GENETIC VARIABLES FOR POTATO
L.A. Manrique, T. Hodges, and B.S. Johnson

Abstract

Crop models should predict growth and yield under a wide range of environmental conditions. General use of models can only be accomplished if genetic inputs are incorporated into the model to account for genetic variability in response to environment and management. This study summarizes existing knowledge on genetic variables and related environmental responses for potato and describes procedures for collecting data to estimate these variables for several important growth processes. These genetic inputs will be used to incorporate genetic variability in modeling potato growth and tuber yield.

Compendio

Los modelos de cultivos deben permitir el pronóstico del crecimiento y rendimiento bajo una amplia gama de condiciones ambientales. El uso general de los modelos puede solamente ser llevado a cabo si se incorporan al modelo elementos genéticos para estimar la variabilidad en la respuesta al ambiente y al manejo. Este estudio resume el conocimiento existente sobre las variables genéticas y las respuestas ambientales relacionadas con ellas y la papa y describe los procedimientos para obtener la información para estimar estas variables para varios procesos importantes del crecimiento. Estos componentes genéticos serán utilizados para incorporar variabilidad genética en el modelado del crecimiento y el rendimiento en tubérculos de papa.

Introduction

Crop growth simulation models provide a diversity of potential applications and worldwide use if they can predict growth and yield under a wide range of environmental conditions for a number of cultivars of a crop. Such broad geographical use of models can only be accomplished if genetic variables are incorporated into the model to account for varietal differences in phenological and growth responses to changes in environ-

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ment and management. Genetic variables free crop models from cultivar-specific constraints. Hence, careful selection and accurate characterization of these genetic inputs for specific genotypes are important to strengthen the capabilities of crop models.

Genetic variables for potato are poorly understood because data needed to characterize them are not available, or are not in a form suitable for use in modeling. Efforts are currently underway (28, 30, 33, 34) to identify and characterize potential genetic variables for potato (Table 1).

However, more research is needed to gain a better understanding of the fundamental relationships between the genetically controlled characteristics of potato growth and development and the environment. Furthermore, a standard methodology is needed to facilitate the collection of data required to compute the genetic variables for potato.

This paper has three objectives: (i) to review existing knowledge on genetic variables for potato modeling, (ii) to identify areas where additional research on genetic variables is required, and (iii) to develop a methodology designed to collect data required to determine genetic variables for potato.

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The potato (SUBSTOR) model (19) is one of the crop models being developed by the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) project of the University of Hawaii. The genetic variables G2 and G3 in the SUBSTOR model were selected to characterize genetic variability of potential leaf area expansion rate and potential tuber growth rate in response to temperature, respectively (Table 1). Genetic variables are needed for additional cultivar differences in phenological and growth responses to environment and management.

<table>
<thead>
<tr>
<th>Genetic Variable*</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of determinacy or sensitivity of G3 to excess nitrogen</td>
<td>G1</td>
</tr>
<tr>
<td>Leaf growth rate</td>
<td>G2</td>
</tr>
<tr>
<td>Tuber growth rate</td>
<td>G3</td>
</tr>
<tr>
<td>Partitioning coefficient</td>
<td>G4</td>
</tr>
<tr>
<td>Tuber dry matter content</td>
<td>G5</td>
</tr>
<tr>
<td>Thermal time to VE</td>
<td>VE1</td>
</tr>
<tr>
<td>Thermal time to T1</td>
<td>P1</td>
</tr>
<tr>
<td>Daylength sensitivity of T1</td>
<td>P1d</td>
</tr>
<tr>
<td>Thermal time to T1a</td>
<td>P2</td>
</tr>
<tr>
<td>Sensitivity to excess nitrogen during T1a</td>
<td>P2n</td>
</tr>
<tr>
<td>Thermal time from T1 to T4</td>
<td>P3</td>
</tr>
</tbody>
</table>

*VE = Emergence, T1 = Tuber initiation, T4 = Harvest maturity, T1a = Possible new growth stage between T1 and tuber growth (1 or 2 days in tropical environments to 2 weeks in temperate regions).