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1 Estimation of crop nitrogen status from time series remotely sensed data

K. R. McCloy (1)**, J. E. Olesen** (1)
(1) University of Aarhus, Denmark

There has been an extensive body of work that has shown that various physical parameters of the vegetation canopy can be estimated from remotely sensed data. Some of this work has shown that remotely sensed data is correlated with chlorophyll content and hence nitrogen levels in the plant. Various papers have reported that they have been able to establish a relationship between Leaf N density and remotely sensed data with a Coefficient of Determination of about 0.9. However a major drawback of single time estimates of chlorophyll content or nitrogen levels is that it does not provide the temporal context in which the measurement is taken and as a consequence it does not enable the user to judge the significance of the measurement. For example, similar measurements can be found from a crop that is deficient in Nitrogen, as with a crop planted later and hence at a somewhat earlier stage in plant development.

This paper will report on work done using the seasonal crop profile of a series of trial plots for Winter Wheat and Spring Barley with varying levels of fertiliser treatment over four seasons to derive estimates of Crop Nitrogen levels. The approach was to fit the seasonal profile to functions using both the standard least squares fitting criteria and an envelope criteria, so as to derive models of the profile that provided a best fit using the standard Minimisation of the Sums of Squares and to form an envelope to the data. From these models were then derived indices for this particular profile; the indices for the different treatments were then regressed against the measured Crop N levels.

The fitting work did not find that one model could provide a god fit to the data, whereas a combination of two models, one representing the growth phase of the crop and one the mature phase was found to provide a good fit to the data. The work found that the envelope fit gave better results, particularly when the crop was suffering various forms of damage, such as due to moisture stress, disease and predation. Of the derived indices, the maximum gradient was found to be very susceptible to fluctuations in the data, whereas the area beneath the curve was found to be quite robust.

The Winter Wheat results showed that the area beneath the curve index values derived using a two-function envelope fitting curve for each crop profile fitted to field measured values of Crop N using a linear function gave results with a Coefficient of Determination of 0.96 to 0.98 and an F statistic in excess of 400. The Spring Barley results using the same processing approach and sequence gave results with a Coefficient of Determination of 0.76 to 0.79 and an F statistic in excess of 40.