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Enhancing Crop Resilience with Phytoliths

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Phytoliths are small silica bodies that are produced within plant cells and provide the plants with resistance against insect pests. They mimic natural barriers and thus deter insects from feeding on the plants. In agriculture, we employ synthetic pesticides which are dangerous to the environment and human health. Silicon, which is present in the soil, is less hazardous to the health of the plants and therefore can be used. Silicon when absorbed by the plants, increases the rigidity of plant tissues and renders them less palatable and digestible to pests. Silicon can be used as a sustainable approach in controlling pests and losses in crops.

Introduction

Insects pests are a major threat to plants and to counter this threat, plants have developed many different ways of protecting themselves. One of these natural defenses is the formation of phytoliths which are small silica bodies within plant tissues. Phytoliths function as mechanical structures that reduce the chances of insects to feed on plants. This process is one of the defense mechanisms of plants to various stress factors such as pest invasion. In traditional agriculture, synthetic pesticides are used for pest control purposes. However, these chemicals are known to have some impacts on the environment and the health of human beings. Another method is the usage of silicon which is a valuable microelement present in the soil. The silicon from the soil makes the tissues of the plants stronger and also increases their immunity to pests. This makes plants less attractive and less palatable to insects.

Silicon has been reported to play a role in plant defense in many crops such as rice, sugarcane, maize and cotton. It has been found that silicon enhances the plant health and decreases the pest attack which is a better and environment friendly solution for pest control. Thus, knowing these natural defense mechanisms, it is possible to create more effective methods of crop protection and minimize the use of toxic chemicals.

Phytoliths: Formation and Function

Formation of Phytoliths: Phytoliths are siliceous bodies which are formed within tissues of plants. They arise from the accumulation of silica (SiO_2) within the cell wall and in the cell lumen. Soluble silica is taken up from the soil by plants and polymerizes to form solid silica structures. These phytoliths differ in shape, size and density according to the plant species and the plant tissue.

Function of Phytoliths in Plant Defense

1. Physical Barrier: They make a hard and rough layer which may discourage the herbivores from grazing on the plants.

2. Nutrient Absorption: Due to their presence in the cell walls, it could be that the phytoliths restrict the access of nutrients to the pests hence making the plant less appealing.

3. Herbivore Deterrence: The mechanical damage that phytoliths inflict to herbivores can cause discomfort and lessen feeding.

Silicon in Plant Defense

Silicon in Plant Health Silicon is one of the beneficial elements that plants take up from the soil. It is stored in cell walls and cell cavities and it reinforces plant tissues and increases their tolerance to different stresses. Silicon contributes to:

1. Cell Wall Reinforcement: Silicon deposition also strengthens the cell walls and hence reduces the permeability of the cell walls to pests and pathogens.

2. Disease Resistance: Silicon accumulations in plants lead to enhanced resistance to diseases that are as a result of fungi and bacteria.

Si in plants enhance three type of defence mechanism against insect herbivore

1. Physical defence
2. Induced biochemical defence
3. Nutritional defence

1. Physical defence: Plants require silicon to defend themselves against insects. In the leaves, stems and roots, silicon creates tiny particles known as phytoliths which make these parts hard. In rice plants, silicon forms a double layer beneath the cuticle that increases the surface's roughness. This roughness hinders the mouthparts of insects in such a way that they cannot feed as they used to do.

Silicon also increases mechanical strength of plant tissues, this slows down insects from penetrating through the plant and provides more time for natural enemies, harsh climate or chemicals to take effect on them. Silicon accumulates in plant tissues, and plants containing more silicon are less palatable and less easily digestible for insects, thus, their growth is retarded.

Silicon can also affect the insects' gut lining which hampers their ability to feed and grow. This can help to reduce the chances of insects developing resistance to the pesticides and also help to enhance the effectiveness of chemicals used in conjunction with silicon.

2. Induced biochemical defence: Applying plant resistance inducers is one of the safest methods of managing insect pests since they do not involve the use of chemicals. Silicon assists in the physical reinforcement of the plant and in the enhancement of the chemical barrier after an insect attack.

Silicon activates stress signals in plants by affecting hormone pathways thus causing the plants to produce defense chemicals. Some plants have different mechanisms of defending themselves depending on the kind of insect that is attacking it. These defenses are regulated by key hormones such as salicylic acid (SA), jasmonic acid (JA), and ethylene. JA is effective in the protection against insects that either bite or consume plant tissues while SA and JA are effective against insects that suck plant fluids.

New studies reveal that silicon has compatibility with JA to improve plant defense. Silicon can also 'condition' plants, which means that it puts them in a position to respond more efficiently to subsequent attacks by insects.

3. Nutritional Defense: Silicon works in conjunction with other nutrients and assists plants to fight insect pests. This implies that when plants have high silicon content, it impacts on the availability of nutrients such as nitrogen. This can result to insects feeding more on these silicon-rich plants. Also, the plants contain high silica that reduces their palatability and digestibility hence slowing down the growth of insects.

Silicon and Pest Management: Silicon's impact on pest management is significant:

1. **Deterrence:** Plants with higher silicon levels are less attractive to pests due to increased mechanical strength and reduced nutritional value.

2. **Improved Plant Growth:** Silicon can enhance overall plant health and growth, making plants more resilient to pest attacks.
3. **Reduced Pest Damage:** Studies have demonstrated that silicon application can decrease pest feeding rates and overall pest damage.

Applications in Agriculture

Incorporation of Phytoliths in Crop Management

1. **Soil Amendments:** Phytolith-rich materials, such as rice husks, can be used as soil amendments to improve soil quality and plant health.
2. **Phytolith-Based Products:** Products containing phytoliths can be developed to enhance plant defenses against pests.

Use of Silicon in Sustainable Farming

1. **Silicon Fertilizers:** Silicon-based fertilizers can be applied to crops to improve their resistance to pests and diseases.
2. **Integrated Pest Management (IPM):** Incorporating silicon into IPM strategies can reduce the need for chemical pesticides, promoting more sustainable agriculture practices.

Conclusion

Phytoliths and silicon are valuable tools for improving plant health and defending against pests. Phytoliths, tiny silica particles in plants, help by creating barriers that make it harder for pests to feed on them. Silicon, a key nutrient, strengthens plant cells and boosts their ability to resist pests and diseases. Using these natural elements can lead to better crop protection and health. Ongoing research will help us understand how to use phytoliths and silicon more effectively in agriculture. By incorporating these methods, we can create more sustainable farming practices.

References

1. Kumar, D. N. T., Manjunatha, K. L., Rakshitha, T. N., Basavaraj, N., Hadimani, & Pampareddy. (2024). Phytoliths for insect pest management. International Journal of Advanced Biochemistry Research, SP-8(8), 664 - 670.
2. Islam, W., Tayyab, M., Khalil, F., Hua, Z., Huang, Z, & Chen, H. Y. H. (2020). Silicon-mediated plant defense against pathogens and insect pests. Pesticide Biochemistry and Physiology, 168, 104641.