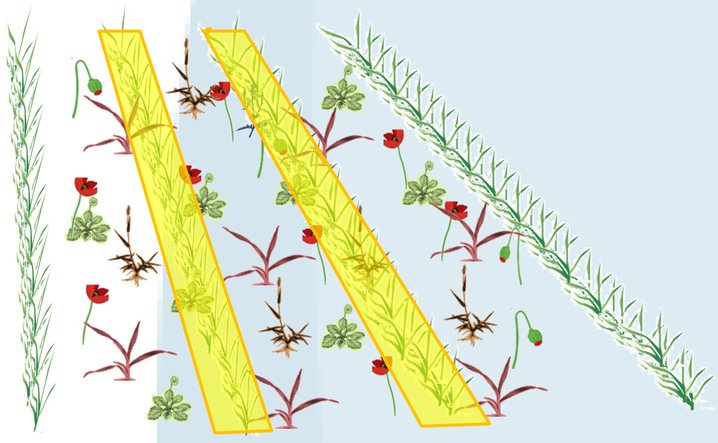
Fast method for the Weeds' impact evaluation on a field crop using Smartphones

E. Romano [a], C. Bisaglia [a], M. Palumbo [b], N. Virzì [b], F. Sciacca [b], S. Saia [c,d], I.Pecorella[c] and P.De Vita [c]

a) **CREA Research Centre for Engineering and Agro-Food Processing**, *Via Milano, 43 - 24047 Treviglio (BG), Italy*
b) **CREA Research Centre for Cereal and Industrial Crops**, *Corso Savoia 190 - 95024 Acireale (CT), Italy*
c) **CREA Research Centre for Cereal and Industrial Crops**, *S.S. 673 km 25+200 - 71122, Foggia, Italy*
d) **CREA Research Centre for Cereal and Industrial Crops**, *S.S. 11 per Torino, Km 2,5 - 13100, Vercelli, Italy*

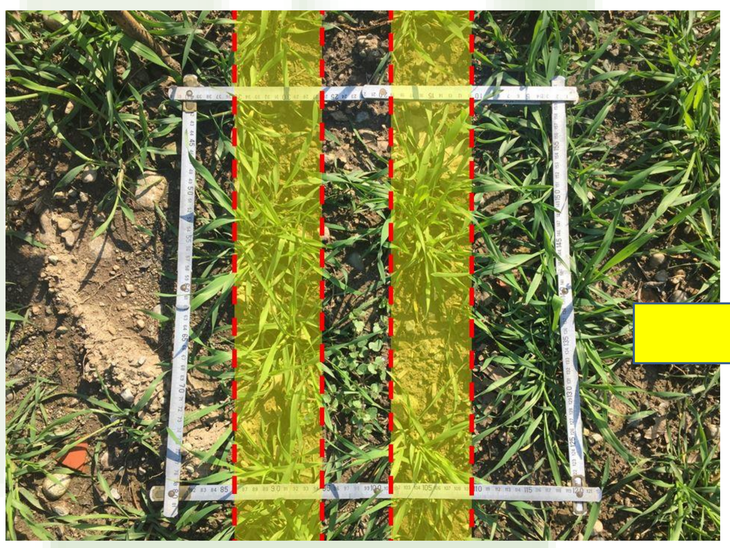
The amount of weeds and the composition of its population can influence wheat grain yield and its quality, especially in organic farming systems, and have implication for the management of the system in space and time. Thus, knowing the weed flora traits with precise and on time reading are important factors for agronomic management both in conventional and organic farming and can play a role in decision-making at wide scale.



The Aim

The present study is a preliminary assessment of an algorithm implemented in an application which is based on pictures taken by the smartphone and provides for the quantification of the percentage on total pixels representing the soil to ponder the presence of weed biomass against the crop. The implemented app is a simple application that requires the operator, after taking the picture, to draw on the same pictures lines representing the cultivation rows.

The Process



A picture with the lines indicating of the rows (yellowed bad with red hatched lines)

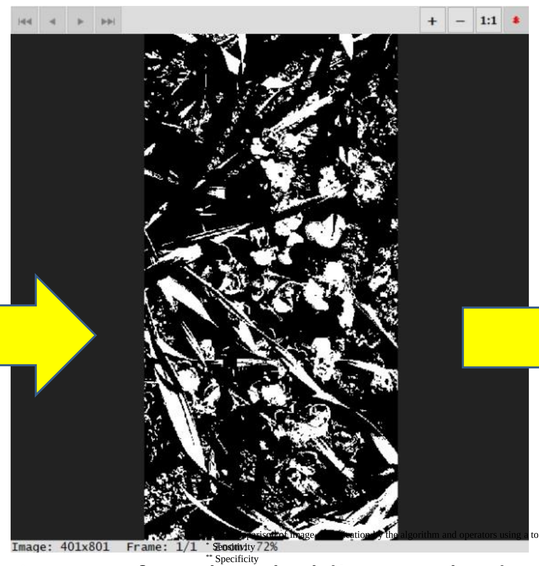


Image after thresholding method

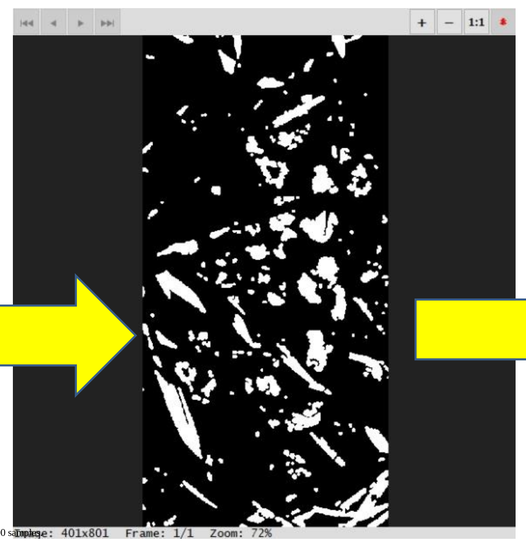


Image after *medianFilter* function

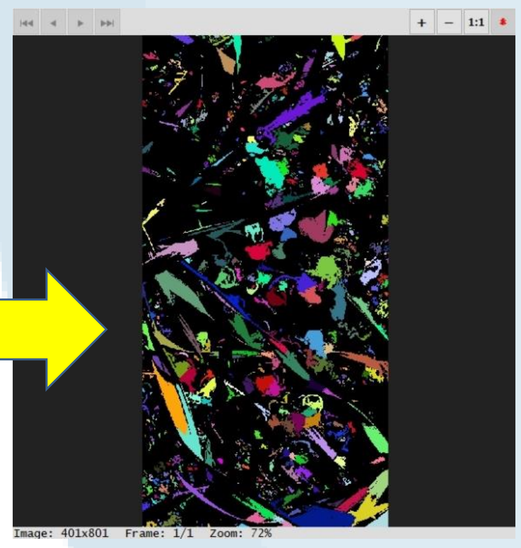
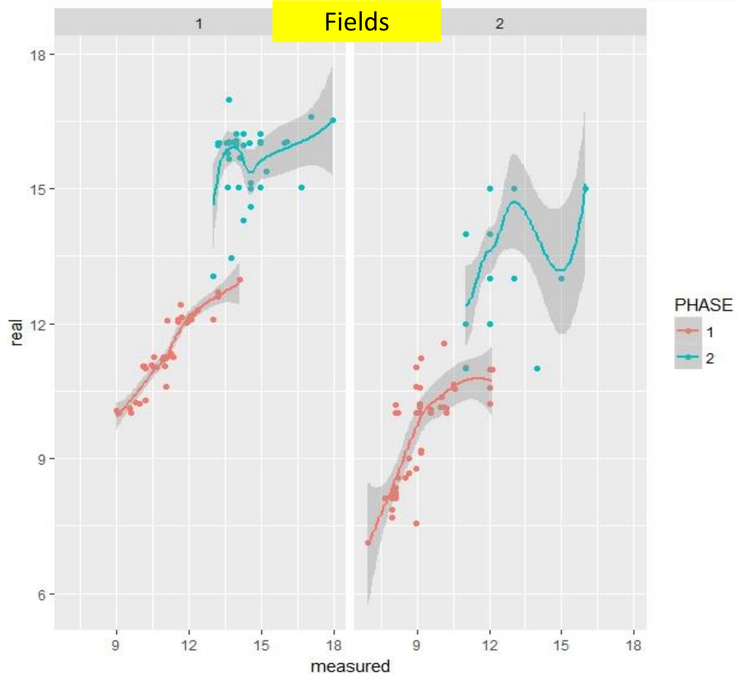


Image after *watershed* function

The images, altogether 200, were elaborated through the "R" statistical software, using the *EBImage* package. This R package provides general purpose functionality for image processing and analysis. In this study were adopted thresholding methods on RGB followed by *medianFilter* and *watershed* functions.

For the evaluation of the efficiency of the algorithm used, the correct detection rates and the false detection rate were considered.

Reference condition	Measured Weed	Measured Non-Weed	Percent correct
Real Weed	127 (true positives)	32 (type II error)	0.80 %*
Real not-weed *	2 (type I error)	9 (true negatives)	0.82 %**
Correctly classified images* (* Sensitivity ** Specificity)			0.68 %



Percentage values of measured and actual weed biomass in the two fields

Percentage of weeds in the second phase was higher than in the first (p-value <0.05). However, a difference (p-value <0.01) was also observed between the two methods of computing the percentage of biomass , with lower values for image analysis than direct sampling. Similarly, an interaction between the method and phase of observation occurred (p-value <0.05), suggesting that the method of extraction of values based on the proposed algorithm has responses that are affected by the percentage actually present and that probably underestimates the actual values at low percentages or overestimate at increasing amounts of weeds.

Results and Conclusions

- The procedure resulted highly sensitive and showed a high specificity towards the weed biomass. Overall, the proposed processing system showed 80% of results corresponding to the actual percentage of biomass present, with errors in only 18% of cases and an underestimation never higher than 2%. The picture shots repeated over time on the same sampling site showed that the deviation between the values measured with the proposed algorithm and the actual ones had a trend related to the growth of both the crop and the weed biomass.
- The implementation of the algorithm in the application for the smartphone or automated systems is therefore possible, which will allow to express in real time, soon following the picture shots, the value of present weed biomass, and thus facilitate the operator in the choices of intervention, in the best economic optimization of resources and towards the sustainability of agricultural management.

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