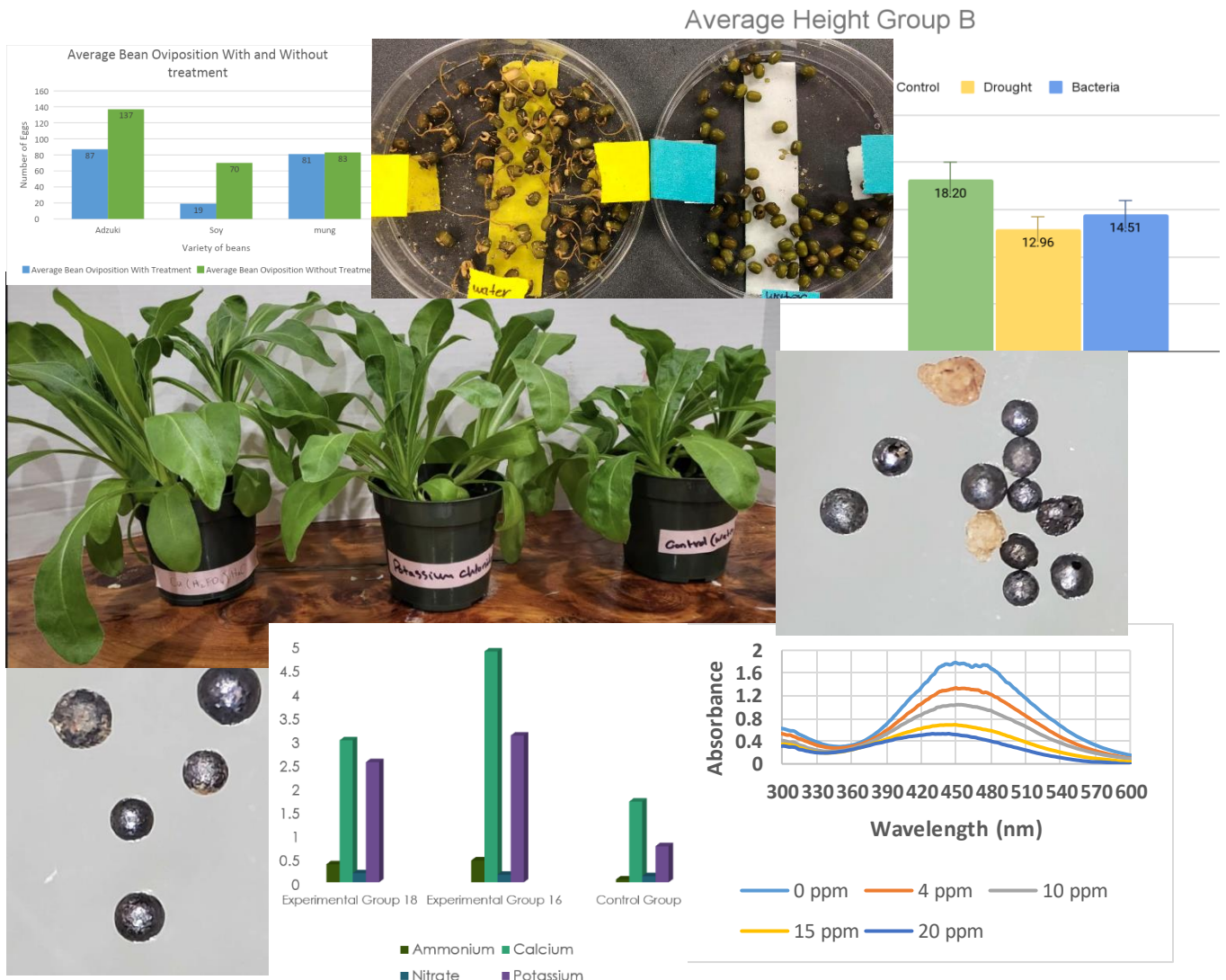


2022 Fall Science Presentations



Science 299 independent research projects are semester-long independent research projects that students pursuing an A.S. in Science are required to complete prior to graduation. Students carry out their research under the guidance of a PVCC science faculty member as mentor. The Abstracts of projects completed in Fall 2022 are included in this booklet.



Special thanks to the following laboratory staff for facilitating student projects:

Mark Little (Chemistry)

Pam Schoppee Bortz (Biology)

Dareen Aloudeh – Biology 299

The Effect of Phosphorus and Potassium on Germination and Growth of Calendula Seeds

Agriculture is essential to human survival, but farmers are forced to use chemical fertilizers instead of organic fertilizers due to climate change. Calendula is an annual flower and is a self-seeding plant which is quite interesting. Calendula flowers grow in southern Europe and the Eastern Mediterranean area and that's where it originated and can survive the winter season in mild climates. Calendula can be grown in the Fall or in Spring. The scientific name for the Calendula seed is "Calendula officinalis" (Jagdish) and it's a member of the Asteraceae family. The purpose of this experiment is to determine if phosphorus (triple superphosphate) and potassium chloride affect the germination and growth of Calendula seed compared to water (control).

I hypothesized that triple superphosphate and potassium chloride affect Calendula seed germination and growth. Therefore, I used two different fertilizers (Potassium Chloride) and (triple-superphosphate) to cultivate the flowering calendula plant. For my research, I dissolved the treatments in water and applied it separately. During the first four weeks of seed germination, seeds were watered using a filter. In week five the plant was treated with fertilizer. The plants were exposed to the same temperature of 25.5° Celsius when they were treated with water, triple superphosphate, and potassium chloride. Furthermore, during the germination and growth stages, the plants received periodic illumination of 12/12.

After five weeks, the plant that received triple-superphosphate had the highest growth rate compared to the plants that received potassium chloride and water. It was also observed that plants treated with potassium chloride had more leaves and healthier roots. The plant treated with water however showed fewer leaves, weaker roots, and is shorter in height than the other fertilized plants.

It can be concluded from the experiment that potassium chloride fertilizer and triple superphosphate promote the germination and growth of Calendula seeds. Variation analysis showed that there were significant differences in seed plant height and leaf number among different treatments. Significant differences were noted between seeds exposed to triple-superphosphate, and potassium chloride solutions. Seeds exposed to triple-superphosphate grew earlier and had more abundant flowers and buds. Triple-Superphosphate, and (KCl) fertilizers are added during the vegetative growth stage, the germination energy is $\geq 99\%$, and the seed yield is

the highest (Dangi, et al., 2019). There was no significant difference in the average height of plants, the number of leaves, and the height of roots. P-value > 0.05.

Faculty Advisor: Dr. Donna Hoefner

Nazanin Bayani – Biology 299

The Influence of Amount and Time of Mung Bean Exposure to Caffeine on Bean Beetle Reproduction

As bean beetles, *Callosobruchus maculatus*, are agricultural pests, I wanted to study factors that may influence their reproduction and movement using 4 performance parameters: oviposition, number of hatchlings, percentage of hatches and movement. Adult female bean beetles lay (ovipost) fertilized eggs on seed beans, such as mung or adzuki beans, which then hatch with the larvae pupating into a mature adult within 3-4 weeks. After reading how caffeine influences the mating behavior of male red flour beetles *Tribolium castaneum*, causing caffeine exposed flour beetles to more quickly court, mount and inseminate, I hypothesized that caffeine may increase performance parameters for bean beetles (Nishi, 2010). Additionally, I wanted to see if exposing beetles to light could increase their performance on the parameters as well. To test these hypotheses, I exposed bean beetles to mung beans soaked for 1- and 24-hours in 2 common caffeinated drinks: Nescafe and Red Bull and compared their performance parameters to beans soaked for 1- and 24-hours in water and dry beans. I also exposed bean beetles to light and soaked beans for 1- and 24-hours in water.

Results show a statistical significance for the average number of hatchlings on the dry beans versus the beans soaked in red bull for 24 hours. The percent hatchlings for beans soaked in Red Bull for 24 hours was twice that of the dry beans and the beans soaked in water and the distance traveled by hatchlings from beans soaked for 24 hours in Red Bull and for 1 hour in both caffeinated substances was significantly greater when compared to the hatchlings from the water-soaked or dry beans. These results suggest that while the substances used to soak the beans, soaking beans, and the time the beans soaked, did not affect oviposition, soaking the beans for 24 hours in Red Bull did increase the average number and percent hatchling. Movement of the hatchlings was also affected by the caffeinated substances. The light study showed an inverse relationship between the amount of time the beans soaked and the exposure of the beans to light.

Faculty Advisor: Dr. Virginia York

Sydneye Bronson – Biology 299

Growth Habits of *Brassica rapa* under biotic and abiotic stress

The cost of produce is directly related to how easy or difficult it is to produce and ship to a non-native areas. Crops require specific conditions to be successful and as global temperatures rise it becomes increasingly difficult to maintain the balance needed for the most bountiful and cost effective harvest. Research on how plants respond to changes in the environment is an important part of our ability to feed populations at reasonable cost. *Brassica rapa* is related to cabbages, broccoli, and other herbaceous vegetables that are consumed worldwide and is a good model for experimentation. This study was conducted to examine the effect of drought and bacterial infection of *Pseudomonas aeruginosa* on the development of *B.rapa*. Two groups were planted: group A planted on 9/30 and group B planted on 10/27. Two seeds per cell were planted in the water wicking trays with two 14-14-14 fertilizer pellets. Once germinated the seedlings were pruned to 1 plant per cell totaling 16 per treatment. All cells were kept between 70° and 80° and watered 2x a week with tap water. Control and bacteria cells were provided 500ml; drought was given 300ml. Group B was inoculated on planting day, group A was inoculated on 10/27. A serial dilution ranging from 1:1 to 1:10⁶ was used to determine the ideal cell density necessary for inoculation without overwhelming the soil. Groups were observed for 3 additional weeks post inoculation. The experiment resulted in plants that were deprived of water exhibited stunted growth but had an higher average of leaves. The infected plants, although full size, were more brittle than the uninfected control groups. The findings support the hypothesis with both groups having statistically significant different height as compared to the control group and a slightly significant increase in leaf production which was unexpected. This leads me to conclude that height is the indicator for leaf production which in turn is an indicator for flower production. A plant under stress would sacrifice maximum height in an effort to make sure it can produce a set of flowers. There seems to be a minimum height a plant must reach in order for flowers to develop but not a maximum height. These are promising results as it shows that plants are resilient and adaptive enough to survive immediate stress and still grow flowers and ultimately fruit.

Faculty Advisor: Dr. Marlana Yost

James Chambers – Geology 299

Micrometeorites on PVCC Campus

Micrometeorites are pieces of space debris broken off from asteroids and comets that have fallen to Earth's surface. Micrometeorites are usually gathered for study from Antarctic ice, but recent studies have shown urban locations to be a viable location for micrometeorite capture and analysis. This project aims to assess the presence of micrometeorites found in the drainage pipes

around the PVCC campus and to test if there is any significant difference in the number of micrometeorites captured at various locations around campus. We collected micrometeorites by first collecting sediment from various locations around campus and washing away any organic material and letting the samples dry. The samples were then separated via sieving to split the samples into distinct size groups. These new samples were sifted through using a magnet to further separate the magnetic material to be analyzed for micrometeorites. The final separation of samples was analyzed under microscope and any micrometeorites found were retrieved and placed into separate containers. The results of this experiment showed that micrometeorites could be found at all locations surveyed in this experiment and in multiple size ranges, with most micrometeorites staying within the 250 to 125 micrometer size range. Some locations and sizes ranges, however, contained no micrometeorites. Ultimately, this experiment is inconclusive as to whether certain locations are more likely to capture micrometeorites as the calculated masses of micrometeorites captured at each location contained a large degree of error due to the non-standardized mass of the petri dishes used to store the samples.

Faculty Advisor: Callan Bentley

Erica Evans - Biology 299

Essential Oils as an Oviposition Deterrent in *Drosophila melanogaster* and *Zaprionus indianus* Fruit Flies

Fruit flies are a notorious agricultural pest that ruin fruit production all over the world. Chemical repellents pose a threat to both human and environmental health. Essential oils provide a more natural and healthy method of repellent. Citrus essential oils contain a natural chemical called Linalool. Linalool has a toxic, oviposition-deterrent property to it. Previous studies have shown that the application of higher linalool concentrations caused fewer eggs to be laid on those apples. I hypothesized that if an essential oil is applied to a piece of fruit then the fruit flies will be repelled from eating, mating, and laying eggs on said fruit. Making the flies attracted to the control apple. Flies were caught at Carter's Mountain Orchard, Albemarle County, Va on October 20 and November 3, 2022, in the Fuji row. Flynap chemical was added into vials for inhalation and incapacitation. Flies were sexed and species identified under a microscope. Peppermint oil, orange oil, and water were put onto the three apples which were replicated in all four containers. Flies and apples were put into their containers for one week for mating and laying eggs. After one week, eggs were counted, and apple slices were put into their own vials for two weeks to hatch. No emerged adults were found but the data suggests the overall preference for the control apple with 53% of the total counted eggs being laid on these slices. The data suggest that citrus oil repels the flies relative to the control, but results are inconclusive and future trials should be conducted. The peppermint oil had 26% of total eggs while the orange oil only had 21% of eggs but future studies with larger sample sizes are needed to determine the differential effects of the two oils. The importance of this experiment is the new methodology and set-up created that will be used for future students to build off.

Faculty Advisor: Dr. Joanna Vondrasek

Determination of the Healthiest Olive Oils

Many of our foods contain various essential elements including proteins, carbohydrates, and oils which constitute a significant source of dietary lipids. Selecting healthy oils and learning how these oils affect our health has become a priority for many people. In addition to having a high concentration of monounsaturated fatty acids, olive oil is a food that also contains a number of compounds with biological benefits. Antioxidants, such as chlorophyll and carotenoids, included in olive oil may help the body protect itself against cellular aging, which can lead to a variety of ailments and health issues. The objective of the following experiments was to compare the relative fatty acid and antioxidant content of five olive oils (Africa, Black, Light, Garlic, and lemon) in order to find the healthiest oil. Three trials were performed for each oil and the amount of free fatty acids in each oil was determined using an alizarin yellow indicator. A spectrophotometer was used to measure the amount of chlorophyll in five oils. The absorbance spectra of all five oils show the Lemon and Garlic oils were likely the healthiest oils because these oils had a higher amount of antioxidants. All five of these oils showed the presence of chlorophyll in their fluorescence spectra, with African oil showing a higher amount than lemon or garlic. All of the oils had free fatty acids as shown by Alizarin yellow test. African oil had a higher price compared to garlic and lemon but did not have significantly improved concentrations of any major antioxidants. It is important to use the healthiest oil for our foods, and the price is not always indicative of quality.

Faculty Advisor: Dr. Frances Rees

Comparing Vitamin C Content in Fruit Juices and Supplements

Maintaining excellent health requires daily consumption of numerous vitamins and minerals. The Food and Drug Administration (FDA) has provided guidelines describing the recommended amounts a healthy individual should consume each day. Medical conditions may arise if proper vitamin levels are not maintained. One of the earliest diseases to be linked to a vitamin deficiency was scurvy, which was brought on by a lack of vitamin C. In this project, two methods were used to determine the Vitamin C content of fruit juices and supplements. The first method involved titrating dilute solutions of pure vitamin C stock, fruit juice, or vitamin supplements with an iodine-starch indicator. The second method involved titrating similar vitamin C solutions with a dichloroindophenol indicator. The analyte solutions were titrated to determine and compare the concentrations of Vitamin C within commercially available fruit juices and over-the-counter supplements. For the juices, the amount of vitamin C in 40 mL was found to be an average range of 1.31 to 11.49 mg and 2.5 to 5 mg for the iodine and dichloroindophenol titration, respectively.

For the supplement, the amount of vitamin C was found to be an average range of 1.18 to 1.32 mg and 6.7 to 8 mg for the iodine and dichloroindophenol titration, respectively. This experiment demonstrated that oranges contained the highest vitamin C content of the fruits, while the concord grape had the lowest amount of Vitamin C. From the supplements, Nature Bounty had the highest vitamin C content. This experiment demonstrates that dietary sources of vitamin C, such as orange juice, a far more potent sources of vitamin C than their over-the-counter supplement counterparts. Overall, it can be stated that it is often "better" to drink one cup of orange juice, than it is to take three pills of vitamin C supplements.

Faculty Advisor: Dr. Frances Rees

Athiya Hajji Mohamed -- Biology-299

Bean preference and Degree of Oviposition for *Callosobruchus maculatus* with and without pesticide

In the tropical and subtropical countries of Asia and Africa, the bean beetle creates huge financial losses because these areas are heavily reliant on agriculture. Beetle larvae burrow inside and feed on crop nutrients until pupating and destroys crops. The aim of this research is to determine bean beetle preferences in order to reduce financial loss to the farmers and minimize crop damage. I hypothesize that the bean beetles will show a preference (specifically adzuki bean) for untreated beans and those treated with pesticide will exhibit lower fertility by less oviposition. I used 10 grams of each adzuki, soy, lentil and mung beans treated with neem oil pesticide and without pesticide treatment with mating pairs of female and male beetle. Pesticide trail and non-pesticide trail beetles preferred adzuki bean on average amount of oviposition compared to other beans but these results were not statistically significant. No viable hatchlings were found on the soy bean or lentils in both treated and untreated trails, no hatchling were produced on pesticide trails. The only statistically significant oviposition difference was between treated and untreated soybeans. This suggests the use of neem oil as a pesticide may create a hospitable environment for oviposition and so not an appropriate method to control the beetle population. Statistically the p-Value did not support my hypothesis since the level of oviposition in the pesticide trails is contrary to the original hypothesis.

Faculty Mentor: Dr. Virginia York

Determination of Fluoride Levels in Different Types of Toothpaste

Fluoride is a naturally occurring mineral found mainly in water, soil, plants, and rocks. There are different types of fluorides that have different uses. Fluoride is commonly used in dentistry to strengthen enamel. It helps to prevent cavities. In addition, fluoride is used in many oral hygiene products such as toothpaste and mouthwash. Among many fluorides used are tin(II) fluoride (commonly known as stannous fluoride), sodium fluoride, amine fluoride, and sodium monofluorophosphate, all of which are biologically and chemically unique. Amine fluoride provides bacterial protection and reduces plaque buildup in teeth.

Experiments were carried out to determine if there is any difference in fluoride levels in different types of toothpaste samples. Three types of toothpastes were used: Sensodyne Extra whitening, Sensodyne Sensitivity, and Sensodyne Mint. Small amounts of each toothpaste sample (0.200 g) were dissolved in 0.100 M KCl and the solutions were boiled for 2-3 minutes. The suspensions were filtered by using gravity filtration process. The fluoride samples were mixed with Fe(III)-SCN complex in 1:3 ratio and absorbance was measured using spectroscopy. The dark red color from Fe(III)-SCN complex bleaches once the fluoride solution is mixed. A calibration plot of absorbance at 480 nm versus fluoride concentration (ppm) was created (Figure 1). Similar steps were repeated for toothpaste solutions. The data analysis shows that all types of toothpaste samples tested have similar concentrations of fluoride.

Faculty Advisor: Dr. Harish Subedi

Is There Fertilizer Runoff at Spring Creek Golf Club?

Fertilizer runoff can cause harm to local waterways. Excess amounts of fertilizer in water can kill native plants and even cause toxic algal blooms. Excess fertilizer in water can not only be detrimental to aquatic ecosystems, but larger vertebrates and humans that use them. This study was conducted in order to determine if there is fertilizer runoff at Spring Creek Golf Club. The golf course has been understaffed for most of the recent year. As a result, less runoff prevention practices such as aeration and verticutting have been done. In this research project, various samples were collected from the ponds located on holes 18 and 16 of the golf course both before and after rainfall, as well as a private pond where no fertilizers are used in the surrounding areas. The samples were then taken to the lab and analyzed using Vernier ion specific electrodes to determine the concentration of ammonium (NH_4^+), calcium (Ca^{2+}), nitrate (NO_3^-), and potassium (K^+). The concentrations of the ions were significantly higher in the ponds located on the golf course than the control pond (Figure 1). This supports the hypothesis that there is fertilizer runoff at Spring Creek Golf Club. However, there was no significant difference in the concentrations of ions in the water samples collected before and after rainfall.

Faculty Advisor: Dr. Harish Subedi

Alyssa Pittington – Biology 299

Smell Preference of Fruit Flies by Species and Sex

Fruit flies are a common pest when it comes to fresh produce. There are many types of fruit flies in the United States, including *Drosophila melanogaster*, *Drosophila immigrans*, and *Zaprionus indianus*. Finding out whether different species or sexes of fruit flies are more attracted to different scents can be important for determining ways to both keep food away from them and to get rid of the invasive *Z. indianus*. Flies were collected from Carter Mountain Orchard in Albemarle County on October 27, 2022. The smell preference of the flies was tested against water, vinegar, sugar, and Splenda to try and determine if flies preferred or avoided certain scents. Using gated traps with a scented filter paper circle and apple inside of them, *Z. indianus* (n=10), female *Drosophila* (n=5), and male *Drosophila* (n=5) were given time to select a trap. Due to few flies entering the traps, the data was inconclusive; however, it showed possibilities that flies avoid sugar and Splenda. Future studies could use these methods to further determine the smell preferences of different sex and species of fruit flies.

Faculty Advisor: Dr. Joanna Vondrasek

Amber Thompson – Biology 299

Northern Cardinal (*Cardinalis cardinalis*) Activity Morning Versus Evening in Rural and Urban Areas

The Northern Cardinal, scientific name *Cardinalis cardinalis*, is known to reside in both rural and urban settings, but prefers dense shrubby areas, including backyards and open woodlands. The purpose of this study was to determine the effects of urban and rural location and time of day on the activity levels of the Northern Cardinal. It was hypothesized that the Northern Cardinal would be more active in the morning in rural areas. Point counts were performed every morning from 8-9 AM and 4-5 PM. The urban location counts were performed on the PVCC campus outside of the Community Garden from Monday October 17th to Sunday October 23rd. The rural half of the study was performed along a powerline easement in Louisa County from Tuesday October 25th to Monday October 31st. Activity levels were monitored through the tracking of sightings and the tracking of calls by both ear and the use of the Merlin Bird ID App. There was an overall average of 12 sightings in the morning and 1 sighting in the evening. There was an overall average of 971 calls in the morning and 320 calls in the evening. It was found that the Northern Cardinal is more active in the morning in urban areas. This conclusion proved part of the original hypothesis wrong. While it was proved that the Northern Cardinal is more active in urban areas it was correctly hypothesized that the Northern Cardinal is more active in the morning. This study can be conducted again in different urban and rural areas to give more definitive proof that the Northern Cardinal is more active in urban areas.

Faculty Advisor: Dr. Melinda Clark

This material is based upon work supported by the National Science Foundation under Grant Number 1712724. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.