Crop model assisted characterization of appropriate traits for the rice TPE in Brazilian Cerrados

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Introduction

Many agronomic traits of interest such as yield, but also specific leaf area and biomass partitioning can be used to enhance the rate of genetic improvement for rice. Trait expression in upland rice is affected by abiotic stresses such as drought, temporally and spatially changing the means and variances of grain yield.

Crop simulation models have captured much of the understanding of plant growth over nearly 40 years of plant system research (Sinclair & Seligman, 1996), providing a dynamic framework for the physiological dissection of complex growth and development traits. In spite of limited success of early efforts to use agronomic crop models for genotypic characterization based on heuristic approach (Hammer et al., 2005), it is now possible to use crop models to simulate different phenotypic traits and their respective impact on yields for a wide range of TPEs.

The Cerrado region, specifically Goiás state, is characterized by three different drought stress patterns for short upland rice: low, mid-season and terminal stress (Heinemann et al., 2007), low stress being predominant, when there is no restriction (deep soil) for root development due to *Al*-induced acidity in deeper soil layers. However, for shallow soil condition there is a predominance of mid-season stress occurrence. For a plant breeding program, it would be desirable to know which phenotypic traits could further improve plant adaptation for targeted environments.

The objective of this study is to estimate the added value of combining specific phenotypic traits, such as duration of vegetative phase, specific leaf area, response to soil water status to maintain or improve grain yield in the upland rice target population of Goiás state.

Material and Methods

The crop model RICE06, derived from the generic model SARRAH and implemented in the ECOTROP modeling platform of Cirad, was parameterized and validated for one upland rice short cultivar (Guarani). For this purpose, field experiments were carried out at Porangatu (two planting dates - 12/05/2006 and 11/06/2006) and Goiânia (11/01/2006). Based on the "standard genetic coefficients" obtained through the parameterization, 17 virtual genotypes were created by modifying and combining the parameters: maximum and minimum specific leaf area (SLAmin and SLAmax), depletion P factor (threshold value of soil water content from which the crop begins to experience water stress) and vegetative period duration. SLAmax and SLAmin (input data) were modified in plus and minus 20%, P factor values were 0.2, 0.35 and 5.0, 0.35 being reference value, and values for vegetative period were 490 and 700 degree days, 490 being the reference. Leaf area index (LAI = SLA * Leaf Biomass) is calculated based on daily values of SLA (calculated based on Michaelis model using SLAmax and SLAmin as an input data).

The crop model was run for all genotypes in the TPE defined by Heinemann et al. (2007) for two scenarios: deep and shallow soil.

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Results

Results shown here are just preliminary tests (to check model sensitivity to chosen parameters) for one site (CNPAF station of Embrapa), for a no stress year (2002) and two environments, deep and shallow soil. For deep soil, Figure 1a, shows that the increase of vegetative period does not lead to a gain in relative yield (relation between yield obtained from virtual genotype and yield obtained by the standard genotype). For a higher vegetative period, the increase of specific leaf area (increase on the difference of SLAmin and SLAmax as an input data) decreases the relative yield. For shallow soil (Figure 1b) an increase in vegetative period could provide higher relative yields. Apparently, this result is the opposite of expected in the region, since in shallow soils it is expected that short-cycle cultivars have better performance. However, simulation must be done for all sites and planting dates in TPE to verify this trend.

Conclusions

This study will demonstrate, for a region where TPEs were characterized in detail, how crop modelling can assist ideotype definition and thus facilitate preliminary choices for a breeding programme.

Reference

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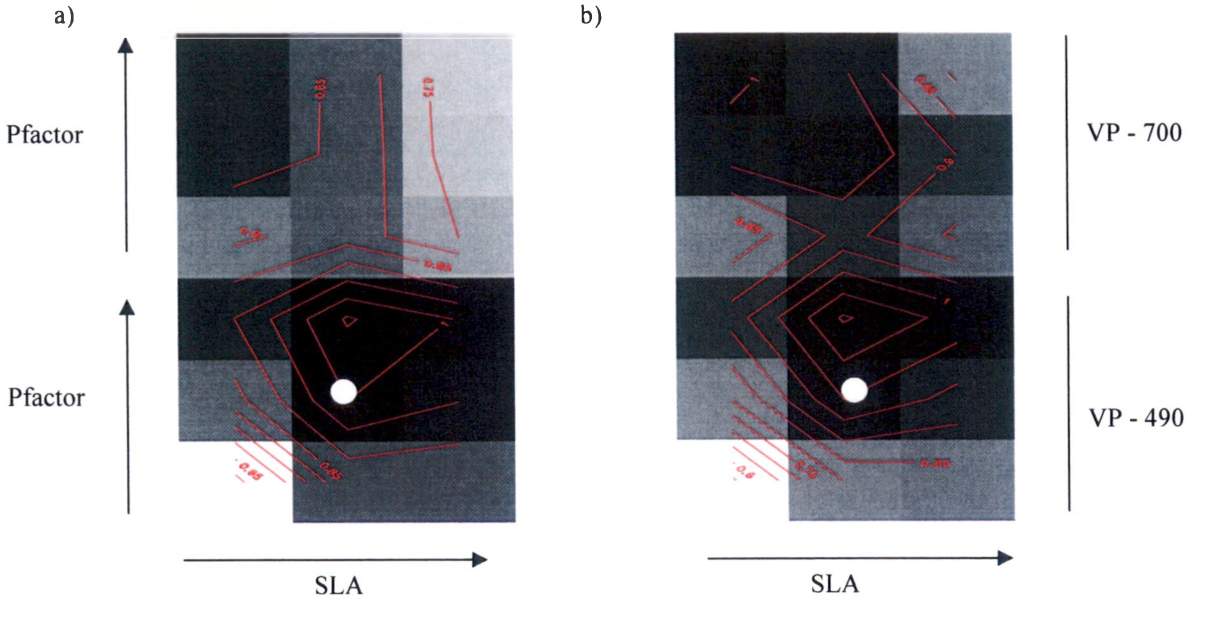

Fig. 1. Effect of P factor, specific leaf area based on the difference of SLAmin and SLAmax as an input data (SLA) and vegetative period (VP) on the relative yield (relation between yield obtained from virtual genotype and yield obtained by the standard genotype) for a) deep soil and b) shallow soil. The white circle represents the standard genotype (Guarani).