Plant Topic: **Increasing Plant Tolerance to Oxidative Stress via Overexpression of the AtOXR2 Gene**

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I. Problem

- Biotic stress conditions (fungi, parasite, harmful insect) and abiotic stress conditions (drought, intense sunlight, wind, and temperature) produce reactive oxygen species (ROS).
- ROS are molecules that contain oxygen that are chemically reactive, and are formed as a byproduct from aerobic metabolism.
- ROS, at normal levels, is vital for plants as it plays important role in signaling plant processes such as: growth, development, response to biotic/abiotic environmental stimuli, and programmed cell death
- However, when ROS levels exceed the cell's normal levels, they become dangerous, potentially toxic reactive compounds that can cause protein, lipid, and DNA damage.
- ******Excess ROS are harmful and dangerous to plants******

II. Proposed solution

- ******Increase plant tolerance to oxidative stress******
- How? overexpressing a mitochondrial protein (AtOXR2) that reduces oxidative stress
- How to increase AtOXR2 gene expression? Via T-DNA insertion of mutant lines
- What is T-DNA insertion? *Agrobacterium tumefaciens* (bacterial plant parasite that causes tumors) T-DNA insertion mutagenesis – involves transfer of DNA of the tumor-inducing (Ti) plasmid, however the Ti plasmid has removed tumor-inducing genes, and replaced with the AtOXR2 gene, which then incorporates its T-DNA, containing the AtOXR2 gene, into the host's genome
- Attachment of Agrobacterium to plant cells – need to do more personal research on how the presence of polysaccharides assists attachment leading to genetic transfer

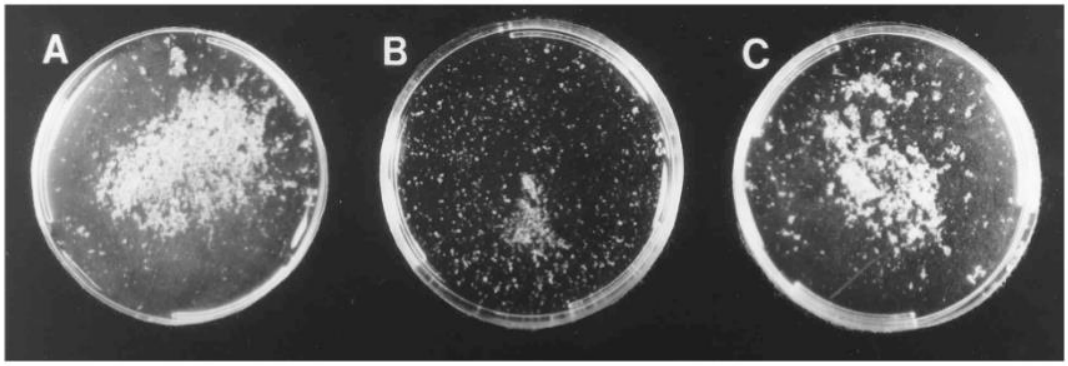

FIG. 2. Effect of polysaccharide pools on aggregation of carrot cells incubated with *A. tumefaciens* C58 for 48 h. Past studies had shown that virulent strains of *A. tumefaciens*, which were able to attach, caused aggregation of the carrot cells (see text). (A) Cells with no polysaccharide added. (B) PW/W from strain C58 (100 μg/ml). Note the inhibition of aggregation due to the addition of the PW/W preparation. (C) PW/P from strain C58 (100 μg/ml). All of the petri dishes shown contained approximately 10^5 carrot cells/ml. The addition of an equal amount of the PW/P preparation had little inhibitory effect on carrot cell aggregation. Similar results were obtained with PW/CI from strain C58 and all three pools from strain C58::A205 (data not shown). Thus, only the strain C58 PW/W preparation was able to effectively inhibit the aggregation of carrot cells.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC179406/pdf/1795372.pdf

III. Regulatory issues

- In the research that I've found, the experiments have been done on certain model organisms: small flowering plants related to cabbage and mustard (Arabadopsis), as well as in rice (japonica), but does this translate to all crop-yielding plants??
- We don't know the harm or long term effects of genetically modified plants:
    1. Do these genetically modified plants abstract additional soil nutrients, leaving the soil more deprived than the non-genetically enhanced counterpart?
    2. Do the genetically modified plants have an effect on the biotic population that it harbors (insects/bacteria/fungi)?
    3. Most tumors have mutations in cell regulation/expression, perhaps since we're altering a tumor inducing (Ti) plasmid and replacing it with a gene that reduces oxidative stress, leading to larger growth, the alteration could lead to uncontrollable plant growth

IV. Proposed regulation

- Start mass trials on a few crop-yielding plants, such as corn, soy, wheat
- test for any potential adverse effects on: biotic population, soil quality, uncontrolled growth, etc.

V. References *[VARIANCE: Needs full references]*

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC179406/pdf/1795372.pdf

how agrobacterium attach to plant cells

https://www.ncbi.nlm.nih.gov/pubmed?term=(photosynthesis)%20AND%20oxygen

what I searched in ncbi to find articles based on "Photosynthesis" and "oxygen"

https://academic.oup.com/jxb/advance-article/doi/10.1093/jxb/erz147/5427669

above article is research article on increasing plant biomass & tolerance to oxidative stress via AtOXR2 protein

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3578903/

article above explains what ROS is (reactive oxygen species)

http://www.plantphysiol.org/content/154/3/1304

above article is research article on overexpression of DSM2 significantly improving drought resistance in rice

https://microbewiki.kenyon.edu/index.php/Agrobacterium_tumefaciens

review article on agrobacterium tumefaciens

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4091114/

article above explains oxidative stress

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4091114/

article above explains reactive oxygen species

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3108046/

article above explains T-DNA insertion having epigenetic changes

https://www.annualreviews.org/doi/full/10.1146/annurev.arplant.51.1.223?url_ver=Z39.88-2003&rfr_id=ori%3Arid%3Acrossref.org&rfr_dat=cr_pub%3Dpubmed

article above explains T-DNA transfer process

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3197693/

importance of oxidative stress