Determining Optimum of Planting Date and Variety Selection for Wheat Production in Alabama

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Introduction

Wheat (*Triticum aestivum* L.) growth and development is affected by climate variability. Increases in mean temperature often accelerate phenology resulting in early maturation (Asseng, 2010) while drought stress caused by irregular rainfall during heading can reduce the pollen viability (Herbek, 2010) resulting in low yield (Asseng, 2010).

Wheat production in the southeastern U. S. occurs during the winter months when climate is highly influenced by the El Niño Southern Oscillation (ENSO). ENSO influences changes both temperature and precipitation in the Southeast. During El Niño phase, winters tend to be colder and wetter, while La Niña phase brings warmer and drier winter climate conditions. Adapting wheat management practices to ENSO forecasts would provide potential to reduce climate related risks.

Objective

1. To evaluate the performance of the cropping system model (CSM) CERES-Wheat for simulating the impact of various management practices on wheat yield at two environments in Alabama, USA.
2. To use the CSM-CERES-Wheat model to determine the optimum planting date and variety for these two environments in Alabama.

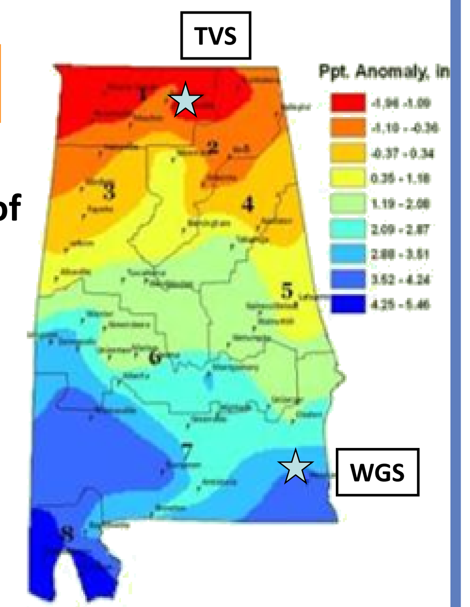


Figure 1. Precipitation anomalies map for Jan- Mar. period during El Niño phase

Materials and Methods

Model Calibration and Validation

1. The CSM-CERES-Wheat model of the DSSAT Version 4.0 (Jones et al., 2003; Hoogenboom et al.2010) was calibrated using experimental data collected from a planting date/wheat variety study conducted in Belle Mina (TVS - North) and Headland (WGS - South), during the2009/2010 and 2010/2011 growing seasons and evaluated using historic yield data from the Official Variety Trials at the same locations.

2. For both locations, two varieties of winter wheat included in this study were AGS 2060 (Early maturity) and Baldwin (Late maturity) planted at four planting dates (PD) at approximately 15 day intervals.

Table1. Planting dates for all locations

Year/ Location	Planting Date 1	2†	3	4
2009/10				
TVS - North	Oct. 17	Oct. 29	Nov. 15	Nov. 30
WGS - South	Nov.2	Nov. 16	Nov. 30	Dec. 11
2010/11				
TVS - North	Oct. 15	Oct. 30	Nov. 15	Nov. 30
WGS - South	Oct. 29	Nov. 13	Nov. 26	Dec. 10

† The standard date of planting

– Daily Weather records from 1950-2010 were obtained from the Cooperative Observer Program (COOPS) for both locations. The soil type for locations were Decatur silt loam soil (TVS) and Lucy sandy loam soil (WGS).

Seasonal Analysis

– Seasonal Analysis tool on the CSM-CERES-Wheat model was used to identify yield differences by ENSO phases between both planting date and Variety at both locations.

3. Simulated wheat yield were classified by year into ENSO phases using the JMA index (Japan Meteorological Agency) is a categorical index that classifies the Oct-Sept year as Warm, Cold or Neutral year. (Japan Meteorological Agency, 1991; Center for Ocean-Atmospheric Prediction Studies, 2009).

Results and Discussion

Model Calibration and Validation

1. Phenology was accurately predicted by the CSM-CERES-Wheat model with a Root Mean Squared Error (RMSE) varying from 7.013 to 8.68, and a d-statistic varying from 0.975 to 0.964. These values were obtained from the differences between the observed vs. the simulated days from planting to anthesis for both sites (Figure 2).

2. Grain Yield was also accurately simulated by the CROPSIM-CERES-Wheat model with a Root Mean Squared Error (RMSE) varying from 989.4 to 1448, and a d-statistic varying from 0.619 to 0.605. These values were obtained from the differences between the observed vs. the simulated yields at both site-years (Figure 3).

Figure 2. Simulated Vs Observed Anthesis date for the AGS 2060 and Baldwin varieties.

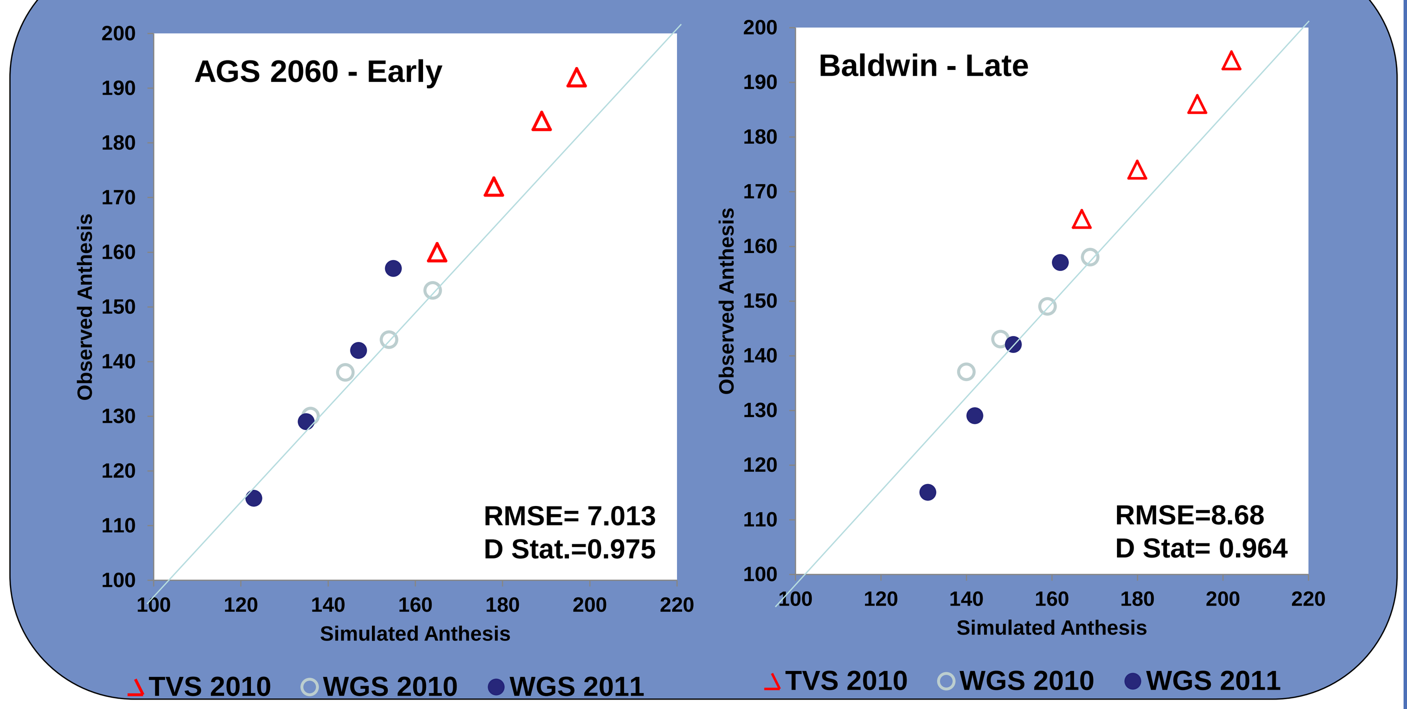
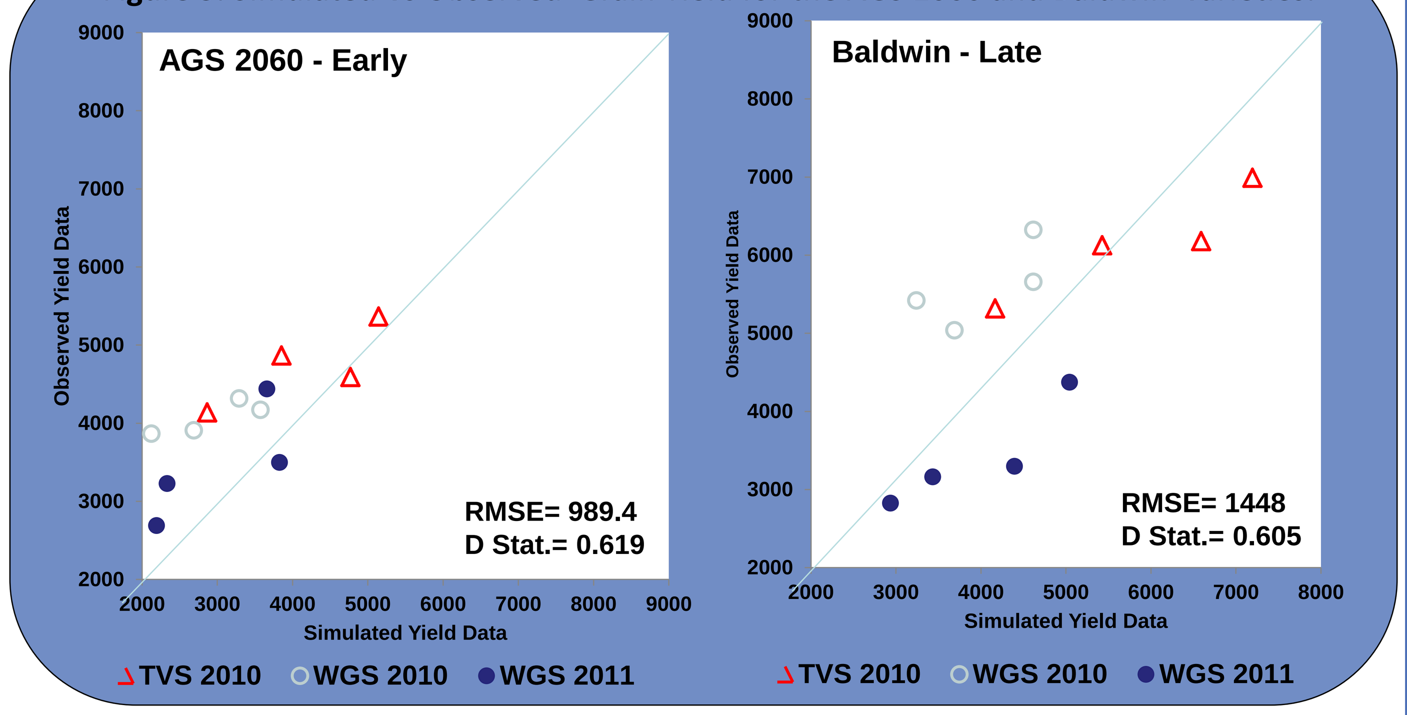


Figure 3. Simulated Vs Observed Grain Yield for the AGS 2060 and Baldwin varieties.



Seasonal Analysis

3. The planting date analysis using 60 years of historic weather data for each location indicated that La Niña had the greatest yield at all locations, while El Niño and Neutral followed (Figure 4).

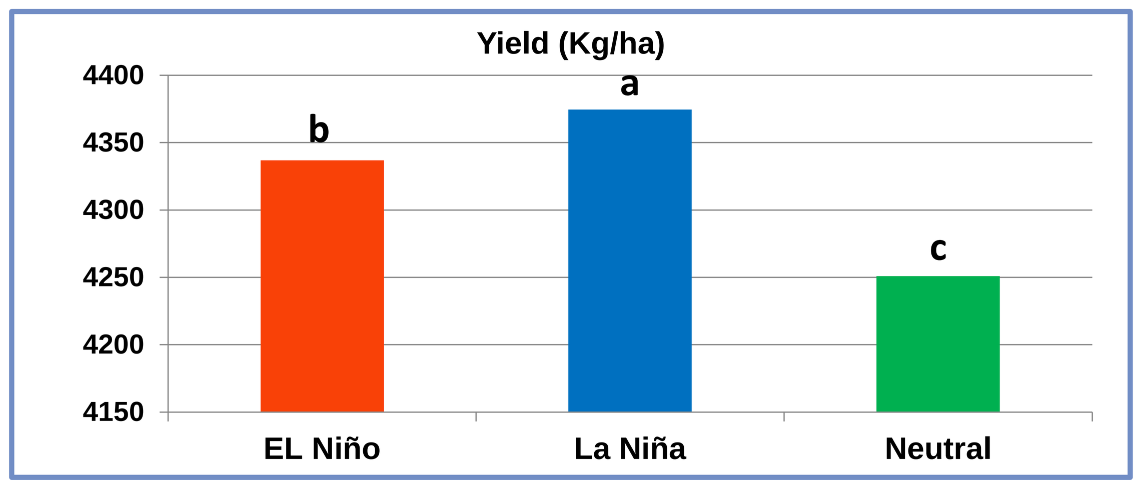


Figure 4. Least Squared Means of Grain Yield for each ENSO Phase: El Niño, La Niña and Neutral.

TVS – North Alabama

–During the El Niño, La Niña, and Neutral phase at TVS, both the early and late maturing variety decreased in yield as PD was delayed. In all cases the late maturing variety had greater yields than the early maturing cultivar.

– Yield differences among planting dates did not change between ENSO phases for the late maturing variety . Yield decreased 24% as planting date was delayed. This trend was also observed on the early maturing variety during the La Niña and Neutral phases. For the early maturing variety, 18% yield decrease was observed as planting date was delayed.

WGS – South Alabama

–During the El Niño and La Niña phases at WGS, yield decrease as planting date was delayed for both varieties. For the early maturity variety during Neutral phase, increases in yield until PD2 and for later planting dates yield decreases.

– In all cases the late maturing variety had greater yields than the early maturing cultivar.

– For both varieties, significant yield differences among planting dates were not observed between ENSO phases, however; higher yields were observed for Nina and Neutral phases.

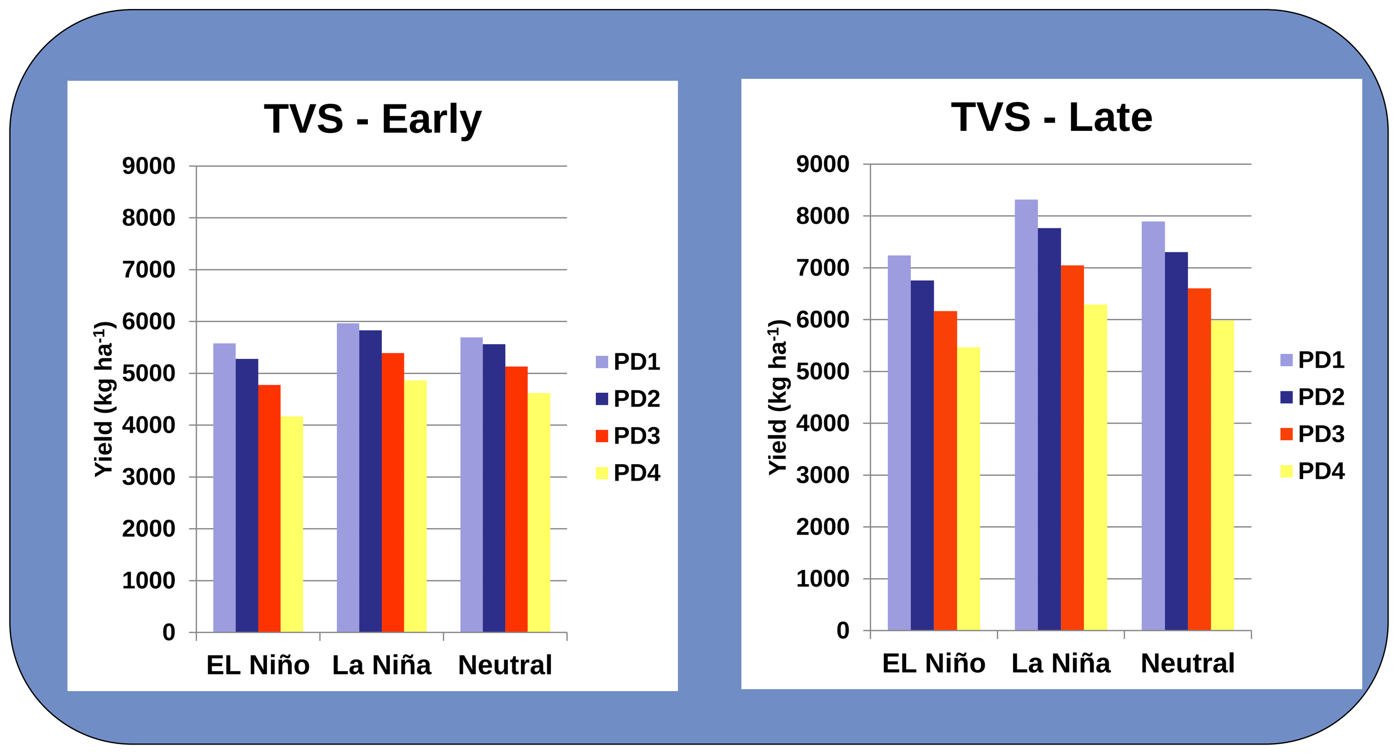


Figure 5. Simulated planting date yields at the TVS location for each ENSO phase.

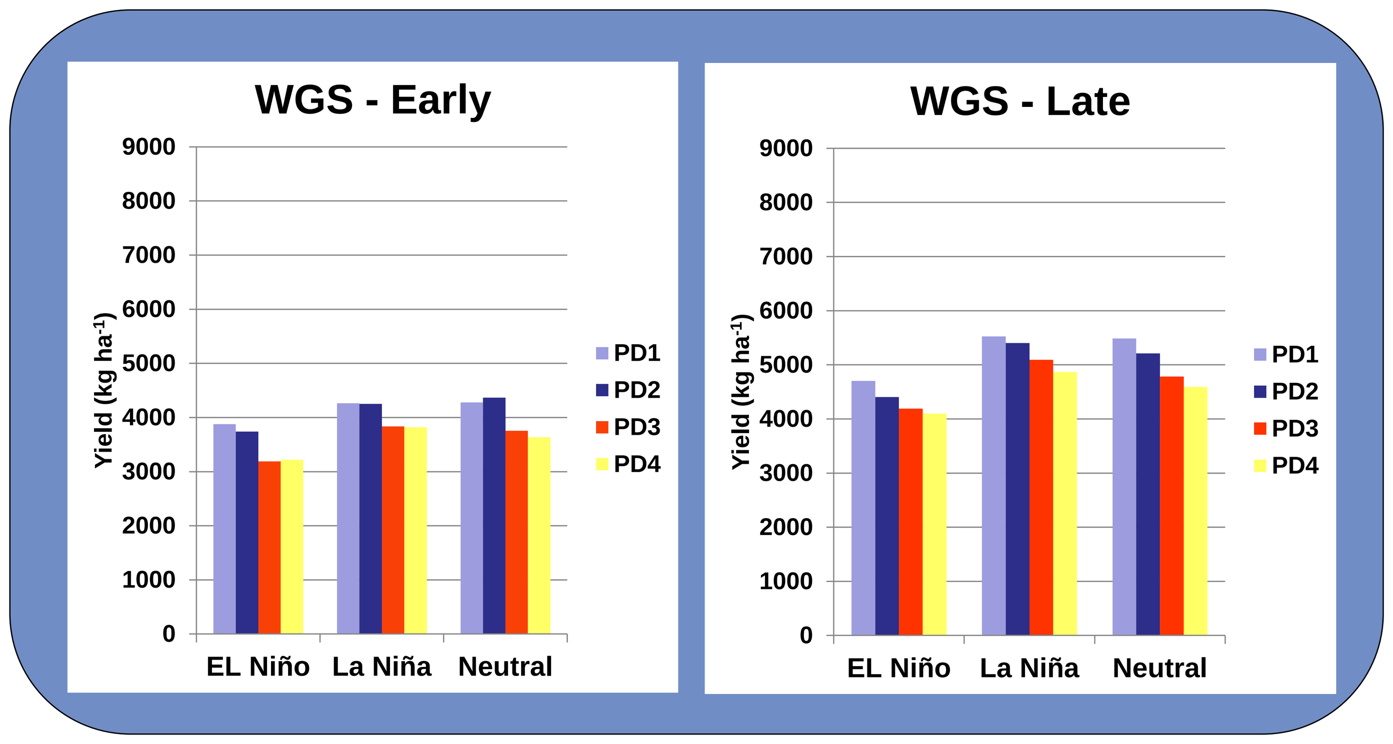


Figure 5. Simulated planting date yields at the WGS location for each ENSO phase.

Conclusions

1. The CROPSIM-CERES-Wheat model accurately simulated phenology and yield for two wheat varieties grown in contrasting environments, e.g., Belle Mina and Headland, in Alabama different management practices.

2. The CROPSIM-CERES-Wheat model was a useful tool to identify the impact of planting date for each Specific ENSO phase at the contrasting environments. Results found using the CROPSIM-CERES-Wheat model agree with previous studies.

3. The planting date analysis using 60 years of historic weather data indicated that the selection of a planting date is dependent on location and the specific ENSO phase for each cultivar

Acknowledgement

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References

Asseng, S., I. Foster, and N.C. Turner. 2010. The impact of temperature variability on wheat yields. Global Change Biology. 10:1365-2486.

Center for Ocean-Atmospheric Prediction Studies (COAPS). 2009. ENSO Index According to JMA SSTA. http://coaps.fsu.edu/jma.shtml. Accessed April 6, 2012.

Herbek, J. and C. Lee. 2010. University of Kentucky Website http://www.ca.uky.edu/agc/pubs/id/id125/02.pdf. Accessed April 6, 2010.

Hoogenboom, G., J.W. Jones, P.W. Wilkens, C.H. Porter, K.J. Boote, L.A. Hunt, U. Singh, J.L. Lizaso, J.W. White, O. Uryasev, F.S. Royce, R. Ogoshi, A.J. Gijsman, and G.Y. Tsuji. 2010. Decision Support System for Agrotechnology Transfer (DSSAT) Version 4.5 [CD-ROM]. University of Hawaii, Honolulu, Hawaii.

Jones, J.W., G. Hoogenboom, C.H. Porter, K.J. Boote, W.D. Batchelor, L.A. Hunt, P.W. Wilkens,U. Singh, A.J. Gijsman, and J.T. Ritchie. 2003. DSSAT Cropping System Model. European Journal of Agronomy18:235-265.