NATIONAL
FFA ORGANIZATION

Agricultural
Proficiency
Awards

Example Application

Please do not plagiarize example application

NOTE:

RESUME'S HAVE BEEN REFORMATTED SINCE 2015 APPLICATIONS. MAY APPEAR DIFFERENT IN EXAMPLE PROVIDED

Agriscience Plant Systems

National Research Proficiency

Plant Systems

AA
AA0001
550000000

Applicant Information

Applicant Name
Chance Smith

Chapter Name
Anywhere High FFA Chapter

Statement of Candidate and Parent/Guardian

We have prepared this application and certify that the records are true, complete and accurate and we hereby permit for publicity purposes the use of any information included in the application with the exception of the following:

Date	Parent/Guardian Signature

Date	Candidate's Signature

Certification

We have verified the application and find that the statements contained herein are such that we are able to recommend him/her for the Degree/Award. Furthermore, we verify that he/she has conducted themselves in a manner to be a credit to the organization, chapter, school and community.

Date — Chapter Advisor Signature

Date — Superintendent or Principal Signature

Date — Employer Signature (Placement applicants only)

Date — State Advisor or State Executive Committee Signature

National Research Proficiency
Basic Award Setup Information

I. Application Dates

Began Agricultural Education
8/1/2011

Application Ending Date
12/31/2014

II. Proficiency Type

Proficiency Type
Plant Systems

Primary Pathway of SAE
Plant Systems

National Research Proficiency

Performance Review A

1. Briefly explain your SAE and how it related to this award area.

Throughout my SAE research projects, I used the SCIENTIFIC METHOD TO SOLVE AGRICULTURAL PROBLEMS to assess the effects of growing environment on the productivity of plants. I began FFA in a middle school agriculture program where I was initially interested in CDE competitions. Later, I was walking through the school greenhouse where I noticed differences in plants of the same species. The question gave me the impetus to research four projects: (1) My first project determined that soil temperature can be used to control internode elongation of plants - 7mm increase. This led to (2) my second project which concluded that soil temperature can be used to control the height of plants, just as well as expensive chemical growth regulators - 0.1mm difference. Because of my expertise in the impact of growing environment on plants, another FFA member sought my help in (3) my third project on her family farm. My research indicated that environmental factors such as high tunnels can increase the sugar content - 20% - and production of blueberries. I learned in my literature review about the health benefits of blueberries. This caused (4) my fourth agriscience research project where I found that blueberries grown under high tunnels will produce 33.3% more - 0.10 Absorbance Units (AU) - antioxidants. The SKILLS I learned in this SAE will help me be SUCCESSFUL in college and medical school. I want to have a career as a doctor of radiology, while living on my family farm.

2. Briefly explain how your roles, responsibilities, and/or management decisions related to this award area changed.

When I BEGAN, I had little understanding of the STEPS required to complete a research project. My advisor taught me a regimented way to use the scientific method to solve agricultural problems. In following these steps, I had to master many skills. Initially he, or more experienced agriscience researchers, would provide me assistance and gradually I mastered almost every skill needed. I learned to set up experimental designs appropriate for my projects. I then began to learn to use math and statistical analysis to evaluate my data. I found how projects lead to new questions. For example, after learning environment could affect blueberry sugar, I wanted to know if high tunnels would help in other ways. This led me to find that they assist in increasing antioxidant content. I learned to conduct several types of statistical analysis which predicted that my experiments would prove similar results on a much larger scale. I learned the value of RECORD KEEPING in the scientific process and kept meticulous records. When presenting my project over the years, I found communication with others quite easier than before through experience. With practice, my communication skills improved greatly. Throughout this process, I matured and gained responsibility and EXPANDED MY ROLES which are required to complete growing phases of an agriscience project. These skills and experiences are making my life better and my future brighter, especially helping me in choosing a career in medicine.

3. Briefly explain what is the single greatest challenge you faced in this award area and how did you overcome that challenge?

My greatest challenge were the OBSTACLES to data collection during my experiments. In plant systems over several years, I met this challenge in several STEPS: (A) In my 1st project, I did not have agriculture class during my growing period while the temperature data needed to be collected on the beans. My advisor and fellow FFA members would collaborate with me and help me obtain the needed measurements. (B) Next, I continued expanding my research and eliminate the need for chemical growth regulators used by plant growing companies to make their plants profitable. I faced an obstacle because I was new to the use of chemical growth regulators with plants. I didn't know how to distribute the chemicals to the experimental set of plants, and collecting the actual measurements was new to me due to the safety practices. I overcame this challenge by learning and studying all the needed safety practices when in contact with chemicals. After learning the needed skills, I used the safety methods to safely conduct my experiment. (C) In my 3rd and 4th projects, I lived a distance from the site that called for daily measurements. I was forced to seek the help of an FFA member who lived nearby my testing site who collected and recorded air temperatures when I was unable. In all of my research projects, I have faced challenges that needed to be overcame to collect data for each experiment. With the help of my advisor and other FFA members, I was able to OVERCOME these challenges.

National Research Proficiency
Performance Review B

Briefly explain your three greatest accomplishments or findings in this award area.

Accomplishment/Finding #1

My first accomplishment was learning that soil temperature could be used to regulate the growth of plants. In this phase, the plants that received the treatment of heated soil on average were 24.52mm in height, the plants that received no treatment on average were 17.19mm in height. I concluded that plants treated with a higher soil temperature were 41.2% taller than plants grown with a lower soil temperature. Also, I concluded that the need for chemical growth regulators can be eradicated by the use of controlling the soil temperature. The difference in height between the plants grown with controlled soil temperature and those treated with chemical growth regulators was only 0.1mm which was 0.09%.

Accomplishment/Finding #2

My second accomplishment was I found environmental factors such as high tunnels can increase the sugar and antioxidant content of blueberries. The average difference of 2.5 more Brix produced per sample under the high tunnels in the results of the project represented an increase of about 22.1%. This partially helped to support the hypothesis. Also, Any State blueberry producers could exceed the USDA label recommendations for sugar content by about 25.5% by using high tunnels. The USDA recommends 1g of sugar per cup of blueberries. I found an average of 13.8g of sugars per cup of blueberries. Finally, high tunnels increased the antioxidant levels of blueberries by 2,705.6 TEAC which is a 30% increase over the USDA recommendations.

Accomplishment/Finding #3

My third accomplishment was the use of statistical analysis to support each hypothesis of this research. Due to limitations, smaller data sets than agriculture industry standards were necessary to conduct this research. Therefore, statistical analysis was used to evaluate for significant differences if these experiments had been conducted on a larger scale. When evaluating the data in project 1, I found a significant increase in growth (p-value of 0.0029 - see p. 8). In my last two phases, I found a significant increase in high tunnel sugar and antioxidant production (p-values of <0.0001 both years - see Research Papers). All of these measurements were accepted because they were less than the critical value (<0.05).

National Research Proficiency
Performance Review C

What are three ways your experiences or opportunities in this award area will impact your future.

Impact #1

My first impact has to deal with the overall improvement of research skills which will help my career in the medical research field. During my project, I learned to conduct statistical analysis, kept records of every detail during my project, and used numerous laboratory tools and equipment while working both in a scientific setting and in the field. Most importantly, I learned to collect data that can be used in valuable decisions like those I will have to make on the job during my future career. I want to be successful and I need every advantage I can learn through agricultural education. Having excelled in agriscience fair on the State and National level will be notable to interviewers when I am being considered for medical school, also.

Impact #2

The second impact of this project was that it taught me valuable communication skills. These skills will definitely help me while in interviews for medical school and prospective employers when I graduate. During these experiments, I met with various people to obtain insight on greenhouse technology, chemical growth regulators, blueberry production, and other related topics. I also met people while presenting my project who inquired about my experiments. I learned how to present myself and articulate my research to a variety of people. In doing so, I learned to represent my FFA chapter and other stakeholders with an interest in my projects. I estimate that I spent over sixty (60) hours practicing and presenting my SAE research projects.

Impact #3

The third impact was my SAE strengthened my academic skills which will benefit me in college and my career. In academics, I would ask where and when I would use this knowledge again. During my SAE, I applied skills that I learned from years before in Math, English, and Science. I really came to understand that Math is the language of Science. I used knowledge of Math to measure plant growth, sugar, and antioxidant differences, then to conducted statistical analysis of data, and used knowledge of English to write my agriscience project reports. I used knowledge of Science by applying the scientific method to solve real-life problems. These skills helped me obtain a respectable GPA (3.9), it also helped me rank well in my class (58 of 653).

National Research Proficiency
Supervised Agricultural Experience - Research Projects

Can Variations of Soil Temperature Be Used to Control Stem Internode Elongation of Plants?
Plant Systems

Years
2011 - 2012

Hours
284

Research Expenses

Year	Expense Item	Memo/Description	Cost
2011	1835 trays	Used to house the 3.5 inch growing pots	$1
2011	3.5 inch square pots	Plants were grown in these	$0
2011	Fafard 4P soil mix	Needed for growing experimental plants	$11
2011	Logbook	used to record data and pertinent information	$3
2012	Green bean seed	Type of plant used in experiment	$2
2012	Soil Thermometer	Used to gauge the temperature of the soil	$10
2012	Temperature Data Logger	Used to track the daily temperature over the course of the experiment	$65
			$92

Research Income

Year	Income Source	Memo/Description	Cost
2011	Family	logbook	$3
2012	Anywhere Ag Department	All other expenses	$89
			$92

Please give a detailed explanation of how you obtained your project materials.

My 1st project was conducted in my school's greenhouse. I wanted to evaluate the impact of soil temperature on the internode elongation of bean plants. I was able to conduct this project because of the resources that were available from the school. Just like a large university agricultural researcher, I relied on crops grown in the greenhouse. As the beans were growing, I measured the internode length using a metric ruler and controlled the temperature of the soil. I collected this data and was then able to take the data to the agriscience laboratory at my school where I analyzed it and prepared my project. Overall, my school and family provided the resources so I could conduct my first agriscience research project.

Abstract

While in the school greenhouse, the researcher noticed the stem height of plants appeared to be affected by different growing conditions. The purpose of this project was to create an experiment to investigate if soil temperature impacts internode elongation in plants.

The hypothesis for this project was based on the background information and it stated that using a constant higher soil temperature in plants will have a statistically significantly greater stem internode elongation length than plants with variations of cooler and warmer soil temperature.

A literature review was performed to gather information on plant stem height, DIF, and use of plant growth regulator chemicals. With the increased demand for organically grown plants, plant growers are seeking an alternative to chemical growth regulators. Therefore, the use of soil temperature as a means of regulating height was used to develop a hypothesis.

A two group experiment was designed to test the hypothesis. Bean seeds were planted in cups and allowed to germinate. Half of the plants (experimental set) were placed on a heat pad and maintained at a temperature of eighty degrees. The second set (control set) was subject to variation in air temperature only. Measurements were taken from cotyledon to the first vegetative node of each plant. The averages of the two groups (control-17mm and experimental 24mm) were evaluated in an ANOVA for significant difference.

Three conclusions were made: (a) Hypothesis was accepted due to the p-value -0.0029, (b) plant internode elongation can be controlled with soil temperature, and, (c) controlling plant height with soil temperature can reduce need for chemical plant growth regulators.

INTRODUCTION

Greenhouse growers often face the challenge of plants becoming too tall (reference information not provided). Research has been conducted about using day time and night time air temperature (also known as DIF) to control plant height or stem elongation. Also, many growers use chemical growth regulators to control plant height.

DIF has impact on plant's internode length. Plants grown under a positive DIF are taller than plants grown under a zero DIF and plants grown under a zero DIF are taller (DIF Temperature Control, n.d). When comparing plants that have been treated with chemical growth regulators, plants controlled by temperature are at least 10 millimeters taller (reference information not provided).

DIF is the difference between day and night temperatures. Many growers use this method of controlling plant height. Studies show that as the DIF increases, the plant height does too (Quantification of temperature …, n.d.). A plant with zero DIF has identical day and night temperatures.

The problem to be investigated in this project was to evaluate whether soil temperature can be used to regulate plant height. This would possibly be used as a management tool for growers preferring not to use chemical growth regulators.

Procedure

REVIEW OF LITERATURE

Having identified the problem, the first step was to conduct a background study. A review of literature from a variety of sources was conducted using internet sources, journal articles, textbooks, and personal interviews provided information and ideas for this study.

Plant Growth

According to (reference information not provided), there are several factors important to plant growth:

Stem Elongation-The large bud at the apex of a stem is called the terminal bud. The terminal bud is important because it contains the apical meristematic tissue or the primary growing point of the stem. This is where hormones, called auxins are produced and released into the plant. These hormones then migrate down the stem influencing growth.

Internode-The internode of a plant is the area between the nodes of the stem where cells elongate.

Node-Enlarged regions on the stems where buds are located and leaves are not attached.

Plant height-Plant height is "the sum of the number of nodes and the length of each internode." It is heavily influenced by green house temperatures, for it increases as the average temperature increases.

Chemical Plant Growth Regulators

There are many plant growth regulators that plant growers use in plant production. Some of these include B-Nine, Cycocel, A-rest, Bonzi, and Sumagic (reference information not provided). B-Nine passes into the leaf and moves within the plant to the growing points, reducing internode elongation. Cycocel and Bonzi are most commonly used on poinsettias, hibiscus, azaleas, and geraniums while Sumagic is used mainly on tomato, eggplant, and pepper plants.

MATERIALS AND METHODS

Hypothesis

The hypothesis for this project was when using a constant higher soil temperature, plants will have a statistically significant greater stem or internode elongation length than plants with variations of cooler and warmer soil temperature.

Purpose and Objective

The purpose of this project was to evaluate if soil temperature could be used as a means of controlling plant height. The objective of this project was to develop a procedure to be used by plant growers to assist in developing plant height. The general approach was to use the scientific method as a systematic means for reaching the objective of this project.

Experimental Design

The researcher designed an experiment to test the hypothesis. The researcher chose the experimental design with two groups. The experimental group received the treatment of being maintained at a relative constant higher temperature. The control group received no treatment except for being subject to fluctuations of the greenhouse temperature for normal plant growth. A post-test measurement of internode elongation was used to collect data for the experiment.

Methods

The researcher used these steps to carry out this experiment are as follows:

1. Filled trays with soil.
2. Watered each tray until moist.
3. Planted two seeds in each cup.
4. Grow lights in the greenhouse were used to extend the light period or day length to 12 hours.
5. Placed the first set (experimental) on a heating pad set at eighty degrees Fahrenheit.
6. Placed second set (control) on greenhouse table.
7. Set up temperature data logger to record greenhouse air temperature.
8. Soil temperature was measured and recorded each day in the morning of the two treatments with soil thermometer.
9. Grow lights were set to ensure plants received a total twelve hours of light.
10. After the first true leaf formed above the cotyledon node, researcher measured length of internode of plants between cotyledon (C1) and first vegetative (V1) node of each plant in each treatment.
11. Recorded data in log book, and transferred to excel spreadsheet.
12. To reduce impact of outlying data the five highest and five lowest readings on samples were removed from data analysis.

Testing Site

The researcher used the Anywhere School Greenhouse for conducting the experiment. The greenhouse is approximately 25" x 50" in size. It is fairly new, only being three years old. Features of the greenhouse include: 1800 square feet of space with raised plant growth tables. Two tables have two 400 watt grow light suspended with timers to supplement light or increase day length exposure for plants. The temperature is controlled with thermostats with heat provided by a gas heat system and evaporative pad cooling. Large exhaust fans proved for ventilation with four horizontal air flow fans mounted over head to facilitate air circulation in greenhouse.

Data Analysis

An analysis of variance ANOVA was performed to assess if the measurements of internodes generated in the experiment between the control and experimental sets were significantly different. A p-value of less than 0.05 was considered significant. An ANOVA test is used to compare the averages of small sets of numbers, such as generated in this experiment, to determine if there is a statistically significant difference. The researcher used an Excel spreadsheet to perform the statistical analysis.

Limitations

The study had several factors or variables that limited its effectiveness. These variables could prevent other researcher in different situations from reaching similar findings. Some of the limitations include scarcity of funds, equipment, and time to perform a more in-depth evaluation over a longer period of multiple growing conditions.

Controlling variations of temperature in the greenhouse was inconsistent and affected by outside temperature, light, and weather conditions. The lack of an accurate method of taking precise measurements of incremental changes in soil temperature over specified time intervals prohibited the researcher from collecting more precise data on soil temperature.

Conclusion

RESULTS

The researcher conducted an experiment that would evaluate whether temperature effects stem or internode elongation in plants during this experiment.

Data

Table 1. INTERNODE MEASUREMENT FROM COTYLEDON NODE TO V1 NODE. The table below demonstrates the averages of the multiple measurements in millimeters taken over the eighteen days in this experiment.

Control	Treatment
17.19	24.52

The table above is a list of the average internode measurements of the stem between the cotyledon node and the V1 node of the plant. The researcher actually gathered 80 measurements from the experimental and control groups. For the convenience of the reader, the averages are displayed above. The top and bottom 5 measurements were removed from the data analyzed to remove the extreme outlying measurements.

The air temperature of the greenhouse was monitored using the Extech Datalogger instrument for eighteen days of the experiment. Temperatures were recorded at 12 hour intervals at 5 AM and 7 PM. Temperatures varied from daytime to night time in a range of 53 degrees Fahrenheit to 82 degrees Fahrenheit. This variation was used as the control of the samples for soil temperature variation.

Trends

The data listed above shows that both sets in the experiment showed a positive correlation. Both sets stayed at a fairly constant rate, although the experimental was always greater than the control measurements.

Statistical Analysis

Table 2. ANOVA- ANALYSIS OF INTERNODE LENGTH. The table below represents the statistical analysis of the data. Significant at the <0.05 level.

Source	SS	df	MS	F	P-value	F crit
Between Groups	4038.465	70	57.6924	1.94223	0.00294	1.48311
Within Groups	2109	71	29.7042			
Total	6147.465	141				

The accepted p-value was <0.05. The ANOVA in the table above revealed a p-value of 0.00294. This p-value was less than the accepted value.

DISCUSSION AND CONCLUSION

Conclusions

As a result of this project, the researcher has drawn several conclusions:

1. The first conclusion relates to the hypothesis. The differences found in the results of internode growth of the control versus the experimental group were statistically significant according to the ANOVA test. The ANOVA evaluated the data which was the results of this project. The p-value was 0.0029, which is less than the accepted p-value of 0.05, therefore, the first conclusion was the hypothesis was accepted.

2. The second conclusion relates to plant growth management. In the results of the experiment, the experimental set's average of 24.52 millimeters was about 7 millimeters greater than the control set's average of 17.19 millimeters. The second conclusion was plant internode elongation can be regulated or impacted by variations in soil temperature.

Earlier researchers (2012) conducted, helped support this statement by providing a series of information that showed similar results. This conclusion helps to support the hypothesis as well as it demonstrates an increase in the internode length.

3. The third conclusion relates to the use of soil temperature variation to possibly decrease the use of chemical plant growth regulators. After conducting research on the subject, it was found that soil temperature can be used to control internode elongation in plants and will be more beneficial to plant growers than chemical growth regulators. The results of this experiment show that soil temperature could possibly impact internode length up to 41.2%.

Other studies conducteded on the subject agreed when compared, plants with regulated temperature were at least 10 millimeters taller than plants treated with chemicals. The third conclusion was soil temperature can decrease the use of chemical growth regulators.

Recommendations

The researcher made several recommendations as a result of this project. The first recommendation was that this project be repeated on a larger scale with more plants. The second recommendation was a more precise method of controlling and measuring soil temperature be used in the future study. The third recommendation was a more precise measurement of internode elongation be developed and used in data collection on more than one internode on each plant sample.

ACKNOWLEDGEMENTS

The researcher would like to thank the following businesses, organizations, and individuals for their help:
Anywhere School for the use of its greenhouse and supplies, Agriculture Teacher for aiding the researcher in enhancing the project and giving his time and efforts, and the Agricultural Education Program for inspiring the researcher to conduct an agriscience project. agriscience project.

REFERENCES (Not provided for example purposes)

National Research Proficiency
Supervised Agricultural Experience - Research Projects

Can Soil Temperature Be Used to Control Stem Internode Elongation Like Chemical Growth Regulators?
Plant Systems

Years: 2012 - 2012
Hours: 330

Research Expenses

Year	Expense Item	Memo/Description	Cost
2012	4 inch cups	Plants were grown in these	$1
2012	B-9	Chemical growth regulator used in experiment	$90
2012	Fafard 4p soil mix	Type of soil plants were grown in	$280
2012	Flat bush snap beans	Type of plants used in experiment	$2
2012	Lab coats	Worn during experiment	$5
2012	Redi-Heat Soil Heating Pad	Used to heat the plants	$130
2012	Safety glasses	Worn during experiment	$3
2012	Trays	Plants were grown in these	$2
			$513

Research Income

Year	Income Source	Memo/Description	Cost
2012	Anywhere Agriculture Department	All expenses	$513
			$513

Please give a detailed explanation of how you obtained your project materials.

My 2nd project was an outgrowth of my 1st. Having determined that soil temperature can be used to control the growth of plants, I wanted to eradicate the need for chemical growth regulators. Again, my school provided resources. After planting both groups of plants, I distributed the required chemical growth regulators to my experimental group. Some of my materials and equipment needed were given or loaned to me through the Anywhere High School Agriculture Department. I was able to measure the internode length of the bean plants. I used a metric ruler to measure the internode length of the plants. Again, I was able to conduct this research project thanks to the investment of the Anywhere High School Agricultural Education program.

Abstract

The researcher noticed stem height of plants appeared to be affected by different growing conditions in the greenhouse. So, the purpose of the experiment was to investigate if soil temperature affected internode elongation in plants compared to chemical growth regulator grown plants.

A review of literature was performed to gather information on plant stem height, DIF, and use of growth regulator chemicals. The hypothesis for this project was based on the background and stated that using a constant higher soil temperature in plants will have a statistically similar stem internode elongation length than plants treated with a chemical growth regulator such as B-9.

A two group experiment was designed to test the hypothesis. Bean seeds were planted in cups and allowed to germinate. Both sets of the plants were placed on a heat pad and maintained at a temperature of eighty degrees. The second set (control set) was subject to a chemical growth regulator every other week. Measurements were taken from the bottom of plant to the first vegetative node of each plant. The averages of the growth of the two groups (control - 11.42mm, experimental - 11.41mm) were evaluated for statistical similarity.

Four conclusions were determined: (a) Hypothesis was accepted (p-value 0.98), (b) stem length can be controlled using soil temperature, (c) can reduce the need for chemical plant growth regulators, and, (d) growers could save $8,000,000 annually using lower soil temperature. Recommendations included the need for a larger experiment, a more precise method of controlling and measuring soil temperature, and a precise measurement of elongation.

INTRODUCTION

Often plant growers face the challenge of greenhouse plants becoming too leggy prior to final transplanting.
Much research has been conducted and utilizing of day time and night time air
temperature to control stem elongation. Growers use chemical growth regulators to control plant height or stem elongation.

The researcher found in an earlier study, that increased soil temperature could definitely increase stem internode elongation. The researcher found that DIF has a great impact on most plant species' internode length. It was discovered that plants grown under a zero DIF are taller than plants grown under a negative DIF (DIF Temperature Control, n.d). When comparing plants that have been treated with chemical growth regulators to plants with a regulated soil temperature, the plants controlled by temperature are at least 10 millimeters greater in stem height than those that use chemicals.

The problem to be investigated in this project was the regulation of plant height via soil temperature. This would possibly be used as a management tool for growers preferring not to use chemical regulators or who do not have the resources to use the DIF method for controlling stem elongation.

Procedure

PURPOSE AND OBJECTIVE

The purpose of this project was to evaluate if soil temperature was a means of controlling plant height. The objective of this project was to develop a procedure to be used by plant growers to assist in developing plant height. The general approach was to use the scientific method as a systematic means for reaching the objective of this project.

REVIEW OF LITERATURE

A review of literature from a variety of sources was conducted using internet sources, journal articles, textbooks, and personal interviews which provided information and ideas for this study.

Plant Growth

According to Lee's Introduction to Horticulture, there are several factors important to plant growth:

Stem Elongation-The large bud at the apex of a stem is called the terminal bud. The terminal bud is important because it contains the apical meristematic tissue or the primary growing point of the stem. This is where hormones, called auxins are produced and released into the plant. These hormones then migrate down the stem influencing growth.

Internode-The internode of a plant is the area between the nodes of the stem where cells elongate.

Node-Enlarged regions on the stems where buds are located and leaves are not attached.

Plant height-Plant height is "the sum of the number of nodes and the length of each internode." It is heavily influenced by green house temperatures, for it increases as the average temperature increases.

Chemical Plant Growth Regulators

There are many plant growth regulators plant growers use in the plant production. Some of these include B-Nine, Cycocel, A-rest, Bonzi, and Sumagic. B-Nine passes into the leaf and moves within the plant to the growing points, reducing internode elongation. Cycocel and Bonzi are most commonly used on poinsettias, hibiscus, azaleas, and geraniums while Sumagic is used mainly on tomato, eggplant, and pepper plants. (reference information removed for example)

Summary

In this search of literature, information was found on the internet and the researcher's school's textbooks. The information was helpful to study by providing information regarding stem internode elongation, and methods of safely distributing chemical growth regulators.

MATERIALS AND METHODS

Hypothesis

The hypothesis for this project was plants treated with a constant higher soil temperature will have statistically similar stem or internode elongation length to plants treated with a chemical growth regulator. This hypothesis was based on the information described in the Findings of Earlier Work and Review of Literature sections of this report.

Experimental Design

The researcher designed an experiment to test the hypothesis. The researcher chose the two group experimental design. The experimental group received the treatment of being maintained at a relative constant lower soil temperature, being subject to fluctuations of the greenhouse temperature for normal plant growth. The comparison group received the treatment of higher soil temperature and B-9 chemical growth regulator. A post test measurement of internode elongation was used to collect data for the experiment.

Methods

The researcher used these steps to carry out this experiment are as follows:

1. Filled trays with soil.
2. Watered each tray until moist.
3. Planted two bean seeds in each cup of soil.
4. Placed the first set (experimental) on a greenhouse table.
5. Placed second set (control) on heating pad set at eighty degrees Fahrenheit and treated weekly with B-9 chemical growth regulator.
6. Set up temperature data logger to record greenhouse air temperature.
7. Soil temperature was measured and recorded each day in the morning of the two treatments with soil thermometer. The growing period was 18 days.
8. After the first true leaf formed above the cotyledon node, researcher measured length of internode of plants from the bottom of the plant and first vegetative (V1) node of each plant in each treatment.
9. Recorded data in log book, and transferred to excel spreadsheet.

Testing Site

The researcher used the Anywhere High School Greenhouse for conducting the experiment. The greenhouse is approximately 25” x 50” in size. Features of the greenhouse include: 1800 square feet of space with raised plant growth tables. Two tables have two 400 watt grow light suspended with timers to supplement light or increase day length exposure for plants. The temperature is controlled with thermostats with heat provided by a gas heat system and evaporative pad cooling. Large exhaust fans proved for ventilation with four horizontal air flow fans mounted over head to facilitate air circulation in greenhouse.

Data Analysis

An analysis of variance, ANOVA, was performed to assess if the measurements of internodes generated in the experiment between the control and experimental sets were statistically similar. A p-value of more than 0.90 as considered similar. An ANOVA test is used to compare the averages of small sets of numbers, such as generated in this experiment, to determine if there is a statistically significant difference. The researcher used an Excel spreadsheet to perform the statistical analysis.

Limitations

The study had several factors or variables that limited its effectiveness. These variables could prevent other researchers in different situations from reaching similar findings. Some of the limitations include scarcity of funds, equipment, and time to perform a more in-depth evaluation over a longer period of multiple growing conditions. Controlling variations of temperature in the greenhouse was inconsistent and affected by outside temperature, light, and weather conditions. The lack of an accurate method of taking precise measurements of incremental changes in soil temperature over specified time intervals prohibited the researcher from collecting more precise data on soil temperature.

Conclusion

RESULTS

The researcher conducted a project to test internode elongation rates. He evaluated the similarity between plants grown with warmer soil, and plants grown with chemical growth regulators.

Data

The researcher conducted an experiment that would evaluate whether temperature effects stem or internode elongation in plants during this experiment. The table (Table 3) below displays the results of the experiment. As described in the table, the researcher used a two group design for the experiment, with an experimental and control set.

Table 3. INTERNODE MEASUREMENT FROM COTYLEDON NODE TO V1 NODE. The table below demonstrates the averages of the multiple measurements in millimeters taken over the eighteen days in this experiment.

Plant #	Experimental	Control
1	12.0	10.6
2	10.0	10.5
3	11.0	11.2
4	12.2	11.3
5	12.0	12.0
6	12.1	10.5

7	11.5	11.8
8	10.8	12.3
9	11.2	12.1
10	11.7	11.4
11	12.2	11.9
12	10.6	10.7
13	11.7	10.5
14	10.5	11.8
15	10.8	12.1
16	11.0	12.3
17	12.0	11.6
18	12.1	10.9
Average	11.41	11.42

The table above is a list of the average internode measurements of the stem between the bottom of plant and the V1 node of the plant. The researcher actually gathered 36 measurements from the experimental and control groups. For the convenience of the reader, the averages are displayed above.

The air temperature of the greenhouse was monitored using a Data logger instrument for eighteen days of the experiment. Temperatures were recorded at 12 hour intervals at 5 AM and 7 PM. Temperatures varied from daytime to night time in a range of 53 degrees Fahrenheit to 82 degrees Fahrenheit. This variation was used as the control of the samples for soil temperature variation.

Trends

The researcher constructed a graphic representation of the data to aid in the understanding of the results of this project. The data listed shows that both sets, control and experimental, in the experiment showed a positive correlation. The growth rates of both of these sets of plants receiving varying treatments stayed at a fairly constant rate, with not much difference between the experimental was always greater than the control measurements.

Analysis

An analysis of the data was conducted after the experiment was completed. The researcher used an ANOVA to analyze the data on Microsoft Excel Spreadsheet.

Table 4. ANOVA- ANALYSIS OF INTERNODE LENGTH. The table below represents the statistical analysis of the data. Significant at the >0.90 level.

Summary

Groups	Count	Sum	Average	Variance
Column	11	8205.4	11.4111	0.47163
Column	21	8205.5	11.4167	0.43676

ANOVA

Source	SS	df	MS	F	P-value	F crit
Between Groups	0.00028	1	0.00028	0.00061	0.98041	4.13002
Within Groups	15.4428	34	0.4542			
Total	15.4431	35				

The accepted p-value was >0.90. The ANOVA in the table above revealed a p-value of0.98. This p-value generated in the statistical analysis was more than the accepted value.

DISCUSSION AND CONCLUSION

An experiment was conducted to evaluate the effectiveness of the use of cool soil temperatures for the regulation of stem internode elongation as compared to a chemical growth regulator. The average length of plants receiving the treatment of cooler soil temperatures was 11.41mm while the plants receiving the treatment of chemical growth regulator were 11.42mm. A statistical analysis found statistical similarity between the two sets of plants.

Conclusions

As a result of this project on plant internode growth rates, the researcher drew several conclusions. Each conclusion and its pertinent and specific discussion follows:

1. The first conclusion relates to the hypothesis. The differences found in the results of internode growth of the control versus the experimental group were statistically similar according to the ANOVA test. The ANOVA evaluated the data which was the results of this project. The p-value was 0.98, which is more than the accepted p-value of 0.90. Therefore, the first conclusion was the hypothesis was supported.

2. The second conclusion relates to plant growth management. In the results of the experiment, the experimental set's average was 11.41 millimeters and the control set's average of 11.42 millimeters. This indicated only a 0.01mm difference in growth rates between the two sets of plants in the experiment. The second conclusion was plant internode elongation can be regulated or impacted by variations in soil temperature.

Earlier research Carvalho, Heuvelink, Cascais, and Kooten (2012) conducted, helped support this statement by providing a series of information that showed similar results. This conclusion helps to support the hypothesis as well as it demonstrates an increase in the internode length.

3. The third conclusion relates to the use of soil temperature variation to decrease the use of chemical plant growth regulators. After conducting research on the subject, it was found that soil temperature can be used to control internode elongation in plants and will be more beneficial to plant growers than chemical growth regulators. The results of this experiment show that soil temperature could possibly impact internode length. This experiment only generated a growth difference of 0.01mm which was 0.09%

Other studies conducted (reference removed) agreed when compared. Those researchers also found that plants with regulated temperature were similar to plants treated with chemicals. The third conclusion was soil temperature can decrease the use of chemical growth regulators.

4. The last conclusion deals with the economic impact of this project. The results of that economic impact are displayed below in Table 5.

Table 5. ECONOMIC IMPACT OF SOIL TEMPERATURE REGULATION. The table below represents an economic analysis of the results of the project using indicated measurements.

Item	Value
Commercial Greenhouses in US	88,000
Cost of 1 bag of B-Nine	$90
Total	$7,920,000

The researcher sought to determine the value of this project to greenhouse growers in the United States. He concluded that if each grower in the United States (United States Census Bureau, n.d.) purchased just one bag of B-Nine chemical growth regulator annually, they would save almost $8,000,000 by using lower soil temperature instead.

Recommendations

The researcher has several recommendations for this project. The first recommendation is that this project be repeated on a larger scale with more plants. The second recommendation is that a more precise method of controlling and measuring soil temperature be used in the future study. The third recommendation a more precise measurement of internode elongation be developed and used in data collection on more than one internode on each plant sample.

ACKNOWLEDGEMENTS

The researcher would like to thank the following businesses, organizations, and individuals for their help: Anywhere High School for the use of its greenhouse (reference removed) for aiding the researcher in enhancing their project, (reference removed) giving his time and efforts, and the Agricultural Education Program for inspiring the researcher to conduct an agriscience project.

REFERENCES:

Removed for example purposes

The Impact of Growing Environment on Blueberry Sugar Content

Plant Systems

Years
2013 - 2013

Hours
378

Research Expenses

Year	Expense Item	Memo/Description	Cost
2013	High Tunnels	Covered 1 acre of blueberries	$22,500
2013	Lab coat	Worn during experiment	$5
2013	Laptop	Used Microsoft Excel program to format our data and results from our experiment	$468
2013	Logbook	Used to lot down obsevations and write reports while conducting our experiment	$2
2013	Magic Bullet blender	Used to grind up blueberries into samples to place on brix refractometer to measure sugar	$25
			$23,000

Research Income

Year	Income Source	Memo/Description	Cost
2013	Coggins Farms	All other expenses	$22,998
2013	LHS Agriculture Department	Logbook	$2
			$23,000

Please give a detailed explanation of how you obtained your project materials.

I wanted to combine aspects of my earlier research with a new investigation. I had previously hypothesized environment improved plant growth. This year, I actually measured the environment and quality improvement in blueberries together. The school agriculture department and Anywhere Farms helped me with my research needs. I used equipment and methods in my previous project last year at Anywhere High School. Through the knowledge gained of my work in the previous years, I knew how to operate many of the procedures I used to complete my project. I am very thankful that the Anywhere High School agriculture program, and Anywhere Farms have provided the resources to help me conduct my research over these past years.

Abstract

“High tunnels,” or open greenhouses, are used to improve crop production. The purpose of the project was to evaluate high tunnels for improving the sugar content in blueberry production. Results were gathered using the scientific method.

A literature review was conducted to gather information about blueberries, blueberry sugar measurement, and high tunnels. Based on the background, a hypothesis was developed which stated that a significantly higher amount of sugar content would be produced in the blueberries using high tunnels due to the greenhouse affect the high tunnels have on the blueberries.

An experiment was designed to test the hypothesis performed in a number of steps: (a) Three high tunnels were erected, (b) blueberries were planted, grown, and harvested under normal conditions, (c) blueberries from each area were pureed and measured for sugar content, (d) records were kept of sugar content in the test areas, and, (e) an analysis of variance was conducted of the data. In the experiment, an average of 13.8 Brix measurement was obtained from under the high tunnels while others averaged 11.3 Brix.

Four conclusions were drawn: (a) The hypothesis was supported via a significant p-value of <0.0001, (b) 2.5 Brix more sugar was produced by blueberries grown under the high tunnels, about a 20.6% increase, (c) blueberry producers could exceed USDA food label recommendations by 26.5%, and, (d) the value added by high tunnels in sugar content exceeds $2,000,000. It is recommended that this project be repeated on a larger scale and that the blueberry industry in any state review the economics of using the high tunnels to increase blueberry sweetness.

INTRODUCTION

High tunnels, or open greenhouses, increase blueberry production by 15%. Also, blueberries grown under high tunnels have over a 20% increase in sugar content (reference removed). Similar to high tunnels, soil temperature has been found to affect the overall internode length of plants, and that by controlling the soil temperature, the need for chemical growth regulators is diminished (reference removed).

Other previous studies included (reference removed), who said sugar can be “loaded” through improved environmental conditions. (reference removed) found that limiting growth conditions can cause berries to cease sugar production.

The use of three high tunnels covering approximately one acre of blueberries was instituted on a farm on the sub-tropical border. While it required a great deal of effort and time to install the high tunnels, the effects on food quality, specifically sugar production, and environment had not been completely evaluated. The problem for this study was that blueberry quality that might be positively impacted by high tunnel technology use, however, an in depth evaluation of their impact on food quality had not been conducted. The researcher set out to use the scientific method to solve this agricultural problem.

Procedure

REVIEW OF LITERATURE

A review of literature was conducted concerning blueberry production, blueberry sugar content, and high tunnels.

Blueberries

Blueberries are known as flowering plants of the genus Vaccinium, a species which also includes cranberries and bilberries, that are perennial with dark-blue berries (reference removed). Cyanococcus are the most common fruits sold, also known as "blueberries," and are native to North America. Blueberries are usually erect but sometimes grow as short shrubs varying in size from 3.9 inches to 160 inches tall. In commercial blueberry production, there are smaller species known as "lowbush blueberries." These varieties are also synonymous with “wild” types and the larger "high bush blueberries” are most cultivated.

The leaves can be deciduous or evergreen. The flowers are bell-shaped and usually white, pale pink or red or even sometimes tinged greenish. The fruit is a berry about 0.20–0.63 inches in diameter with a flared crown at the end. These berries are pale greenish at first, then reddish-purple, and finally become dark blue when ripe. These berries have a sweet taste when mature with variable acidity. Blueberry bushes usually bear fruit in the middle of the growing season. However, fruiting times are affected by local conditions like altitude and latitude so the duration of peak harvest can vary from May to August depending upon variety of conditions.

Growing requirements of blueberries.

Blueberries require full sunlight and well-drained soil according to (reference removed), a nursery supply company. Plants will tolerate partial shade, but shade will cause fewer blossoms and a decline of fruit production. Poor air movement also increases danger of spring frost injury to blossoms and can cause disease development.

Blueberries require acid soil with a pH of 4.5 to 4.8. The growth of the plant is slowed and the foliage turns yellow if the pH is too high. If the pH is too high for an extended period of time, the plants will die. Blueberry plants are long-lived, so time and effort in preparing the soil is considered a wise investment.

Any State Blueberry Acreage

According to the Any State Blueberry Commission, blueberries grow well in Any State. In 2012, Any State was projected to become the second largest producer of blueberries. Fourteen thousand acres of blueberries are grown each year and each year the acreage increases along with production.

Blueberry Sugar Content

Blueberries fall somewhat in the middle of fruits in regards to sugar content according to (reference removed). Raspberries and strawberries are lower than blueberries in sugar content, while bananas and apples are higher. No sugar added blueberries contain about 7.4 grams per each one-half cup. Blueberry labels vary in sugar content up to 15 grams per cup, with the USDA at 11 grams per cup (reference removed)

Blueberry Production

The Any State blueberry harvest season starts in mid to late April and lasts through July in some parts of the state. The harvest season in Any State lasts through August, giving Any State the longest harvest of any blueberry growing state in the country with a total of 90 plus days of harvest (reference removed).

High Tunnels

High tunnels are a manufactured product used to increase the production of various crops. They are basically open greenhouses. According to (reference removed), some of the benefits include: Early and late season extension, improved produce quality and yield, ability to be insured, increased ability to efficiently manage field environment, reduced plant stress, efficiency in production planning, and consistency and predictability of harvest.

Brix

According to (reference removed). He was the first to measure the density natural juices of plants by floating a hydrometer in the juice. A measure of the percent of solids in a given weight of solution. (reference removed) sometimes expressed another way: (reference removed) equals the pounds of sucrose, fructose, vitamins, minerals, amino acids, proteins, and other solids in one hundred pounds of a solution. A 3 degree Brix reading would equal to 3g of solids in 100ml of solution.

(reference removed) Refractometer

According to (reference removed) refractometer is the instrument used to measure refractive index of an item's sucrose level. The sucrose level is usually called it's (reference removed) level. Although (reference removed) refractometers are best known for measuring liquids, they are also used to measure gases and solids. A (reference removed) refractometer is frequently used by grape growers, Kiwi fruit growers, home brewers, as well as food producers for testing of sucrose levels in their fruit.

Related Studies

The researcher found information from several studies that linked improved environmental conditions to an increase of sugar production in berries. A researcher from (reference removed), found an increase in production of berries under high tunnels. He also found an increase in the sugar content of berries grown under the high tunnel.

(reference removed) uses high tunnels for berry production. The owner, (reference removed) is very impressed with high tunnels. He said high tunnels on their farm increased the quality of other kinds of berries.

(reference removed), found that improved environmental conditions can “load” sugar in berries.

Limiting growth conditions were identified to cause berries to cease sugar production. (reference removed) previously found that high tunnels increased blueberry production by 15%. This would represent a sizable gross increase in revenue for Any State blueberry farmers. Also found in a preliminary study that blueberries grown under high tunnels had a 20.8% increase in sugar content. (reference removed) found that soil temperature could affect the growth of plants, and that by controlling the soil temperature, the need for chemical growth regulators is diminished (reference removed).

Summary

In this search of literature, information was found on the internet and television. The information was helpful to the study by providing information regarding blueberry sugar content and high tunnels.

MATERIALS AND METHODS

Hypothesis

The hypothesis for this project was the sugar content of blueberries grown under high tunnels would be significantly greater than those growing an open field due to the improved environment. The literature, described in the Abstract and Review of Literature sections, detailed some evidence that blueberries would be more productive in sugar when grown under high tunnels.

Experimental Design

The researcher designed an experiment to test the hypothesis. The researcher chose the experimental design. The experimental group received the treatment of high tunnels. The control group received no treatment. The post-test was evaluation of the sugar content of blueberries produced in both the control and experimental sets.

Methods

The steps used to carry out this experiment are as follows:
1. Install plastic and plant blueberries.
2. Install three high tunnels.
3. Regular maintenance of blueberries: Mowing, spraying, fertilizing, etc.
4. Measure the air temperature outside and under the high tunnels.
5. Harvest blueberries as normal. Keep accurate markings of the containers that blueberries are picked into and shipped in.
6. Take random samples of blueberries.
7. Puree samples.
8. Measure sugar content using Brix refractometer.
9. Record data in a logbook as needed. Conduct statistical analysis.

Testing Site

This experiment will take place in the field and laboratory. The growing site was located on a family farm in Any State. The actual site is a 50 acre blueberry field. The field has three high tunnels installed. The three high tunnels cover approximately a half acre in area each. The testing site is the researcher's school agriscience laboratory.

Statistical Procedure

A t-test was performed to assess if the sugar content measurements generated in the experiment between the control and experimental sets were significantly different. A p-value of less than 0.05 was considered significant. The researcher used a QuickCalcs website ((reference removed) to perform the statistical analysis.

Limitations

One limitation is lack of funds, equipment, and time to perform a more in-depth evaluation. Growing conditions vary greatly from farm to farm. This soil type on the family farm was extremely low in pH and had to be brought up several increments before planting. Pine bark was used to make the soil pH equivalent, unlike other farms, which may use lime or other ways to correct pH for blueberry production. The fertilizer and herbicides used around the blueberry plant also vary. Some blueberry growers may not have the same type of weeds or use varied control methods.

Another variable is the climate and the humidity in Any State. Compared to other places it could be very difficult to grow with colder weather, unlike Any State which is a sub-tropical region and subjected to a great deal of humidity. Extremes in temperatures effect agriculture differently due to humidity. Late winter and early summer temperatures can have drastic effects on blueberries.

Conclusion

RESULTS

The researcher conducted a project to compare the amount of sugar in the blueberries underneath the high tunnels to those not grown under high tunnels. The high tunnels function like a greenhouse that covers the blueberries and helps in the growing process. The project was sparked in an effort for the agriculture blueberry industry to help increase the sugar content in blueberries by using high tunnels.

Data

A dependent variable of temperature under the high tunnels was measured as a part of this experiment. The table (Table 6) shows the difference in air temperature under the high tunnels and outside of the high tunnels during the months of preceding the experiment.

Table 6. TEMPERATURE DATA. This table illustrates a comparison of the temperature of blueberries grown in the open field versus those grown under high tunnels (measured in degrees Fahrenheit).

	Date	Field Temp	High Tunnel Temp
1	2-15-14	63	71
2	2-18-14	62	69
3	2-20-14	64	70
4	2-23-14	66	74
5	2-25-14	64	71
6	2-28-14	68	74
7	3-4-14	70	78
8	3-7-14	70	77
9	3-9-14	69	75
10	3-11-14	70	78
11	3-15-14	71	78
12	3-17-14	73	79
13	3-20-14	72	80
14	3-24-14	73	80
15	3-27-14	71	77
16	3-30-14	74	82
17	4-2-14	75	82
18	4-5-14	75	81
19	4-8-14	76	84
20	4-10-14	76	83
21	4-13-14	78	84
22	4-16-14	79	87
23	4-18-14	82	89
24	4-21-14	82	88
25	4-24-14	81	89
26	4-28-14	83	90
27	5-2-14	82	88
28	5-6-14	86	95
29	5-9-14	88	95
30	5-13-14	89	96

Averages	74	81

There is an average difference of seven degrees Fahrenheit between the field temperature and the high tunnel temperature. This shows that the high tunnels produce an improved growing environment for blueberries.

The researcher conducted an experiment that would evaluate the content of blueberry sugar underneath high tunnels. During the experiment, the blueberry sugar content was measured to determine the outcome. Even though there is limited space that the high tunnels cover, it is easy to observe the difference in the size and vigor of the blueberries when compared to the rest of the field. Table 7 shows difference in the sugar content in the open field and underneath the high tunnels.

Table 7. SUGAR DIFFERENCE BETWEEN HIGH TUNNELS AND OPEN FIELD (reference removed). This table illustrates a comparison of the sugar production of blueberries grown in the open field versus those grown under high tunnels (reference removed).

Sample	Control	Sugar
1	11.5	14.0
2	11.0	12.3
3	10.8	14.5
4	10.8	13.5
5	12.0	14.0
6	11.0	14.8
7	11.5	12.0
8	10.0	16.5
9	11.0	14.5
10	13.0	13.5
11	10.5	15.3
12	12.5	14.3
13	13.0	12.8
14	9.8	12.5
15	14.0	15.5
16	12.5	14.0
17	11.0	13.3
18	10.8	14.5
19	10.3	13.5
20	12.0	13.0
21	11.5	14.3
22	11.5	11.5
23	9.5	16.5
24	11.5	14.5
25	13.0	14.0
26	10.5	14.8
27	12.0	14.3
28	12.5	10.8
29	9.8	12.0
30	14.0	15.0
Averages	11.3	13.8

The average content of all three tunnels was 13.8 Brix. The most often occurring range regarding the sugar content fell into the 14.0-14.9 Brix range. The highest sugar produced in a sample was (reference removed). The experimental set yielded higher sugar content than the open field. The difference was (reference removed).

Trends

The researcher detected some trends in the data. The trends were apparent when the results of the project were arranged graphically for visual inspection. The sugar content from the control group tended to be less than the sugar content from the experimental group. The majority of the experimental samples contained higher sugar than those in the control samples. Also, the field temperature was lower than the temperature under the high tunnels.

Statistical Analysis

An analysis of the data was conducted after the experiment was complete. The researcher used a t-test to analyze the data on the GraphPad webpage.

Table 8. ANALYSIS OF SUGAR CONTENT OF BLUEBERRIES. This table illustrates a statistical analysis of the production of blueberries under the high tunnels versus in the open field. Significant at the <0.05 level.

Data

Group	Group 1	Group 2
Mean	11.452	13.783
SD	1.118	14.290
SEM	0.208	0.261
N	30	30

Analysis

Source	Df	T	SED	P-value
Btwn Groups	57	6.9627	0.492	<0.0001

The accepted p-value was 0.05. The t-test in the table above revealed a p-value of <0.0001. This p-value was less than the accepted value.

DISCUSSION AND CONCLUSIONS

An experiment was conducted with the purpose of determining the improvement in the food quality of blueberries and environmental conditions. The researcher found an increase of over 26% in the sugar content of blueberries resulting from improved environmental conditions. A statistical analysis found a significant difference in the increase.

Conclusions

As a result of this project, the researcher drew several conclusions regarding the impact of high tunnels on the sugar content of blueberries. These conclusions and accompanying pertinent discussions for each are enumerated as follows:

1. The first conclusion relates to the hypothesis. The difference in sugar content from the field to the high tunnels, detailed in the results of the study, was significant according to statistical analysis. The p-value generated by the statistical analysis the researcher conducted was <0.0001, which is less than the accepted p-value of 0.05. Therefore, the first conclusion was that the hypothesis of the research project was accepted.

2. The second conclusion concerns sugar production which was the purpose of the project and is detailed in the results of the project. The second conclusion was that the production of blueberry sugar content was greater under the high tunnels. The average difference of 2.5 more (reference removed) produced per sample under the high tunnels in the results of the project represented an increase of about 22.1%. This partially helped to support the hypothesis.

This agreed with the findings of earlier work, (reference removed)
It also agreed with the results at (reference removed). The owner, (reference removed)
told the researcher that high tunnels increased the quality of other berries, strawberries, raspberries, and blackberries,
at the farm.

3. The third conclusion considers the impact of the high tunnels. The third conclusion is that Any State blueberry producers could exceed the USDA label recommendations for sugar content by about 25.5% by using high tunnels. The USDA recommends 11g of sugars per cup of blueberries (reference removed). The researcher found an average of 13.8g of sugars per cup of blueberries. See below (Table 9) for a demonstration of the impact.

Table 9. IMPACT OF HIGH TUNNELS ON BLUEBERRY SUGAR CONTENT. This table illustrates the increase in blueberry sugar content using high tunnels over the USDA label recommendations. Measurements are grams per cup converted to a percentage.

Item	Amount
USDA Label Recommendations	11g/1 cup
High Tunnel Blueberries	13.8g/1 cup
Total Increase	2.8g/1 cup
Percentage Increase	25.5%

This conclusion was expected when considering the earlier research. (reference removed), and (reference removed) found similar findings that improved environmental conditions would assist in increasing the sugar content of blueberries.

4. The fourth conclusion is about the economic impact. The fourth conclusion is that high tunnels could add more than $2,000,000 of sugar to the 14,000 acres of Any State blueberries annually (reference removed). Table 10 (below) illustrates this estimation.

Table 10. ECONOMIC IMPACT OF HIGH TUNNELS ON BLUEBERRY SUGAR CONTENT. This table illustrates the estimated cost of the increase in blueberry sugar content using high tunnels in the state of Any State annually. Measurements used varies, including, pounds, acres, cups, grams, and dollars.

Item	Value
High tunnel production/acre (lbs)	13,249.00
Any Stateblueberry acreage	14,000.00
Total production	185,486,000.00
Cups of blueberries (1 lb = 3 cups)	556,458,000.00
Total added grams (3 grams/cup)	1,669,374,000.00
Added pounds (453.592g/lb)	3,680,342.69
Cost of sugar (per lb)	$0.53
Total Value	$2,208,205.61

The researcher estimates the value of the added sugar to the Any State blueberry industry. The researcher converted the measurement of pounds of sugar. This was multiplied by the acreage of Any State blueberries and by the value of sugar per pound.

RECOMMENDATIONS

The researcher made several recommendations. The first recommendation is that this project be repeated on a larger scale for reliability purposes. This project might show different results given variance in climate and soil types keep the impact of high tunnels in varied settings. The second recommendation is that the blueberry industry and farmers use the results of this test to increase blueberry sugar content. This study did not address installation cost against the increase of production and the increase in profit, but it did show a gain for farmers.

ACKNOWLEDGEMENTS

The researcher was able to conduct this large project due to fair amount of assistance. The researcher would like to thank the following businesses, organizations, and individuals for the help they rendered in the completion of this project:
for inspiring research to conduct the project and helping through it all. (removed for example purposes)

REFERENCES

Removed for example purposes.

Does Improved Growing Environment Increase Antioxidant Content in Blueberries?

Plant Systems

Years
2014 - 2014

Hours
390

Research Expenses

Year	Expense Item	Memo/Description	Cost
2014	0.50 inch Test Tube Cells	Cells for Thermo Spectronic 20+	$99
2014	Blueberry samples	Testing for antioxidant content	$1
2014	Oxford Biomedical - Total Power Antioxidant Kit	Used for measuring antioxidants	$305
2014	Thermo Spectronic 20+	Used for measuring antioxidants	$1,200
			$1,605

Research Income

Year	Income Source	Memo/Description	Cost
2014	Anywhere Farms	Donated blueberry samples	$1
2014	AHS Agriculture Department	Spectronic, Kit, Test Tubes	$1,604
			$1,605

Please give a detailed explanation of how you obtained your project materials.

I wanted to combine aspects of my earlier research with new investigation. I had previously hypothesized environmental impact improved the sugar content and production of blueberries. This year, I actually measured the impact that environmental conditions had on the antioxidant levels of blueberries. The school agriculture department and Anywhere Farms helped me with my research needs. I used equipment and methods in my previous project last year at Anywhere High School, also I used a thermo spectronic which measures very small substances using light absorbance or light transmittance units. I am very thankful that the high school agriculture program has provided the resources to help me conduct my research over these past years.

Abstract

The purpose of the project was to evaluate high tunnels for improving the antioxidant content in blueberry production. Results were gathered using the scientific method.

A literature review was conducted to gather information. Based on the background, a hypothesis was developed which stated that a significantly higher amount of antioxidants would be produced in the blueberries using high tunnels due to the improved environmental growing conditions.

An experiment was designed to test the hypothesis performed in a number of steps: (a) Three high tunnels were erected, (b) blueberries were planted, grown, and harvested under normal conditions for Any State, (c) blueberries from each area were pureed and measured for antioxidants content, (d) records were kept of antioxidant content in the test areas, and, (e) an analysis of variance was conducted of the data. In the experiment, an average of 0.039 Absorbance Units (AU) measurement was obtained from under the high tunnels while others averaged 0.030AU.

Four conclusions were drawn: (a) The hypothesis was supported via a significant p-value of 0.0084, (b) 0.010AU more antioxidants was produced by blueberries grown under the high tunnels, about a 32.2% increase, (c) blueberry producers could exceed USDA antioxidant recommendations by 26.2%, and, (d) the value added by high tunnels in antioxidants content exceeds $4,900,000. It is recommended that this project be repeated on a larger scale and that the blueberry industry in Any State review the economics of using the high tunnels to increase blueberry sweetness.

INTRODUCTION

The Any State Blueberry Commission called for research on the antioxidant levels in blueberries. The use of three high tunnels covering approximately one acre of blueberries was instituted on a family farm. The researcher had previously evaluated the use of high tunnels for producing sugar in blueberries.

Another researcher previously found that high tunnels increased blueberry production (reference removed). This seemed to indicate that high tunnels create an improved environment for blueberries which also lead to an increase in sugar content (reference removed). Also, the past findings included soil temperature could affect plant growth (reference removed).found that growth conditions could effect berry quality. The previous year, the researcher evaluated the environmental impact that high tunnels had on blueberry production and sugar content. Blueberries grown underneath high tunnels due to improved environmental factors increased blueberry sugar content 22.1% (reference removed).

The problem for this study was the impact of high tunnels on blueberry antioxidant levels had not been examined. The researcher wanted to expand his previous research and evaluate the impact of high tunnels on the environment and resulting quality of the antioxidant levels in the blueberries.

Procedure

REVIEW OF LITERATURE

A review of literature was conducted concerning blueberry production, blueberry antioxidant content, and high tunnels.

Blueberries

Blueberries are known as flowering plants of the genus Vaccinium, a species which also includes cranberries and bilberries, that are perennial with dark-blue berries (reference removed). Cyanococcus are the most common fruits sold, also known as "blueberries," and are native to North America. Blueberries are usually erect but sometimes grow as short shrubs varying in size from 3.9 inches to 160 inches tall. In commercial blueberry production, there are smaller species are known as "lowbush blueberries." These varieties are also synonymous with “wild” types and the larger "high bush blueberries” are most cultivated.

The leaves can be deciduous or evergreen. The flowers are bell-shaped and usually white, pale pink or red or even sometimes tinged greenish. The fruit is a berry about 0.20–0.63 inches in diameter with a flared crown at the end. These berries are pale greenish at first, then reddish-purple, and finally become dark blue when ripe. These berries have a sweet taste when mature with variable acidity. Blueberry bushes usually bear fruit in the middle of the growing season. Fruiting times are affected by local conditions like altitude and latitude so the duration of peak harvest can vary from May to August depending upon variety of conditions.

Growing Requirements of Blueberries

Blueberries require full sunlight and Ill-drained soil according to (reference removed), a nursery supply company. Plants will tolerate partial shade, but shade will cause fewer blossoms and a decline of fruit production. Poor air movement also increases danger of spring frost injury to blossoms and can cause disease development.

Blueberries require acid soil with a pH of 4.5 to 4.8. The growth of the plant is slowed and the foliage turns yellow if the pH is too high. If the pH is too high for an extended period of time, the plants will die. Blueberry plants are long-lived, so time and effort in preparing the soil is considered a wise investment.

Any State Blueberry Acreage

According to the Any State Blueberry Commission , blueberries grow successfully in Any State was projected to become the second largest producer of blueberries. Fourteen thousand acres of blueberries are grown each year and each year the acreage increases along with production.

Blueberry Antioxidant Content

The US Department of Agriculture determined that blueberries scored highest overall in total antioxidant capacity per serving after testing 24 varieties of fresh fruit, 23 vegetables, 16 herbs and spices, 10 different nuts, and four dried fruits, said (reference removed). He goes on to say that antioxidants are vital in countering free radicals, which are harmful byproducts of cellular metabolism that can contribute to cancer and other age-related diseases.

Blueberry Production

The Any State blueberry harvest season starts in mid to late April and lasts through July in some parts of the state. The harvest season lasts through August, giving Any State the longest harvest of any blueberry growing state in the country with a total of 90 plus days of harvest (reference removed).

High Tunnels

High tunnels are a manufactured product used to increase the production of various crops. They are basically open greenhouses. According to (reference removed), some of the benefits include: Early and late season extension, improved produce quality and yield, ability to be insured, increased ability to efficiently manage field environment, reduced plant stress, efficiency in production planning, and consistency and predictability of harvest.

Antioxidant Capacity

Antioxidant capacity (reference removed) is a measurement of antioxidant strength, measured in units called (reference removed). Due to the difficulties in measuring individual antioxidant components of a complex mixture (such as blueberries or tomatoes), (reference removed) equivalency is used as a benchmark for the antioxidant capacity of such a mixture. (reference removed) equivalency is most often measured using the ABTS decolorization assay.[1] The (reference removed) assay is used to measure antioxidant capacity of foods, beverages and supplements. Ferric reducing ability of plasma is an antioxidant capacity

Spectrophotometer

The spectrophotometer is an instrument which measures the amount of light of a specified wavelength which passes through a medium. The amount of light absorbed by a medium is proportional to the concentration of the absorbing material or solute present. Thus the concentration of a colored solute in a solution may be determined in the lab by measuring the absorbency of light at a given wavelength. Wavelength (often abbreviated as lambda) is measured in nm. The spectrophotometer allows selection of a wavelength pass through the solution. Usually, the wavelength chose which corresponds to the absorption maximum of the solute. Absorbency is indicated with a capital A (reference removed)

Antioxidants

According to (reference removed), Antioxidants are important disease-fighting compounds. They help prevent and repair the stress that comes from oxidation, a natural process that occurs during normal cell function. A small percentage of cells become damaged during oxidation and turns into free radicals, which can start a chain reaction to harming more cells and possibly disease. Blueberries, cranberries, and blackberries rank the highest in antioxidant levels (reference removed).

Related Studies

The researcher found information from several studies that linked improved environmental conditions to an increase of antioxidant production in berries. A researcher from Kansas State University (reference removed), found and increase in production of berries under high tunnels. He also found an increase in the sugar content of berries grown under the high tunnel.

A colleague (reference removed). They spent some time with the owner, (reference removed) while touring the farm. He told them high tunnels on their farm increased the quality of other kinds of berries.

(reference removed), a specialist in grapes from (reference removed), found that improved environmental conditions can “load” sugar in berries. Limiting growth conditions were identified (reference removed) to cause berries to cease antioxidant production.

(reference removed)(2012) previously found that high tunnels increased blueberry production by 15%. This would represent a sizable gross increase in revenue for Any State blueberry farmers. Warren also found in a preliminary study that blueberries grown under high tunnels had a 20.8% increase in sugar content. (reference removed) found that soil temperature could affect the growth of plants, and that by controlling the soil temperature, the need for chemical growth regulators is diminished (reference removed).

Summary

In this search of literature, information was found on the internet and interviews. The information was helpful to the study by providing information regarding blueberry antioxidant content and high tunnels.

MATERIALS AND METHODS

Hypothesis

The hypothesis for this project was the antioxidant content of blueberries grown under high tunnels would be significantly greater than those growing an open field due to the improved environment. The literature, (reference removed), detailed some evidence that blueberries would be more productive in antioxidant when grown under high tunnels.

Experimental Design

The researcher chose the experimental design to test the hypothesis. The experimental group received the treatment of high tunnels. The control group received no treatment. The post-test was evaluation of the antioxidants content of blueberries.

Methods

The steps used to carry out this experiment are as follows:

1. Install plastic and plant blueberries, under high tunnels and in field.
2. Regular maintenance of blueberries: Mowing, spraying, fertilizing, etc.
3. Measure the air temperature outside and under the high tunnels weekly.
4. Harvest blueberries as normal noting packing as to field location of blueberries.
5. Take random samples of blueberries and puree samples.
6. Measure antioxidants content using a Total Antioxidant Power Kit (reference removed).
7. Record data in a logbook as needed. Conduct statistical analysis.

Testing Site

This experiment will take place in the field and laboratory. The growing site is located on one of the researcher's family farm in Any State. The actual site is a 50 acre blueberry field. The field has three high tunnels installed. The three high tunnels cover approximately a half acre in area each. The testing site is the researcher's school agriscience laboratory.

Statistical Procedure

A t-test was performed to assess if the antioxidant content measurements generated in the experiment between the control and experimental sets Were significantly different. A p-value of less than 0.05 was considered significant. The researcher used a (reference removed) to perform the statistical analysis.

Limitations

This study has several factors, or variables, that could effect, or limit, it's findings. One limitation is lack of funds, equipment, and time to perform a more in-depth evaluation. Growing conditions vary greatly from farm to farm. This soil type on the family farm was extremely low in pH and had to be brought up several increments before planting. Pine bark was used to make the soil pH equivalent, unlike other farms, which may use lime or other ways to correct pH for blueberry production. The fertilizer and herbicides used around the blueberry plant also vary. Some blueberry growers may not have the same type of soil or use varied control methods.

Another variable is the climate and the humidity in Any State. Compared to other places it could be very difficult to grow with colder weather, unlike Any State which is a sub-tropical region and subjected to a great deal of humidity. Extremes in temperatures effect agriculture differently due to humidity. Late winter and early summer temperatures can have drastic effects on blueberries

Conclusion

RESULTS

The researcher conducted a project to compare the amount of antioxidant in the blueberries underneath the high tunnels to those not grown under high tunnels. The high tunnels function like a greenhouse that covers the blueberries and helps in the growing process. The project was sparked in an effort for the agriculture blueberry industry to help increase the antioxidant content in blueberries by using high tunnels.

Data

The researcher conducted an experiment that would evaluate the content of blueberry antioxidant underneath high tunnels. During the experiment, the blueberry antioxidant content was measured to determine the outcome. Even though there is limited space that the high tunnels cover, it is easy to observe the difference in the size and vigor of the blueberries when compared to the rest of the field. Table 10 (next page) shows difference in the antioxidant content in the open field and underneath the high tunnels.

Table 10. ANTIOXIDANT DIFFERENCE BETWEEN HIGH TUNNELS AND OPEN FIELD. This table illustrates a comparison of the antioxidant production of blueberries grown in the open field versus those grown under high tunnels (measured in Absorbance Units).

	High Tunnel Experimental	Open Field Control	Difference
1	0.040	0.030	0.010
2	0.060	0.030	0.030
3	0.030	0.040	-0.010
4	0.060	0.030	0.030
5	0.050	0.020	0.030
6	0.050	0.030	0.020
7	0.040	0.050	-0.010
8	0.030	0.040	-0.010
9	0.030	0.030	0.000
10	0.030	0.020	0.010
11	0.020	0.030	-0.010
12	0.030	0.020	0.010
13	0.060	0.020	0.040
14	0.040	0.030	0.010
15	0.030	0.030	0.000
16	0.030	0.010	0.020
17	0.030	0.030	0.000
18	0.040	0.030	0.010
19	0.040	0.040	0.000
20	0.040	0.030	0.010

Ave	0.039	0.030	0.010

The average antioxidant levels of all three tunnels was 0.039 Absorbance Units (AU). The most often occurring range regarding the antioxidant content fell into the 0.020-0.040AU range. The highest antioxidant produced in a sample was 0.060AU. The experimental set yielded higher antioxidant content than the open field. The difference was 0.010AU greater.

Trends

The researcher detected some trends in the data. The trends are apparent when the results of the project were arranged graphically for visual inspection. The antioxidant content from the control group tended to be less than the antioxidant content from the experimental group. The majority of the experimental samples contained higher antioxidant than those in the control samples.

Analysis

An analysis of the data was conducted after the experiment was complete. The researcher used a t-test to analyze the data on the GraphPad webpage.

Table 11. ANALYSIS OF ANTIOXIDANT CONTENT OF BLUEBERRIES. This table illustrates a statistical analysis of the production of blueberries under the high tunnels versus in the open field. Significant at the <0.05 level.

Data

Group	Group 1	Group 2
Mean	0.03900	0.03000
SD	0.01165	0.00858
SEM	0.00261	0.00192
N	20	20

Analysis

Source	Df	T	SED	P-value
Btwn Groups	38	2.7809	0.003	0.0084

The accepted p-value was 0.05. The t-test in the table above revealed a p-value of 0.0084. This p-value was less than the accepted value.

DISCUSSION AND CONCLUSIONS

An experiment was conducted with the purpose of determining the improvement in the food quality of blueberries and environmental conditions. The researcher found an increase of over 26% in the antioxidant content of blueberries resulting from improved environmental conditions. A statistical analysis found a significant difference in the increase.

Conclusions

As a result of this project, the researcher has drawn several conclusions regarding the impact of high tunnels on the antioxidant content of blueberries. These conclusions and accompanying pertinent discussion for each are enumerated as follows:

1. The first conclusion relates to the hypothesis. The difference in antioxidant content from the field to the high tunnels, detailed in the results of the study, was significant according to statistical analysis. The p-value generated by the statistical analysis the researcher conducted was <0.00084, which is less than the accepted p-value of 0.05. Therefore, the first conclusion was that the hypothesis of the research project was accepted.

2. The second conclusion concerns antioxidant production which was the purpose of the project and is detailed in the results of the project. The second conclusion was that the production of blueberry antioxidant content was greater under the high tunnels. The average difference of 0.010 more Absorbance Units produced per sample under the high tunnels in the results of the project represented an increase of about 33.3%. This partially helped to support the hypothesis.

This agreed with the findings of earlier work, (reference removed)
. It also agreed with the results at (reference removed). The owner, (reference removed)
, told the researcher that high tunnels increased the quality of other berries, strawberries, raspberries, and blackberries,
at their farm.

3. The third conclusion considers the impact of the high tunnels. The third conclusion is that Any State blueberry producers could exceed the USDA label recommendations for antioxidant content by about 30% by using high tunnels. The USDA recommends (reference removed)of antioxidants per cup of blueberries (reference removed). The researcher found an average of 0.030 absorbance units of antioxidants per cup of blueberries. See below (Table 12) for a demonstration of the impact.

Table 12. IMPACT OF HIGH TUNNELS ON BLUEBERRY ANTIOXIDANT CONTENT. This table illustrates the increase in blueberry antioxidant content using high tunnels over the USDA label recommendations. Measurements are grams per cup converted to a percentage.

USDA Label Recommendations	9019 (TEAC)/1 cup
High Tunnel Blueberries	11724 (TEAC)/1 cup
Total Increase	2705 (TEAC)/1 cup
Percentage Increase	30%

This conclusion was expected when considering the earlier research. (reference removed) found similar findings that improved environmental conditions could assist in increasing the antioxidant content of blueberries.

4. The fourth conclusion is about the economic impact. The fourth conclusion is that high tunnels could add more than $4,700,000 of antioxidant to the 20,000 acres of Any State blueberries annually (reference removed)

Table 13. ECONOMIC IMPACT OF HIGH TUNNELS ON BLUEBERRY ANTIOXIDANT CONTENT. This table illustrates the estimated cost of the increase in blueberry antioxidant content using high tunnels in the state of Any State annually. Measurements used varies, including, pounds, acres, cups, grams, and dollars.

Item	Value
High tunnel production/acre (lbs)	13,249.00
Any State blueberry acreage	20,000.00
Total production	84,000,000.00
Convert to grams (I lbs=454 grams)	38,136,000,000.00
Molecular Weight of TEAC (grams)	0.003
Added grams	95,450,594.40
Cost of antioxidant (per gram)	$0.05
Total Value	$4,772,529.72

The researcher estimates the value of the added antioxidant to the Any State blueberry industry. The researcher converted the measurement of trolox equivalents to pounds of blueberries. This was multiplied by the acreage of Any State blueberries and by the value of blueberries per pound.

Recommendations

The first recommendation is that this project be repeated on a larger scale for reliability purposes. This project might show different results given variance in climate and soil types keep the impact of high tunnels in varied settings. The second recommendation is that farmers use the results of this test to increase blueberry antioxidants content. This study did not address installation cost against the increase of production and the increase in profit, but it did show a gain for farmers.

REFERENCES

References removed for example purposes.

ACKNOWLEDGEMENTS

The researcher was able to conduct this large project due to fair amount of assistance. The researcher would like to thank the following businesses, organizations, and individuals for the help they rendered in the completion of this project: (acknowledgemenets removed) for taking all the pictures.

National Research Proficiency
Learning Outcomes & Efficiency Factors

	Learning Outcome or Efficiency Factor	Beginning Level	Level Attained	Description
1	Refractometer for sugar measurement	Year: **2013** Level: **0**	Year: **2013** Level: **12.55 Brix/average**	In my third project, I learned to use the Brix refractometer to measure the sugar content of blueberries. When I began, I had no idea how I would take these measurements. For a post-test, I learned to use the refractometer to measure both the control (11.3Bx) and experimental (13.8Bx) sets.
2	Germination rate of pole beans	Year: **2011** Level: **0% germination**	Year: **2012** Level: **97% germination**	I used pole beans in my 1st and 2nd projects as the specimens in my experimental designs. I used skills I learned in agriculture classes to plant and care for the bean seeds. I used Farfard 4P potting soil and 4x4 containers to grow them in I only lost 3% of the 64 beans that I planted.
3	Growth regulation of pole beans via soil temperature versus chemical growth regulator	Year: **2011** Level: **7mm or 0% controlled**	Year: **2012** Level: **0.01mm or 99.85% controlled**	The objective of my 2nd experiment was to control plant growth using cool soil temperature to match control via chemical growth regulators. In my 1st project, I found that warmer soil temperatures caused 7mm more growth. Using cool soil temperatures, I was able to control plant growth.
4	Plant growing environment assessment of DIF enhancement	Year: **2013** Level: **0% environment assessment**	Year: **2013** Level: **100% environment assessment**	I had experimented with the effects of soil temperature previously, but wanted to assess DIF (difference of day and night air temperatures) in my 3rd project. I was able to use a month of data to find a 7 degree F increase under high tunnels, which enhanced production and quality of blueberries.
5	Spectrophometer use for antioxidant measurement	Year: **2014** Level: **0% antioxidant measurement**	Year: **2014** Level: **100% antioxidant measurement**	I wanted to measure antioxidant enhancement caused by environment in my last phase. Measurement of antioxidants requires specialized equipment for extremely small measurements. In this experiment, I successfully used a Spectronic spectrophotometer to perform measurements (average of 0.0345AU).

National Research Proficiency
Skills, Competencies, and Knowledge

A. Five Primary Skills, Competencies, and Knowledge within your Pathway

	AFNR Performance Indicator	Contributions to Success
1	PS.02.01 Determine the influence of environmental factors on plant growth.	In my first project, I evaluated the influence soil temperature had on the internode elongation of bean plants. The beans treated with higher soil temperature on average were 24.52mm tall and the plants with no treatment were on average 17.19mm tall. This concluded that environmental factors have an influence on plant growth (see PHOTO #2).
2	PS.03.05 Harvest, handle and store crops.	I would harvest blueberries as they matured underneath the high tunnels and out on the open field. I then used 60 blueberries samples in experiment and tested the sugar content in each group. I found that the blueberries underneath high tunnels had on average 2.5 greater grams/cup of sugar, than the blueberries grown out in the open field.
3	PS.02.01 Determine the influence of environmental factors on plant growth.	The third hypothesis called for an increase in sugar content from an improved growing environment (see Research Paper #3). Therefore, I measured temperature differences (the Dependent Variable) resulting from the high tunnel treatment. The temperature in the high tunnels varied from 69 to 96 degrees F while the open field varied from 62 to 89 degrees Fahrenheit (F). The difference averaged about 7 degrees F, resulting in an improved growing environment.
4	CS.07.01 Apply safety/health practices to AFNR worksites.	In all of my research, whether it be in a classroom, greenhouse, or a field, I made sure to always follow safety guidelines and be aware of my situation. When I was working with chemical growth regulators, I always wore safety glasses, lab coats, and gloves to protect my hands and body during my experiment. Maintaining safety was the most important objective during my research.
5	CS.09.02 Apply skills with computer software to accomplish a variety of business activities.	Statistical analysis performed with various software (see Research Papers) proved the data collected over my experiments were significant (p-values 0.0029, 0.98 and <0.0001 - twice). These p-values indicated confidence intervals of 98-99%. When I utilized a critical p-value of 0.05, these confidence intervals actually mean that I am 95% sure that if another researcher used similar procedures under similar conditions, they would probably find very similar results.

B. Five Supporting Skills, Competencies, and Knowledge outside your Pathway

	AFNR Performance Indicator	Contributions to Success
6	BS.02.04 Safely manage biological materials, chemicals and wastes used in the laboratory.	In my second agriscience research project, I used the chemical growth regulator B-9 to treat one group of beans. I mixed the appropriate amount of B-9 into water and distributed the chemical to the experimental group of beans (see PHOTO #1). While using the chemical growth regulator, I wore a lab coat, close toed shoes, safety goggles, and gloves to perform my experiment. Practicing safety was the main priority while conducting not only this experiment, but my entire agriscience research SAE.
7	ESS.03.02 Apply soil science principles to environmental service systems.	In my first two projects, I applied soil science principles to the growth of bean plants, to determine if soil temperature greatly affected the internode elongation of plants. In my background research and literature review (see Research Papers), I learned about DIF, internodes, and all the plant growth processes. I used the principles of DIF throughout my entire research project. I concluded that environmental factors such as soil temperature can be used to control plant height.

8	FPP.04.02 Evaluate, grade and classify processed food products.	I was able to test sugar content by using a refractometer. I took samples underneath the high tunnels (Control Set) and from in the open field (Experimental Set). The sugar testing posed quite a problem initially because I needed to find the correct method to test sugar content. With some investigation and help, I found a refractometer and completed my research. It was easy to read the sugar content on the (see Personal Page).
9	FPP.04.02 Evaluate, grade and classify processed food products.	In my fourth agriscience research project, I measured antioxidants in blueberries grown underneath high tunnels, and those grown out in the open field. The Any State Blueberry Commission has discussed making this type of research a priority (reference removed) I found that high tunnels increase the cancer-fighting antioxidant level (33.3%).
10	FPP.01.02 Work effectively with industry organizations, groups and regulatory agencies affecting the food products and processing industry.	Because blueberries are both an agricultural commodity and a food, they are subject to regulation by the USDA. USDA has recommendations for blueberry sugar and antioxidant content. I used a refractometer (see PHOTO #4) to measure their sugar and a spectrophotometer to measure their antioxidant content. As a standard, I used USDA label recommendations for comparison. I found that high tunnels increased the sugar content (26%) and antioxidants (30%) over USDA recommendations.

National Research Proficiency
Resume

1. Career Objectives
In May 2016, I will graduate from Anywhere High School with Honors. I plan to enroll in the Any State University, majoring in Biology, as well as obtaining my American FFA Degree. After gradating, I plan to attend medical school. After completion of medical school I want to use my experience (such as agriscience research) and education to begin my career as a Radiologist and researcher.

2. Agricultural Science Courses
I will graduate in May of 2016. I have excelled in advanced classes as well as many Advanced Placement classes. I have a 3.98 un-weighted GPA and a 4.35 weighted GPA. Currently I am in the top 8% of my junior class, with my class rank being 58 out of 653 students.

Agricultural Education Classes: Basic Agriculture, Agriculture Mechanics, Wildlife Management, Forestry Science 1
Advanced Placement Classes: AP Government, AP Human Geography, AP Environmental Science, AP US History, AP Statistics, AP Biology, AP Macro Economics, AP Micro Economics.

3. Supervised Agricultural Experiences
2014. Outdoor Recreation SAE. 119 hours.
Wildlife Management SAE. 133 hours.
Sugar Cane SAE. 1 acre. 94 hours. 321 bottles of syrup produced.

2013. Outdoor Recreation SAE. 119 hours.
Wildlife Management SAE. 104 hours.
Sugar Cane SAE. 1.5 acres. 109 hours. 417 bottles.

2012. Outdoor Recreation SAE. 119 hours.
Wildlife Management SAE. 91 hours.
Sugar Cane SAE. 1.5 acres. 129 hours. 466 bottles.

2011. Outdoor Recreation SAE. 119 hours.
Wildlife Management SAE. 110 hours.
Sugar Cane SAE. 1.5 acres. 111 hours. 432 bottles.

2010. Outdoor Recreation SAE. 119 hours.
Wildlife Management SAE. 123 hours.
Sugar Cane SAE. 1.5 acres. 115 hours. 442 bottles.

4. FFA Involvement and Leadership
2014. Summer Leadership Camp. Forestry Field Day- Tree Identification.

2013. Summer Leadership Camp. Chapter Officer Retreat. Junior Advisor.
Wildlife Management Team
Land Judging Team

2012. Summer Leadership Camp. Chapter Officer Retreat. Reporter.
Wildlife Management Team
Land Judging Team

2011. Summer Leadership Camp. Chapter Officer Retreat. Sentinel.
Livestock Judging Team

2010. Summer Leadership Camp. Chapter Officer Retreat. Ass't. Reporter.

2009. Summer Leadership Camp. Fundraiser Committee
Livestock Judging Team

2008. Summer Leadership Camp. Fundraiser Committee.

5. Community Service
Cumulative total: 160 hours
2014. Assist teachers in classroom during pre- and post-planning; 4H Kids Dig it Event; Feeding the Hungry ministry at First Baptist Church; Assisted with the Child Advocacy Center Fundraiser Event

2013. Assist school teachers in classroom during pre- and post-planning; 4H Kids Dig it Event; Feeding the Hungry ministry at First Baptist Church; Assisted with the Child Advocacy Center Fundraiser Event

2012. Baptist Church Men's Ministry- assisted in yard work for a widow; 4H Kids Dig it Event; Child Advocacy Center Fundraiser Event; Assisted with Field Day at local Elementary School

2011. 4H Kids Dig it Event; Child Advocacy Center Fundraiser Event

2010. Special Olympics

6. Accomplishments
2014. Winner State Agriscience Fair. Food Systems. Division IV.
Winner National Agriscience Fair. Food Systems. Division IV.

2013. Winner State Agriscience Fair. Plant Systems. Division I.
Winner National Agriscience Fair. Plant Systems. Division I.
2nd place Area Wildlife Management CDE.

2012. Winner State Agriscience Fair. Plant Systems. Division III.
5th place National Agriscience Fair. Plant Systems. Division III.
3rd place Wildlife Management CDE

2011. Winner State Wood Fabrication Competition.

7. Certifications, Skills, and Memberships
2014. Forestry CTAE Pathway Completer. Lowndes High School.
Forestry Mechanical Systems CTAE Pathway Completer. Lowndes High School.
Forestry/Wildlife Systems CTAE Pathway Completer. Lowndes High School.

2014. Y Club Member. Representative at Youth Assembly.

2013-2014. Student Council Member. Anywhere High School

2014. Selected as a member of Anywhere Youth Leadership League

2012-2015. Class Cabinet Member. Anywhere High School.

2012. Wildlife Management Credential. Any State Agribusiness Council.

2012-2015. National Beta Club Member.

2012-2015. National Honor Society Member.

2012-2015. National Sporting Clay Association Member.

2011 - 2015. 4H Member. Any County.

2011 - 2015. S.A.F.E. Shooting Team Member.

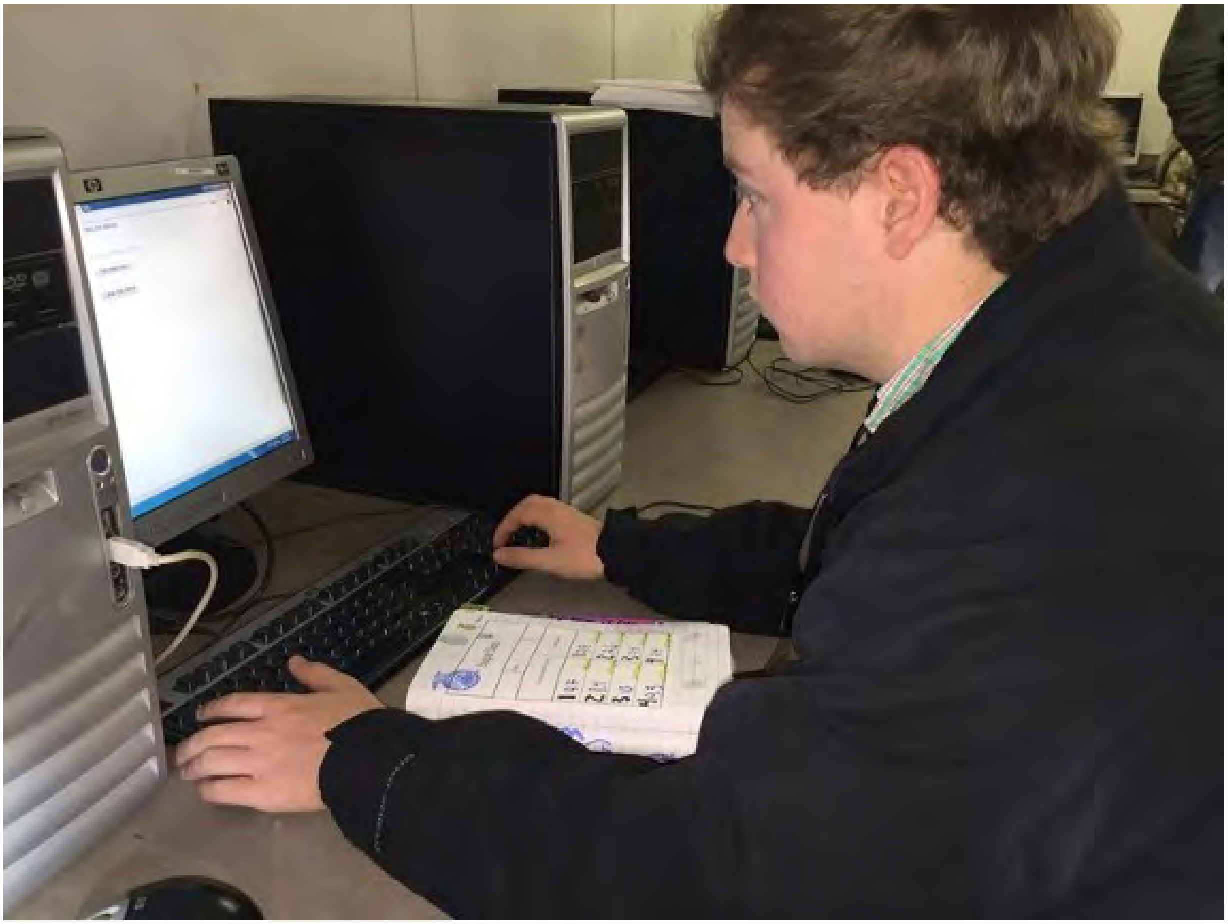
8. Recommendations

RECOMMENDATIONS REMOVED FOR EXAMPLE PURPOSES

I began my scientific investigations after questions arose from a walk through the school greenhouse. In my second project, I found that using cool soil temperatures could reduce the need for expensive chemical growth regulators. I used a 2 group experimental design with the experimental group receiving the treatment of B-9, a chemical growth regulator, and the control group receiving no treatment. A fun part of this project was growing 60 plants that served as the specimen for my experiment.

National Research Proficiency
Project Photos

Accurate data collection is important in research. I measured the internode length of both groups of plants using a metric ruler. Both groups of plants were placed on a soil heating pad set at a constant 80 degrees Fahrenheit. I concluded that by using soil temperature, I controlled the internode elongation of plants (to a length of 11.41cm), about the same as chemical growth regulators (a length of 11.42cm average). I monitored the progress, noting growth and other changes daily in my logbook.



Learning to apply the scientific method through my research has taught me the skills to utilize computer data records and statistical analysis to a real-world agricultural problem. Computer entry of data and statistical analysis skills were learned during my research while using Microsoft Excel, Word, and PowerPoint to follow the scientific method in my research. I conducted 4 statistical analyses (ANOVA and T-tests) during my research (p-values included 0.01,<0.0001 and 0.0029).

I used my research expertise to help a student with a blueberry SAE to evaluate environmental impact on sugar content. After a review of literature and talking with experts, we learned that a refractometer could easily be used to collect data, measuring the sugar content of blueberries in both the Experimental and Control sets. The refractometer was easy to read (Personal Page) and I found a twenty-six percent (26%) increase over USDA recommendations while using it to collect data.

National Research Proficiency
Project Photos

Collecting measurements of the air temperature were needed to evaluate the improvement of the growing environment for blueberries caused by the treatment of high tunnels. I collected measurements of the air temperature under and outside of the high tunnels over the course of thirty (30) daily measurements. I determined there was a 7 degree Fahrenheit average difference (9.5% improvement). This portion was designed to evaluate the impact of air temperature increase as a Dependent Variable.

The increase in sugar found in blueberries from high tunnels led to the question of other benefits from improved growing environment. A Literature Review determined that blueberries are very high in antioxidants which are linked to decreased heart disease and cancer. Using a Spectronic 20 spectrophotometer, I determined that the treatment of high tunnels caused an increase (2,705) of 30% over USDA recommendations. Using the scientific method has let me help both agriculture and people.

National Research Proficiency
Checklist of Minimum Qualifications

- All items must be "MET" to qualify.
- Only computer-generated checks are shown here.

Item	Value
Each research project includes an abstract, procedure, and conclusion.	MET
Candidate has fully described and selected one to five Learning Outcomes or Efficiency Factors.	MET
Candidate has fully described all ten Skills, Competencies, and Knowledge.	MET
All pictures include captions.	MET
All pictures include a digital upload.	MET
Application includes at least one full calendar year of records.	MET
If graduated, applicant must have completed at least three full years of agriculture, or all of the agriculture offered at the school last attended.	MET
If graduated, applicant must have been out of high school for no more than one year	MET
Ending Date is Dec 31 of the year prior to the National Convention which you are applying to receive an award.	MET
Employer or Instructor's Statement must be printed and submitted with the application.	MUST ATTACH
Personal Page must be printed and submitted with the application.	MUST ATTACH

National Research Proficiency
Manual Review Sheet & List of Attachments

Reviewed By: ______________________________

To improve the quality of applications submitted, and to eliminate the need to disqualify an application at the national finalist level of competition each agricultural proficiency award the state advisor should certify application submitted.

Note: The following are manual reviews of the application and a listing of attachments and page limitations for the complete application. Please review each item and exactly follow the instructions for each attachment.

Manual Review of Application:

Approve (Check if Yes):

☐ 1. Applicant has in operation, and has maintained at least one calendar year of SAE records to substantiate an outstanding SAE program, which exhibits comprehensive planning, managerial and financial expertise, SAE Details page(s)

☐ 2. Applicant, parent or guardian, chapter advisor, school superintendent or principal and State FFA Advisor properly sign the application.

☐ 3. I hereby confirm there are no exaggerated, misleading, deceptive or false statements or claims about the applicant's experience, or performance in this application. Additionally, I confirm this supervised agricultural program has been conducted with the highest possible regard for the quality and human production practices as the products and/or services impact public safety and consumer confidence.

Attachments & Manual Review (Instructions Below)

Approve (Check if Yes):

☐ 1. Applicant has included a written evaluation limited to one page by the most recent employer or agriculture instructor describing the progress that the applicant has made in developing the skills and competencies necessary for success within the award area in which they are applying. (Limit to ONE Page 8 ½ x 11)

☐ 2. Applicant has included a maximum of one page (maximum size 8 1/2" X 11") of additional information. This may **NOT** include the following: videos; CDs, DVDs, flash drive; etc.

☐ 3. In the application, the applicant has included for EACH research SAE project: (1) Abstract, (2) Procedure (Materials & Methods), and (3) Conclusion.

Anywhere High School

June 16, 2015

To Agriscience Proficiency Committee:

Chance Smith began his FFA career in the sixth grade at Anywhere Middle School. Immediately, he became active in various FFA competitive events such as Woodworking, Wildlife Management and more. Following his introduction to exploratory agriculture education, Chance became interested in pursuing more agriculture classes, SAE and FFA opportunities by continued association with agriculture education at Anywhere High School.

While a member of the Anywhere High School FFA Chapter, Chance has excelled in both technical preparatory and academic classroom participation. He especially enjoyed technical classes where he received hands-on instructional activities. Chance completed segments of the agriculture curriculum while gaining experience in areas of agriscience, forestry, wildlife management and other courses.

Chance has taken the knowledge and skills he has been taught in his classes and applied them to his outstanding FFA participation and SAE projects. He has won Anywhere Agriscience Fair (three times) and twice won his division of the National Agriscience Fair. He has assisted other students with the SAE's, proficiencies and preparing for various CDEs. He has demonstrated agricultural leadership by serving many different capacitites.

Chance has an excellent program of agriscience research activities carried out over several years. He also found that high tunnels increased the quality of blueberries. He has certainly demonstrated many skills and competencies related to agriscience. He wishes to make a career in the medical field and wants to get every amount of training and education that will help him master that area, including his work with his research SAE.

Finally, Chance is a sincere person of highest moral character. He is courteous to everyone and is very respectful of his parents and teachers. He is a natural leader that our students respect greatly. He also tends to lead by example, rather than simply demanding actions of others. He has held several FFA officer positions and performed multiple duties for the FFA chapter through the years.

Chance has proved himself to be a gentleman in his dealings with his school activities, FFA activities, and in his personal life. His eagerness to learn competitive aptitude, and perpetual good attitude have made him a pleasure to teach. He has been a tremendous asset to our agriculture education program at Anywhere High School. I highly recommend that Chance be given consideration for the Agriscience proficiency.

PERSONAL PAGE UNAVAILABLE