The use of NDVI in a differentiated nitrogen application strategy in perennial ryegrass for seed production

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BACKGROUND

Nitrogen (N) is important to achieve high seed yields however N can at the same time have a negative impact on the surrounding environment. Many scientists and companies are working to develop a method that is able to optimise the utilisation of N in agricultural crops. One method that is current being tested is the use of crop index to predict seed yield or the N-application rate necessary to achieve maximum seed.

AIMS

The overall aim is to develop and implement differentiated N application based on images and calculation of normalised difference vegetation index (NDVI). The more practical aim is to link NDVI measurements to seed yield in perennial ryegrass (*Lolium perenne* L.) and this correlation has been shown in earlier findings (Figure 3).

The eBee drone is 96 cm wide and the weight is 0.71 kg. It is made of EPP foam and has a carbon frame and parts. The propel is at the back and is driven by an 160W engine. The battery has a capacity of 11.1 V and 2150 mAh. The maximum air time is 45 minutes and the speed is 40 to 90 km per hour. The eBee can be controlled up to 3 km from the control unit and can cover up to 1000 ha. The linear landing precision is 5 meters but strongly dependent of wind speed.

MATERIAL AND METHODS

We are using an eBee drone with the MultiSPEC 4C camera to measure NDVI. The multiSPEC 4C camera is measuring in the green (550 nm), red, (660 nm), red edge (735 nm) and NIR (790 nm) wavelengths. The resolution of the four sensors is 1.2 Mp. The ground resolution at 45 meter is 4.5 cm per pixel. The eBee has an upward-facing irradiance sensor which automatically compensates for sunlight variation. We use 80% overlap which gives us 7-8 images per point. Pix4D is use to stich the images together and to calculate NDVI.

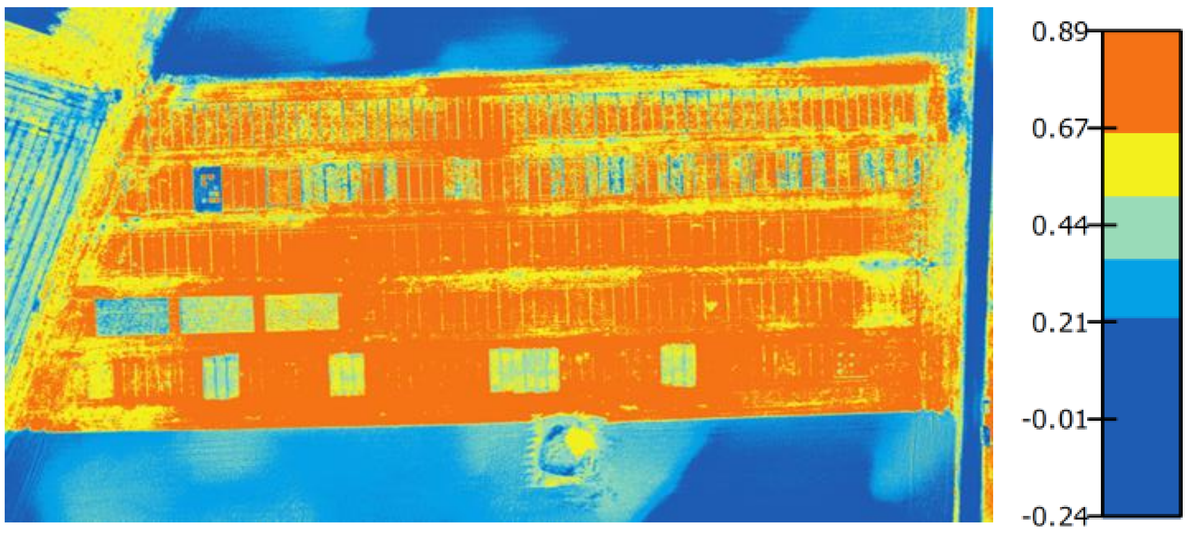

Figure 1. NDVI map of field plot experiment used to describe growth and development of grass seed crops in different projects. Scale of NDVI is shown to the right.

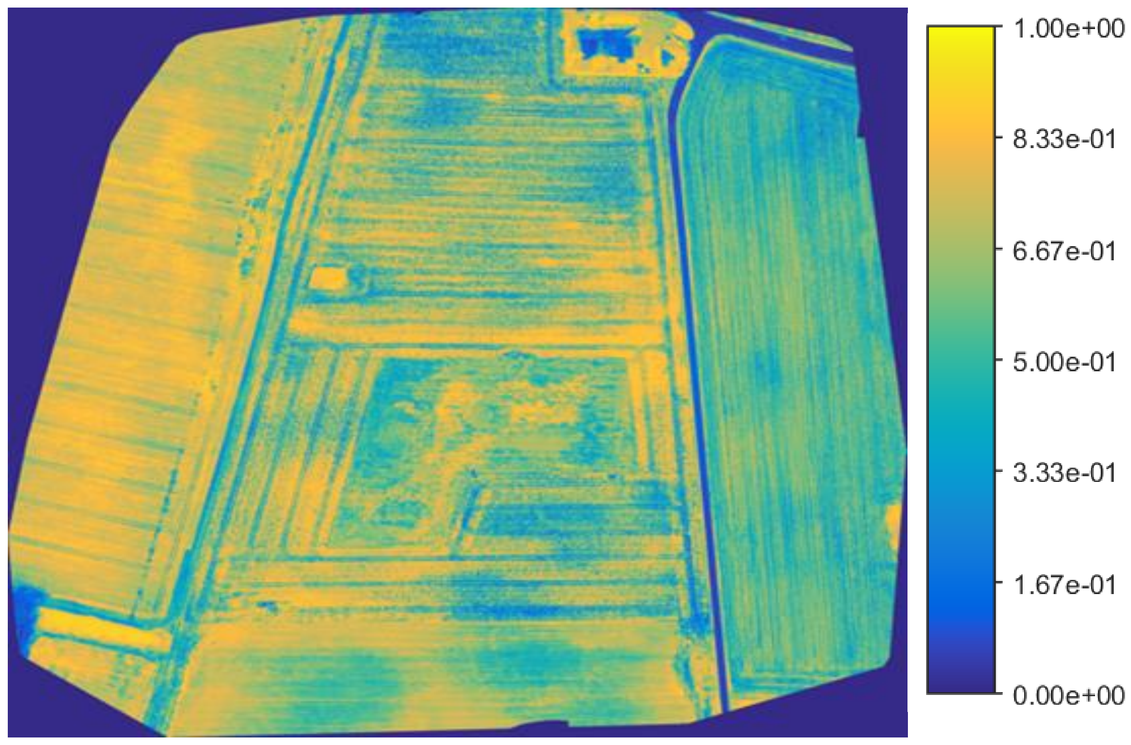

Figure 2. NDVI map of field. Scale of NDVI is shown to the right.

RESULTS AND DISCUSSION

There is a positive correlation between NDVI and seed yield in perennial ryegrass (Figure 3) up until approximately 1500 kg seed per ha where after the curve is flat, probably due to saturation. We assume that this saturation was specific for the field experiment under investigation as other results (Figure 2) has shown NDVI values above 0.9.

The use of NDVI to adjust in-season N-application is current being tested. The first results show that it is still possible to correlate NDVI to seed yield at a time during the growing season where an additional N application will increase seed yield.

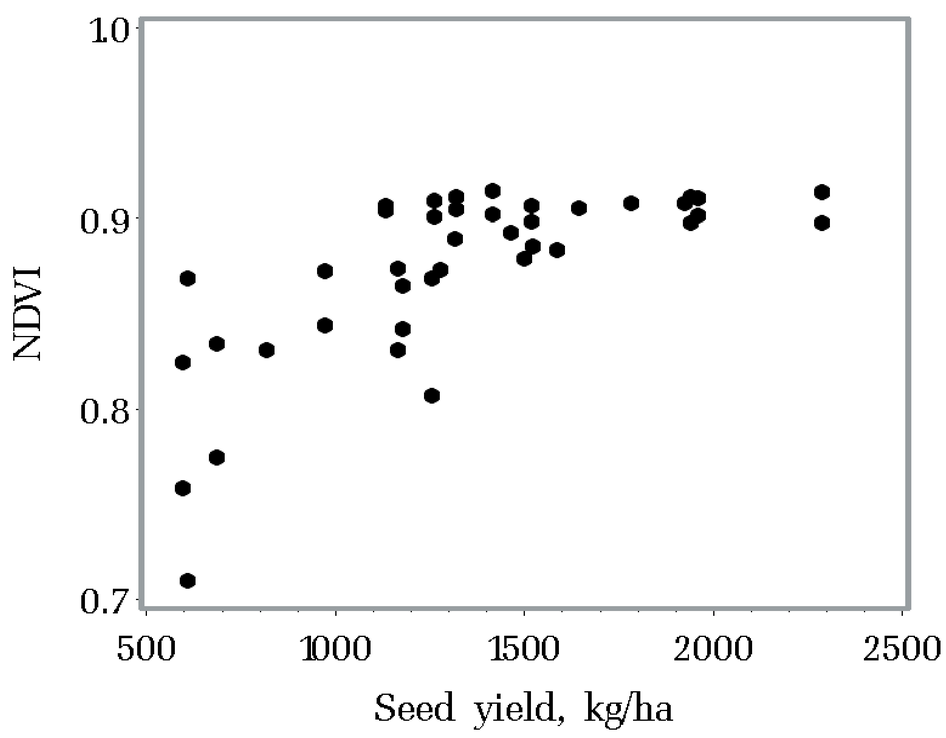

Figure 3. Normalise Difference Vegetation Index (NDV) plotted against seed yield of perennial ryegrass..

The Danish nitrogen (N) regulation

The Danish N regulation started 1985 where the first Action plan on N, phosphorus (P) and organic matter (NPo action plan) was implemented. Additional targets followed which had the purpose to reduce surplus N and especially nitrate-N from Danish agricultural production. The targeted reduction in nitrate leaching has primarily been achieved through the implementation of a 'maximum allowed N application rate' to each crop species. The 'maximum allowed' refers to the N rate a farmer can apply without having to pay a very high tax of the N applied. The 'maximum allowed N application rate' for each crop species is further divided for some crops according to soil type and management.

During the implementation of the first action plan, benchmarks for maximum N application rates were equivalent to 'economical optimum N fertiliser application rates' (ECO-N). ECO-N is a calculation utilising economic returns for product sold (i.e., seed yield) and the cost of N. However, ECO-N calculations are of course an "*ex ante"* calculation as the actual yield, crop unit price and N are unknown at the start of the season when N is bought.