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Nano-Delivery System for Efficient Genetic Transformation of Recalcitrant Wheat Without Tissue Culture or Agrobacterium

Nanoparticle delivery inserts genes into wheat seeds without Agrobacterium or tissue culture, speeding stable transformations in recalcitrant varieties.

Cereal grains like wheat form the backbone of the global food system, contributing billions of dollars every year to global economies and ensuring food security for people everywhere. Given the incredible importance of wheat, much research has been dedicated to its genetic improvement, focusing on traits such as yield, disease resistance, nutrient profile, and many more. However, wheat, like many cereal grains, is known as a recalcitrant species, or one for which genetic transformation is difficult to achieve with existing methods. Current techniques rely on a combination of agrobacterium DNA introduction followed by a process called tissue culture, in which plant tissue is painstakingly developed and selected for under sterile conditions. Tissue culture as a method is also limited by its genotype dependency, making it applicable to only some of the thousands of wheat varieties currently available. A second option is particle bombardment, which has also proven extremely difficult to implement effectively in cereal grains and suffers from genotype-dependent limitations. These methods therefore constrain research and development to specialty labs with highly trained staff, while also lacking efficacy and widespread applicability.

In response to these limitations, researchers at Purdue University have developed a novel method of introducing transformative genes to wheat that utilizes innovative nano-delivery technology. This method cuts down on development and testing time, does not rely on agrobacterium, and eliminates the need for sterile tissue culture, opening new doors for potential development settings and lowering the threshold for effective personnel training. This new method has also been shown to have improved efficacy among recalcitrant species such as wheat. The use of nano-delivery techniques promises to break down current barriers in the genetic transformation of staple crops like wheat, ushering in a new era of genetic enhancement that will reduce the likelihood of devastating crop losses,

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increase profits, and modernize the cereal grain industry as a whole.

Technology Validation:

Researchers have experimentally shown this technique's ability to successfully lead to the expression of transgenes. An experiment was conducted using two different types of specialty nanoparticles to introduce plasmid DNA into the genome of wheat seeds. These seeds (T0) were then cultivated, and their progeny were selected for successful transgenic transformation. Those selected seeds (T1) were cultivated, and their offspring (T2) were shown to maintain the introduced phenotype.

Advantages:

-Faster process

-Does not require agrobacterium

-Does not require tissue culture

-Eliminates need for many of the specialty skills traditionally required for DNA transformation, streamlining R&D and personnel training

-Effective method for recalcitrant species such as wheat, which are known to be difficult to transform

Applications:

-Agricultural research and development

-Production of genetically modified organisms (GMOs).

-Transformation of recalcitrant cereal species, which are both extremely economically important and historically difficult to transform.

TRL: 5

Intellectual Property:

Provisional-Patent, 2024-06-26, United States

PCT-Patent, 2025-06-26, WO

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method,precision crop improvement,modern GMO techniques