Remote Sensing Of Frost Damage In Wheat: Trying to Identify Spectral Response Patterns Across Space And Time

Mary E. Murphy[1]

[1]The University of Western Australia, 35 Stirling Hwy, Crawley, WA, 6009,
mary.murphy@research.uwa.edu.au

Keywords: spectral, remote sensing, uas, wheat, frost

Abstract:

Radiant frost during the reproductive stages of wheat (heading, anthesis) is a major constraint to the Australian grains industry, causing considerable wheat yield reductions and substantial economic losses. Frost is estimated to cost Australian growers an average $M360 per year ($M120 per year in direct costs). As frost damage becomes an increasing burden on wheat production, investment into frost mitigation and adaptation has targeted four areas: improving methods for predicting frost events, development of frost tolerant wheat strains, enhancement of farm management strategies to avoid frost or reduce frost risk, and early detection of post event frost damage and yield impacts. My research focuses on the latter aspect – post-event detection and mapping.

Remote sensing approaches for managing vegetation resources have developed rapidly over the past 40 years, from the use of low spatial and spectral resolution airborne or satellite based sensors, to the use of hyperspectral and/or higher resolution sensors including those deployed on Unmanned Aerial Systems (UAS) or "drones". Spectral information collected by remote sensing devices provides insights into plant physiological conditions, but the appropriate methods, spectral bands and sensor deployment techniques for mapping post-event frost damage is largely unknown. In particular, little use has been made of hyperspectral sensors to more fully understand and identify regions of the electromagnetic spectrum (EMS) which may be key in identifying frost induced damage or sterility.

To this end, this research applies a combination of laboratory and field-based remote sensing techniques with the objective of identifying and investigating the changing spectral response of wheat after a frost event, and with a view to reliably mapping damaged at the paddock scale.

Overall, this research aims to answer four key research questions: (1) Are there regions of the EMS that are particularly sensitive to frost induced damage in wheat? (2) Do these regions differ across phenological stages? (3) Over what timescales is it possible to detect change in the EMS using optical remote sensing techniques? (4) What temporal, spectral, and spatial scales are most appropriate to capture data on the extent of frost damage in the field? Whilst this research is still in the early stages, using a band averaging technique,

preliminary hyperspectral imagery of lab based frosted and unfrosted wheat plants was compared with the spectral characteristics of commercially available sensors commonly deployed on standard UAV platforms. Varied results indicate that to fully differentiate frost damaged plants at the paddock scale, bespoke filters not currently available on the open market may be required.

References:

Frederiks, T.M., Christopher, J.T., Harvey, G.L., Sutherland, M.W. and Borrell, A.K., 2012. Current and emerging screening methods to identify post-head-emergence frost adaptation in wheat and barley. *Journal of experimental botany*, *63*(15), pp.5405-5416.

Marcellos, H. and Burke, M.J., 1979. Frost injury in wheat: ice formation and injury in leaves. *Functional Plant Biology*, *6*(4), pp.513-521.

Marcellos, H. and Single, W.V., 1984. Frost injury in wheat ears after ear emergence. *Functional Plant Biology*, *11*(2), pp.7-15.

Nebiker, S., Annen, A., Scherrer, M. and Oesch, D., 2008. A light-weight multispectral sensor for micro UAV—Opportunities for very high resolution airborne remote sensing. *International Arch. Photogrammetry and Remote Sensing Spatial Information*, *37*, pp.1193-1198.

Primicerio, J., Di Gennaro, S.F., Fiorillo, E., Genesio, L., Lugato, E., Matese, A. and Vaccari, F.P., 2012. A flexible unmanned aerial vehicle for precision agriculture. *Precision Agriculture*, *13*(4), pp.517-523.