DIRECT AND INDIRECT DEFENSE MECHANISM REVEAL COMPLEX PROTECTIVE SHIELD AGAINST INSECT HERBIVORES IN RICE

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Plants use effective defense strategies against herbivores that depend on rapid induction of plant metabolites. Two major defense strategies involve direct and indirect defense mechanisms. Our group is using two crops, rice and sorghum, to understand plant innate defense mechanisms against insects. Here we discuss the role of two major rice phenolamide (PA) conjugates, p-coumaroylputrescine (CoP) and feruloylputrescine (FP), and examine volatile signals emitted from rice plants attacked by insect herbivores. Metabolites were determined by LC-MS/MS in 6-week-old cv. Nipponbare rice seedlings. Volatile compounds were collected and measured by ion trap GC-MS. Genes were cloned, expressed in vitro and recombinant proteins used for biochemical assays. Gene expression was determined by quantitative RT-PCR. CoP and FP were strongly induced by chewing and sucking herbivores. In bioassays with synthetic CoP and FP, survival of rice sucking pest, brown planthopper (Nilaparvata lugens), was reduced after addition of CoP or FP to artificial diet (100µg/mL). Next, we identified genes for phenolamide biosynthesis in rice by cloning and biochemical approaches. Phenolamides and their genes expressed in tissue specific, as well as inducible manners in rice. While main constitutive expression and metabolite accumulation occurred in field-grown roots and panicles, herbivores and mechanical wounding induced additional expression and accumulation of CoP and FP in rice leaves. Herbivory elicited emissions of several volatile organic compounds: A generalist herbivore tended to provoke stronger responses compared to specialist rice insect pest. Volatiles were emitted in diurnally specific patterns, suggesting differential way of communication between plants and insects during light and dark periods. Rice plants use both direct and indirect defense mechanism for effective protection against herbivores, forming complex protective shield that assures survival of rice even under strong biotic pressure in nature.

Key words: insect herbivores, phenolamides, plant defense, rice; sorghum, volatile compounds