Reflectance-Based Characterization of Wheat Cultivars for Identifying Drought Tolerance

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ABSTRACT

Spectral reflectance indices have been used to differentiate genotypes for yield potential and water relations. However, little information is known for the genotypic differences in spectral indices and their relations to drought tolerance in the US Southern Great Plains (SGP). The objective of this study was to characterize genotypic variation in various spectral reflectance indices and their relations to drought tolerance in wheat. Field experiments have been conducted using twenty different wheat genotypes with a wide genetic background. The genotypes were grown under dryland and irrigated conditions. Measurements included spectral reflectance, chlorophyll, leaf area index, biomass, plant height and yield. Comparison of spectral reflectance measured on different wheat genotypes showed that remote sensing has the potential to identify different wheat varieties and develop spectral models for estimating plant parameters.

INTRODUCTION

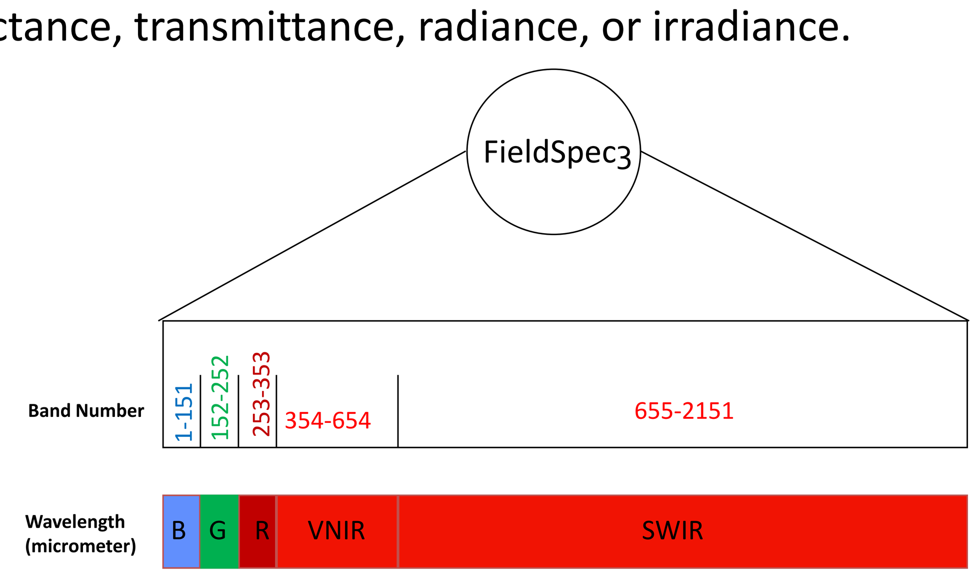
In the US Southern Great Plains, drought stress is one of the single most important factors for reducing yield in winter wheat. Selection of drought tolerant wheat cultivars has been and will continue to be a critical strategy for wheat management under water-limited conditions. Yield is still the primary trait used in cultivar selection. It is largely unknown as to which other traits contribute to drought tolerance in wheat genotypes in the SGP. Spectral reflectance indices have been used to differentiate genotypes for yield potential and water relations. However, little information is known for the genotypic differences in spectral indices and their relations to drought tolerance in the SGP. The **objectives** of this study were to (1) evaluate spectral reflectance data for 20 wheat cultivars well adapted to High Plains environment; (2) develop remote sensing based models for estimating plant parameters (leaf area index, plant height, biomass and chlorophyll).

MATERIALS AND METHODS

	IRRIGATED	DRYLAND
Location	Bushland, TX (Lat. 35˚11'N, Long. 102̊06'W)	
Growing Season Mean Maximum & Minimum Temp.	18.4, 1.8 °C	
Long-term Precipitation (WW)	287 mm	
Climate Type	Semi-arid, erratic precipitation, high evaporative demands	
Crop Type	20 Wheat Genotypes	
Experimental Design	Randomized Complete Block Design	
Soil Type	Pullman clay loam	
Row Spacing	18 cm	
Plot Size	3.7 m^2	5.6 m^2
Seeding Rate	67 kg/ha	50 kg/ha
Date of Planting	Oct. 24, 2011	Nov. 4, 2011
Date of Maturity	Jun. 18, 2012	Jun. 6, 2012
Irrigation Type	Furrow irrigation	None
Date of Data Collection(Reflectance)	May 5, 2012	Apr. 27, 2012
Stage of Data Collection	Heading /Anthesis	

FieldSpec3 Spectroradiometer

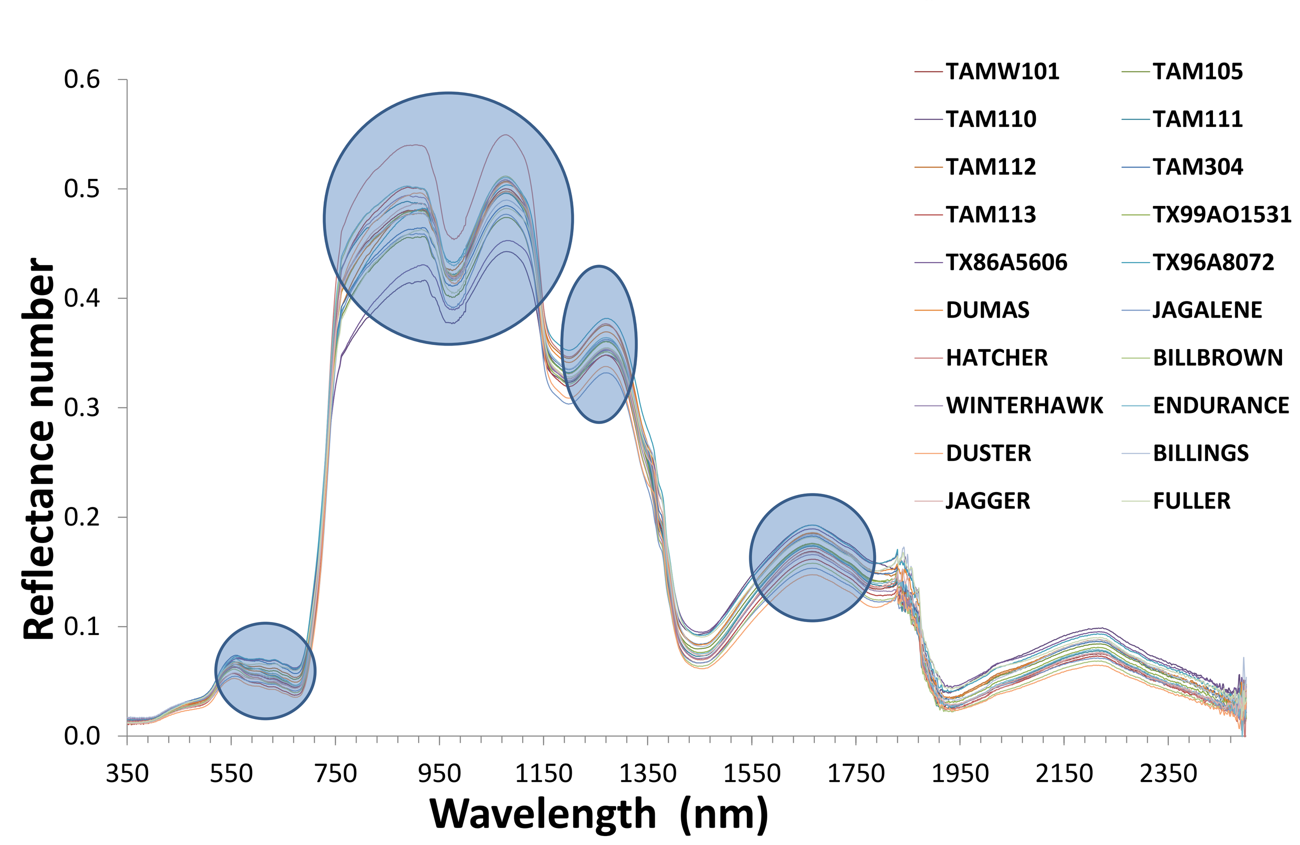
It is an optical Instrument that uses detectors to measure reflectance, transmittance, radiance, or irradiance.



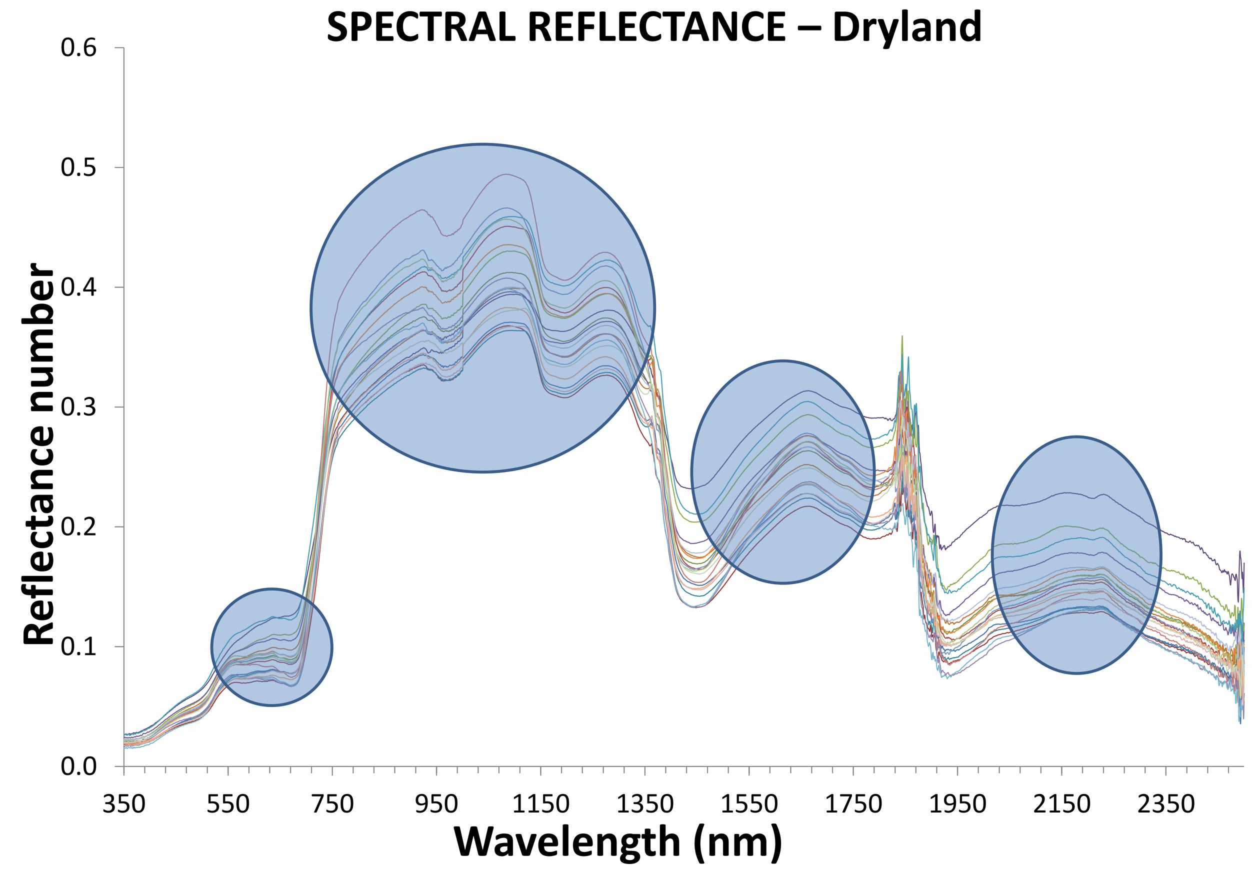
- The spectral reflectance measurements were taken using ASD FieldSpec3 portable spectroradiometer (ASD, Boulder, CO).
- The reflectance data in the visible and near infrared range (350-2500 nm) was collected with a 25° field of view from a distance of approximately 50 cm above the canopy in a nadir position.
- Five spectral readings were randomly measured between 12:30 and 3:30pm across the plot from 5 different locations. The mean of 5 readings from 3 replicated plots was used to estimate the spectral reflectance indices.

RESULTS

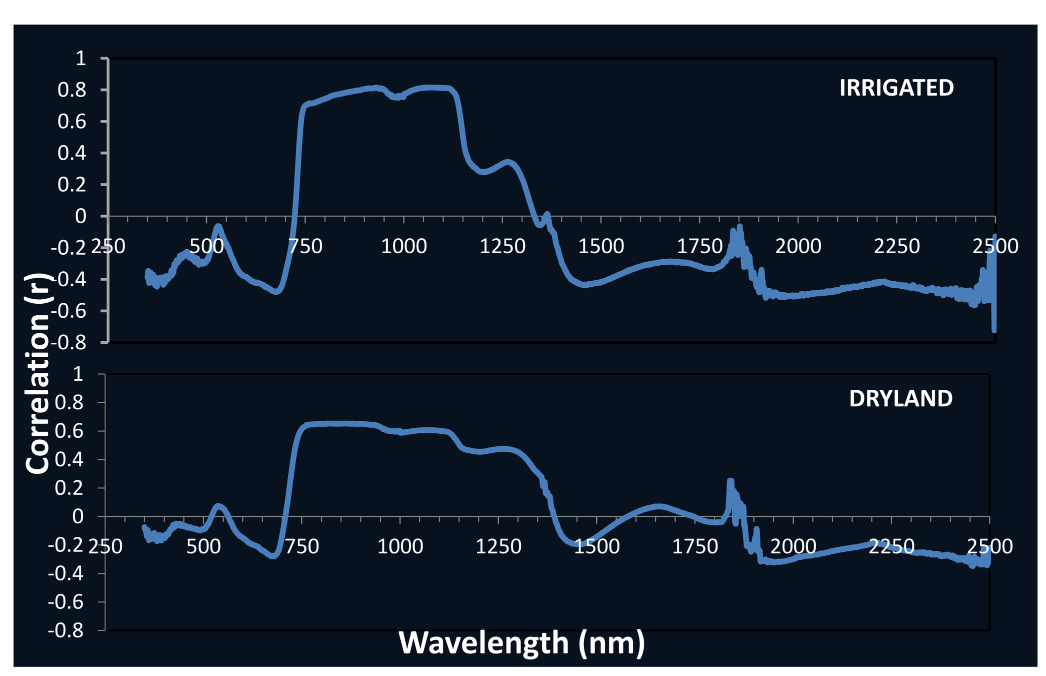
SPECTRAL REFLECTANCE – Irrigated



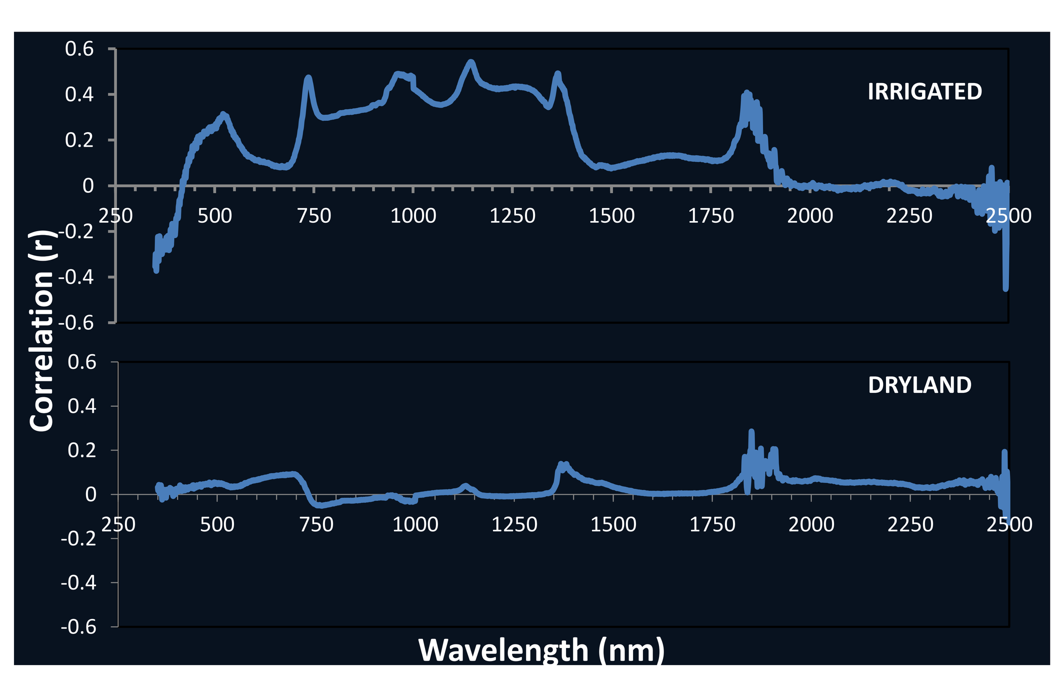
SPECTRAL REFLECTANCE – Dryland



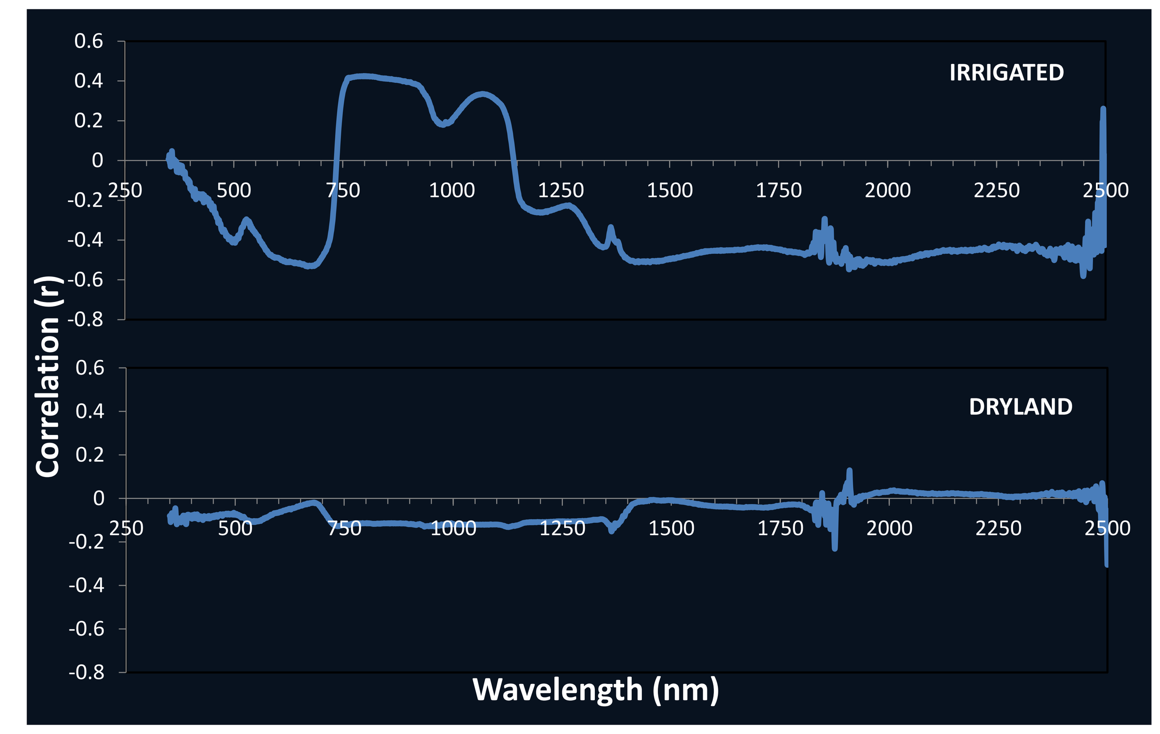
Correlation Curve – LAI



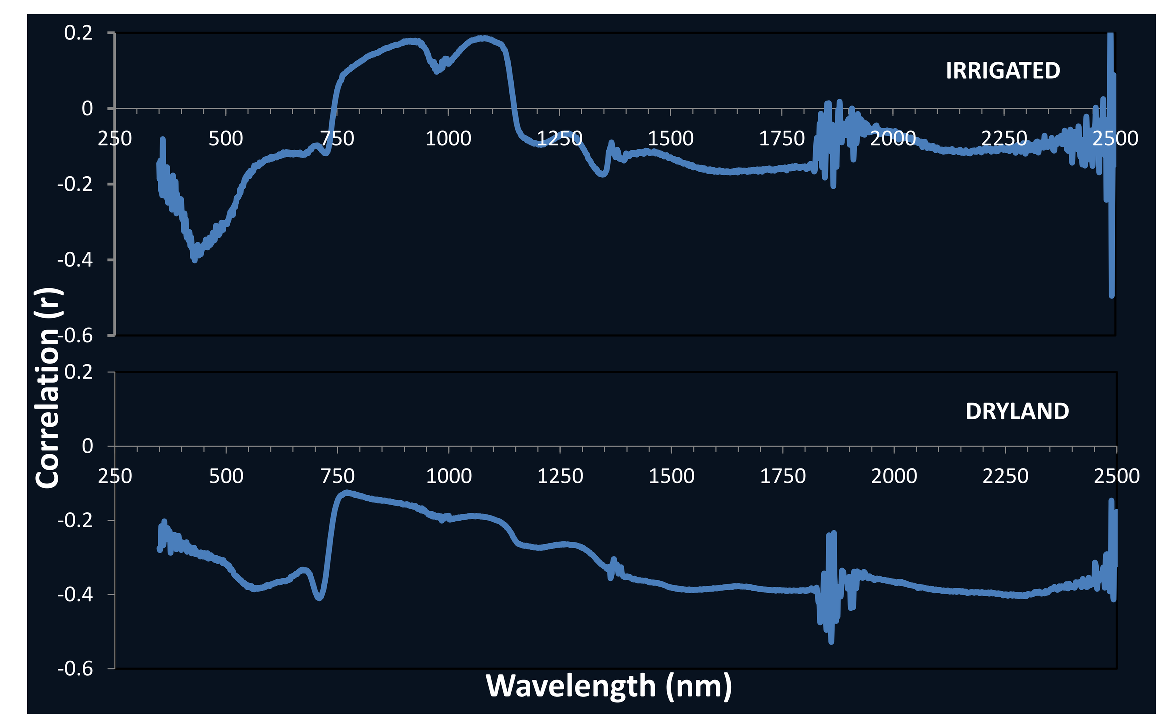
Correlation Curve – Biomass



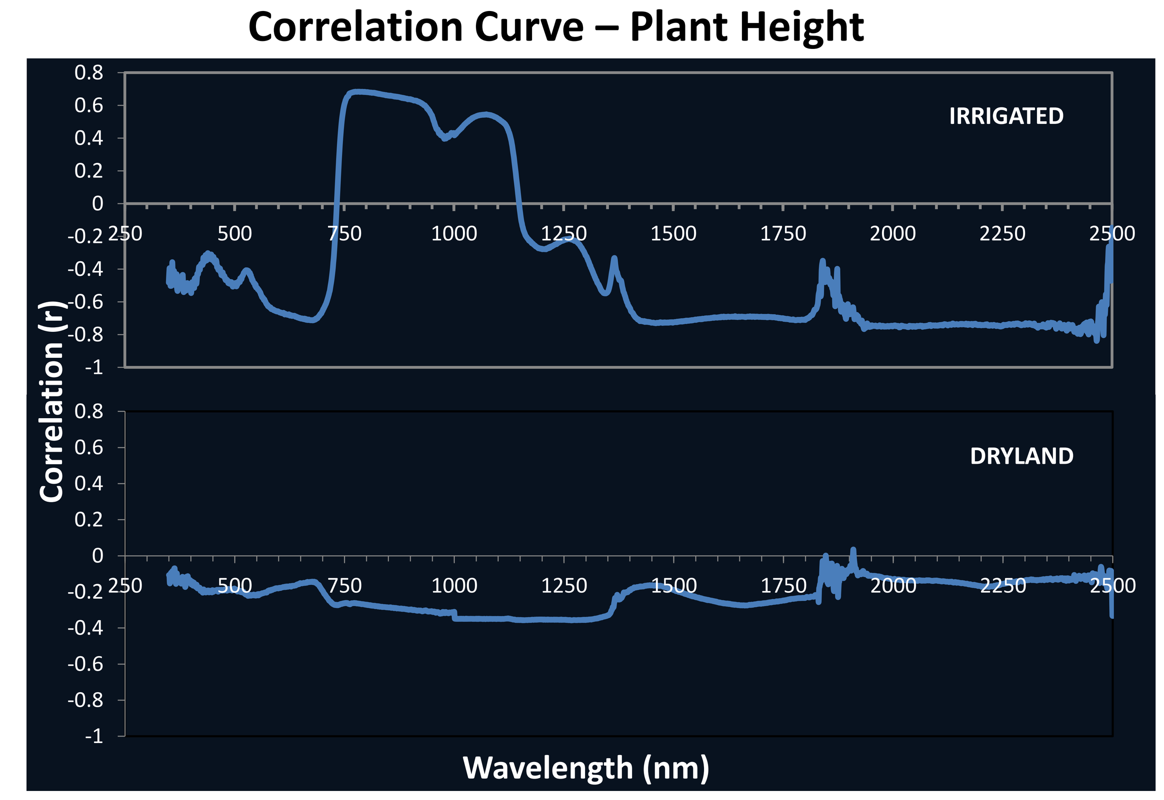
Correlation Curve – Yield



Correlation Curve – Chlorophyll content



Correlation Curve – Plant Height



CONCLUSIONS

- Spectral reflectance curves showed that remote sensing has potential to identify plant traits conferring drought tolerance.
- Higher correlation values in red, near-infrared, and middle infrared bandwidths indicated that spectral-based statistical models can be developed for estimating plant parameters.
- These results are consistent with results reported in the literature.

NEXT STEPS

- To avoid redundancy in bands, we plan to use following techniques to reduce the number of bands for model development:
- Principal component analysis (Reduced to two bands)
- Band differencing
- Stepwise regression technique