USING IMAGERY AS A PROXY YIELD MAP AND SCOUTING TOOL

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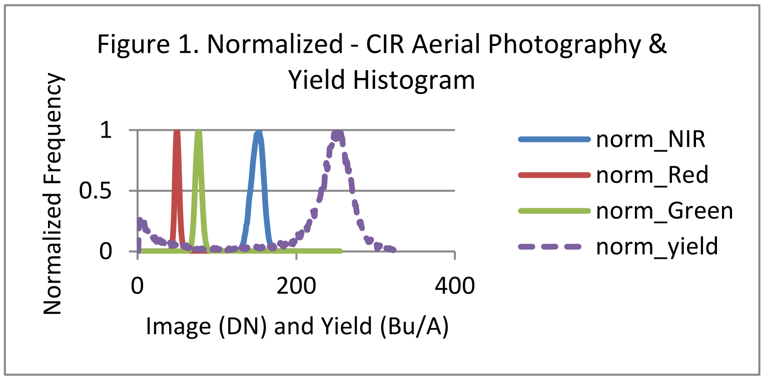
ABSTRACT

Combine yield maps represent a post-mortem quantification of the spatial variability in crop vigor that occurred during the growing season. The spatial resolution of yield maps is defined by the width of the combine header but the length of the cell depends on the ground-speed of the implement and how long it takes for the grain to reach the mass-flow sensor that quantifies yield. Grain collected from the center of the combine header naturally reaches the mass-flow sensor before the grain that enters from the outer ends of the header. In contrast, aircraft imagery and some satellite images can be used to generate field maps with much higher spatial resolution than combine yield maps. Images collected during the growing season have been shown to illustrate some of the same patterns as presented in combine yield maps. Crop canopy sensor data collected during the growing season can also be used to generate maps that characterize crop vigor and spatial patterns. Timely assessments of crop vigor (color and biomass) with either imagery or crop canopy sensors make it possible to identify and investigate areas within fields that are likely to have reduced yields. Spatial information obtained by producers and consultants from selected areas will help to plan remedial action (nutrients, irrigation, pesticide applications) or determine if cultural practices, weather, or insect damage contributed to reduced crop vigor. Processing imagery and sensor data into useable maps that illustrate spatial patterns can be as simple as using NIR reflectance data or one of several vegetation indices. Images and sensor maps generated closer to harvest are more highly correlated with yield because less time is available for weather to impact yield. Normalizing in-season data is one way to redistribute the total amount of grain from a field on a spatial basis to generate a proxy yield map. Proxy yield maps based on aircraft imagery will be used to illustrate greater resolution of spatial patterns than a combine yield map because of complex grain processing operations. Thermal images of in-season vegetation will illustrate specific information regarding crop water status that is likely related to soil properties or irrigation water distribution problems.

RESULTS

Color infrared imagery taken several weeks after silking of irrigated maize was analyzed to examine the histograms of the green, red, and near infrared (NIR) spectral data. After harvest, a histogram of the combine-generated yield map was also generated. Histograms were normalized to the highest value of each. Shapes of the four histograms were quite similar and quite normal, but the widths were somewhat different (Figure 1).



The NDVI values were calculated and normalized to the mean (resulting nNDVI values were 0.0 to 1.5). These nNDVI values were re-normalized to a "zero" base by subtracting 1.0 (resulting $nNDVI_{zero}$ range was -1 to +1). The proxy yield value for each pixel was calculated using a sigmoid (logic) function:

$$\text{Proxy Yield} = (2\text{Yield}_{em})*(1/(1 + \text{Yield}_{em}*\text{YSpread}^\wedge(\text{alpha}*\text{nNDVI}_{zero})))$$

Where $Yield_{em}$ is the estimated mean yield from the producer, YSpread is the reasonable percent yield above and below the mean yield (perhaps 20%), and alpha is a coefficient (~0.9 to 1.0) to generate a preliminary proxy yield map having a range in yield values comparable to that offered by the producer. The NDVI values in the histogram should be scrutinized to eliminate extraneous values (i.e., consider values between 10 and 90 or 95 percentile) (Figure 2).

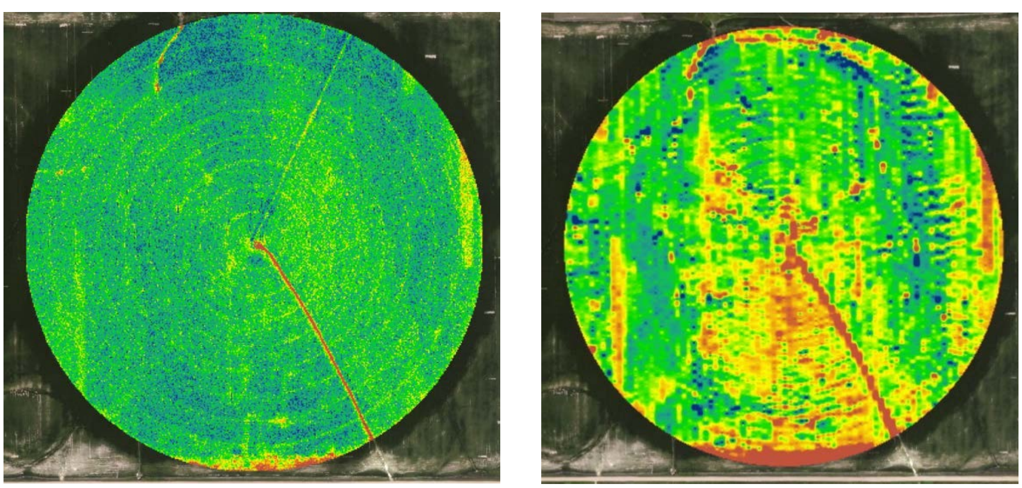


Figure 2. Proxy yield map based on NDVI image (left) and yield maps (right).