

## ***Interactive comment on “Assessing shadow effects on Photochemical Reflectance Index (PRI) for the water stress detection in winter wheat” by Xin Yang et al.***

### **Anonymous Referee #1**

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Yang et al. studied the impact of shadow fraction on the capability of PRI to predict relative water content, RWC, in winter wheat. The concept of this analysis is very interesting. However, I have some questions on how the authors concluded that a varying shadow fraction has limited impact on the prediction of RWC.

#### Specific Comments

The conclusion is that shadow fraction does not significantly affect the prediction capabilities of PRI of relative water content. I find that hard to believe. If PRI is different for a range of shadow fractions and water content in an entire plant is generally similar than there must be a difference? Let's think about a pixel with either 10% shadow or 90%

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shadow (we don't know what it is), the PRI is different (right?) but the relative water content in the plant is not (or is that a wrong assumption?).

It would be interesting to mention whether this conclusion holds up for other crop types. How generally applicable is the outcome of this research?

I don't understand why the authors focus on just PRI. The title only mentions PRI, but the research also includes different forms of NDVI and WI. However, on Page 3, line 7, only different formulations of PRI are mentioned. It seems like a waste of data, when the feature extraction is so limited. There are many other VI's in literature than can be explored, such as; health index (HI), plant senescing reflectance index (PSRI), renormalized difference vegetation index (RDVI), and normalized photochemical reflectance index (PRI<sub>n</sub>) to name a couple. A nice overview of narrowband indices can be found in (López-López, Calderón, & González-Dugo, 2016).

The terms "stressed plants" and "mixed" are confusing. I assume this is water stressed, but how stressed are they? It would be cleaner to use quantifying terms like RWC. This also applies to figures 3 and 4. It would be interesting to see the trend over RWC and not over days of water stress. Mixed is mentioned several times and shown in figures, but what is it? What percentage of shadow/sunlit?

A quick google search on "assessing shadow effects on photochemical reflectance index" pointed me at two valuable papers that weren't cited. The authors should consider including them ; (Suárez, Zarco-tejada, Sepulcre-cantó, & Pérez-priego, 2008) and (Zhou et al., n.d.).

Page 1, line 1, the authors of this paper look at more than only PRI. The title makes it seem like this is the only Vegetation Index.

Page 3, line 7, what is the seasonal scale? I don't see this in the rest of the paper.

Page 3, line 30-31, can the authors explain why they use three pots for hyperspectral imaging and three for collecting samples? Why aren't the same pots used for both

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imaging and sampling? How big is the possible error that is introduced here?

Page 4, line 1, it is unclear to me what kind of measurements the authors are talking about.

Page 4, line 16-19, can the authors elaborate a little more on the characteristics of the hyperspectral camera. Mention the FWHM (Full Width Half Max) and the spatial resolution.

Page 4, line 21, I don't think you should say "errors", maybe use "variation".

Page 4, line 23, can the authors explain more about the wavelength correction? How is this different from the radiometric calibration and what is the in- and output?

Page 4, line 27, why do the authors use the Mahalanobis distance method, and what is it?

Page 4, line 29, how is the overall accuracy determined? How many validation points are used?

Page 5, line 12-15, the feature extraction in this section is somewhat unclear to me. Can the authors describe why an interpolation function was used and not the closest wavelength to determine the VI's? Moreover, the decision for these VI's is not mentioned and there are other VI's besides PRI. Hence, the title of the paper does not match the content of the paper. There are many other VI's, band combinations and features that can be extracted from a hypercube.

Page 5, lines 15-19, I'm unfamiliar with this approach of normalizing the difference of a normalized index. It would be helpful if the authors show previous studies that use this approach, or if they could justify this method in another way.

Page 6, lines 4-9, the statistical analysis section is very concise and lacks insight in the process. Can the authors make it clear which method is used for which part of the analysis? Further on in the paper the uniform model is introduced, but this is not

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mentioned in the statistical analysis section. Please include this.

Page 7, figure 2, legend; "sunlit leave". The figure would be more informative if the confidence interval was included (I assume that the data shown is the average response?). How much do the two groups differ?

Page 7, Table 2a&b, this table contains a lot of information, but it is unclear what the most important numbers are. Maybe move this to supplements. Another statistic which can be insightful is a 2-sample t-test and find the VI with the lowest p-value for the most significant difference between sunlit leaves and shadow.

Page 9, line 12; how is it possible to have a plot of unstressed plants over days of water stress?

Page 11, table 3, what do the numbers mean? Is it the Pearson's correlation coefficient? Make this clear in the caption.

Page 12, figure 5, this figure is not very informative. Either explain why this figure is useful or take it out.

Page 13, table 4, same comment as for table 3, what is the relationship? Is it a correlation coefficient?

#### Technical Corrections

Page 1, line 21, I think it should be "and frequent".

Page 1, line 26, it states that monitoring the change in canopy temperature is a direct way to evaluate water stress. Shouldn't this be indirect?

Page 5, line 10, I would leave out the following sentence; "The fraction of shadow and the fraction of sunlit leaves should be summed to 1".

Page 6, line 13, leave out "obviously".

Page 6, line 13, leave out "The spectra of the shadow showed a rise in the near infrared

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region, but”.

Page 8, line 8&10; use “decreased” instead of “fell”.

Page 14, line1, I think it should be “Discussion” and not “Discussion References”.

#### References

López-López, M., Calderón, R., & González-Dugo, V. (2016). Early detection and quantification of almond red leaf blotch using high-resolution hyperspectral and thermal imagery. *Remote Sensing*. Retrieved from <http://www.mdpi.com/2072-4292/8/4/276/htm>

Suárez, L., Zarco-tejada, P. J., Sepulcre-cantó, G., & Pérez-priego, O. (2008). Assessing canopy PRI for water stress detection with diurnal airborne imagery, 112, 560–575. <https://doi.org/10.1016/j.rse.2007.05.009>

Zhou, K., Deng, X., Yao, X., Tian, Y., Cao, W., & Zhu, Y. (n.d.). Assessing the Spectral Properties of Sunlit and Shaded Components in Rice Canopies with, 1–17. <https://doi.org/10.3390/s17030578>

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