A new tool for sensitive detection of phosphorus deficiency in plants under field conditions

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Phosphorus (P) is essential for optimal crop yields, however, it is estimated that about 30% of the world's arable land is suffering from P deficiency. Estimation of crop P requirement is usually performed by classic soil extraction analysis. However, they are very uncertain and are often not able to reflect the plant available P in the soil. I will present a unique analytical principle based on chlorophyll *a* fluorescence, that allows rapid, non-destructive, onsite assessment of plant P status by recording the so-called OJIP transient of a dark-adapted leaf.

Both mono- and dicots have been cultivated in hydroponics with decreasing P availability to ensure a wide range of P tissue concentrations to test and improve the coverage of the prediction model. Re-supply experiments were further performed to test P dynamics and flexibility. In addition, field experiments have been performed in low-P soils, to test the method under natural conditions.

Chlorophyll *a* fluorescence (also known as OJIP curves) is known to reflect the status of the photosynthetic electron transport chain. The plant P status is influencing the photosynthetic performance, especially by decreasing the rate of ATP synthase, causing an acidification of the thylakoid lumen, which will result in a changed flow of electrons between the two photosystems. These specific changes are revealed by the shape of the OJIP curve, which can be correlated with the bioactive pool of P in plants. A mathematical model has been developed which estimates the plant P status from both mono- and dicots (Carstensen et al., 2018; Frydenvang et al., 2015). The model has been integrated into a new handheld P-tester which allows estimations of crop P status directly in the field, based on the obtained chlorophyll *a* fluorescence transients. With the new P-tester, it is possible to detect P deficiency much earlier and much more accurately than previously.

Carstensen, A., Herdean, A., Schmidt, S.B., Sharma, A., Spetea, C., Pribil, M., Husted, S., 2018. The impacts of phosphorus deficiency on the photosynthetic electron transport chain. Plant Physiol. 177, 1–14.

Frydenvang, J., van Maarschalkerweerd, M., Carstensen, A., Mundus, S., Schmidt, S.B., Pedas, P.R., Laursen, K.H., Schjoerring, J.K., Husted, S., 2015. Sensitive Detection of Phosphorus Deficiency in Plants Using Chlorophyll a Fluorescence. Plant Physiol. 169, 353–61.