The root of the matter: The role of nitric oxide in root branching

October 7 2013

The structure and plasticity of root systems play an important role in determining the growth and yield of crop plants, and understanding how environmental and biological factors affect root structure is of key importance for plant scientists—particularly agricultural scientists.

Lateral roots, as the name implies, are secondary roots that grow laterally out of a plant's main root, much like branches grow out of the trunk of a tree. The arrangement of roots is determined by a complicated combination of environmental signals based on the availability of nutrients and water in the surrounding environment, hormonal signals, and external stimuli. The presence and strength of each of these signals act as a cue to the plant, which can then make a 'decision' about when and where to form a lateral root.

Nitric oxide is known to be an important regulatory and signaling molecule in both plants and animals and plays an important role in root system formation. Numerous studies have found this molecule to be required for lateral root development in plants such as tomatoes, rice, corn, lupine, and *Arabidopsis*.

A new study, led by researchers at the Universidad Nacional Autónoma de México and the Universidad Autónoma del Estado de Morelos in Cuernavaca, Mexico, has re-evaluated the effect of nitric oxide on lateral root formation, focusing on the process of lateral root initiation and utilizing a new parameter for measuring lateral root density. By treating *Arabidopsis thaliana* with a nitric oxide donor (sodium

nitroprusside) and examining the resulting root system formation, Dr. Dubrovsky and colleagues have determined that this molecule can, in fact, have the opposite effect as previously found and actually inhibit root branching. The new study is available for free viewing in the October issue of *Applications in Plant Sciences*.

"A key finding of this study is that nitric oxide has a dual action on root branching," states Dubrovsky. "Within the same root system, when evaluated on a cellular basis, it may both promote and inhibit root branching in different root portions."

It turns out, the timing of root initiation and how the lateral root density is measured are important. By taking these nuanced factors into account, Dubrovsky and collaborators have found that in primary root portions formed before treatment, nitric oxide promotes lateral root formation, whereas strong inhibition of *de novo* formed laterals was observed in primary root portions that began forming during the treatment.

"The lateral root is a basic unit of the root system," explains Dubrovsky. "To understand how lateral root initiation is controlled in different groups of plants, including crops, under different environmental conditions, we need a simple and reliable method for analysis and comparison."

A previous study led by Dubrovsky proposed a method, termed the lateral root initiation index, for quantifying the initiation of lateral roots in plants. By normalizing root growth for differences in cell size, a more precise estimate can be obtained.

It was with this index that the current study uncovered the inhibitory effects of nitric oxide.

"This new parameter, the lateral root initiation index, provides

researchers with the ability to uncover hidden but important information about root initiation and branching," says Dubrovsky. "This index can be used for any crop plant and, although not a panacea, we hope that the scientific community will recognize its value and ease of use."

Provided by American Journal of Botany