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Predicting bread quality parameters using remote sensing: a case study in Tuscany region

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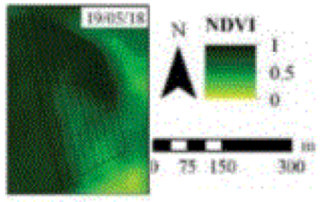
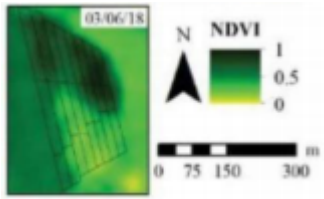
Introduction

Wheat is one of the most cultivated cereal worldwide. Specific quality characteristics are required by the baking industry including protein content (Pc) and rheological properties. For that reason it is important to determine the quality components to place flour in the market and define food safety programs (Guerrini et al., 2020; Ortolan and Steel, 2017). In the last years, the use of satellite images have been adopted as a method to determine in field wheat characteristics remotely (Fabbri et al., 2020). The study aim was to estimate the bread quality characteristic from satellite images before wheat harvesting.

Materials and Methods

The research was carried out in Monteroni D'Arbia, Tuscany for two winter wheat cultivars, using one old (Verna) and one improved (Bologna) variety during 2016/2017 growing season. The field was cultivated with 24 treatments comprising 2 wheat varieties, 3 N levels(35,80 and 135 kg N ha-1), 2 sowing densities (90 and 180 kg seed/ha), and 2 sulphur treatments (0 and 6.4 kg S ha−1) each replicated 3 times. At harvesting, 3 samples of aboveground biomass were collected manually for each plot. Samples were oven dried to determine grain yield and analyzed for determining Nc, Pc, dough tenacity (P), dough extensibility (L), the P/L ratio, the index of swelling (G), and the dough strength (W) as reported in Guerrini et al. (2020). In this experiment we used Sentinel 2A images to calculate vegetation indices (VIs) reported in Fabbri et al. 2020. The spectral images were downloaded from the Copernicus website for the months closed to harvesting (May 25 and June 26 2017). Pearson correlation coefficient (R) was used to identify the correlation between VIs and quality parameters.





Results

Variety	Par	CCCI	EVI	EVI2	NDVI	MCARI	MSAVI	OSAVI	TCARI
Bologna	P	-0.52	-0.59**	-0.59**	-0.60**	0.14	-0.57**	-0.59**	0.16
	P/L	-0.52	-0.64**	-0.64**	-0.64**	0.04	-0.61**	-0.64**	0.05
	N	0.63**	0.69*	0.69*	0.67**	-0.21	0.68**	0.69*	-0.20
	Pc	0.59**	0.65**	0.65**	0.62**	-0.19	0.64**	0.65**	-0.18
Verna	P	0.57**	0.70*	0.71*	0.70*	0.76*	0.69*	0.71*	0.76*
	W	0.41	0.56**	0.56**	0.56**	0.65**	0.55	0.56**	0.66**
	Nc	0.56**	0.65**	0.65**	0.64**	0.64**	0.65**	0.65**	0.64**
	Pc	0.56**	0.65**	0.65**	0.63**	0.62**	0.64**	0.65**	0.63**

Variety	Par	CCCI	EVI	EVI2	NDVI	MCARI	MSAVI	OSAVI	TCARI
Bologna	P	-0.72*	-0.68**	-0.68**	-0.45	0.60**	-0.71*	-0.68**	0.57**
	L	0.71*	0.68**	0.67**	0.38	-0.59**	0.70*	0.67**	-0.58**
	P/L	-0.79*	-0.72*	-0.72*	-0.50	0.68**	-0.76*	-0.72*	0.67**
	G	0.71*	0.67**	0.67**	0.39	-0.60**	0.70	0.67**	-0.58**
	N	0.83*	0.82*	0.82*	0.50	-0.65**	0.84*	0.82*	-0.62**
	Pc	0.80*	0.79*	0.79*	0.47	-0.63**	0.81*	0.79*	-0.59**
Verna	P	0.23	0.67**	0.67**	0.72*	0.48	0.66**	0.67**	0.49
	Nc	-0.01	0.63**	0.63**	0.67**	0.67**	0.59**	0.63**	0.67**
	Pc	-0.03	0.62**	0.62**	0.67**	0.68**	0.58**	0.62**	0.68**

Table 1 – Correlation between bread quality parameters and VIs in May (upper) and June (lower); * and ** indicate significant correlations (P<0.05 and P<0.01).

Conclusions

The most used VIs were used and a strong correlation was detected for Nc and Pc prediction in both cultivars. The highest correlation were found in June, closed to harvesting, expecially for Bologna variety. The relationship resulted influenced by the variety. The analysis might be used to determine wheat bread quality characteristics and target the product on the market following farmers and bakery industry purposes.

References

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