Early Vegetative Growth Simulation in a Common Bean RIL Population

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Introduction

- Common bean (*Phaseolus vulgaris* L.) is one of the most cultivated legumes and economically important worldwide.
- During the last two decades common bean has become a significant economic crop in North Dakota, which is the US leading producer.
- Early monitoring of vegetative growth can help in identifying stand quality and diseases in order to ensure high seed yields.
- The relationship of the bean life cycle and seed yield can be used to develop an economic growth rate.
- Crop models help enhance agricultural research. Previous dry weight simulations in common bean (Adikua et al. 2001) suggested good predictions under water stress conditions.
- Knowledge of the phenological stages influencing common bean growth and development is crucial to obtain reliable yield estimates and help optimizing management and production practices.

Objectives

- This study aims to predict the growing rates and phenologic stages of 164 common bean recombinant inbred lines (RILs) and the parents ('Negro Jamapa' and 'ICA-Calima') at five locations. The results from North Dakota are reported.

Figure 1. Field view of flagged plants at Prosper Research Site in 2012.

Materials and Methods

- The experiment was conducted at the Prosper Research Site located ~ 30 km NW of Fargo, North Dakota. Rainfall for the period was 157.0 mm and the average temperature was 20.0 ^{o}C during the growing season.
- Phenological data were collected twice a week from six flagged plants over 164 plots replicated three times in a resolvable row-column design.
- Dry weight of the main stem (DWMS), hypocotyl (DWH), and the primary leaves (DWU) were used to predict bean growth at vegetative stages.
- Growth rates were determined by using the Blackman (1919) equation:

$$W = W_0 e^{r(t-t0)}$$

W = biomass (g)
W_0 = initial biomass at t_0 (g)
r = growth rate (g day^{-1})
t = time (days)
e = natural logaritm (Ln)

- Data were analyzed (ANOVA) using the PROC MIXED procedure (SAS Institute, 2008).
- Predictions were evaluated by using the square root mean square error [RMSE (Willmott, 1985)]:

(P= predicted and O=observed)

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n}(P_i - O_i)^2}{n}}$$

Results

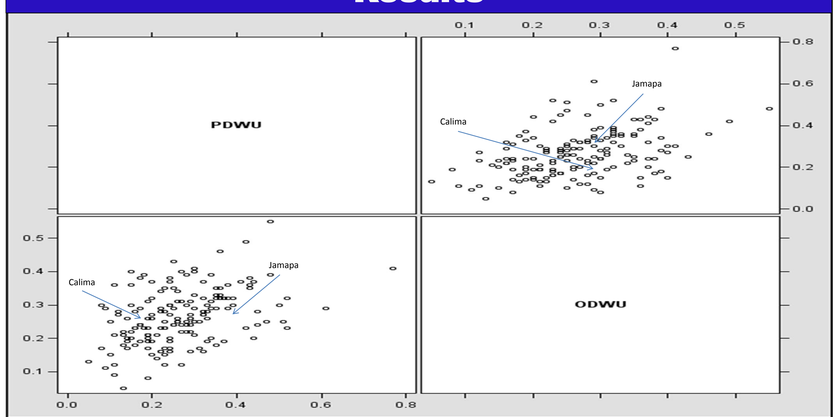

Figure 2. Predicted (PDWU) and observed (ODWU) dry weight (g) of primary leaves.

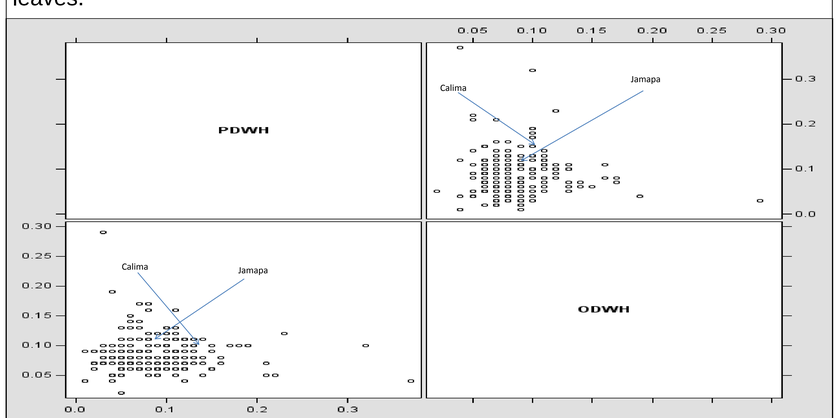

Figure 3. Predicted and observed dry weight of hypocotyl.

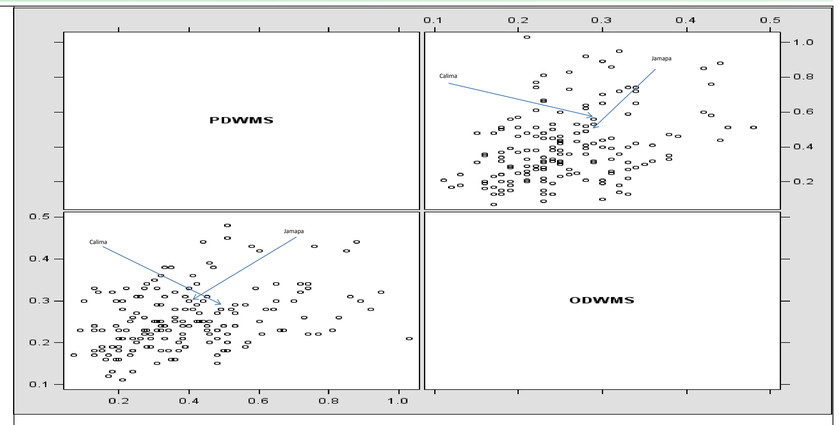

Figure 4. Predicted and observed dry weight of the main stem.

- RMSE values close to 0 indicate good predictions.
- DWH was predicted better with RMSE (0.06) than DWU (0.11) and DWMS (0.24).
- Early vigor of the selected traits was predicted more or less accurately.
- DWH of Jamapa was predicted better than Calima.

Summary and Future Work

- The evaluation indicates good predictions for common bean early vegetative growth.
- Primary leaves, hypocotyl and main stem dry weight are traits associated with grain yield and thus can be good selection criteria in breeding program.
- DWH can be used as direct selection criteria for early vigor following by DWU and DWMS.
- These preliminary results will be useful in the near future and the data set can be adjusted and matched with QTL for developing a gene-based crop model including all locations.
- Results across locations in North Dakota, Florida, Puerto Rico and two locations in Colombia will be a good evidence of genotype by environment interaction.

Acknowledgements

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