Quantification of growth-defense trade-offs in a common currency: nitrogen required for phenolamide biosynthesis is not derived from ribulose-1,5-bisphosphate carboxylase/oxygenase turnover.

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Abstract

Induced defenses are thought to be economical: growth and fitness-limiting resources are only invested into defenses when needed. To date, this putative growth-defense trade-off has not been quantified in a common currency at the level of individual compounds. Here, a quantification method for ^{15}N-labeled proteins enabled a direct comparison of nitrogen (N) allocation to proteins, specifically, ribulose-1,5-bisposphate carboxylase/oxygenase (RuBisCO), as proxy for growth, with that to small N-containing defense metabolites (nicotine and phenolamides), as proxies for defense after herbivory. After repeated simulated herbivory, total N decreased in the shoots of wild-type (WT) Nicotiana attenuata plants, but not in two transgenic lines impaired in jasmonate defense signaling (irLOX3) and phenolamide biosynthesis (irMYB8). N was reallocated among different compounds within elicited rosette leaves: in the WT, a strong decrease in total soluble protein (TSP) and RuBisCO was accompanied by an increase in defense metabolites, irLOX3 showed a similar, albeit attenuated, pattern, whereas irMYB8 rosette leaves were the least responsive to elicitation, with overall higher levels of RuBisCO. Induced defenses were higher in the older compared with the younger rosette leaves, supporting the hypothesis that tissue developmental stage influences defense investments. We propose that MYB8, probably by regulating the production of phenolamides, indirectly mediates protein pool sizes after herbivory. Although the decrease in absolute N invested in TSP and RuBisCO elicited by simulated herbivory was much larger than the N-requirements of nicotine and phenolamide biosynthesis, ^{15}N flux studies revealed that N for phenolamide synthesis originates from recently assimilated N, rather than from RuBisCO turnover.

Identifier

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