The Effect of the Phytoglobin Protein on Drought Stress Response in Maize Seedlings

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WHAT IS PHYTOGLOBIN?

- Plant hemoglobin-like protein
- Has an iron group in the center
- Has a high oxygen affinity
  - Can’t function as an O₂ transporter
- Participates in stress responses by scavenging nitric oxide (NO)
  - Involved in conversion of NO into nitrate
  - NO is involved in stress signalling

PROPOSED MODEL

- High levels of NO lead to increased amounts of the stress hormone ethylene
- Ethylene induces reactive oxygen species (ROS) production, leading to plant stress, and eventual Programmed Cell Death (PCD) under drought conditions

RESEARCH QUESTION

- How does phytoglobin expression affect the plant response to drought stress?

TREATMENTS

- Maize (Zea mays) grown to 2-collar, 3-leaf stage and cut at base of stem
- Placed in water for 1 hour, then in polyethylene glycol (PEG) for up to 16 hours to simulate drought (Steuter et al, 1981. Plant Physiology 67: 64-67)
- Three lines: phytoglobin over-expressor (PGB1 up)
  - Phytoglobin downregulator (pgb1 down)
  - Wild type (WT)

GENE EXPRESSION

- Plants treated in H₂O for 16 hours showed no wilting or signs of drought stress
- Plants treated in PEG were wilted in comparison
  - PGB1 up was less wilted than the other phenotypes

ROS STAINING

- ROS staining (blue colour using nitroblue tetrazolium) was performed on the control and PEG-treated plants
- Showed the same pattern as gene expression:
  - Water controls were unaffected (low ROS)
  - WT had the middle amount of stain
  - pgb1 down had the darkest staining
  - PGB1 up had the least staining
- Levels of nitric oxide changed the amount of ROS stain
  - Increasing NO with SNP increased ROS staining
  - Decreasing NO with cPTIO decreased ROS staining
- Changing NO affects ROS production, and thus stress

CONCLUSION

- Over-expressing phytoglobin increases drought stress tolerance in maize seedlings by decreasing levels of NO, ethylene and ROS production

Figure 1: Phenotypic expression of drought stress in transgenic lines under PEG treatment

Figure 2: Gene expression using RT-PCR of ACS2 gene in maize over 0, 4, 8, and 16 hours

Figure 3: Visualization of ROS in maize leaves using nitroblue tetrazolium stain