# CALIFORNIA STATE SCIENCE FAIR
# 2015 PROJECT SUMMARY

**Name(s)**

**Joshua B. Duquette**

**Project Number**

**S1801**

**Project Title**

## A Comparson of Conventional Algae Growing Techniques to Photobioreactors

**Abstract**

**Objectives/Goals**

Problem Statement: Is the use of an Algae Bio-reactor a more effective method then using Conventional Techniques when the variable being compared is Algal biomass?

**Methods/Materials**

Materials:
Algae, Ankistrodesmus (Green); This was used instead of microalgae because microalgae is harder to strain and grow, so using an algae with similar characteristics demonstrates accuracy of the idea without having to use the microalgae.

Cool White (40 Watts) 15 cm away from all culture tuber (8 hour dark 16 hour light cycle), Glass Jars *12 + Lids, Purified Water, Coffee Filters, Mixing Spoon, Box, Thermometer, Large Pot, Tongs, Towel, Strainer, Test Tube.

**Results**

Results: The algae grown using the conventional (current) techniques grew the best. The control grew very close to the same amount. The bio-reactor grew the least. The average layer penetration of the bio-reactor was 4.33 but the maximum was 7. The average layer penetration of the Control was 7 and the conventional grown group was 7.5 layers average with 8 being the highest layer penetration in both groups. All jars had a thick ring of algae at the bottom where growth was most concentrated. The jars had an area of dense growth on the side. The average height of this growth was 1.75 cm up the side. The highest was 4.5, however this produced neither the highest layer penetration nor the layer penetration near the highest. This suggests that this result was an outlier. However, this growth models layer penetration accurately in every other case. It should be noted that even with a reduced amount of solution, the control and conventional groups both produced this layer.

**Conclusions/Discussion**

Conclusion: The bio-rector produced the least average biomass meaning that is should not be used as a substitute for current algae growing techniques. This may be because the algae is able to grow faster in natural light as opposed to white light or because algae needs more consistent gas exchange with the environment. In future research, modifying the bio-reactor will be necessary to produce a higher algae yield with a more consistent result. Large scale production of algae may have a different result than small scale testing because the volume will help mitigate these affects.

**Summary Statement**

Comparing the yeild of algae biomass of different algae culturing texhniques.

**Help Received**

Father ordered materials

# CALIFORNIA STATE SCIENCE FAIR
## 2015 PROJECT SUMMARY

**Name(s)**
Natalie L. Epstein

**Project Number**
**S1802**

**Project Title**
# The Effect of Seed Species and Expiration Date on Germination Rate

**Abstract**

**Objectives/Goals**
My project was to determine if the expiration date of a seed, and the type of the seed, has an effect on the seed#s germination rate.

**Methods/Materials**
3 different species of onion seeds and 3 different species of pea seeds were chosen for the experiment. 18 expired (2014) seeds of each species was obtained and 18 current (2015) seeds of each species was contained. Each seed was planted individually in a plant flat with nutritious seed mix, with identical conditions that were optimal for all the plant#s growth. They were given sunlight and watered daily. The germination was counted every day for proper data collection.

**Results**
Expired seeds had a germination rate of 6-30% lower than current seeds with only one exception. The average difference between the 2014 seed germination rate and 2015 seed germination rate was 16.67%, with the 2015 seeds having more germination. The onions germinated less than the peas did with both years, with the Alaskan pea specifically having 100% germination both years.

**Conclusions/Discussion**
Fresh seeds have a healthy embryo whose cells are filled with water. Old seeds have lost water in the cell tissue and the embryo starts to shrivel, which is why germination rates drop the older the seeds are. Onions and peas are both seeds with some of the quickest dropping germination rate after their expiration date, and they also both have a life expectancy of only one year. Alaskan peas contain less sugar than other pea species. This causes them to germinate and mature earlier than other pea plant cultivars. According to this data, if you want a consistent germination rate of at least 90%, then current seeds are essential for success.

**Summary Statement**
My project determines the effect of expiration date on the germination rate of seeds.

**Help Received**
A local seed shop owner helped me decide which seed species to use and provided the materials.

# CALIFORNIA STATE SCIENCE FAIR
# 2015 PROJECT SUMMARY

**Name(s)**
Shivani Gupta

**Project Number**
**S1803**

**Project Title**
## Exploring the Relationship between the Duration of Electrical Voltage and Plant Growth

**Abstract**

**Objectives/Goals**
The purpose of the project was to determine the effect of the duration of electric field on tomato plant growth. It has been established through research that the presence of an electric field has a positive effect on plant growth. It was hypothesized that there is a direct relationship between the duration of electric field and plant growth and that twenty-four hours of electric field per day would stimulate plant growth the most.

**Methods/Materials**
Tomato seeds were germinated in soil and subsequently, plants were exposed to electric field at five different levels: A (4 hours electric field daily), B (9 hours), C (15 hours), D (24 hours), and E (0 hours, control). Electric field was generated using two 9V batteries connected in parallel and galvanized steel nails as electrodes. Plant height was measured weekly for 70 days, and at the end of the experiment, plant tissue testing was conducted at a local agricultural laboratory to determine the concentration of nutrients in the treated and control plants.

**Results**
Every treated plant group maintained an average height taller than that of control throughout the experiment. This range of increase in plant height (compared to control) was 10-55%. Based on the Analysis of Variance test, plant groups A and D performed the best, plant groups B and C ranked second in growth, and plant group E exhibited slowest growth. There was no notable difference in nutrient amount between treated (plant tissue consolidated from the electrically treated plants) and control plants. The concentration of various nutrients in the treated and control groups remained within the preferred ranges provided by the lab.

**Conclusions/Discussion**
The hypothesis was partially correct. Although plant group D (24 hours of electricity daily) yielded in the highest average plant height, there was no significant difference in plant height between plant groups A and D. With plant nutrient analysis, we can conclude that plants treated with electricity contained the adequate concentrations of essential nutrients necessary for optimum growth. This electrical treatment presents an eco-friendly method to accelerating plant growth and increasing crop yield.

**Summary Statement**
This project aims to determine the effect of the duration of electric field on tomato plant growth.

**Help Received**
I would like to thank Mr. David Wechsler, founder of Electric Fertilizer, for being my mentor for this project and the Agriserve lab for providing the plant tissue tests.

# CALIFORNIA STATE SCIENCE FAIR
# 2015 PROJECT SUMMARY

**Name(s)**

Virginia F. Hsiao

**Project Number**

**S1804**

**Project Title**

## Investigating the Effect of Magnetism on Pollen Germination and Pollen Tube Directionality

**Abstract**

**Objectives/Goals**

Pollen germination, which results in pollen tube growth, facilitates fertilization in angiosperms. While modern technology has increased magnetic exposure to plants, current research about the effects remains inconclusive. The goal of this project is to investigate the effects of magnetism on pollen germination and pollen tube directionality.

**Methods/Materials**

Lily pollen was tapped onto glass slides with 90 µL of water and placed in petri dishes lined with coffee filters soaked in 5 mL of water. A control group received no further treatment and was isolated from other groups. Two treatment groups of neodymium magnets with either 1.27 cm (large) or 0.635 cm (small) diameters were set up. Two respective magnets, one facing toward north and the other south, were placed 1.5 cm away from each edge of the slides. After 24 hours, the number of pollen tubes and the directionality were recorded.

**Results**

The large magnet conferred the highest pollen germination rate, followed by the small magnet, then by the control. For directionality, pollen tubes exposed to the small magnet showed a preference towards the north end. The pollen tubes exposed to the large magnet showed no preference.

**Conclusions/Discussion**

This study indicates that magnetism has an effect on pollen germination and pollen tube directionality. T-tests found that the large magnet group's germination rate was statistically significant compared to the control and found that the small magnet group's germination rate was insignificant compared to the control. T-tests also confirmed that the small magnet's tendency to the north end was statistically significant compared to the south end. Further research on the large magnet's effects of directionality is suggested.

**Summary Statement**

I investigated the effect of magnetism on pollen germination and tube directionality and found that increased magnetic exposure increased pollen germination and that pollen tube directionality was only affected by certain magnetic strengths

**Help Received**

Katherine Ward, for generously providing lab space and experimental support; Lynn, for helping me collect anthers every week; Ah Sam Florist, for graciously providing anthers for project

# CALIFORNIA STATE SCIENCE FAIR
# 2015 PROJECT SUMMARY

**Name(s)**

Atticus J. Humphrey

**Project Number**

**S1805**

**Project Title**

## Maintaining Fertilizer Effectiveness While Controlling Pollution from Chicken Manure

**Abstract**

**Objectives/Goals**

The objective of this study is to identify a reliable and cost effective solution which will reduce pollution from chicken manure while maintaining the manure#s effectiveness as a fertilizer.

**Methods/Materials**

Study includes 2 test models:

Manure Analysis includes

3 independent variables and a control. Test subjects are 8 adult Rhode Island Red layer chickens in test groups of 4 subjects divided into 2 cages. The feed modification and manure amendment will consist of a 3% protease enzyme ratio to 100g of 5600 layer feed and 3% amendment of wood ash applied to ½ of each test manure group collected. 1qt of each variable will be transported to Dellavalle Labs for chemical analysis. A LECO machine will be used for nitrogen testing and an ICP for potassium and phosphate testing. Both the LECO samples and the ICP samples will be dried and ground before testing. ICP samples will go through series of digestion before testing.

Seed Germination and Plant Growth

Plants will be arranged into 5 groups of 10 per soil amendment. The soil will be Jiffy: Natural and Organic Seed Starting Mix. Each will be mixed with, at a 20% ratio of manure to soil: Non-modified feed produced manure (MFPM), non-MFPM with wood ash amendment, protease enzyme MFPM, and protease enzyme MFPM with wood ash amendment. Every three days the plants will be measured using height and width.

**Results**

Manure Analysis

Non MFPM; N: 13.2 lbs./ton, $K_2O$: 16.4 lbs./ton, $P_2O_5$: 23 lbs./ton. Non MFPM with wood ash; N: 17.8 lbs./ton, $K_2O$: 15.4 lbs./ton, $P_2O_5$: 21.6 lbs./ton. Protease enzyme MFPM; N: 18.4 lbs./ton $K_2O$: 14.2 lbs./ton, $P_2O_5$: 19.8 lbs./ton. Protease Enzyme MFPM with wood ash; N: 18.2 lbs./ton, $K_2O$: 15.4 lbs./ton, $P_2O_5$: 21.6 lbs./ton.

Seed Germination and Plant Growth

Control: 55.18 cm average. Non MFPM: 38.20 cm average. Non MFPM with wood ash: 37.10 cm average. Protease enzyme MFPM: 44.68 cm average. Protease enzyme MFPM with wood ash: 24.47 cm average.

**Conclusions/Discussion**

This study does indicate that nitrogen levels can be maintained while potassium and phosphate levels are

**Summary Statement**

Can chicken feed modification combined with manure amendments reduce pollution while maintaining fertilizer effectiveness?

**Help Received**

Scott Fridlund, Laboratory Director of Dellavalle Labs

# CALIFORNIA STATE SCIENCE FAIR
# 2015 PROJECT SUMMARY

**Name(s)**
Esther E. Koh

**Project Number**
**S1806**

**Project Title**
## The Core Properties of Propagated Stem Cuttings that Germinated in Water

**Abstract**

**Objectives/Goals**
The aim of this project was to discover the similar characteristics propagated stem cuttings had which allowed them to have a higher advantage of germinating. Because the genetic makeup of most fruits and cultivars is highly heterozygous, the unique characteristics of plants grown through seeds will be lost or will revert to less desirable forms. However, through propagation in carefully controlled environments, most cultivated plants continue to exist and be commercially available today. I sought out to find these common properties that proved to be essential in developing a new adventitious root system in stem cuttings.

**Methods/Materials**
To observe which characteristics of plants allow them to germinate in water when cloned, three stem cuttings from 16 different plant types (48 in total) were used to test for the various stems, age groups, and rooting systems. Some of the stock plants used were the ficus benjamina, graptosedum, tomato vine, sweet potato, portulacaria afra, etc. These cuttings were propagated in water for 55 days in controlled conditions, and observations were recorded every 5 days. Factors (such as callus, auxin, and carbohydrate) that possibly contributed to this probability were tested. Levels of auxin synergists were determined by the amount of leaves, while carbohydrate content was found by the stem's firmness.

**Results**
There was no relation between stem type and root initialization. However, the age of the parent plant had a great effect on the success of a stem cutting. Of the age groups tested, 61% of the germinated cuttings came from the youngest stock plants. The favorable cutting material also contained high amounts of carbohydrate and auxin synergists. The similar direction the adventitious roots emerged from was also noted in the germinated cuttings.

**Conclusions/Discussion**
In the absence of synthetic rooting hormones, the likelihood of a stem cutting germinating depended upon certain attributes such as the anatomical patterns of adventitious roots, age of the stock plant, amount of carbohydrates, and especially auxin. Propagated cuttings taken during the juvenile stage, contained high amounts of carbohydrate and auxin, grew adventitious roots corresponding to the primary rays from which they originate, and had this unknown substance in the cells which established favorable rooting conditions had a much greater likelihood of developing a new root system.

**Summary Statement**
The similar characteristics of the germinated stem cuttings that were advantageous towards root initiation, such as the amount of auxin and root formation, were found that helped preserve the desirable characteristics of various cultivars.

**Help Received**
Special thanks towards my dad for letting me take cuttings from his garden.

# CALIFORNIA STATE SCIENCE FAIR
# 2015 PROJECT SUMMARY

**Name(s)**
Daniel A. Kuai

**Project Number**
**S1807**

**Project Title**
## Investigating Regional Plant Evolution with Chloroplast Sequencing

**Abstract**

**Objectives/Goals**
The purpose of this experiment is to determine what plant species the French marigold (Tagetes patula), Grandiflora petunia (Petunia grandiflora), Garden pansy (Viola wittrockiana), Douglas-Mugwort (Artemisia douglasiana), and Ash Meadows gumplant (Grindelia fraxino-pratensis) most closely resemble through sequencing of the genome Rubisco within the chloroplast.

**Methods/Materials**
To extract the plant DNA, I first added various buffers to each plant tissue and vortexed, incubated and centrifuged the lysate until DNA was purified. I then ran the solution through a Polymerase Chain Reaction machine utilizing 2 different primer mixes to amplify the Rubsico enyzme. I then ran a gel electrophoresis analysis of the PCR products and sent the positive PCR products with positive results to Dr. Christopher Baysdorfer at California State University, East Bay to sequence. Once I received the sequencing, I utilized the software program FinchTV to view and convert the cladograms and the software program BLAST to find other similar rubisco sequences.

**Results**
From the gel electrophoresis, I was able to obtain genetic sequences for the French marigold and the garden pansy. I then determined that the plant most closely related to the French marigold was the Gaillardia aristata (blanketflower) and the plant most closely related to the garden pansy was the Viola arvensis (Field pansy).

**Conclusions/Discussion**
In conclusion, this experiment is applicable to society since plants have potential medicinal benefits. The French marigold is known to have bug repellant and anti-fungal properties, thus being very useful in gardening. The Garden pansy is used in phytotherapy, the study of the use of extracts of natural origins as medicines. This experiment can also be used to identify other plants that have similar drought-resistant characteristics, a benefit to the region during periods of extreme or prolonged drought conditions.

**Summary Statement**
Determining which plants are most closely related using chloroplast genome sequencing

**Help Received**
My teacher supervised the DNA purification, PCR analysis, and gel electrophoresis processes. Professor Christopher Baysdorfer sequenced my PCR products. My dad and mom took pictures during my experiment.

# CALIFORNIA STATE SCIENCE FAIR
# 2015 PROJECT SUMMARY

**Name(s)**

Larson T. LeDuc; Ken Ross

**Project Number**

**S1808**

**Project Title**

## Once in a Green Moon: A Study of Plants' Survival in a Simulated Lunar Day Cycle

**Abstract**

**Objectives/Goals**

Can plants that serve nutritional value to humans survive the limitations of light defined by the lunar day cycle?

**Methods/Materials**

Two identical light-sealed boxes were built to simulate the darkness of space. Fans blew air through baffles to allow sufficient airflow but omit external light. Full spectrum light emitting diode (LED) light bulbs were used to simulate sunlight and the box interior was covered with aluminum foil to prevent light loss. Each box contained five or more plants per species. The light and dark periods were incrementally lengthened until a 2-week period was obtained. The growing conditions of the plants were monitored throughout testing, using sensors that measured humidity, temperature, and carbon dioxide content. Following a testing period, the plants were evaluated based on leaf quality color, height, leaf spread, and number of leaves.

**Results**

The levels fluctuated with the timing of the fans (every 6 hours) and the light cycle of the boxes. The carbon dioxide levels in the experimental box were higher than the control box during the first 36 hours of the night of the experimental box indicating more cellular respiration occurred and thus growth. After the first 36 hours the carbon dioxide levels in the box lowered to slightly above normal daylight as the plant growth ceased and returned to standard metabolism levels to survive. The carbon dioxide levels dropped one more time significantly after another 72 hours of the night of the experimental box, as some of the plants began to stop metabolizing as their glucose reserves waned.

**Conclusions/Discussion**

The survival rate at 2 weeks of darkness was 27%. The carbon dioxide log supports the theory that the plants had depleted their reserves and were beginning to die. The surviving plants also showed significantly less chlorophyll and leaves, indicating that the plants were not growing. The combined results indicate that most of the plants would not survive the lunar night cycle and for those plants that do, the plants will not be able to provide nourishment for humans.

**Summary Statement**

This project was to test if nutritious plants for humans can survive the limitations of light and dark as defined by the lunar day cycle.

**Help Received**

Guidance from Ms. Laurie George, University of Illinois Extension, Unit 23, on box design. Advice from Reuben, Quartz Hill Garden Center employee on soils. Parents helped construct boxes and transplant plants into boxes.

# CALIFORNIA STATE SCIENCE FAIR
# 2015 PROJECT SUMMARY

**Name(s)**

**Madison P. Meredith**

**Project Number**

**S1809**

**Project Title**

## A Novel Strategy for Augmented NUE: The Use of Actinomycetic Transmembrane Metabolism in Agricultural Crops: Year 3

**Abstract**

**Objectives/Goals**

Nitrogen Use Efficiency (NUE) is of major concern to growers, especially to those who farm in semi porous soils. Actinomycete bacterium is found in many types of soil, but most concentrated in organic compost. Worm fecal matter is of high quantity of these useful bacteria, which assists in immobilization in the nitrogen process, as well as supplies nitrogen into the mass flow in the soil system. This study was performed to determine if the NUE can be increased when affected by the addition of pinpointed microorganisms found in worm feces.

**Methods/Materials**

The affects of Actinomycete additives on nitrogen use efficiency were assessed under controlled open conditions in a 12 week growth trial, with UN-32 (TRT 1) and UN-32 plus microorganism liquid (TRT 2) applied to 162 short rooted Lactuca sativa (Romaine Lettuce) and Brassica oleracea (Green Commit Broccoli). The worm feces was turned into liquid form through a system known as bacterium cultivation: a 72 hour process by which microorganisms are put under ultimate conditions for production, and then applied as an alternative water source during nitrogen treatments.

**Results**

Confidence intervals for the Romaine Lettuce (TRT 1: (0.40575, 0.72592) μ = 0.565 ó = 0.204, TRT 2: (0.255579, 0.56254) μ = 0.409 ó = 0.1954) and Green Commit Broccoli (TRT 1: (0.06312, 0.21369) μ = 0.1409 ó = 0.087, TRT 2: (0.11619, 0.26381) μ = 0.19 ó = 0.0827) root and leaf biomass testing proved the resulting yield for the crops which received the UN-32 and microorganism liquid to be greater than the crops which received UN-32. T-tests for Broccoli provided more evidence that the microorganism solution positively affects nitrogen use efficiency.

**Conclusions/Discussion**

An optimum confidence interval and standardized z-score suggested that the use of Actinomycete bacterium to transport nitrogen, utilizing their near undistinguishable cell wall, is a viable solution to inadequate NUE; resulting in a 38% NUE efficiency increase for broccoli, and a 43% NUE efficiency increase for lettuce.

**Summary Statement**

By pinpointing Actinomycete bacterium, and cultivating it in liquid form, I created a microorganism solution that increases nitrogen-use-efficiency in short rooted agricultural crops by 38-43%.

**Help Received**

Used lab equipment and facility at Research for Hire Agricultural Research Farm under the supervision of John Corkins

# CALIFORNIA STATE SCIENCE FAIR
# 2015 PROJECT SUMMARY

**Name(s)**
Adaeze M. Oduma

**Project Number**
**S1810**

**Project Title**
## Effect of Wind Seed Dispersal

**Abstract**

**Objectives/Goals**
The objective of this project is to find the effect of wind speed on seed dispersal using dandelions and fan to mimic wind. I believe that the higher the wind speed, the further the seedling would travel.

**Methods/Materials**
9 dandelions were placed in a small glass jar for each speed of the fan, which represented 3 types of wind speeds. Each seedling from each dandelion was measured in centimeters using meter sticks and averaged for that speed's trial.

**Results**
Speed one's averaged distances for each trial was 17 cm, 475 cm, and 371 cm. The speed two's averaged distances for each trial was 431 cm, 497 cm, and 467 cm. The speed three's averaged distances for each trial was 754 cm, 625 cm, and 809 cm.

**Conclusions/Discussion**
Dandelion seedlings are supposed to be able to travel long distances because they are umbrella-shaped. They are also easily dispersed by the wind because of the size. The data supports that seed dispersal increases in distance as the wind speed increases. At the lowest wind speed, the average distance reached by the dandelion seeds were 288 cm compared to an average of 729 cm at the highest wind speed in this experiment.

**Summary Statement**
My project is about finding out exactly how far dandelion seedlings could travel and where they end up.

**Help Received**
Used Mr. Estrada's classroom and was under his supervision

# CALIFORNIA STATE SCIENCE FAIR
# 2015 PROJECT SUMMARY

**Name(s)**
Sophie J. Parsa

**Project Number**
**S1811**

**Project Title**
## Trees: Family or Foe?

**Abstract**

**Objectives/Goals**
The goal of this project is to see how the size of an investigated area of land affects the evidence of habitat filtering and competitive exclusion. I looked at different quadrat sizes on a plot of land at UCSC (the FERP database) and used the program R to examine the phylogenetic distances of the plant present in the quadrat. My hypothesis is that as the quadrat decreases in size competitive exclusion becomes prevalent.

**Methods/Materials**
*PD=phylogenetic distance, All quadrats are in m^2
Materials - I used the computer program R, the UCSC FERP database of plants, a phylogenetic distance matrix and phylogenetic tree for the species on the FERP plot.
Methods-
1.Load data files into R: FERP database, PD matrix, taxonomy file
2.Observed Data: Loop through all possible quadrats of the sizes 5m, 10m, 20m, 50m, 100m each time finding the 10% quantile PD (observed10Q) for the plants in the given quadrat.
3.Random Data: Then for each quadrat, loop 1000 times, each time finding the 10% quantile PD from a group of randomly selected plants(of the same number as found in the observed quadrat).
4.Store number of random 10% quantiles <= to Observed10Q/1000 (%randsmaller)
5.Make a histogram of %randsmaller for all quadrats of a given size
6.quadrats with %randsmaller < median of histogram show habitat filtering and greater than median indicate competitive exclusion

**Results**
83% of the 100m quadrats show habitat filtering. 68% of the 50m quadrats show habitat filtering. 59% of the 20m quadrats showed habitat filtering. 64% of the 10m quadrats show competitive exclusion. 75% of the 5 meter quadrats show competitive exclsuion.

**Conclusions/Discussion**
My hypothesis was correct. As quadrat size decreases, evidence of habitat filtering does as well. The largest quadrat size (100m) showed the most habitat filtering and the smallest (5m) showed the least. The 20m quadrat was the turning point where the distribution was almost 50-50 between habitat filtering and competitive exclusion. Finally, the complete shift to competitive exclusion is evident in the 10m quadrats.

**Summary Statement**
This projects investigates evidence of competitive exclusion and habitat filtering in plants on different sized quadrats of land.

**Help Received**
Dr. Gregory Gilbert helped by answering questions and clarifying concepts. He also helped me write some R code.

# CALIFORNIA STATE SCIENCE FAIR
# 2015 PROJECT SUMMARY

**Name(s)**
Andee L. Poole

**Project Number**
**S1812**

**Project Title**
## Effect of Age on Primary Nutrient Content in Bovine Manure

**Abstract**

**Objectives/Goals**
The purpose of my science fair experiment was to determine if aged bovine manure loses its nutrient levels and effectiveness as a plant fertilizer over time. I investigated at what age, or level of decomposition, bovine manure should be used as a plant fertilizer based on its effectiveness and the levels of potassium, nitrogen, and phosphorus it contains. If bovine manure can be used more effectively as a plant fertilizer, farmers will be able to use the most productive agricultural techniques. My hypotheses stated that the youngest manure (fresh) would contain the highest nutrient levels and as as the best plant fertilizer to radish seeds and fescue seeds.

**Methods/Materials**
1.)Collect approximately 5 pounds of fresh manure while wearing gloves and place in a trough to age 6 months. 2.)Repeat Step 1 in 3 months and the day before the experiment. 3.)Place each age of manure in a black trash bag and let sit outside for 48 hours in a location with direct sunlight to evaporate moisture. 4.)Align six long trays with 15 9oz SOLO cups. 5.)Label each tray with the appropriate seed type and manure age. 6.)Plant radish seeds and fescue seeds hydroponically. 7.)Place 10 grams of small gravel in each cup. 8.)Mix 175mL of water and 10 grams of manure and place 5 grams of the mixture in each cup. 9.)Plant 1/2 gram of fescue seeds in appropriate cups and 20 radish seeds in appropriate cups. 10.)Cover cups with sealing wrap and let grow for 10 days. 11.)Remove shoots of plant from cups. 12.)Evaporate plants in an oven at 400 degrees for 2 hours. 13.)Measure the biomass. 14.)Use the Rapitest Soil Test Kit to measure the amounts of nitrogen, potassium, and phosphorus in the manure. 15.)Compare data.

**Results**
The oldest manure (6 months old) contained the highest levels of nitrogen, phosphorus, and potassium. The oldest manure also acted as the best plant fertilizer for the radish plant seeds. The middle- aged manure (3 months old) acted as the best plant fertilizer for the fescue grass seeds.

**Conclusions/Discussion**
Throughout my experiment, I learned the importance of testing soil samples in order to ensure the best planting environment for crops. My investigation portrayed that no matter the age of manure, manure has a surplus of nitrogen. I also learned that there is a relationship between nutrient abundances and effective fertilizers.

**Summary Statement**
It is an investigation to determine the nutrient levels and effectiveness as a plant fertilizer in manures at different levels of decomposition and determine any correspondences between the two.

**Help Received**
Used a scale at Sanger High School under the supervision of Mr. Aalto.

# CALIFORNIA STATE SCIENCE FAIR
# 2015 PROJECT SUMMARY

**Name(s)**
Dale J. Risk, III

**Project Number**
**S1813**

**Project Title**
## Water Sources and the Growth of Lolium multiflorum (Annual Ryegrass) (Year 4)

**Abstract**

**Objectives/Goals**
This year I will take my previous mixture of 50% Colorado, 30% Reclaimed, 20% Aquifer and compare it to mixtures used currently by golf course superintendents. I will look for the most effective water mixture; effectivity will be determined by cost per gallon, algae inhibition, reduced fertilizer usage, and reduced aquifer consumption.

**Methods/Materials**
Materials: Aquifer Water, Reclaimed Water, Colorado River Water; Water Absorbent Beads; Lolium multiflorum seeds.

Survey distributed to Golf Course Superintendents regarding water sources and practices.

Seed Germination & Growth Methods: Prepare absorbent beads; add applicable water mixtures. Place 10 seeds at the bottom of each via. Record seed germination and growth.

**Results**
The most effective mixture for seed germination and grass growth was 50% Colorado, 30% Reclaimed, 20% Aquifer.

11 Golf Courses Superintendent responded to the survey. The average responses were:
43% use Aquifer water in their bodies of water, 57% use Canal water in their bodies of water.
17% do not use the same water used in ponds and lakes to irrigate their landscapes, while 83% do.
The average amount of money spent annually on fertilizer is $118,000.
The average amount of money spent annually on water is $84,333.

**Conclusions/Discussion**
The mixture of 50% Colorado, 30% Reclaimed, 20% Aquifer, yields better results when considering Algae inhibition and Aquifer consumption. The higher concentration of Reclaimed water discourages biological growth. Due to the filtration process, Reclaimed water makes an ideal counteractive agent to the algae growth. Additionally, the low percentage of Aquifer water reduces aquifer consumption. The high amounts of Colorado water will encourage Lolium multiflorum, a type of plant that grows with much less requirements than algae, to grow without the necessary use of fertilizer.

**Summary Statement**
Maximize effective golf course water mixtures of Aquifer, Reclaimed, and Colorado River while minimizing aquifer use.

**Help Received**
Coachella Valley Water District provided water samples; survey responses from golf course superintendents from the Hi-Lo Chapter of the Golf Course Superintendents Association of America.

# CALIFORNIA STATE SCIENCE FAIR
# 2015 PROJECT SUMMARY

**Name(s)**
Kapil Sinha

**Project Number**
**S1814**

**Project Title**
## Characterization and Utility of Resistance Sources against Resistance-Breaking Rhizomania in Sugar Beet

**Abstract**

**Objectives/Goals**
Rhizomania poses a major problem to sugar beet worldwide, as it not only causes physical harm to the roots but also reduces the quality of sugar yield by up to 95%. Rhizomania resistance sources have long been the best way to protect against beet necrotic yellow vein virus (BNYVV), but new resistance-breaking strains of Rhizomania render the commonly used resistance source, Rz1, ineffective.
1. I needed to determine which resistance source is most effective at lowering virus titer under resistance-breaking BNYVV
2. I compared composite root ELISA values, a commonly used measurement, with individual ELISA values, to determine which is more effective and so develop tools for future projects
3. I examined the effect of temperature as a confounding variable on virus titer

**Methods/Materials**
I had three phases in my project. In the first phase, I conducted ELISAs to determine the approximate virus titer, and then verified the results with qPCRs, from which I determined the exact virus titer in each sample. Next, I compared the composite root mass ELISA to the individual ELISA data, examining the mean virus titer as well as the spread to find out which is more informative and so useful for scientists. Finally, I examined temperature data during the course of my project and compared it to the ELISA and qPCR results to find any correlation between them.

**Results**
Phase 1: The Rz5 resistance source had a low average virus titer and small spread, according to the ELISA and qPCR.
Phase 2: Unlike the individual ELISA, the composite root ELISA gave no indication of spread and gave a large range for the median.
Phase 3: The temperature dropped just before the first harvest, which had two resistance sources, and the virus titer for both resistance sources was low.

**Conclusions/Discussion**
The Rz5 resistance source is the most effective resistance source since it consistently lowered virus titer, and so farmers should use this resistance source to combat the resistance-breaking BNYVV. Instead of using composite root ELISAs, as is traditionally used due to its speed, scientists should conduct individual ELISAs to gain more precise information on virus titer. The temperature drop before the first harvest likely caused a reduction in virus titer since Rhizomania's vector, Polymyxa betae, becomes dormant at low temperatures; hence, temperature is a confounding variable and must be considered in future projects.

**Summary Statement**
I have determined that Rz5 is the most effective resistance source against resistance-breaking Rhizomania, and developed protocols involving ELISA and temperature for future projects with the resistance-breaking virus.

**Help Received**
I thank Dr. Richardson and also Dr. Wintermantel for being my mentors for this project. They permitted me to use USDA equipment, and taught me basic laboratory procedures. The experiment was designed and conducted entirely by myself.

**Name(s)**
Olivia L. Woodford-Berry

**Project Number**
S1815

**Project Title**
# A Novel Approach to Improving Drought Tolerance: The Effects of Biochar on Crop Yield

**Abstract**

**Objectives/Goals**
The objective is to determine the effects of sugarcane derived biochar on the drought tolerance of Lycopersicon esculentum and Lactuca sativa variation longifolia.

**Methods/Materials**
Biochar was produced by placing small pieces of sugarcane in a sealed tin for several hours in open flame. Biochar was added to top soil in various doses (15% or 50% by volume of soil) to the Lycopersicon esculentum and Lactuca sativa seeds grown under drought conditions or sufficient watering conditions. Drought conditions were quantified through preliminary studies testing the soil's water carrying capacity. Drought conditions and sufficient water were defined as 20% (29mL) and 60% (87mL) of the water carrying capacity. Controls without biochar were also studied. Growth over time, survival rate, germination time, and maximum survival time without water were measured.

**Results**
Studies of Lactuca sativa show that a soil composition of 15% biochar has the best effects on drought tolerance. Both biochar groups show greater growth than groups without biochar. On average, plants grown in biochar had a higher survival rate, regardless of watering. The strongest statistical results related to germination, as plants grown in a 50% biochar soil mixture germinate more than twice as fast as plants grown in top soil.

In the case of Lycopersicon esculentum, plants grown in 15% biochar composition show the greatest increase in growth compared to plants grown without biochar under drought conditions and plants grown without biochar with sufficient water. Plants grown in a 15% biochar mixture germinate twice as fast as plants grown in top soil. Overall, both plants show higher survival rates when drought conditions were mitigated with biochar. In addition, Plants grown in biochar can last without water more than three times longer than controls. Furthermore, while fungus appeared in the control groups, no fungus appeared in groups with biochar.

**Conclusions/Discussion**
The results of this study suggest that the addition of biochar to soil improves the drought tolerance of Lycopersicon esculentum and Lactuca sativa variation longifolia.

**Summary Statement**
This experiment tests the use of biochar as a potential tool to mitigate drought conditions and improve the drought tolerance of plants.

**Help Received**
Mentored by Cathy Messenger of Los Gatos High School

# CALIFORNIA STATE SCIENCE FAIR
## 2015 PROJECT SUMMARY

**Name(s)**
Elina B. Yon

**Project Number**
**S1816**

**Project Title**
# Effects of P. stratiotes Phytoremediation of Nitrates and Phosphates and Effects as Organic Mulch Fertilizer on Lettuce

**Abstract**

**Objectives/Goals**
In my research, I have found that nutrient pollution is one of the most prominent problems in America. Excess nitrogen and phosphorus can lead to eutrophication and algal blooms. A source of this nutrient pollution is lawn fertilizers that add nitrates and phosphates to the ecosystem. My project serves to contribute to the measures being taken to effectively reduce nutrient pollution in water and soil by phytoremediation. Rather than merely increasing it by using lawn fertilizers and adding to the nutrient pollution, my project involves creating an organic fertilizer as a way to recycle the nitrogen and phosphorus in our environment.

**Methods/Materials**
I performed my experiment by growing my water lettuce plants in deionized water with different levels of nitrates and phosphates. I had three different settings with high, moderate, and relatively small amounts of nitrates and phosphates.

I mulched the water lettuce plants that showed to have the most nitrate and phosphate uptake to use as organic mulch fertilizer with a food chopper; I prepared 5 pots with this mulch fertilizer, 5 with commercial chemical fertilizer, and 5 control ones. I grew 10 romaine lettuce seeds in each pot.

**Results**
I observed that the group with the most nitrates and phosphates saw the most uptake in nutrients. My second experimental group followed, then, the group with the least amount of nitrates and phosphates showed the least uptake in nitrates and phosphates. The difference between the three data groups is shown to be statistically significant using ANOVA.

My results show that plants treated with the organic mulch fertilizer had the most growth in both height and biomass compared to commercial fertilizer as well as the control group. Although my data is not statistically significant, this shows that organic mulch fertilizer will allow for the efficient recycling of nitrates and phosphates in the ecosystem.

**Conclusions/Discussion**
Through my project, I demonstrated that P. stratiotes can be used to not only clean up nutrient pollution in water, but also prevent it in soil by replacing chemical fertilizers. The phytoremediative capability of P. stratiotes has been demonstrated as well as the positive effect organic mulch fertilizer has on the growth of Lactuca Sativa.

**Summary Statement**
Through my project, I demonstrated that P. stratiotes can be used to not only clean up nutrient pollution in water, but also prevent it in soil by replacing chemical fertilizers with an eco-friendly organic one.

**Help Received**
Research Science Teacher gave me basic guidelines throughout project