



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Shivani Bharadwaj; Ella Foster	Project Number S2201
Project Title The Effect of Smoking on the Incidence and Severity of Systemic Lupus Erythematosus	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective of this case-control study was to determine the effect of cigarette smoking on the incidence and disease severity of systemic lupus erythematosus.</p> <p>Methods/Materials 60 patients with systemic lupus erythematosus (cases) and 60 patients with non-autoimmune causes of joint/muscle pain (controls) were identified and matched for gender and age at a local arthritis clinic. They were asked to complete an anonymous survey regarding their smoking history and, in the case of lupus patients, details about their disease severity, including a disease activity score. Results were analyzed using statistical methods. Cases and controls were compared with regard to smoking history. A subgroup analysis of the lupus patients was also performed to further study differences in disease severity between lupus patients who had a smoking history and those who had no smoking history.</p> <p>Results This study showed no difference in the rates of smoking between the 60 lupus patients (cases) and the 60 non-lupus controls. However, the subgroup analysis of the lupus patients showed a significant increase in the self-reported disease activity score in lupus smokers (4.86 +/- 2.61) compared to lupus non-smokers (3.31 +/- 2.24), p=0.025. Also, lupus patients with a smoking history were significantly more likely to have neurologic disease with odds ratio of 3.43 (85% CI 1.1, 10.67) compared to non-smokers with lupus. Incidence of kidney and lung disease was not different between the two groups, and history of hospitalization for lupus was also not different between the two groups.</p> <p>Conclusions/Discussion This study showed no significant difference in smoking rates between lupus patients and controls, implying that smoking may not increase the incidence of a lupus diagnosis. However, the findings showed that when lupus patients smoke, they have more severe disease. Specifically, they have higher self-reported disease activity scores and a greater incidence of neurologic disease. Thus, patients with lupus should be cautioned against using tobacco products to reduce the risk of more severe disease.</p>	
Summary Statement We showed that smoking may not increase the risk of developing lupus, but lupus patients who have smoked have more severe disease and are more likely to have neurologic involvement.	
Help Received We received help from Dr. Zuzana Foster at the Northern California Arthritis Center in recruiting patients to complete the surveys for our study. We designed our study and our survey questionnaire, and performed the statistical analysis ourselves.	



**CALIFORNIA STATE SCIENCE FAIR
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Name(s) Chloe A. Breen	Project Number S2202
Project Title The Disadvantages of Imidacloprid: The Effects of Imidacloprid on Alfalfa	
Abstract Objectives/Goals The goal of this project is to show that insecticides damage plant life as well as the targeted insects. I observed the growth of alfalfa sprouts with and without an insecticide called imidacloprid. Methods/Materials In this experiment there are two control jars of alfalfa sprouts and two jars of sprouts grown with the chemical. The imidacloprid is found in flea medicines for pets. Results The results of this project are that the sprouts grown with imidacloprid did not succeed past germination, while the control jars continued to grow healthily. Conclusions/Discussion This information could be useful in encouraging people to decrease the use of these insecticides to create safer environments.	
Summary Statement My project is about the negative effects that insecticides, specifically neonicotinoids, have on plant life.	
Help Received Erin Vaccaro	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Elizabeth Chang; Hannah Park	Project Number S2203
Project Title The Effects of Synthetic and Natural Antifungal Medications on the Growth and Viability of <i>Saccharomyces cerevisiae</i>	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Determine the effectiveness of two different synthetic and natural antifungal medications on limiting the growth of <i>Saccharomyces cerevisiae</i> over time.</p> <p>Methods/Materials The synthetic medications used were terbinafine hydrochloride and clotrimazole. The natural medications used were coconut oil and tea tree oil. The <i>S. cerevisiae</i> were cultured on petri dishes. All medications were sprayed onto the <i>S. cerevisiae</i> cultures. The mass of <i>S. cerevisiae</i> while exposed to each medication was recorded in 6 hour intervals over the span of 48 hours.</p> <p>Results The overall mass decrease (final minus initial mass) of <i>S. cerevisiae</i> after exposure to each medication showed the effectiveness of the medications. From greatest to least mass decrease, the results were: terbinafine hydrochloride (0.928 g), coconut oil (0.919 g), tea tree oil (0.890 g), and clotrimazole (0.855 g). Terbinafine hydrochloride was the most effective in limiting cell growth, while clotrimazole was the least.</p> <p>Conclusions/Discussion The simplicity of each medication's mechanism of action in disrupting <i>S. cerevisiae</i> cells determined the medication's effectiveness. This shows that the general type of medication (synthetic, natural) does not impact the overall effectiveness as much as the mechanism of action of each medication's active ingredient.</p>	
Summary Statement We found that the main factor in determining an antifungal medication's effectiveness was its mechanism of action.	
Help Received We designed and performed the experiments ourselves after thorough background research.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Sarah Cohen; Hannah Schalyo	Project Number S2204
Project Title Evaluation of the Effect of Paraben Exposure on Sea Urchin (Strongylocentrotus purpuratus) Fertility	
Abstract Objectives/Goals Evaluation of the effect of parabens on sea urchin fertility through sperm exposure and in vitro fertilization. Methods/Materials Used potassium chloride solution to remove sea urchin gametes. Used propyl- and methylparaben as main chemicals of exposure. Analyzed success of fertilization and effects of paraben exposure through microscope. Results The results show that all concentrations of Methyl- and Propylparaben exposure are detrimental to the sea urchin sperm and fertility. The higher concentrations of paraben exposure had increasingly negative effect on the organisms, as opposed to the lower concentrations. Conclusions/Discussion Based on our research, it has been found that parabens can alter fertility rates when directly exposed to sea urchin gametes. While lower levels of paraben exposure are had a smaller effect on fertility, higher levels made a significant difference in the success of sea urchin fertilization. Therefore, a need for further testing on human fertility is necessary before the amount of parabens found in food and cosmetic could be limited by FDA restrictions.	
Summary Statement We showed that paraben exposure has adverse effects on the survival of sea urchin embryo and sperm motility.	
Help Received We designed the methods ourselves based off of previous research. Our research teacher reviewed our results.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Hunter C. Crawford-Shelmadine	Project Number S2205
Project Title Investigation of the Impact of Common Toxicants on Survival Rates of Daphnia magna after Exposure to LC50 Levels	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The main objective is to determine if Daphnia magna are exposed to LC50 levels of common toxicants found in our waterways, then are removed from those conditions, will they have the same long term survival rate as the Control. The secondary objectives are 1) to determine if there is a correlation that the more harmful the toxicant, the shorter the life span once exposed then removed; 2) if exposure to two toxicants has a statistically significant more lethal impact than exposure to one toxicant.</p> <p>Methods/Materials Phase 1-Scouting - determine concentrations needed for acute reaction. Phase 2-Perform 3 trials of 10 Daphnia magna in 10 toxicant solutions [0%, .2%, .5%, 1%, 1.5%] to determine the LC50 [Lethal Concentration when 50% of population dies]. Solutions: oxybenzone sunscreen, zinc oxide sunscreen, imidacloprid pesticide, nitrogen fertilizer, Oxy & Zinc, Oxy & Pest, Oxy & Fert, Zinc & Pest, Zinc & Fert, Pest & Fert. Phase 3-Use LC50 value from Phase 2. Run 3 trials of ea. solution at 1%. Expose Daphnia to time needed to reach the LC50. Remove survivors & place in spring water. Record death rate.</p> <p>Results 1. In all trials except for one, exposure to 1% solutions prohibited the Daphnia from living out a natural lifespan once placed in spring water. Within 24 hours, 100% of the Daphnia were dead in 7 of the 10 solutions. Only exposure to 1% nitrogen resulted in Daphnia having the same survival rate as the Control. Solutions with nit. & oxy. and nit. & zinc survived 72 hrs & 144 hrs respectively. 2. There is NO consistent correlation between time to reach LC50 and long term survival of Daphnia. 3. If the 2 toxicant solution had either imid. or oxy., the difference in the lethal impact to the Daphnia compared to exposure to the toxicant individually was NOT statistically significant. If the 2 toxicant solution contained zinc. or nit., in all cases except for one, the difference in the lethal impact to the Daphnia compared to exposure to the toxicant individually WAS statistically significant.</p> <p>Conclusions/Discussion My hypothesis is mostly correct. All Daphnia exposed to 1 or 2 toxicants were not able to recover to live out a normal life span compared to the Control, with the exception of nitrogen. This shows that not all toxicants will result in certain death after exposure, once removed from the toxic environment. It also shows the importance of reducing the amount of toxicants that enter our waterways.</p>	
Summary Statement This experiment tests how exposure to LC50 levels of common toxicants in our marine waterways impacts the long term survival of Daphnia magna once they are removed from the toxic environment and placed in a clean environment.	
Help Received I designed and performed the experiment on my own. My mom ordered the materials and provided lab assistance under my direction when needed.	



**CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY**

Name(s) Hannah R. Dam	Project Number S2206
Project Title Can Rubbing Sunscreen on a Plant's Leaves Kill the Plant?	
Abstract Objectives/Goals To determine whether sunscreen actually blocks out all the photons from entering the leaves. Methods/Materials Used 16 arugula plants in total with 4 in each group. For 3 out of the four groups, the brand of organic chemical sunscreen was changed and the last group is the control group. Grew the plants, outside, from seed for 2 weeks and then for the next 3 weeks sunscreensed the plants every other day. Weighed the mass of the leaves to compare the growth of each plant and group. Results All 12 plants with the organic sunscreen applied to them died slowly over the three weeks. Conclusions/Discussion Due to the organic sunscreensed plants gradually turning yellow and weak, a chlorophyll deficiency was indicated and a photon blockage that prevented photosynthesis can be concluded. Since the only factor of the plants' death was a nutrient deficiency from the sun, organic chemical sunscreen with zinc oxide should not be harmful to a human's skin and therefore should be used rather than artificial chemical sunscreens.	
Summary Statement I tested the effects of organic sunscreen with the main ingredient of zinc oxide on plants to show the relative chemical safety of organic sunscreen on human skin.	
Help Received None. I built, planted, designed, and conducted the experiment on my own.	



**CALIFORNIA STATE SCIENCE FAIR
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Name(s) Anastasiya Grebin	Project Number S2207
Project Title Effects of Human Pharmaceuticals on Growth of Common Crop Plants	
Abstract Objectives/Goals 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. Methods/Materials 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. Results 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. Conclusions/Discussion 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.	
Summary Statement 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.	
Help Received I utilized the Harker School OpenLab program for upper school independent researchers to complete all of the research for this project.	



**CALIFORNIA STATE SCIENCE FAIR
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Name(s) Nathan A. Holloway	Project Number S2208
Project Title Analyzing the Toxicity of Imidacloprid on Artemia salina Cysts	
Abstract Objectives/Goals The objective of this study is to analyze the effect that Imidacloprid has on brine shrimp hatching rate and survival. Methods/Materials Brine shrimp eggs and Imidacloprid were commercially available. With increasing concentrations of Imidacloprid, brine shrimp eggs and hatchlings decreased accordingly. Percentages of brine shrimp that hatched and survived were found after counting under a dissection microscope and calculating the data. Integrative methods were used to find the rate of hatching and survival of brine shrimp. Results My results indicate that Imidacloprid is toxic to brine shrimp in the way that it inhibited the hatching of brine shrimp and decreased survival among brine shrimp with increasing concentrations of Imidacloprid. Conclusions/Discussion From the results it is concluded that Imidacloprid is toxic to brine shrimp. Homologies such as hemoglobin, ovaries, and a heart, which are all seen between brine shrimp and larger organisms, indicates the effect that Imidacloprid can have on larger organisms such as humans. In addition, the phenomenon known as biological magnification examines how primary consumers take in toxins from the environment and secondary consumers consume the primary consumers with the toxins, and with more and more consumption, at each consecutive step, the concentrations of toxins increase exponentially, ultimately to be found in humans at higher concentrations.	
Summary Statement As seen in the decline of brine shrimp hatching and survival when exposed to higher concentrations of Imidacloprid, the effects are evident in larger organisms and the environment	
Help Received My teacher provided laboratory equipment and space, in addition to guidance in experimental design and data analysis. I independently researched scientific literature, created novel methods, collected data, and drew conclusions.	



**CALIFORNIA STATE SCIENCE FAIR
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Name(s) Joseph A. Huitt	Project Number S2209
Project Title Don't Mess with my Bee's Nervous System! Investigating the Effects of Neonicotinoids on Bee Colonies	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The objective of this study is to see if honeybees are being exposed to neonicotinoids, and if I can completely eliminate or control the exposure of neonicotinoids to my colonies, keep my hives strong for pollination, over wintering and not contaminating honey.</p> <p>Methods/Materials Tested for neonicotinoid residue in bee samples, corn syrup and honey. 36 hives were exposed to Clothianidin (neonicotinoid) in alfalfa field, 36 hives in cornfield exposed to Thiamethoxam (neonicotinoid), 36 hives in pesticide free corn seed field, 36 hives in pesticide free alfalfa field. Clothianidin and Thiamethoxam are my control groups because bees are commonly exposed to these chemicals to compare effects on the colonies.</p> <p>Results 72 hives exposed to neonicotinoids had major losses 50%-60% in colony size and deformities in the bees, noticeable in baby larvae dying. Neonicotinoids leave trace amounts of residue in honey. I found mite populations to infest the hive, which causes CCD in worker bees and in capped brood cells. There was an insufficient work force to maintain the brood that was present and a noticeable decline in honey production from neonicotinoid fields. Neonicotinoids disrupt the bee's central nervous system, learning and navigation, making them vulnerable to parasites and viruses. After testing High-fructose corn syrup for neonicotinoid residue, it was found and survived the sugar processing.</p> <p>Conclusions/Discussion Exposure to neonicotinoids is killing bees, queens, and leading to CCD by making hives vulnerable to mites, parasites and viruses. It's found in nectar and pollen that worker bees gather, take back to nurse bees to make beebread then fed to new bee larvae, which showed reduced survival, and pupation, deforms new worker bees, disorients its nervous system, or dies in cells before hatching out. Honeybees exposed to neonicotinoids experienced problems with flight, navigation, slower learning new tasks, impacts foraging abilities and hive productivity. Neonicotinoid dust is highly toxic to bee's. High fructose corn syrup tested positive for neonicotinoids. The neonicotinoid defects were cut 100% in most hives and CCD was cut extremely (5%) winter loss. Spray free areas were full of healthy pollen, which led to healthy bees and more honey production. I observed dead bees where fields were treated with neonicotinoids. Corn and sugar syrups contain neonicotinoid residue causing great losses to bee colonies.</p>	
Summary Statement My project shows how bees exposed to sub lethal levels of neonicotinoids are killing my bees and leading to colony calapse disorder.	
Help Received My mom worked with me, as she is a beekeeper, the Bee Diagnostic team helped with my testing along with the USDA.	



CALIFORNIA STATE SCIENCE FAIR 2017 PROJECT SUMMARY

Name(s) Homin Key; Jaskirat Sandhu; Shotaro Yamaguchi	Project Number S2210
Project Title Mycelium's Effect towards Varroa Mites and the Honey Bee Population	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The purpose for this project is to see which test subjects, Watered Oyster Mushrooms, or Unwatered Oyster Mushrooms, will kill or fend Varroa mites the most, without killing the bees. We decided to experiment on this project to help bring a positive change in the honey bee colony and its production as well as reduce the death rates caused by the Varroa mites by eradicating them.</p> <p>Methods/Materials We have obtained our major resources of honey bee colonies and bee keeping equipments from the Glory Bee Farm and the Oyster Mushrooms from the product, #Back to the Roots#. We started by checking our 4 bee colonies available to us, to be healthy and well functioning but infested with Varroa mites. After checking the health of the bees, we would divide the Oyster Mushroom block into 2 separate pieces and place them in separate colonies. We then labeled the bee colony boxes for its individuals material and placed the Watered and unwatered mycelium in the correct box. We placed sticky pads underneath the colony to collect the dead fallen mites and record the number of eradicated mites.</p> <p>Results Compared to the control and the unwatered mycelium, the watered mycelium showed favorable results by eliminating more than 90% of Varroa mites compared to the control. The watered mycelium led to a positive change towards the honey bees and their colony by reducing the number of Varroa mites.</p> <p>Conclusions/Discussion Our experiment shows that the Watered Oyster Mushroom is the most effective way to kill the varroa mites, because the number of dead mites in the total span of the experiment was 425 for the Watered Oyster Mushroom compared to the Control which had 26 and the Unwatered Oyster Mushroom which had 30. The Unwatered Oyster Mushroom had little to no effect on the mites and had the same result as the control (natural). We can conclude that in order for the Oyster Mushroom to be effective for the bees, it needs to be watered. Given the data, the results shows that the Oyster mushroom gave the most positive, long term effect against the mites. This will allow bee keepers to use organic and nonharmful substances to kill pests, in this case the Varroa Mites, to create a healthier bee colony rather than using harmful and in some cases, illegal pesticides to eradicate the Varroa mites and hurting the honey bees.</p>	
Summary Statement We tested factors of Mycelium and learned that Watered Oyster Mushroom will most effectively eradicate Varroa mites and support the growth and production of the honey bee colony.	
Help Received We received help from Ben, a beekeeper at Glory Bee Farm. He taught us how to properly handle the bees and gave us advice on how to count the Varroa mites found in Honey bee colonies.	



**CALIFORNIA STATE SCIENCE FAIR
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Name(s) Momtahina Tahmida	Project Number S2211
Project Title The Effects of Diet Supplements on Heart Palpitation of Palaemonetes	
Abstract Objectives/Goals The objective of this experiment was to determine if diet supplements, (2, 4 Dinitrophenol Sodium, Sida Cordifolia, and Coumarin) would have an effect on heart rate and life expectancy of Glass Shrimps (Palaemonetes). My hypothesis is that if diet supplements (2,4 Dinitrophenolate, Sida Cordifolia (Bala), and Coumarin) is tested for maximum effect on the heart rate of Palaemonetes then, 2,4 Dinitrophenolate will have the maximum negative effects on the heart rate of Palaemonetes. Methods/Materials Solutions of the supplements (2, 4 Dinitrophenol Sodium, Sida Cordifolia, and Coumarin) were made based on estimated dosage for glass shrimps. Dosage of the supplements obtained by comparison with LC50 and LD50 of other animals for each supplement. Results Heart rate of glass shrimps were measured before and after exposure to the supplements for comparison of effect. There was a significant increase in heart rate after exposure to 2,4 DNP Sodium compared to the other supplements. Conclusions/Discussion A significant increase in heart rate of glass shrimp in the 2,4 dinitrophenolate sodium experimental group indicates relation to negative effects as it leads to oxygen consumption and coronary flow increase, which are symptoms of heart failure. This contributes to established research on the supplement by depicting its toxicity along with toxicity of the other supplements.	
Summary Statement I compared effects of diet supplements(2, 4 Dinitrophenol Sodium, Sida Cordifolia, and Coumarin) on heart rate of Palaemonetes to depict their toxicity.	
Help Received I designed the experiment and performed it myself after reading research articles and other experiments. My STAR I teacher, Mrs.Ramirez-De La Cruz, reviewed my experiment.	



**CALIFORNIA STATE SCIENCE FAIR
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Name(s) Haidyn N. Washburn	Project Number S2212
Project Title Assessing Environmental Risk of Silver Nanoparticles Using Daphnia magna	
Abstract Objectives/Goals Colloidal silver and silver nanoparticles have been used for decades to treat various medical conditions and are now being extensively added to a variety of textiles and home goods as an antimicrobial. The present study aims at assessing the environmental impact of silver nanoparticles on the aquatic ecosystem. Methods/Materials Daphnia magna were exposed to varying concentrations of colloidal silver to assess mortality. A stock solution of 1,000 µg nanosilver to 1L water was diluted to 5µg/L, 10µg/L, and 25µg/L to form the 3 test solutions. Each test group consisted of 5 plastic cups containing 5 Daphnia magna for a total of 25 Daphnia magna per test solution. The tests were monitored closely and mortality of Daphnia magna was documented every 2 hours over the course of 28 hours. After 28 hours all Daphnia magna in test groups 1, 2, & 3 were dead. Results After 28 hours all test groups had 100% mortality. The average lifespan per trial of test group 1 (5µg/L) was 19.32 hours. Test group 2 (10µg/L) had an average lifespan of 9.44 hours and test group 3 (25µg/L) had an average lifespan of 6.8 hours. The control group, consisting of 500mls water, only had 3 of the 25 test Daphnia die during testing. Conclusions/Discussion Although mortality was proven to be dose dependent, changes in terms of death rate were significant at 25µg/L colloidal silver concentration exposure. These findings are significant in showing increased toxicity to a vital part of the aquatic food web.	
Summary Statement This study proves that silver nanoparticles dramatically increase mortality in Daphnia magna; threatening a vital component of the aquatic food web.	
Help Received I researched testing techniques required for this study and performed all tests myself.	



**CALIFORNIA STATE SCIENCE FAIR
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Name(s) Gina Y. Yang	Project Number S2213
Project Title Investigating Colony Collapse Disorder: Synergistic Effects of In-hive Miticides on the Health of Honeybees <i>A. mellifera</i>	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals Bee pollination accounts for \$15 billion in added crop value and 1/3 of the food consumed in the U.S. Yet for more than ten years, Colony Collapse Disorder (CCD) has been responsible for unexplained large-scale bee losses. These bee die-offs have implicated not only the deadly parasitic mite <i>Varroa destructor</i>, but also the miticides used to control it. This project investigated the separate and synergistic effects of tau-fluvalinate and thymol, two common miticides, on the health of honeybees. It was hypothesized that bees orally exposed to these two miticides, especially when in conjunction, would exhibit learning and memory impairment and higher mortality.</p> <p>Methods/Materials 150 honeybees were divided into 10 groups of 15. A control group was fed with sucrose solution, while other groups were fed with different concentrations of miticide as follows (1%, 3%, and 5% concentrations of fluvalinate and thymol in conjunction, and the 6 other groups fed with the miticides but separately). All groups were triplicated. Bees were maintained in hoarding cages and allowed to feed ad libitum from feeders. Mortality was recorded daily; after 3 days of feeding, proboscis extension reflex (PER) assays took place to assess olfactory associative learning and memory.</p> <p>Results According to Pearson chi-square test, mortality in all miticide-fed groups, except for those fed with 5% and 10% of fluvalinate/thymol solution, was not statistically different than mortality in control groups. Another Pearson chi-square test was conducted to examine the relationship between the learning performances of miticide-fed bees and controls; the number of PER responses elicited in all miticide-fed groups, except for those fed with 1% thymol solution, was determined to be significantly lower than the number of responses in control groups.</p> <p>Conclusions/Discussion As shown by a lack of conditioned PER response, both miticides had a significant negative impact on bee learning and memory, and both fed in conjunction had an even greater negative impact overall on the bees' health. Olfactory learning and memory association are vital to foraging and homing behavior, which are crucial to colony food supply. Learning impairment in workers would therefore have serious implications for the health of colonies. Thus, the negative effects of miticides on bee learning and memory suggest that their widespread use in hives may have a role in causing CCD.</p>	
Summary Statement The miticides tau-fluvalinate and thymol were determined to have negative effects on honeybee learning and memory, and thus they may be linked to the unexplained honeybee disappearance known as Colony Collapse Disorder.	
Help Received My mentor, Ms. Fallon, provided advice and guidance. Beekeeper Wendy Towner donated live bees; my mother assisted in the purchase of materials and supervised experimentation.	



CALIFORNIA STATE SCIENCE FAIR 2017 PROJECT SUMMARY

Name(s) Jackson Damhorst; Max Freedman	Project Number S2299
Project Title Effects of Varroa Mite Treatments on Bee Memory	
<p style="text-align: center;">Abstract</p> <p>Objectives/Goals The goal of this project was to investigate the effects of recommended treatments of oxalic acid or formic acid for Varroa mite on honeybee memory. This project is the first of its kind to test IPM (integrated pest management) soft treatments on honeybee memory, contributing to the larger body of research to resolve the honeybee decline crisis.</p> <p>Methods/Materials Forager bees were captured, frozen, harnessed into restraints and revived in an 90 F incubator. Bees were conditioned to respond to a 1-Nonanol scent (orange oil) with 40% sucrose:water reward using PER assay. A standardized ISI (interstimulus interval) was performed with 4 second odor stimulation, followed by 3 second feeding with 1 second overlap. 27 trained bees with positive conditioning were randomly assigned to groups (Control, MAQS, OXA). Bees were exposed to their treatment conditions. Bees were then tested again for conditioned response in random order. Results recorded. Procedure was repeated for 5 trials total with a total of 135 bees.</p> <p>Results The control group responses were significantly more consistent when compared to treatment 1(MAQS) and treatment 2 (OXA) tests. Analysis using box plots show both treatment groups are unlikely ($P < .05$) to be drawn from the control group. Preliminary analysis using T-tests suggest mite treatments vs. control are statistically significant. Control vs. treatment 1 (MAQS) has p-value .003471 and control vs. treatment 2 (OXA) has p-value .018549. But comparison between the two treatments is not statistically significant p-value .339367.</p> <p>Conclusions/Discussion Testing and analysis indicates that mite treatments have negative effects on bee memory and learning. Bees exposed to mite treatments have increased levels of negative PER assay responses. The control group, when compared to MAQS group and OA group had more positive PER assay responses. The comparison between OA and MAQS mite treatments is less clear. While both had strong impacts on bee memory, more testing is required to conclude if one is more or less effective. This project is the first of its kind to investigate IPM soft treatments for mites and underscores the importance of further testing of chemicals on honeybee memory to prevent the harmful effects to colonies. Because Varroa mites are one of the causes of CCD leading hive death at a rapid rate, it is urgent research be used to help protect these pollinators.</p>	
Summary Statement We found that "soft" varroa mite treatments have a negative effect on honeybee learning and memory.	
Help Received Patty Freedman helped with data collection. Josh Freedman assisted with data analysis tools.	