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Dynamics of Expression of Ethylene Signal Transducer and Starch Synthesizing Enzyme Genes in Developing Spikelets of Rice Panicle Contrasting for Grain Growth

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Commentary

Spikelets are individual flower units of the complex panicle type inflorescence of rice. Each spikelet is genetically competent to bear a well-filled grain at maturity. However, heterogeneous grain development underscores this potential and spikelets located on the basal part of panicle do not bear grains suitable for human consumption. The problem of poor grain filling is more acute in the newly introduced large-panicle super rice. My research was intended to find out the chemical routes for enhancing grain filling in the inferior basal spikelets. The research ruled out discrimination in photosynthetic assimilate supply, but identified ethylene as being responsible for variation in grain filling capacity among spikelets of rice panicle. Inferior spikelets produce more ethylene impeding the activities of starch synthesizing enzymes to the detriment of grain filling, as a result of which assimilates not used in growth accumulate in the developing kernel. In contrast, superior spikelets located on apical branches of panicle produce less ethylene and fill faster because of metabolic dominance in starch biosynthesis. The regulation of ethylene responses holds a key to breaking yield barrier in irrigated rice, although contribution of other hormones like cytokinin and ABA are not ruled out. More recently it is noticed that high spikelet number of the newly developed super rice cultivars increases grain density of the panicle. In our study, spikelet density correlated negatively with grain quality uniformity resulting in the increase of poorly filled grains of the panicle. Compact arrangement of spikelets also promoted ethylene evolution at the time of anthesis, which compromised with the dominance of superior spikelets. The inferior spikelets had the capacity for post-anthesis expression of genes encoding ethylene receptors and signal transducers longer than the superior spikelets. Enhanced ethylene action correlated positively with the expressions of rice starch regulator *RSR1* gene and negatively with starch synthase *GBSS1* gene. The adverse action of ethylene on grain filling and expression of endosperm starch synthesizing enzyme genes was explored further using recombinant inbred lines differing in panicle grain density with RT-PCR and qRT-PCR studies. The study recorded expression of genes of six isoforms each for sucrose synthase and ADP glucose pyrophosphorylase and four isoforms of soluble starch synthase and two of granule bound starch synthase in the developing kernels. Metabolic dominance of a superior spikelet over an inferior one was dependent on higher constitutive expression of the genes of different isoforms of the enzymes, but the relationship between endosperm starch filling and sucrose synthase activity/expression was more closure than the others. Out of the six isoforms of sucrose synthase, the expression of *SUS3* was most active during grain filling in the lax-panicle rice genotypes and this dominance was lost in the kernels of the compact-panicle rice because of enhanced ethylene production and perception. It is concluded that ethylene could be a second messenger for IAA in apical dominance of rice spikelets.

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