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Rapid silicon accumulation affects carbon-based plant defences and enhances plant resistance to a global insect pest

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1) Crop loss due to insect herbivory is one of the largest challenges facing the agricultural industry. As herbivore populations continue to grow in light of global change, securing crop resources is becoming increasingly critical. Silicon (Si) has been shown to effectively mitigate the adverse effects of herbivores such as the cotton bollworm, Helicoverpa armigera (Lepidoptera: Noctuidae), in crop species (namely grasses), that have evolved the ability to uptake large amounts of Si through their roots and accumulate it in aboveground tissues. Nevertheless, the effectiveness of Si accumulation as a plant defence against herbivory in the short term, and its consequential effects on alternative defence responses, remain unclear.
2) We conducted two discrete experiments to determine the short-term dynamics of Si, chemical defences and resistance to herbivory in the model grass, Brachypodium distachyon: 1) Both Si-supplemented (+Si) and control (-Si) plants were treated with methyl jasmonate (MeJA) as a form of simulated herbivory and we measured the interplay of Si accumulation, the phytohormones jasmonic acid (JA) and salicylic acid (SA), and carbon-based defences over 24 hr. 2) We exposed H. armigera larvae to B. distachyon plants grown under three conditions: +Si, -Si, or treated with Si only once H. armigera feeding began. We measured the effect of short-term plant exposure to Si on H. armigera performance and plant resistance.
3) MeJA-induced Si accumulation occurred as early as 6 hr after treatment via increased JA concentrations. Si supplementation decreased SA concentrations, which could have implications on additional downstream defences. We show a trade-off between Si and phenolics in untreated plants, but this relationship was weakened upon MeJA treatment. Although foliar Si concentrations remained lower, within 72 hr of exposure to Si, plants obtained virtually the same level of resistance to H. armigera as plants exposed to Si for over 30 days. H. armigera feeding also accelerated Si deposition after 6 hr of exposure to Si, however, in as little as 24 hr, levels of Si deposition were similar to plants exposed to Si long term.
4) In addition to its well-documented role as a long-term defence against herbivores, we demonstrate that, over short-term temporal scales, Si accumulation responds to herbivore signals and impacts on plant defence machinery. Further, we provide novel evidence that plants can rapidly incorporate Si into their tissues to mitigate the adverse effects of herbivory as effectively as plants exposed to Si long term.

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