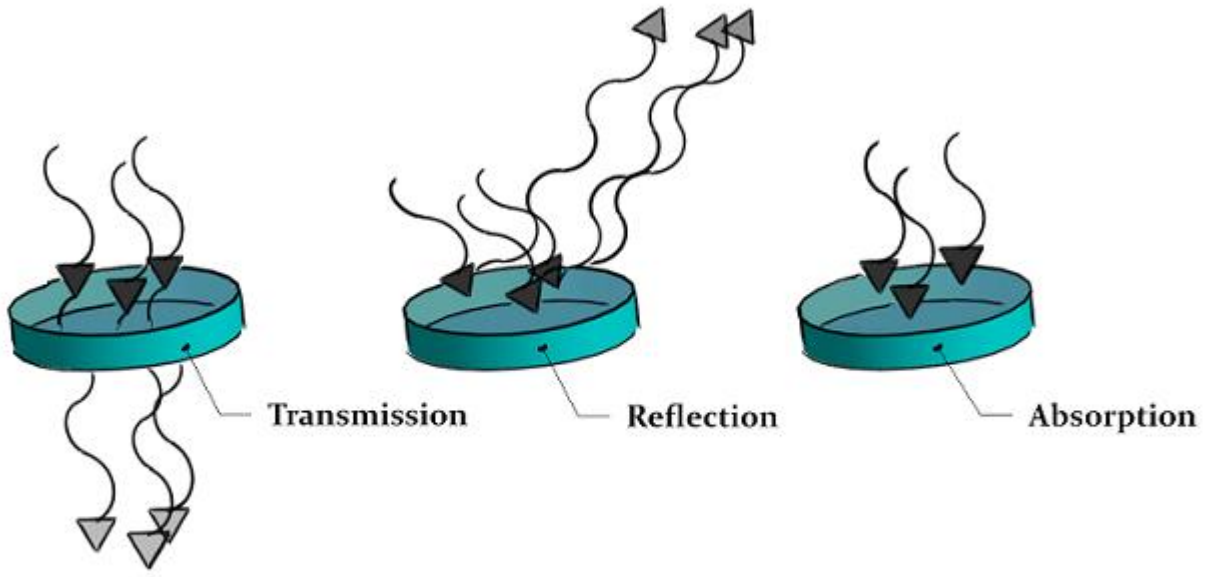
# Spectral Reflectance Characteristics Of Vegetation

Rajitha Athukorala

Interaction of light with matter

# Reflection, Absorption and Transmission



# Vegetation Reflectance

**5 striking features concerning the absorbance of electromagnetic radiation of plants.**

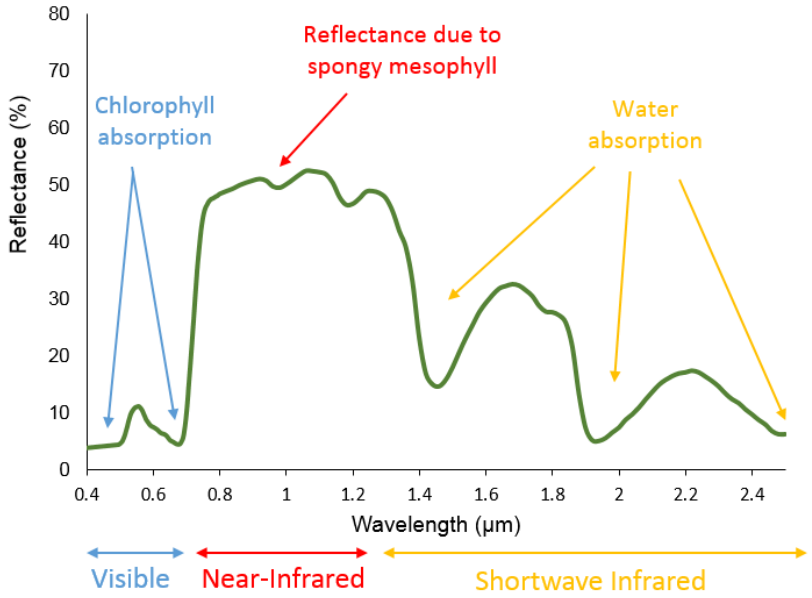
01 ☑ High in the Ultraviolet and the Blue

02 ☑ Reduced in the Green

03 ☑ High in the Red

04 ☑ Very low in the near infrared along with high reflectance and transmission. Abrupt change in reflectance near 700nm.

05 ☑ Very high further in the infrared.



# Prominent zones of the spectral curve of plants

Typical spectral curve of plant is divided into three prominent zones correlated with morphological characteristics of the leaves.

03 Hydric zone

02 Multi dioptric reflectance zone

01 Pigment absorption zone

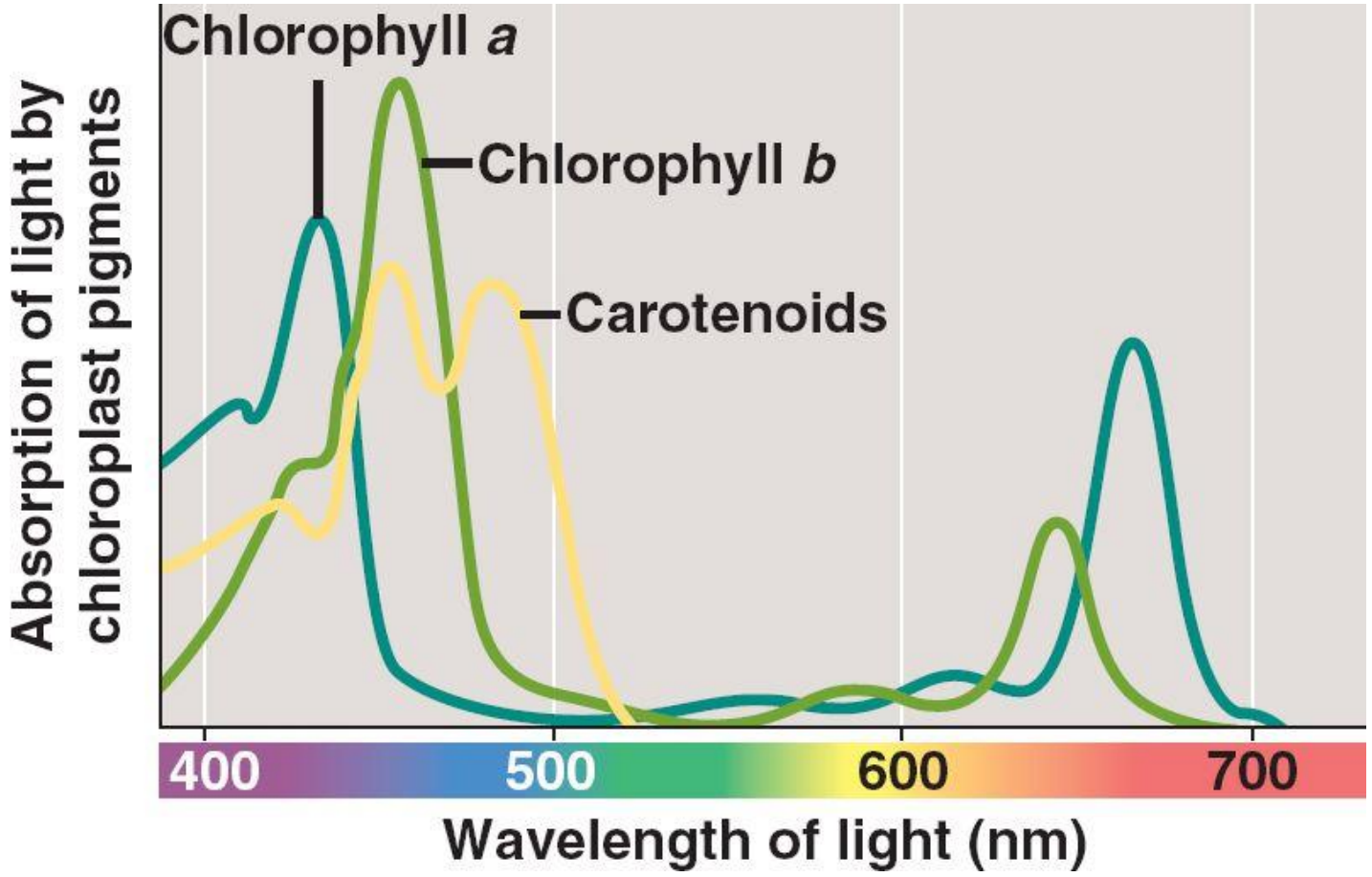
**1. Pigment absorption zone**

**2. Multi dioptric reflectance zone**

**3. Hydric zone**

Prominent zones of the spectral curve of plants

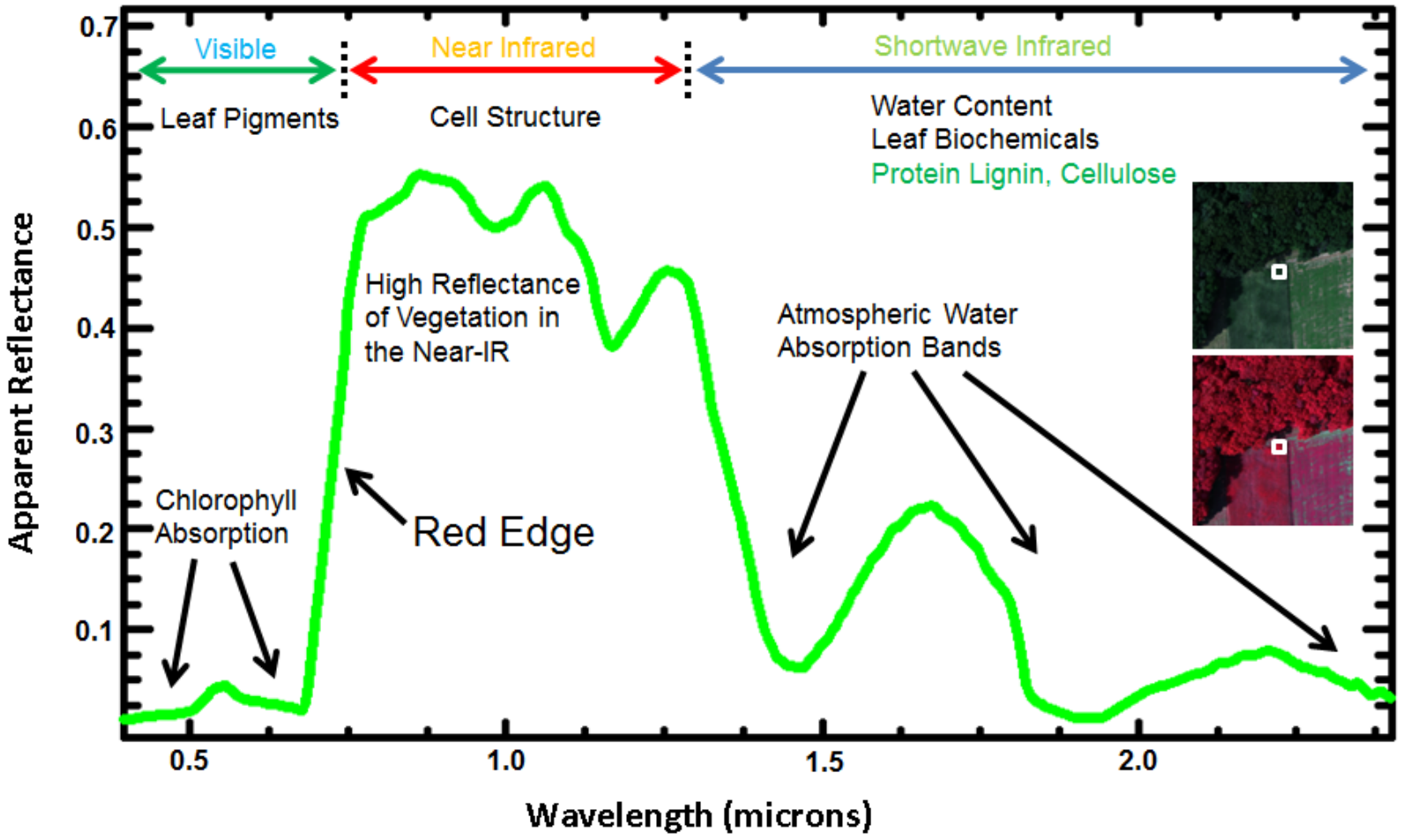
# 1. Pigment absorption zone




The important pigments, chlorophylls, xanthophylls and carotenoids, absorb energy strongly in ultraviolet, blue and red regions. The reflectance and transmittance are weak. The absorbed energy of this part of the spectrum is utilized for photosynthetic activity.

Prominent zones of the spectral curve of plants

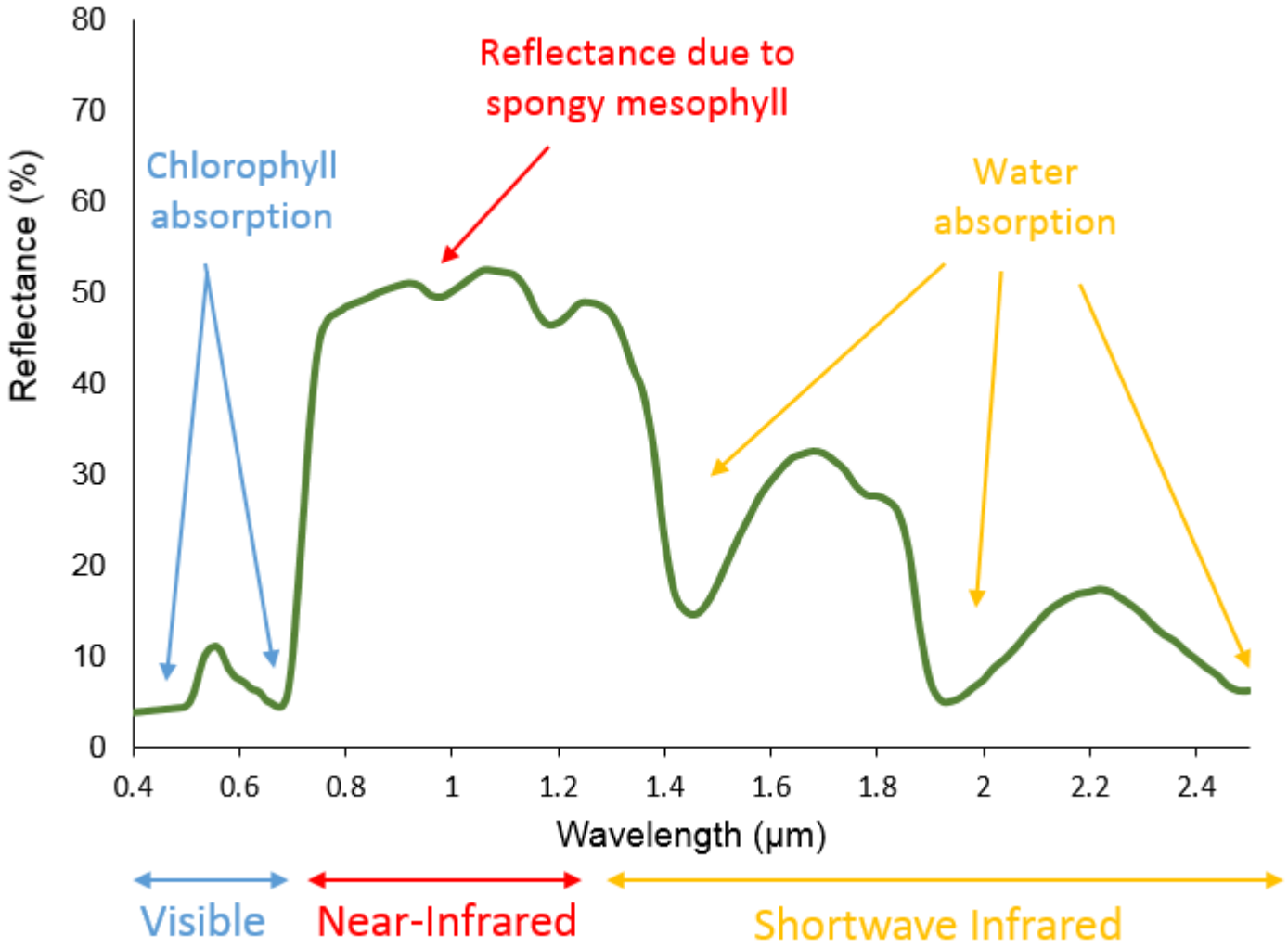
# 2. Multi dioptric reflectance zone




In this zone the reflectance is high while the absorbance remains weak. AII the unabsorbed energy (30-70% according to the type of plant) is transmitted. The reflectance is essentially due to the internal structure of the leaf which the radiation is able to penetrate. The reflectance from internal structure is of physical nature. Apart from the contribution of the waxy cuticle, the magnitude of the reflectance depends primarily upon the amount of spongy mesophyll.

Prominent zones of the spectral curve of plants

# 3. Hydric zone




Amount of water inside the leaf bring on the pattern of spectral reflectance with water-specific absorption bands at 1450, 1950 and 2660 nm. Liquid water in a leaf is largely the cause of the strong absorption throughout middle infrared. Beyond 2500 nm the reflectance becomes less than 5% due to atmospheric absorption.

# Factors affecting spectral reflectance of vegetation

01 Pigmentation

02 Nutritional Status

03 Leaf Anatomy

04 Morphological Adaptations

05 Seasonal Reflectance Change

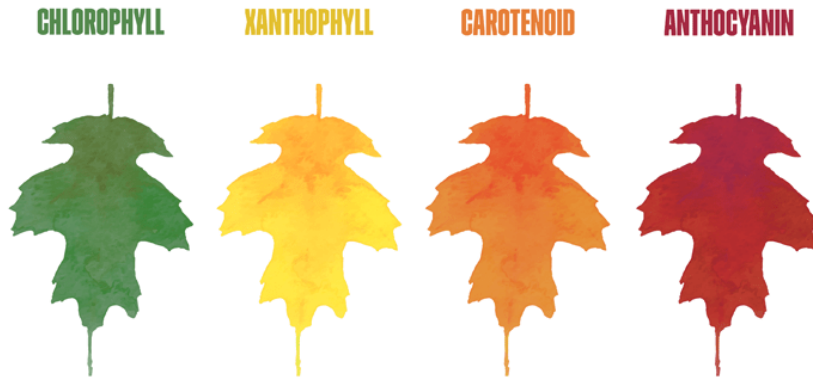
06 External Factors Affecting Spectral Reflectance

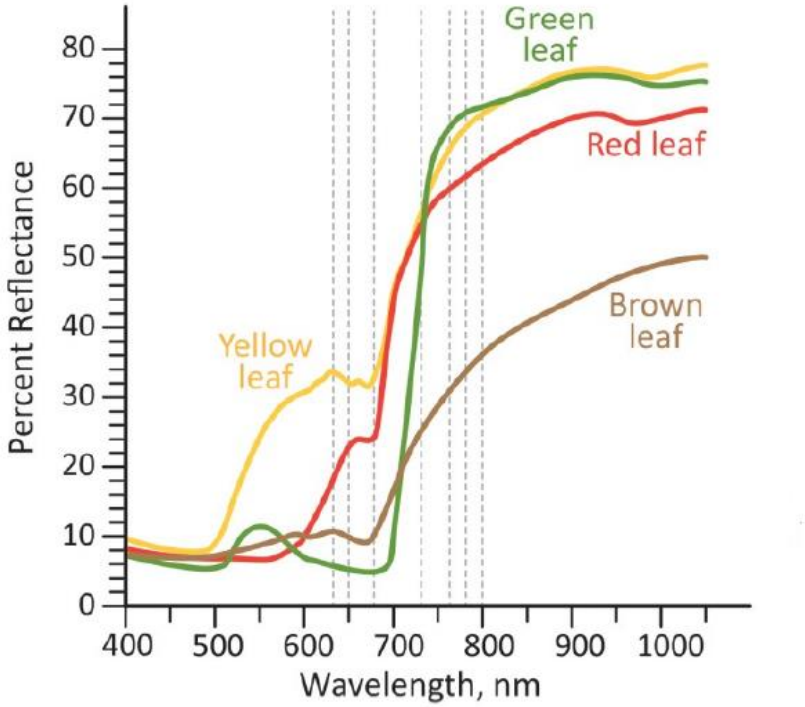
07 Impact of Disease on Spectral Reflectance

Factors affecting spectral reflectance of vegetation

# 1. Pigmentation

Low content of pigmentation results in higher reflectance and vice versa. Moreover different pigments show different spectral response. In yellowing of leaf, which is a stage in the phenological cycle or in certain diseases, breaking down of chlorophylls take place thus letting the presence of carotenes and xanthophylls more evident. During this stage leaf shows sharp increase in reflectance starting at 0.50 nm

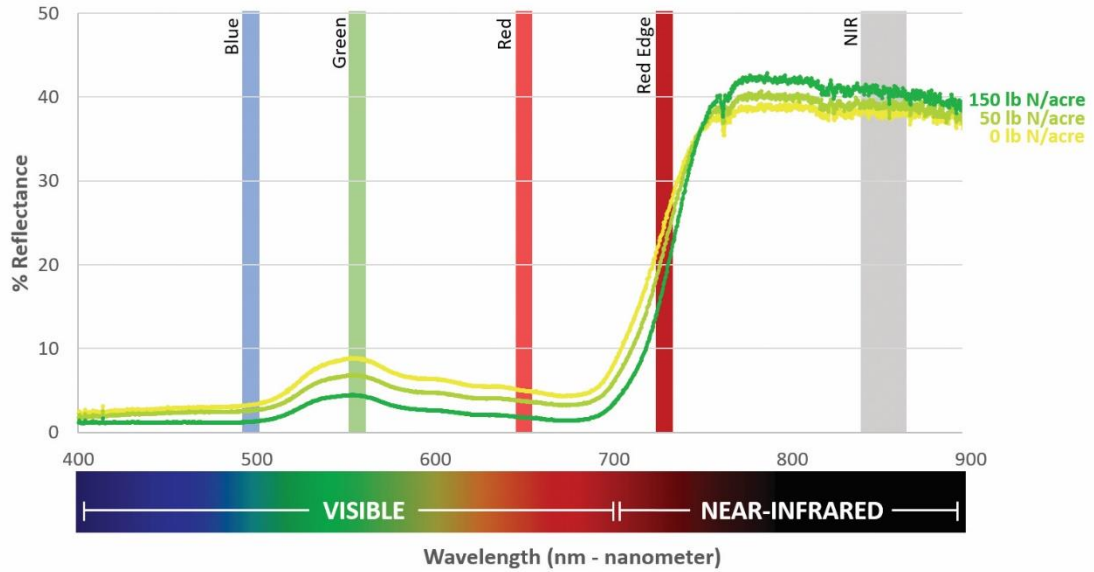


Factors affecting spectral reflectance of vegetation

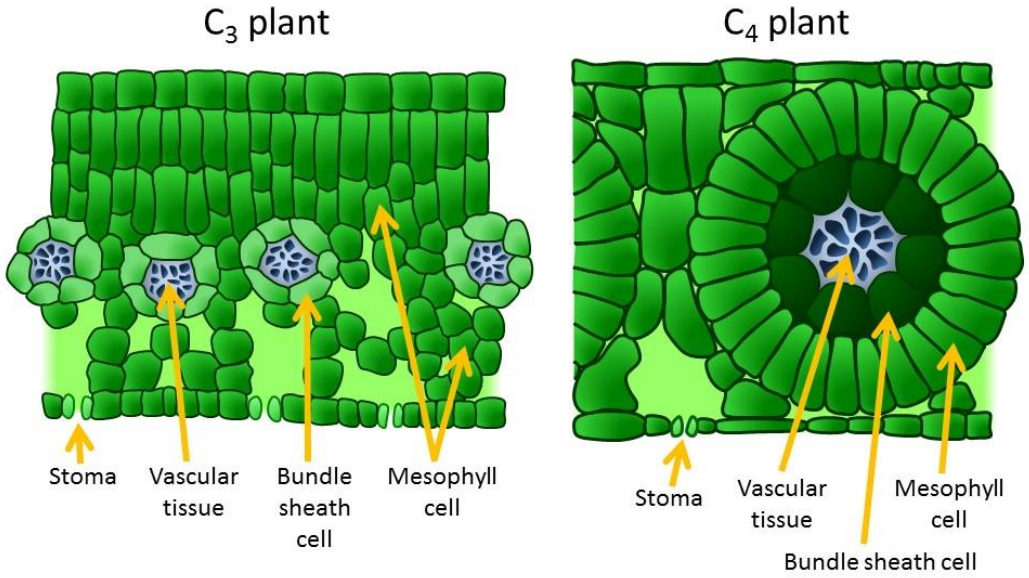
# 2. Nutritional Status

With increases in nitrogen deficiency reflectance increases from 0.5 to 0.7 and 0.7 to 1.3 nm but decreases from 1.3 to 2.5 nm. The increase of reflectance from 0.5 to 0.7nm is since absorption in this spectral region is greatly affected by pigment concentration, which in turn depends on the nitrogen concentration. By lowering the nitrogen content, a decrease in the chlorophylls and consequently a reduced absorption of radiation (hence an increase of reflectance) are expected.



# 3. Leaf Anatomy

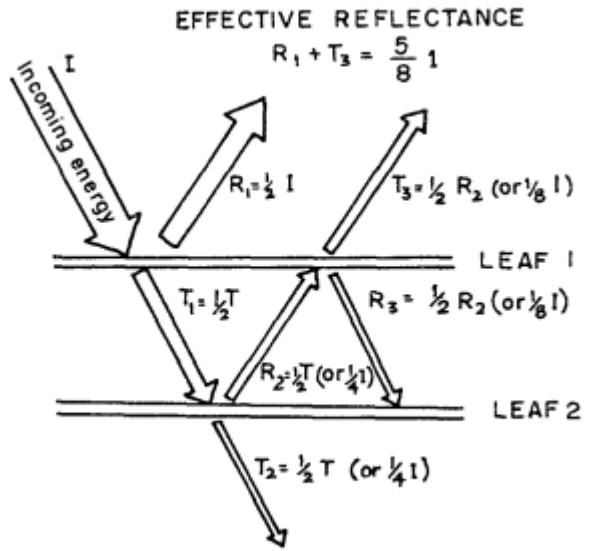
The influence of internal structure of leaf is very significant. Prominent anatomical features which affect the spectral reflectance are cell walls, intercellular spaces, epidermis, palisade and mesophyll cells. When radiation falls on the leaf surface, a part of the energy is reflected from the leaf surface; the reflection depends on cuticle thickness. The rest of the energy passes through the leaf, interacting with the internal cellular structures, and strikes the lower leaves. The internal structure transmits the energy after cell wall and cell sap interaction. A similar phenomenon takes place in the lower leaves also.

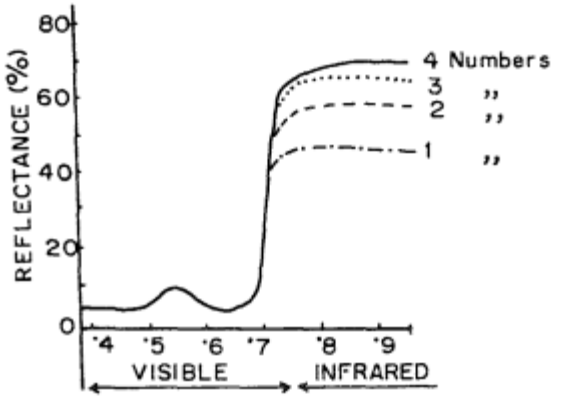


Factors affecting spectral reflectance of vegetation

# 4. Morphological Adaptations

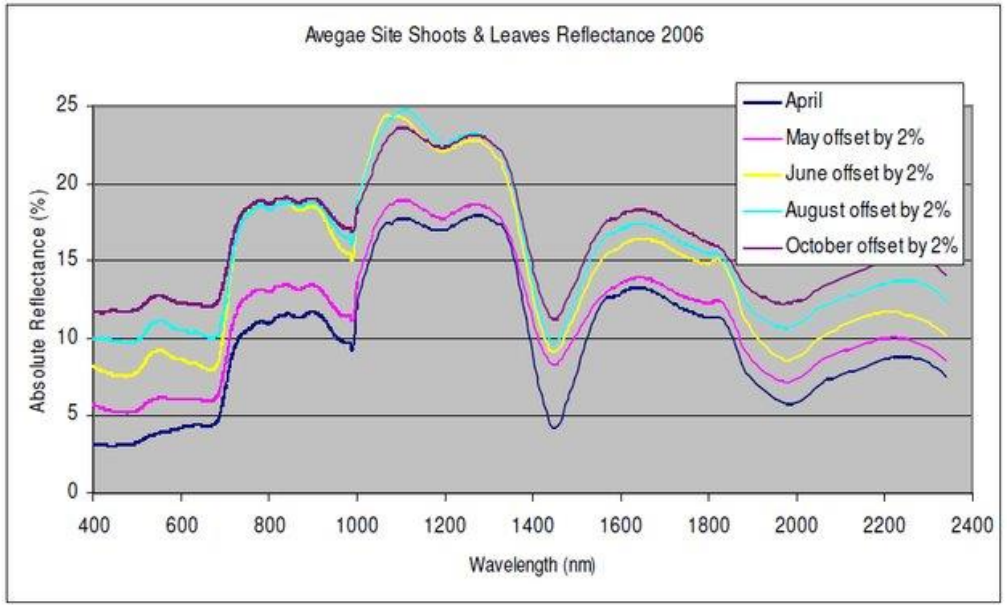
Thorns are reported to have a role in the heat balance of desert plants. Studies on spectral properties of plant with thorns have indicated that absorption of energy is largely altered by thorns by reducing direct solar radiation at cuticular surface since radiation is absorbed more in the thorn and less in the cuticle and spongy tissue of the plant.



# 5. Seasonal Reflectance Change

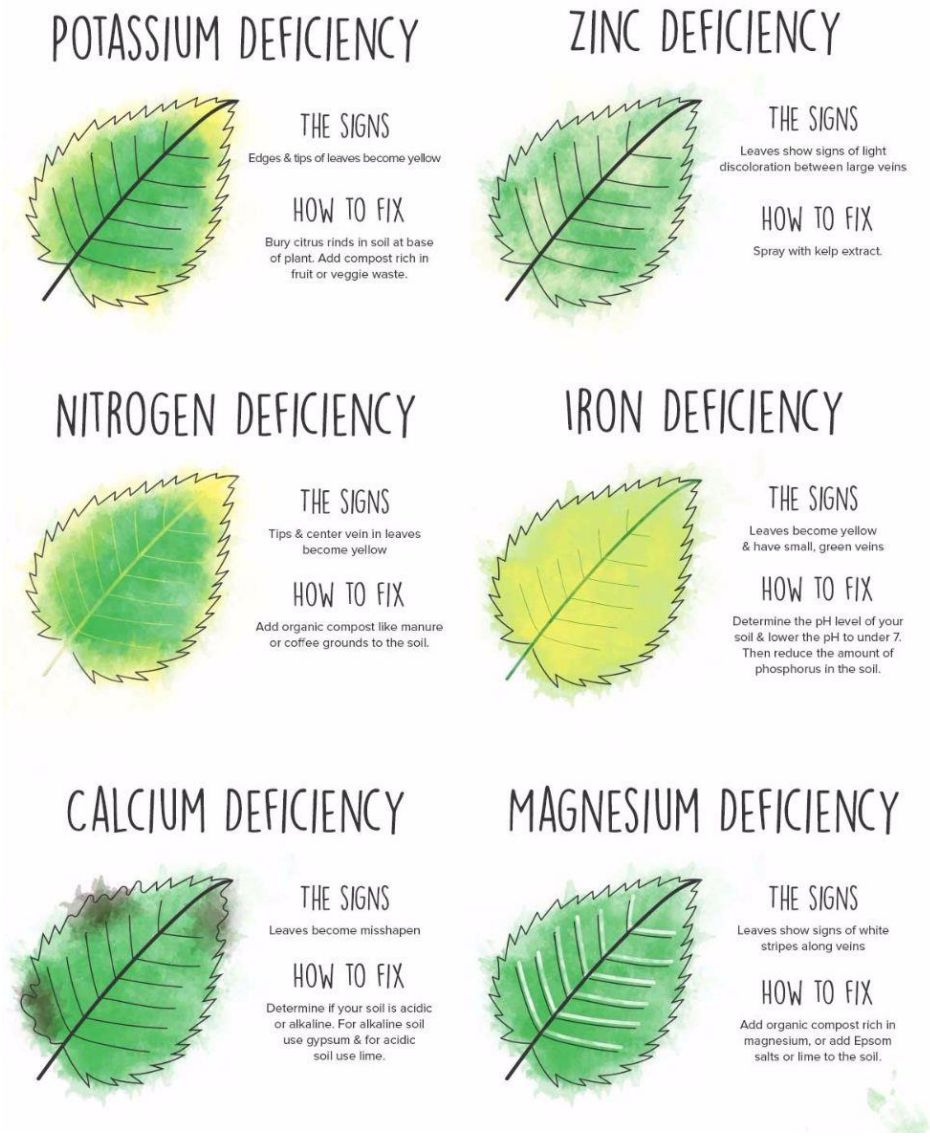
The changes that occur in the spectral properties of plant leaves during the growing season are significant. The very young folded, compact and underdeveloped leaves exhibit lack of chlorophyll. Absorption in the visible range is due to protochlorophyll and anthocyanin. Gradually the leaf becomes more and more green, which decreases red reflectance. Finally, a fully open leaf shows the normal spectral characteristics with the green reflectance strong and the red and blue spectral regions much absorbed.



# 6. External Factors Affecting Spectral Reflectance

The influence of the external factors on the spectral reflectance is due to the alteration they bring about in water content and turgidity, mesophyll structure, evapotranspiration, pigmentation and metabolism.

At ground level : Water availability for the plant. Trophic mineral ion availability with specific evidence for nitrogen, iron (chlorophyll), potassium, phosphorus, calcium or magnesium . Toxic mineral salts (effect of water salinity)
From atmosphere : Climatic factors (wind, air moisture content, temperature, sunshine conditions) Toxic pollutants (especially Fluorine, Sulphur Dioxide) Deposition of dust/particulate matter
Biological pathogenic agents : Parasites Predators
To irradiance incidence angle (sun elevation), which leads to a diurnal variation of the spectral reflectance.



# 7. Impact of Disease on Spectral Reflectance

Effect of disease on spectral characteristics of plants can be understood when it is related to the type of disease.