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RESEARCH

Peptides Show Promise to Advance Agriculture

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Stresses such as heat, drought and salinity (abiotic); bacterial and fungal pathogens (biotic); as well as nutrient (e.g. nitrogen, phosphorus) shortage in arable lands are main factors limiting crop and forage production. Improving plant resilience to stress and efficiency of fertilizer use are key to sustainable and future agricultural productivity, but this requires new approaches and solutions.

Researchers at the Noble Research Institute are taking a novel approach by investigating small peptides as potential agrochemicals to improve plant performance.

Recent progress in basic research indicates great potential for small peptides, compounds consisting of chains of approximately 20 amino acids, to improve plant stress tolerance. A typical plant contains more than 1,000 genes encoding small peptides. In the legume *Medicago truncatula*, a close relative of alfalfa, there may be as many as 4,000.

When plants face abiotic or biotic stresses or nutrient limitation, a significant number of genes encoding small peptides show striking increases in expression, indicating that the derived small peptides play important roles in coping with or overcoming these stresses. Furthermore, an increasing number of the gene-encoded small peptides are now being discovered to act as regulators of plant development, such as root, leaf or flower development and soil microbe interactions, with potential to regulate stress tolerance or nutrient/fertilizer gain.

A key advantage of the peptide approach is that these compounds occur naturally and are bioactive when applied externally. In other words, no genetic changes need to be introduced into crop/forage species through lengthy breeding programs to achieve desired effects when using peptides. In fact, some soil organisms (nematodes) are already known to produce peptides almost identical in structure to plant peptides and are able to alter plant development.

Furthermore, small peptides can be easily synthesized in large quantities. They are often extraordinarily potent, meaning they are bioactive at extremely low concentrations. One ounce of a typical peptide is sufficient to make up enough effective peptide solution to fill five Olympic swimming pools (approximately 3.3 million gallons). Using existing technology, the cost to produce enough of a peptide to cover 1 acre of land could be as low as a few cents. Application of peptides as foliar sprays is possible, although seed coating or application together with fertilizer by banding are also likely strategies.

Sponsored by the National Science Foundation (NSF), researchers at the Noble Research Institute are currently testing an entire library of gene-derived, synthetic peptides for their effects on root growth, gene expression and nodulation of *Medicago truncatula* by rhizobia. In the near future, some of the identified bioactive peptides will be tested on alfalfa in the field, with goals of withstanding nitrogen or phosphorus limitations.