Update in the Use of brt Mutant Tomato Plants for DDT Phytoremediation

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Introduction

Last year's *Report* detailed a then three year study regarding the phytoremediation of dicofol and dichlorodiphenyltrichloroethane (DDT) using bushy root (brt, LA2816) and wild-type tomato plants. This study concluded that the wild-type tomato plants were much more effective at removing the DDT from the soil, but generally did not describe through reasoning as to why this is the case. After the publication of last year's *Report*, further research was performed to solidify conclusions and future study regarding the removal of DDT using tomato plants.

Conclusions

Previously it was stated that, "Research to better explain the reason that wild-type plants are more effective phytoremediators of Kelthane is still ongoing." Such research has been completed with interesting results. The Brix (sucrose) levels measured in the roots of brt mutated plants were significantly higher when compared to wild-type plants. This increased sugar level is caused by the original brt mutation. This mutation altered a sucrose transport protein in the tomato genome and caused additional sucrose transport from the soil through the roots and into the fruit of the plant. As such, the brt plants had a much higher concentration of sucrose in the roots of the plant because this sucrose was collecting and not being transported. The effective result of the extra sucrose in the roots of the plant meant that DDT and dicofol had no transport pathways into the fruit and could not be removed in large quantities. The uptake of DDT is similar to the uptake of sugar and other nutrients; reducing the pathways for build-up in the fruit by eliminating transport proteins ended up decreasing the bushy root mutant's phytoremediation ability.

Higher sucrose transport in the wild-type plant allowed for additional phytoremediation. In this case, the DDT mixed with sucrose and other nutrients in the roots and was transported into the fruit and leaves of the tomato plant. Of this DDT that was transported, the vast majority remained in the fruit of the plant and did not degrade. A small percentage naturally degraded into dichlorodiphenyldichloroethylene (DDE), a more refined version of DDT, but this percentage was determined not to be significant.

Thus, more DDT could be removed when the overall sucrose transport increased and sucrose levels were lower. The high sucrose levels in the roots of the plant and, it is surmised, the fruit of the plant, prevented DDT from being taken up into the fruit and removed from the soil.

Future Study

This study supports the finding that high sucrose levels lead to reduced phytoremediation of DDT. Such a result can be confirmed in a proposed two-step process.

The first step involves testing a counter hypothesis: that even higher levels of sucrose in the roots and fruit of tomato plants will remove even less DDT. This hypothesis must be tested first because the Tomato Genetics Resource Center has a standard "sucrose" mutant (sucr, LA4104) with maximized sucrose levels. By performing similar tests to those done to the brt mutant one should find that phytoremediation is minimized.

If this is the case, it is proposed that the tomato genome be mutated to lower sucrose levels as much as possible. While the wild-type tomato plant is an effective phytoremediator of DDT, both the speed and effectiveness of such phytoremediation can be improved if sucrose levels were further reduced.

As it stands now, a tightly planted area of wild-type tomato plants can remove in excess of seventy-five percent of DDT contamination after only a few months. This is conditioned on the fact that the DDT is accessible by the roots of the tomato plant. Lowering the sucrose levels not only improves phytoremediation, but will also discourage animals from eating phytoremediators and ingesting pesticide. Eventually, the goal will be to transfer the sucrose relationship found in tomato plants to a plant that is not edible in order to reduce concerns about the safety of phytoremediation in public spaces. Overall though, this study has concluded that sucrose negatively affects phytoremediation, the most environmentally friendly method of removing heavy metals and pesticides from the soil.