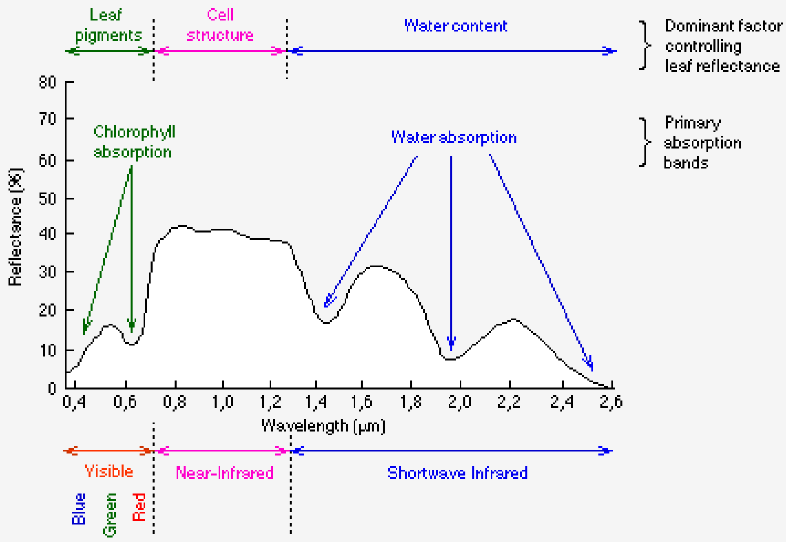
LEAF REFLECTANCE & VEGETATION INDICES

Vegetation interacts with solar radiation in a different way than other natural materials. Vegetation typically absorbs in the red and blue wavelengths, reflects in the green wavelength, strongly reflects in the near infrared (NIR) wavelength, and displays strong absorption features in wavelengths where atmospheric water is present. Different plant materials, water content, pigment, carbon content, nitrogen content, and other properties cause variation across the spectrum. Measuring these variations and studying their relationship to one another can provide meaningful information about plant health, water content, environmental stress, and other important characteristics. These relationships are often described as vegetation indices (VIs). For example, vegetation indices can describe the relative density and health of vegetation for each picture element, or pixel, in an image. Although there are hundreds of vegetation indices, one of the most widely used is the Normalized Difference Vegetation Index (NDVI).
Leaf optical responses to a wide range of biotic and abiotic stresses have been widely researched.
Some researched plant stressors include:

- *Increased CO2 and other gaseous pollutants*
- *Heat stress*
- *Heavy metal toxicity*
- *Exposure to ultraviolet radiation*
- *Water status*
- *Insect pest attack*
- *Herbicide treatment*
- *Salinity effects*
- *Extremes in nutrient availability*

Leaf spectral reflectance provides a vast data resource for assessing plant health based on the impact of biotic and abiotic stresses on leaf biochemistry and anatomy which in turn produces distinct changes in leaf optical properties. Unfavorable growing conditions result in morphological, physiological and/or biochemical changes that impact the manner with which plants interact with light.
Key regions of a reflectance spectrum are:

1. Blue region (400 – 499 nm) which is strongly influenced by absorption of chlorophylls and carotenoids.
2. Blue-green edge (500 – 549 nm) leading to the green peak at 550 nm.
3. Red edge (650 – 699 nm) associated with strong chlorophyll absorption.
4. 700-1400nm range the reflectance characteristics are influenced by cell structure
5. 1400-2000nm range the reflectance characteristics are influenced by water content in the tissues



Reflectance patterns are influenced by leaf surface features, internal architecture and biochemical composition.
Light falling on a leaf can be reflected, absorbed or transmitted. Absorption in the visible (VIS) and infrared (IR) regions of the spectrum is primarily driven by stretching and bending of covalent bonds between oxygen, carbon, hydrogen and nitrogen present in plant biochemical components like sugar, lignin, cellulose and proteins.
In addition, pigments responsible for leaf color also constitute principal absorbing molecules. Because of the central function of these pigments in photosynthesis, chlorophyll content is generally regarded as a good indicator of plant physiological health.
Many nutrient deficiencies result in a decrease in chlorophyll content, a concomitant increase in reflectance in the visible range (400 – 700 nm) a decrease in reflectance in the infrared (700-1100 nm) ranges and blue shift in the red edge inflection point.
Visually, chlorotic changes are perceived as yellowing of leaves.
Key anatomical structures in relation to their mode of interaction with light.