Characterization of Wheat Mapping Population for Determinate and Synchronized Growth; And Yield Estimation By Remote Sensing

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Abstract: Uniform tiller distribution and plant type are crucial traits that are directly linked to the length of vegetative and reproductive phases. These phases are directly linked by altering plant's thermal requirements. Minimum vegetative growth and a earlier synchronized flowering pattern result in a prolonged grain filling period. In determinate plants, minimum vegetative growth leads to sustained photosynthesis and production of sufficient assimilates to maximize size and weight of grains. While, indeterminate plants yield undesirable attributes including a sustained sequence of tillers and non-uniform flowering which lead to variations in the maturity time and grain size. UAV analysis could be helpful in identifying the relationship between plant's morphology and the thermal requirements of individual genotypes at different growth and developmental stages. This research compares conventional phenotyping and UAV based high-throughput field phenotyping techniques to identify plant's growth and morphological features in terms of determinacy and synchronization. This study will provide a key tool for understanding the molecular and genetic basis of wheat ideotype related traits.

Introduction

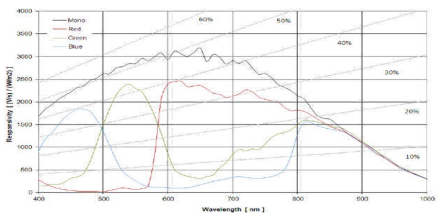
- Crop simulation models define an ideotype as a collection of growth development related crop features within certain environmental conditions. Adaptation of crop production to better cope with changing climatic conditions is therefore a key concern (Chen et al., 2011).
- Biochemical signals for early flowering cause prevention of a further increase in branching by suppressing vegetative meristem development. This mechanism results in uniform tillering and early flowering.
- **Determinate and Uniform flowering** results in physiological maturity of grains occurring at the same time. This provides an advantage in harvesting and quality of final grain production.
- **Indeterminate** tillering pattern/excessive tillers lead to variation in maturity and size of grains (Azam et al., 2002).

Objectives

- Characterization of wheat mapping population for determinate and indeterminate growth.
- Crop growth monitoring using crop reflectance parameters from multispectral UAV data.
- QTLs mapping.

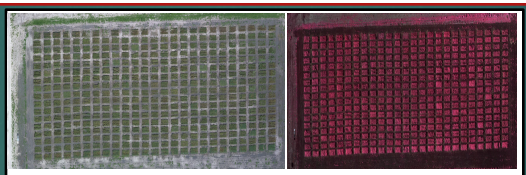
Tetracam ADC-Snap sensors with RGB and CIR cameras were flown over field after every week to collect UAV images.

Camera spectral response for red and green (blue is blocked for NIR Sensing):



Material and Methods

Iso-lines and a set of recombinant inbred lines derived from an initial cross between an Australian spring wheat cultivar Halberd and a North Dakota elite hard red spring wheat cultivar Len were planted at Texas A&M Agri-Life research station field in Corpus Christi and in green house in College Station, TX.

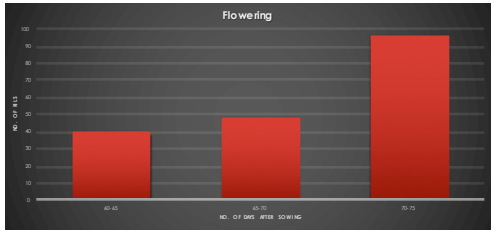


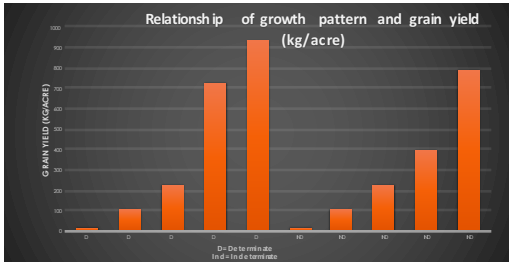
Multispectral images(RGB and NIR) of wheat field

RILS were compared for tillers uniformity and flowering time.

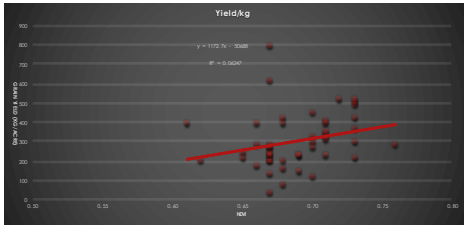
Preliminary Results

In the case of excessive indeterminate growth, sterile tillers use extra resources such as light and water for their vegetative growth as compared to determinate plants. This occurs without significantly contributing to grain production. This was also confirmed by UAV data analysis and statistical yield comparisons.

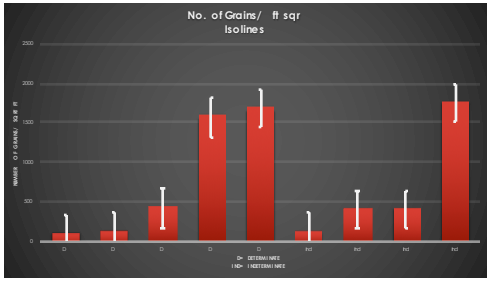




Yield variation in determinate and indeterminate plant types



NDVI=(Near InfraRed)-Red / (NearInfraRed)+Red
NDVI was calculated for each genotype to compare with growth pattern and grain yield



Work in Progress

- Kernel hardness test, to determine the grain quality in relation with growth type.
- Vegetation indices calculation from UAV images to correlate with plant's growth and reproduction pattern.

Conclusion

Combining traditional crop simulation features with modern technologies and strategies of research will be helpful in exploring the potential factors affecting the growth and development of wheat. By optimizing for yield and quality in response to changing climatic conditions, we hope to improve future crop yields.

References

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