PMA06

The Second International Symposium on Plant Growth Modeling, Simulation, Visualization and Applications

November 13-17, 2006, Beijing, P.R. China

ABSTRACTS

(O) - **Phenotypic plasticity and fractal dimension are strong determinants of grain yield in soybean**

A.A. Jaradat, Derya Surek and David Archer

Reliable models are needed to describe plants with complex geometric structures, quantify the impact of management practices on the plant's geometric distribution in space, and predict yield as a function of fractal dimension. We measured growth and developmental variables on single soybean [Glycine max (L.) Merr.] plants under all combinations of two cropping (conventional and organic), two tillage (conventional and strip), and two fertility (with or without nitrogen fertilizer) systems under the short-growing season of the upper Midwestern USA. The normalized geometric structure and vegetative growth characteristics of two genotypically different soybean varieties were quantified using digital imagery during two cropping seasons. Most vegetative and yield-related variables measured were influenced by different management practices, and these variables were strongly correlated with grain yield per unit area. Midday differential canopy temperature (dT) was the single most important environmental factor in predicting the fractal dimension (FD) of both varieties (R^2 range 0.40 - 0.76) and was a reliable indicator of plant stress under different management systems. A multilayer perception neural network with back propagation identified plant dry weight, plant volume, plant circularity, and leaf area per plant, in decreasing order, as reliable (R^2=0.76) predictors of FD. However, the simplest neural network model accounted for 61.0% of the variation in FD and was limited to plant dry weight and number of pods per plant. The latter is an estimate of the number of fruiting nodes per plant. The fractal dimension was the most important predictor in a generalized regression neural network, followed, in decreasing order, by plant dry weight, plant volume and plant circularity, in predicting grain yield m^{-2} (R^2=0.64). Knowledge of how plants respond to single and multiple management practices will help agronomists develop better predictive models and will help farmers refine management practices to optimize yield. The management implications of manipulating phenotypic plasticity and FD to optimize grain yield are presented.

References

Birch, C.J., A. Andieu, C. Fournier, J. Vos and P.Room. 2003. Modeling kinetics of plant canopy architector—concepts and applications. Eur. J. Agronomy 19:519-533

Critten, D.L. 1997. Fractal dimension relationships and values associated with certain plant canopies. J. Agric. Engng. Res. 67:61-72

Vega, C.R.C., V.O. Sadras, F.H. Andrade and S.A. Uhart. 2000. Reproductive allometry in soybean, maize and sunflower. Annals of Botany 85:461-468.