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Opinion Article

Organic Matter Decomposition and Soil Fertility: The Role of Artificial miRNAs

Umer Javed*

Department of Horticulture, Ataturk University, Erzurum, Turkey

DESCRIPTION

MicroRNAs (miRNAs) are small, non-coding RNA (Ribonucleic Acid) molecules that play a critical role in regulating gene expression in plants and animals. Recently, the development of Artificial miRNAs (amiRNAs) has opened new avenues in plant biotechnology, particularly in horticulture. amriRNAs can be engineered to target specific genes, providing a essential tool for enhancing plant traits, improving soil fertility, and contributing to conservation efforts. Artificial miRNAs are designed to mimic natural miRNAs but are engineered to target specific genes with high precision. These synthetic molecules can be introduced into plants through genetic engineering techniques. Once inside the plant, amiRNAs can regulate gene expression by binding to complementary mRNA sequences, leading to the degradation of the target mRNA or inhibition of its translation.

Applications in horticulture

Disease resistance: One of the primary applications of amiRNAs in horticulture is enhancing disease resistance in plants. By targeting genes associated with susceptibility to pathogens, amiRNAs can help develop horticultural plants that are more resistant to diseases. For example, amiRNAs can be designed to silence genes involved in viral replication, providing plants with an enhanced defense mechanism against viral infections.

Stress tolerance: amriRNAs can also be used to improve plant tolerance to abiotic stresses such as drought, salinity, and extreme temperatures. By regulating stress-responsive genes, amiRNAs can enhance the ability of horticultural plants to withstand adverse environmental conditions, leading to more resilient crops.

Nutrient use efficiency: Efficient nutrient use is critical for sustainable horticulture. amriRNAs can be engineered to modulate genes involved in nutrient uptake and assimilation, improving the efficiency with which plants utilize soil nutrients. This can lead to reduced reliance on chemical fertilizers, promoting soil health and reducing environmental pollution.

Enhanced growth and yield: By targeting growth-regulating genes, amiRNAs can be used to boost the growth and yield of horticultural plants. This is particularly important for crops with high commercial value, where increased productivity can have significant economic benefits.

Conservation of horticultural plants

Preservation of genetic diversity: amriRNAs can be used to preserve the genetic diversity of horticultural plants by protecting endangered species from diseases and environmental stresses. By enhancing the resilience of these plants, amiRNAs contribute to the conservation of valuable genetic resources.

Restoration of degraded habitats: amriRNAs can play a role in the restoration of degraded habitats by improving the survival and growth of plants used in reforestation and habitat restoration projects. Enhanced stress tolerance and nutrient use efficiency can help plants establish and thrive in challenging environments.

***Ex situ* conservation:** In botanical gardens and seed banks, amiRNAs can be employed to maintain the health and viability of conserved plant species. By protecting these plants from diseases and environmental stresses, amiRNAs help ensure the long-term preservation of horticultural biodiversity.

Soil fertility and health

Promotion of beneficial microbes: Soil fertility is closely linked to the presence of beneficial soil microorganisms. amriRNAs can be used to enhance the production of root exudates that promote the growth of beneficial microbes, such as mycorrhizal fungi and nitrogen-fixing bacteria. These microbes play a important role in nutrient cycling and soil health.

Reduction of soil-borne pathogens: By targeting genes that make plants susceptible to soil-borne pathogens, amiRNAs can

Correspondence to: Umer Javed, Department of Horticulture, Ataturk University, Erzurum, Turkey, E-mail: Ujaved@edu.tr

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help reduce the incidence of diseases caused by these pathogens. This can lead to healthier root systems and improved soil structure.

Organic matter decomposition: amriRNAs can be engineered to enhance the production of enzymes involved in the decomposition of organic matter. This can accelerate the breakdown of organic residues, improving soil organic matter content and fertility.

Phytoremediation: amriRNAs can be used to enhance the ability of horticultural plants to absorb and detoxify pollutants from the soil. This process, known as phytoremediation, can help restore contaminated soils and improve their fertility for future agricultural use.

Challenges and future directions

While the potential of artificial miRNAs in horticulture is potential, several challenges need to be addressed:

Off-target effects: Ensuring the specificity of amiRNAs to target only the intended genes without affecting other important genes is essential. Off-target effects can lead to unintended consequences and need to be carefully managed.

Regulatory and public acceptance: The use of genetic engineering in horticulture, including amiRNAs, requires careful consideration of regulatory frameworks and public acceptance. Transparent communication about the benefits and safety of amiRNAs is essential.

Technical challenges: Efficient delivery of amiRNAs into plants and ensuring their stability and activity over time are technical challenges that researchers continue to address.

Artificial miRNAs represent a essential tool for advancing horticulture through enhanced disease resistance, stress tolerance, nutrient use efficiency, and growth. Their applications in conservation and soil fertility highlight the potential for sustainable and resilient agricultural practices. While challenges remain, ongoing research and technological advancements are paving the way for the successful integration of amiRNAs into horticultural practices, contributing to food security, environmental sustainability, and biodiversity conservation.