



**CALIFORNIA STATE SCIENCE FAIR  
2017 PROJECT SUMMARY**

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<b>Project Title</b> <b>Effects of Human Pharmaceuticals on Growth of Common Crop Plants</b>	
<p style="text-align: center;"><b>Abstract</b></p> <p><b>Objectives/Goals</b> Modern sewage treatments do not remove majority of pharmaceuticals from the filtrate, releasing 30 to 60% of a contaminant in the outflow. Arid regions such as Pakistan are starting to use treated sewage water for irrigation purposes. Little research is dedicated to repercussions of applying pharmaceuticals to crops. This study evaluates what effects such practices have on development of 3 crop plants. General hypothesis is that application of pharmaceuticals to plants will decrease standard growth metrics such as biomass, root length, height, root-to-shoot ratio, and root biomass.</p> <p><b>Methods/Materials</b> Phase 1 of the study looks at the impact of real life concentrations of Diclofenac, Ibuprofen, Carbamazepine, Lovastatin, and Atorvastatin on germination of soy, wheat, and barley. After irrigation with solutions for 2 weeks, plants were measured for typical growth metrics. Phase 2 evaluated impacts of the compounds on the adult stage of development. 2-week old sets of wheat were irrigated for 2 weeks and assessed on standard metrics. Phase 3 assessed applying combinations of compound classes to wheat seedlings. A set was watered with Ibuprofen, Lovastatin, and Carbamazepine for 2 weeks and measured on typical metrics.</p> <p><b>Results</b> Analysis of Phase 1 data shows that all compounds have a negative effect on some measured endpoints, p-values 0.03-0.3. NSAIDs and Lovastatin application resulted in the top number of deviations from the control group. Phase 2 analysis suggests that Ibuprofen and cholesterol-modulators have a statistically significant negative impact on most measurements, p-values 0.02-0.3. In Phase 3, all measured endpoints showed a statistically significant decrease, p-values 0.01-0.3. The combination also resulted in a prevalence of delayed gravitropism in the study set.</p> <p><b>Conclusions/Discussion</b> Not all endpoints showed significant decreases compared to the control group, but holistically the results point to a deleterious effect of ubiquitous pharmaceutical contaminants on both germination and adult growth of plants. Additionally, observed delays in root gravitropism suggest compound combinations might exacerbate the effects of any one pollutant. An expansion of this study entails molecular interactions within higher plant systems, as well as cheap removal techniques in outdated sewage facilities.</p>	
<b>Summary Statement</b> After assessing growth metrics of 3 crop plants irrigated with common pharmaceutical water pollutants, the results show delayed root gravitropism in response to a combination of compounds as well as a significant decrease of growth.	
<b>Help Received</b> I utilized the Harker School OpenLab program for upper school independent researchers to complete all of the research for this project.	