Spectral assessment of leaf potassium concentration in un-stressed pepper grown in net house

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Background

Potassium (K) plays a major role in providing the correct ionic environment for metabolic processes, thus, essential for plant development and reproduction (Leigh et al., 1984).

Hypersepctral data contains information from tens to thousands of continuous, narrow bands. The data range in the current study is 400-2400 nm, in 5 nm resolution. Similar data is used to assess K as well as other nutrients content in living plants in order to calibrate spectral models to identify nutrients stress (Pimstein et al., 2011).

Objective – To spectrally assess K content in pepper plants, leaves and leaves powder.

Methodology

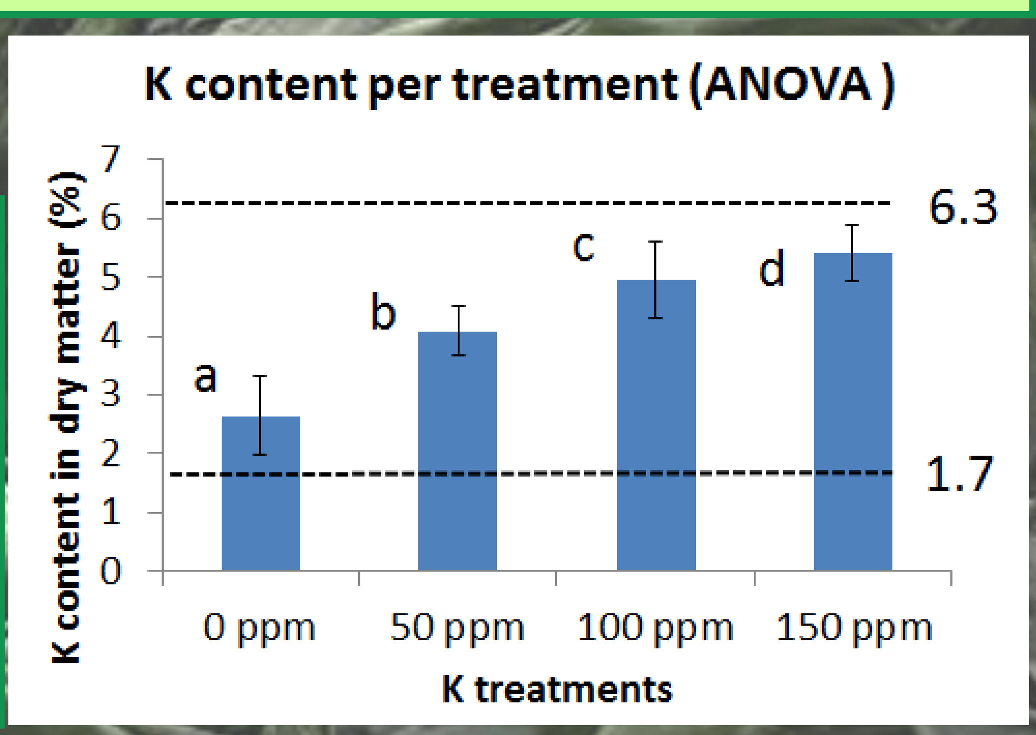
Additional fertilization was applied by irrigation in four levels: 0, 50, 100 and 150 ppm K to pepper plants grown in net house. Canopies (240), leaves (120) and leaves powder (120) were spectrally measured. K and nitrogen (N) concentration in dry matter were obtained from leaf powder.

All wavelengths were correlated to K content. Partial least squares regression (PLS-R) was used to assess K content by spectral data. PLS discriminant analysis (PLS-DA) was used to spectrally separate between different K treatments.

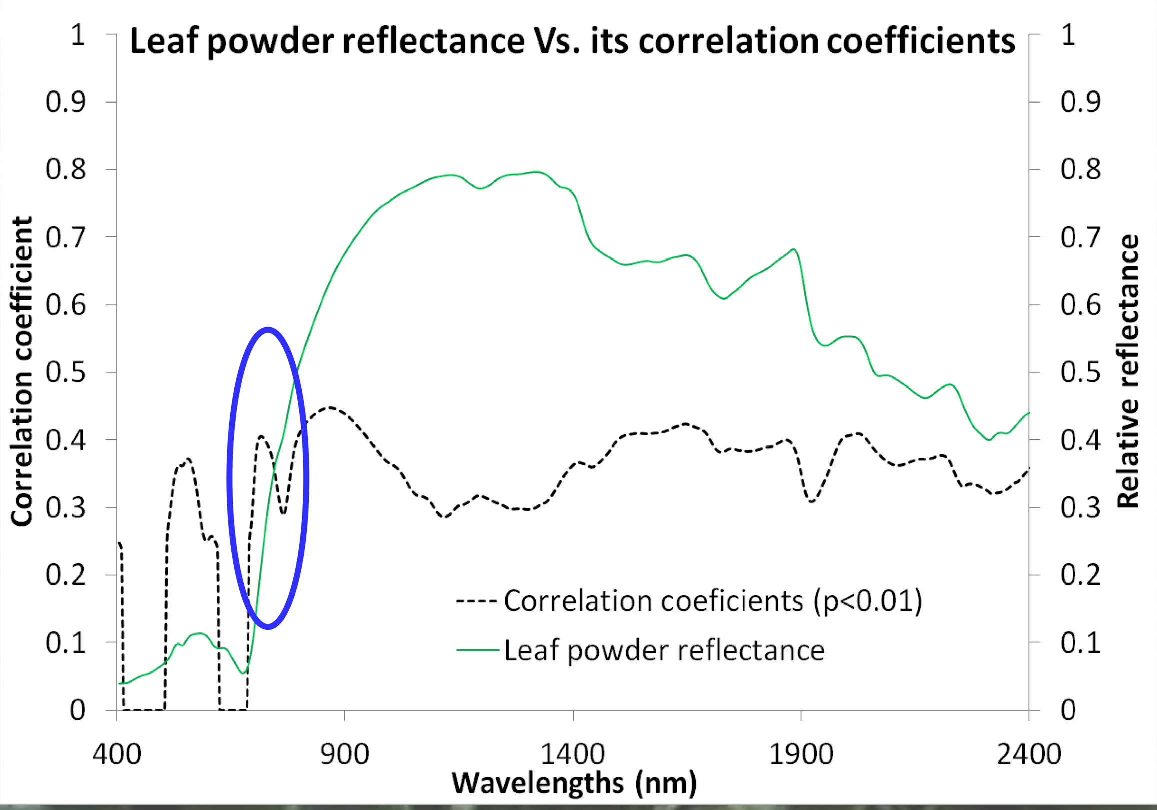
Variable importance in projection (VIP) is an indicator of each wavelength importance in a PLS model.

Results

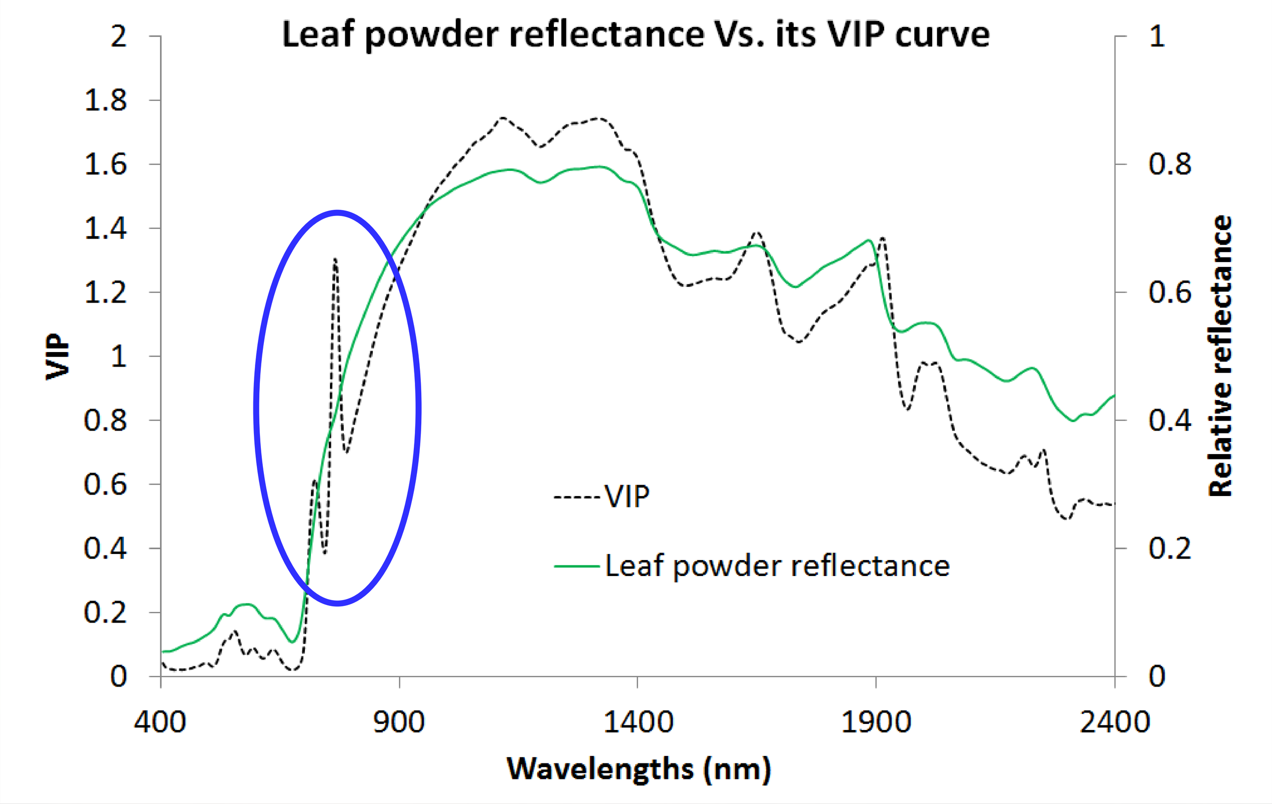
The K contents have shown significant ($p<0.05$) differences between treatments based on ANOVA. Plants from the four treatments have shown no significant difference, in agreement with the increasing K treatment, between treatments for the average height while for average biomass (fresh and dry). The yield was also the same for all four K treatments. Therefore, it is **assumed that the plants were not K stressed**.



Correlation coefficients (R) values of wavelengths in correlation to K content were highest for **leaf powder**. The R curve is similar to the reflectance curve of leaf powder, **except for the red-edge**.



R^2 values for calibration and prediction PLS-R models based on **leaf powder** to K content were 0.80 and 0.71, respectively. The VIP curve is similar to the reflectance curve of leaf powder, **except for the red-edge**.



In PLS-DA calibration and prediction models the total accuracy was low. In most of the cases, of **canopy and leaves, the 0 ppm K** treatment was better classified (user and producer) than the other three treatments.

PLS-DA K prediction by canopy

	0 ppm	50 ppm	100 ppm	150 ppm	Predicted	User %
0 ppm	**11**	4	3	6	24	**45.8**
050 ppm	0	**0**	0	0	0	0
100 ppm	3	0	**4**	5	12	33.3
150 ppm	4	4	11	**5**	24	20.8
Actual	18	8	18	16	**60**	
Producer %	**61.1**	0	22.2	31.3		**33.3**

Conclusions

- Studies exploring spectral assessment of K content are gaining lesser results than those assessing K stress.
- Spectral data of leaf powder was better correlated and regressed than the data of canopy or fresh leaves.
- Although the intensity of spectral data is the major contributor to the correlation and the PLS-R models to k content, the red-edge region shows importance that is not intensity related.
- It is assumed that in case of K stress applying PLS-DA might allow identification of stressed plants.

Based on the results above, leaf K concentration assessment does not seem to be applicative, therefore, it is suggested to explore early K stress identification by spectral means with high spatial resolution as well as to look for alternative methods of K concentration assessment.