

## Charting the Path to Direct Seeded Rice Farming: Genome-wide Associations for Mesocotyl and Root Lengths

Akash Datta<sup>1,2</sup>, Sandeep Sakhale<sup>3</sup>, Shalabh Dixit<sup>2</sup>, Erik J. Sacks<sup>1\*</sup>

<sup>1</sup>Department of Crop Sciences, University of Illinois, Urbana-Champaign, USA

<sup>2</sup>International Rice Research Institute, Los Baños, Philippines

<sup>3</sup>Department of Agronomy and Horticulture, University of Nebraska-Lincoln, Lincoln, USA

Dry-direct seeding of rice is a promising solution to address the pressing issues of water scarcity and seedling emergence is an important trait for crop establishment. We aimed to identify genomic regions associated with seedling establishment traits. We studied a panel of 919 accessions from RDP1, RDP2, and 3K-RGP belonging to three major genetic groups of rice: *aus* (n=253), *indica* (n=334), and tropical-*japonica* (n=332). Seeds were cultured on 1% benomyl-soaked germination paper in test tubes in the dark at 30 °C for 5 days, and data was collected on seedling mesocotyl length and shoot length. The panel was evaluated with ~3.6 million SNPs to identify associations with phenotypes. Overall, the *Aus* lines had a greater average shoot length and mesocotyl length (6.4 cm, 2.0 cm, respectively) than *indica* (6.0 cm, 1.2 cm) and tropical *japonica* (4.7 cm, 0.9 cm).

Genome-wide association study (GWAS) analyses for mesocotyl length identified 138 significant SNPs over 16 genomic regions (peaks) within *indica* and 4 significant SNPs over 4 genomic regions within tropical *japonica*. Based on the estimated LD-decay, 126 unique candidate genes were identified for mesocotyl length. Among the identified candidates from this study, the most promising were *OsCAD* family genes and *OsGSK2*, also found to affect mesocotyl length in rice and maize in previous literature. We also identified genes related to metabolite modification, lignin biosynthesis, and sugar metabolism, consistent with prior studies. The information generated from this study will aid the development of direct-seeded rice varieties to germinate from deep-sowing ultimately helping farmers.