CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

Vardhaan Sai Ambati

Project Number

J1702

Project Title

Are Manufactured Nano-Materials (MNMs) an eco-toxicological risk? - Conducted Using Three MNMs and a Biosensor, Rhizobia

Abstract

Objectives/Goals

Use of MNMs is increasing rapidly, and this experiment is to find out if MNMs are a greater eco-toxicological risk than their conventional sized counterparts, using rhizobia as biosensor. I picked soybean because it's the second largest crop in USA. I chose three commonly used nanoparticles of ZnO, TiO(2) and CeO(2) for the project. These particles end up in farms as solid waste and can cause harm to our ecology by contaminating our food crops, entering our food stream, and impairing rhizobia, which is essential for nitrogen cycle.

Methods/Materials

Soybeans seeds were sown in five groups of three different soil concentrations (5mg, 100mg & 500 mg in 1 kg of soil) made using six chemicals: ZnO, nanoZnO, CeO(2), nanoCeO(2), TiO(2), nanoTiO(2). Normal soil was used for control group. At the unrolled trifoliate (V1) stage, root nodules were crushed, and rhizobia cultures were developed using streaking method. The number of "colony forming units" (CFUs) on the fourth streak was recorded on the fifth day.

Results

The average CFUs per petri-dish are 20 for control group, 8 for non-nano (500mg), and 2 for MNMs (500mg). All plants exposed to non-nano particles except plants exposed to nanoZnO took less time to reach V1 stage than their MNM counterparts. A SEM analysis showed 2.7% of Zinc in ZnO 500mg plant and 3.11% of Zinc in nanoZnO 500mg plant. Also, mushrooms grew in soils containing higher concentrations of MNMs.

Conclusions/Discussion

MNMs are an eco-toxicological risk. The low CFU count proved that MNMs killed the rhizobia essential to the growth of soybeans and the nitrogen fixation. The growth of plants exposed to MNMs was inhibited compared to non-nano group and control group. The presence of mushrooms proved that MNMs caused nitrogen deprivation because an absence of nitrogen slows organic-matter decomposition, allowing mushrooms (fungus) to feed on organic-matter and thrive.

Summary Statement

Using rhizobia as a biosensor, this experiment's goal is to find out if MNM's are a greater eco-toxicological risk than their conventional sized counterparts.

Help Received

Navin Sharma of ICE Inc. mixed nanoparticles with soil and performed SEM analysis; Dr. Holden from Santa Barbara University suggested improvements; Ramona Desai and Wen CAO ,Ph.D., for helping me understand safety procedures; Neha Makhijani, my science teacher, for guiding me throughout the project.