

A highly economical 'refined not mined' alternative to entrenched agricultural products such as Gypsum with the added benefit of Silicon and other trace elements.

Silicon and Insect/Pest Resistance

In general, silicon (Si) is involved in plant resistance against insect pest damage via two major defense mechanisms: physical defense and induced biochemical (chemical) defense. Taken together Si plays a positive role in priming plants for a better defense response against pest infestation.

Research

The earliest report on Silicon relieving insect pressure relates back to research on Silicon's mediated resistance to maize Hessian fly, Mayetiola destructor (an appropriate name), can be dated back to the 1920s (McColloch and Salmon 1923[1]). Si has since been well documented to enhance the resistance against various insect herbivores in many crops of agricultural importance. It has been well documented that Si has a wide range of insect-feeding guilds, including Lepidopteran bores, folivores, phloem-feeding insects, xylem-feeding insects and other plant feeders (Reynolds et al. 2009)[2].

Interestingly, almost all case studies have shown a positive relationship between pest damage control and the accumulation of Si in plant organs (Laing et al. 2006[3]; Reynolds et al. 2009[2]). Reynolds provided a comprehensive over- view of the then current knowledge of Si-augmented resistance to insect pest damage. As expected, over the past years, rapid progress has been made in interactions between Si and JA (Jasmonic acid) in the defense against insect herbivores involving the priming of JA-mediated defense responses by Si and the promotion of Si accumulation by JA (Ye et al. 2013[4]).

Physical Defenses

It has been long recognized that Si deposited as opaline phytoliths in the cell walls of a plant leaf and stem epidermis may act, directly or indirectly, as an antiherbivore defense. As a mechanism of physical defense, Si increases thehardness and abrasiveness of the plant tissues, which accelerates the wear on the herbivore mouthparts: hence, Si acts as a feeding deterrent reducing the palatability and digestibility of the plants leaves and stems thereby potentially impacting on herbivore performance

Induced Biochemical Defenses

As early as 1958, by conducting a laboratory choice study, Sasamoto[5] showed that larvae of the rice stem borer, C. suppressalis, preferred Si-untreated rice stalks as a diet over Si-treated ones and the larvae feeding on the Si-treated rice stalks showed increased mandibular wear, suggesting that the host choice by an insect depended not only on the physical properties of the food but also on its chemical properties, Notably larvae preferred water extracted from the stem of the rice plant grown on N-rich manure to that extracted from the stem of rice plants fertilised with Silicon. Gomes et al. (2005)[6] investigated the effect of Si and previous infestations with aphids on the induction of resistance of wheat to the greenbug and showed that Si alone or together with preinfestation negatively affected the greenbugs preference and population increase rate and induced a significant increase in the activities of peroxidase (POX), polyphenol oxidase (PPO) and phenylalanine ammonia-lyase (PAL) in wheat. The interactions of Si

with white-fly (B. tabaci) in cucumber (Cucumis sativus) (Correa et al.2002)[7] and greenbug in wheat (Gomes et al. 2005)[6] also suggests that soluble Si is important in induced resistance to insect herbivores, as has been shown for Si-mediated resistance induction to fungal pathogens in various crops (Fauteux et al. 2005)[8]. More recent studies have also proved evidence that soluble Si is involved in induced chemical or biochemical defenses to insect herbivore attack through the enhanced production of defensive enzymes or possibly the enhanced release of plant volatiles (Reynolds et al 2009[3]: Kvedaras et al 2009)[9] .

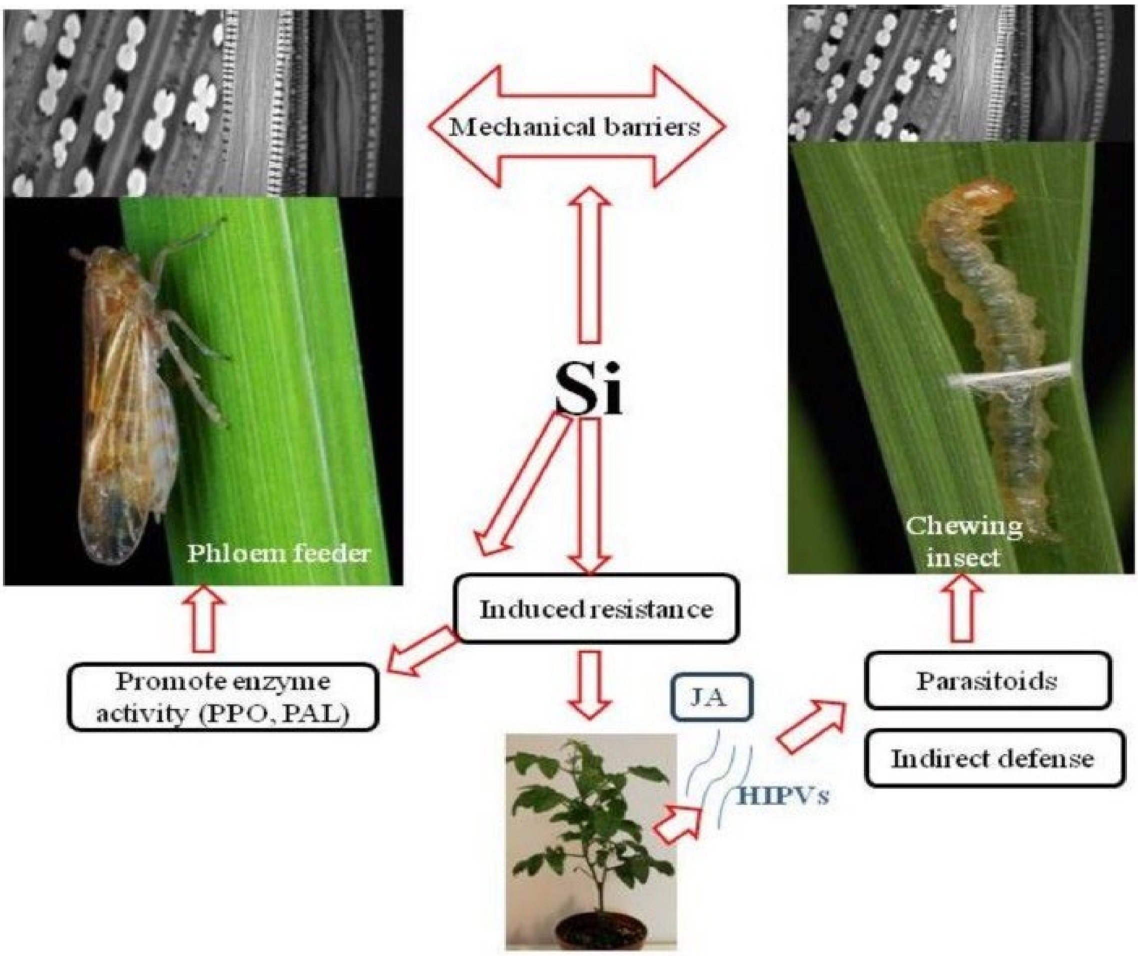

Figure 1. Silicon mediated mechanisms of plant resistance to insect pests. (PPO) polyphenoloxidase, (PAL) phenylalanine ammonia lyase, (HIPVs) herbivore-induced plant volatiles, (JA) jasmonate phytohormone. Silicon and Mechanisms of Plant Resistance to Insect Pests **Fadi Alhousari * and Maria Greger** Department of Ecology, Environment and Plant Science, Stockholm University, 10691 Stockholm, Sweden; 2018

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