Agronomists save tomatoes from toxic aluminum with melatonin

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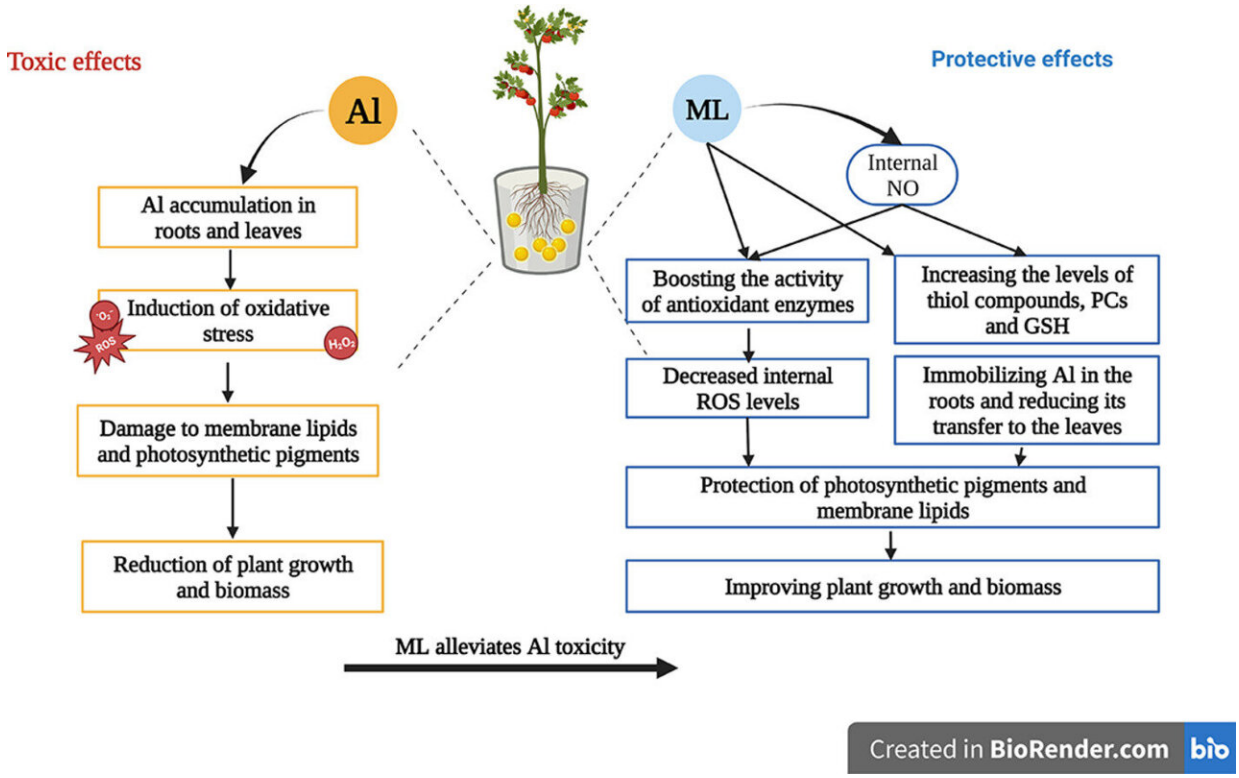

Credit: *South African Journal of Botany* (2023). DOI: 10.1016/j.sajb.2023.09.031

RUDN University agronomists and colleagues from China and Iran have helped tomatoes cope with the toxic effect of aluminum in acidic soils with the help of melatonin. This hormone contributes to nitric oxide

production, blocking the toxic metal and preventing it from destroying plant cells. The results are published in the *South African Journal of Botany*.

In total, 40% of the soils suitable for agriculture on Earth are acidic. In soils with high acidity, aluminum takes a soluble form. That toxic metal does not allow the growth of a high-quality crop. Nitrogen oxide helps plants adapt to poisonous aluminum, and they produce it themselves. RUDN agronomists and colleagues from China and Iran have found a way to increase the release of this gas in plants using melatonin.

"In acidic soils, aluminosilicate turns into soluble forms of aluminum. Plants absorb these toxic compounds. Aluminum combines with cell components and provokes the disintegration of the cell membrane, disrupting cellular signaling pathways. Plants use different strategies to deal with aluminum. One of the most important gases in plants—nitric oxide—increases resistance to stress, including heavy metals," said Meisam Zargar, doctor of agricultural sciences and associate professor of the Agrobiotechnological Department.

To enhance the production of nitric oxide in plants, agronomists decided to use melatonin. It is a hormone that regulates circadian rhythms and the antioxidant system in animals and plants. Its connection with the production of nitric oxide is also known. However, it was not clear whether additional melatonin would help plants cope with the toxic effects of aluminum.

To test this, agronomists planted tomato seeds in an acidic environment. After seven days, they were treated in different combinations and concentrations with aluminum, melatonin, and potassium salt, which absorb nitric oxide. After 42 days, the RUDN agronomists compared the plant indicators.

The addition of aluminum (148 micromoles) increased the level of markers of oxidative stress—malondialdehyde—and aggressive oxidants. The growth of these plants has slowed down, and the content of photosynthetic pigments has decreased. The addition of melatonin (150 micromoles) together with aluminum activated the activity of antioxidants. They protected the cell walls and prevented photosynthetic pigments from being destroyed.

The content of nitric oxide in the leaves and roots of plants has increased. RUDN agronomists suggested that melatonin "blocked" aluminum at the root and prevented it from advancing into stems and leaves. Potassium salt, a nitric oxide absorber, neutralized the protective effect of melatonin. Therefore, the authors concluded that the main component of protection is precisely nitric oxide.

"Melatonin increased the activity of antioxidant enzymes in roots and leaves. This minimized oxidative stress and protected the cell membrane. The results indicate the participation of nitric oxide in protective reactions. We have shown that melatonin contributes to the adaptation of tomato seeds to the toxic effects of aluminum through the regulation of nitric oxide," Zargar said.

More information: Abazar Ghorbani et al, Melatonin-mediated nitric oxide signaling enhances adaptation of tomato plants to aluminum stress, *South African Journal of Botany* (2023). DOI: 10.1016/j.sajb.2023.09.031

Provided by RUDN University

https://phys.org/news/2023-11-agronomists-tomatoes-toxic-aluminum-melatonin.html