Are architectural traits at flowering stage relevant components to account for yield advantage of hybrid rice?

Tanguy Lafarge, Crisanta S. Bueno and Estela Pasuquin
IRRI, DAPO Box 7777, Metro Manila, Philippines, tlafarge@cgiar.org
Cirad-Ca, Ta 70/01, avenue Agropolis, 34398 Montpellier Cedex 5, France, tlafarge@cirad.fr

Abstract

Yield advantage of hybrid rice over conventional inbred rice in tropical favorable environments, up to 15%, is commonly and simply attributed to higher biomass production due to higher seedling vigor and higher harvest index. Addressing hybrid superiority with less integrated plant traits should contribute to the development of plant-type management and the design of improved phenotypes. Precise phenotyping of high-yielding hybrid rice (H1, H3, and H5) and improved lines (I1 and I10) with the same crop duration was performed in a series of field experiments in 2004 and 2005 in the Philippines in order to quantify dynamics in assimilate partitioning and architectural plasticity of the plant in response to canopy competition. As commonly observed, higher yield of hybrid varieties was associated at maturity with higher shoot dry weight (38.5 g m^{-2} for H5 and 31.9 g m^{-2} for I10 in the wet season) and with higher harvest index (0.51 for H5 and 0.46 for I10). Indeed, hybrid rice had the ability to support a heavier panicle with an even weaker stem (high specific stem length), but then was more susceptible to lodging. Early seedling vigor for H1 and I1 was similar in the dry and wet seasons: dynamics in shoot dry matter, leaf area index and specific leaf area (SLA) did not significantly differ between genotypes. In contrast, internode dry weight of H1 was significantly higher with time than that of I1, both in the dry and in the wet seasons: at 69 days after sowing (DAS), it was 5.3 g for H1 and only 2.7 g for I1, while, for H1, there was quicker increase in the partitioning coefficient for internode and quicker decrease in the partitioning coefficient for blade. Internode dry weight of H1 was also significantly higher with time compared to that of I10: 3.9 g at 69 DAS, despite slightly higher vigor (lower SLA in H1). Early seedling vigor was also similar between H5 and I10 when observed in the wet season, as were dynamics in internode dry weight. Increase in shoot dry weight during grain filling in H5 was, however, significantly higher than that of I10 and I1. During the reproductive phase, I1 exhibited a slower stem elongation and a quicker increase in blade angle with the main tiller compared to that of a check hybrid (H3). Despite the increasing competition for access to light in the canopy, I1 also exhibited an increase in the ellipse area formed by the leaf area of the plant at the highest collar level, whereas this was relatively constant for the hybrid variety. At flowering, better light distribution in the hybrid canopy, due to lower mutual shading between leaves, was suspected to have enhanced dry matter accumulation and a larger number of fully elongated stems was suspected to have increased harvest index by maximizing assimilate partitioning to grain right after flowering. Faster internode elongation and more efficient leaf spatial arrangement after canopy closure are proposed as more relevant traits than higher seedling vigor to account for hybrid rice superiority.
Keywords: hybrid rice, seedling vigor, assimilate partitioning, internode elongation, clump characteristics