The role of nitric oxide in survival of low oxygen stress in plants

Results in Brief

The impact of flooding on plant roots

Scientists have investigated how the roots of crops respond to periods of flooding in order to ensure good harvests.

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Plants can suffer from oxygen deprivation during flooding and the resulting drop in energy production can have a significant impact on crop production. Plants respond to oxygen deprivation in several ways, which involve changes in their form and structure and alterations to gene expression and metabolism.

Although extensive research has been conducted into the mechanisms that enable plants to sense and respond to oxygen deprivation, they are still not well understood. However, it is known that oxygen deprivation in roots results in a significant increase in nitric oxide (NO). This small lipophilic free radical is synthesised in almost all organisms and acts as a signalling molecule.

Nitrate reductase and plant mitochondrial pathways are the most likely sources for NO during hypoxia (oxygen deficiency). Furthermore, class 1 haemoglobins play an important role in scavenging NO levels during hypoxia. Therefore, the project TRNOILOS (The role of nitric oxide in survival of low oxygen stress in plants) was

established to investigate how NO contributes to regulation of plant metabolism.

Researchers investigated the role of NO in barley roots under aerobic conditions, comparing wild-type (WT) plants with plants that over expressed non-symbiotic haemoglobin 1 (Hb+). The work showed that NO is important for the homeostasis of oxygen and reactive oxygen species (ROS) under aerobic conditions. This established a regulatory role for NO beyond that which was identified under hypoxic conditions.

Plants that have experienced a period of flooding must pass through a potentially damaging reoxygenation phase, during which levels of ROS can be raised. Project partners therefore studied the impact of NO produced under low-oxygen conditions on this process using seedlings from Arabidopsis, a model organism.

Results indicated that NO generated under transient hypoxic conditions protects plants during the subsequent reoxygenation phase through antioxidant mechanisms. In addition, an investigation into the impact of mitochondrial NO production on mitochondria under hypoxia was carried out. It revealed that nitrite reduction to NO protects mitochondrial structure and functionality in low-oxygen conditions.

The TRNOILOS project successfully provided new insights into the regulatory role of NO in aerobic and hypoxic plant metabolism. Growing evidence for the protective role of NO suggests that it may be possible to protect crops using the controlled release of nitrite or NO into affected plant tissue.

Keywords

Flooding, plant roots, nitric oxide, hypoxia, low oxygen stress

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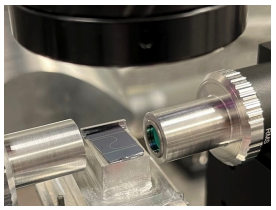

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Project Information

TRNOILOS

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