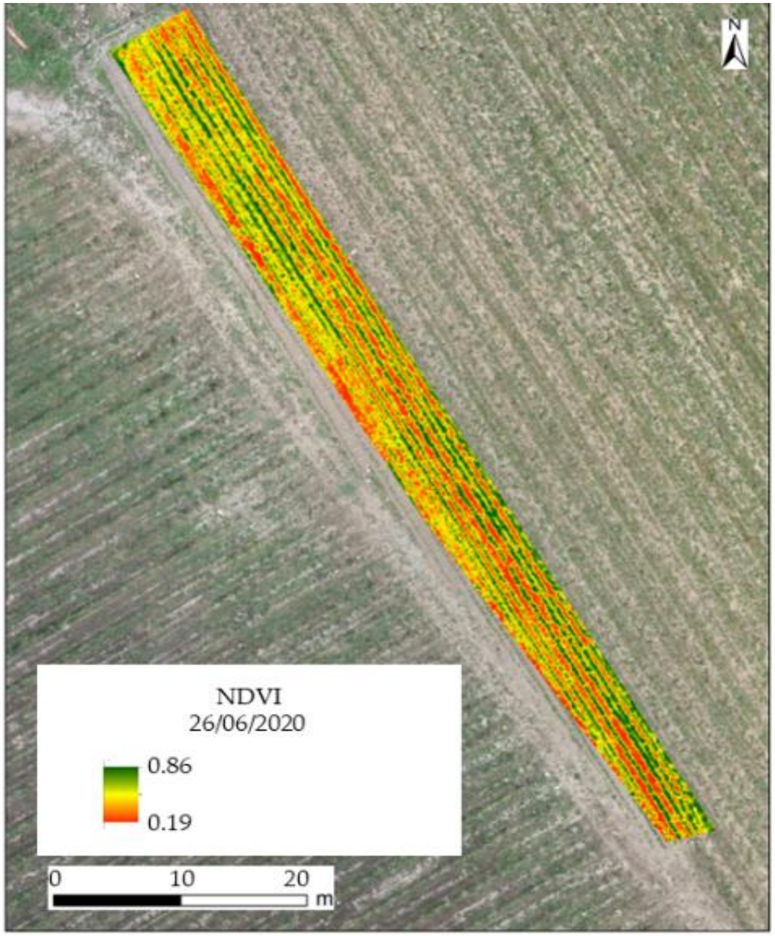

Figure 1. NDVI (Normalized Difference Vegetation Index) map in plants of *Lycopersicum esculentum* L. (considering the three varieties), 7 days before the 1st foliar spraying with Fe and Zn.

Concerning the management of Fe and Zn biofortification workflow in organic tomatoes, the NDVI map was obtained 7 days after the 1st foliar spraying (Figure 1), with the aim of verifying if the culture was in good health conditions to be biofortified.

Table 1. NDVI ((Normalized Difference Vegetation Index) of the three varieties of *Lycopersicum esculentum* L., (obtained on 26th June 2020), 7 days before the 1st foliar spraying with Fe and Zn.

Minimum NDVI	Maximum NDVI	Average NDVI	SD
0.19	0.86	0.44	0.15

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The colorimetric analysis of tomatoes after the 3rd foliar spraying with Fe and Zn showed the highest value at 650 nm, which corresponds to the red color (Figure 2).

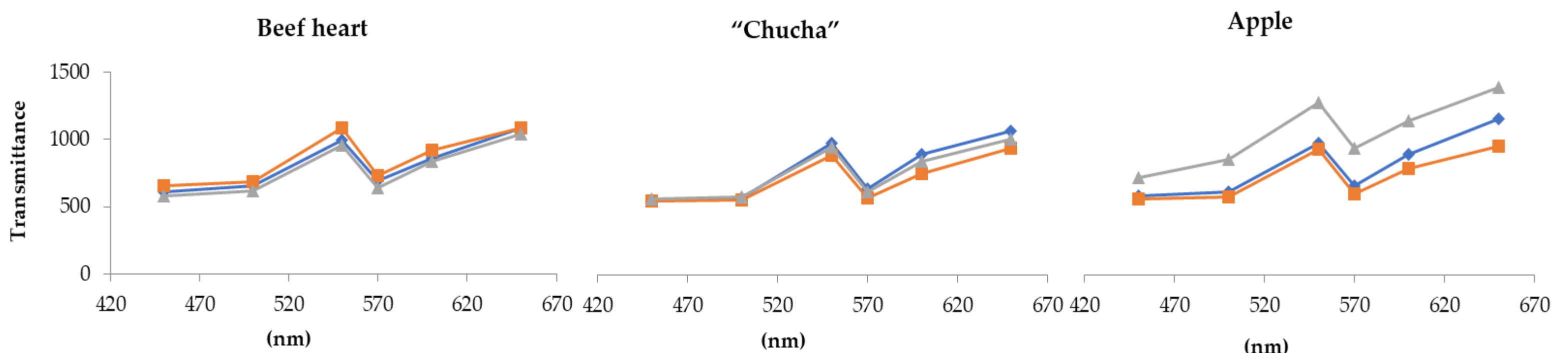

Figure 2. Visible spectra showing the average of transmittance (n = 4) in tomatoes of *Lycopersicum esculentum* L. of the three varieties, after the 3rd foliar spraying (● Control, ■ T1 and ▲ T2).

Mineral content of the leaves, after the 3rd foliar spraying (Table 2), pointed that after foliar spraying "Chucha" and "Apple" varieties, they became biofortified with Fe and Zn (relatively to control, revealing a higher content in T2, followed by T1). However, in the "Beef Heart" variety, Zn content only revealed higher content than the control T2, which may be due to the heterogeneity during foliar spraying or because the accumulation of minerals varies depending on the genotype.

Table 2. Mean values ± S.E. (n = 4) of Fe and Zn in leaves and Zn in tomatoes of *Lycopersicum esculentum* (beef heart, "chucha" and apple), after the 3rd foliar spraying.

		Leaves		Tomatoes
Variety	Treatments	Fe (ppm)	Zn (ppm)	Zn (ppm)
Beef heart	Control	<50	74.92b ± 1.79	38.59c ± 0.43
	T1	<50	62.29c ± 3.97	77.16a ± 0.18
	T2	<50	200.8a ± 1.96	63.12b ± 1.57
"Chucha"	Control	<50	61.67c ± 0.99	30.30a ± 1.98
	T1	140.2b ± 7.94	140.0b ± 3.14	28.76a ± 1.32
	T2	255.0a ± 10.5	167.0a± 2.26	13.71b ± 0.86
Apple	Control	73.90c ± 10.4	54.23c ± 0.70	30.35b ± 2.71
	T1	113.7b ± 3.84	121.7b ± 1.64	33.27b ± 1.43
	T2	273.9a ± 8.55	285.3a ± 2.57	64.32a ± 1.64

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Conclusions

- Using UAV, it was possible to obtain NDVI values and assessed the vegetative stage of the tomato culture (with three different varieties) before the implementation of the biofortification workflow.

- Biofortification workflow with Fe and Zn in an organic production mode showed hat the content of these minerals in leaves and fruits varied among tomato varieties. “Apple” variety showed better relatively to “Beef Heart” and “Chucha” varieties.

- Foliar spraying with Fe and Zn can increase these chemical elements in tomato leaves and fruits (without major changes in the color of fruits).

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