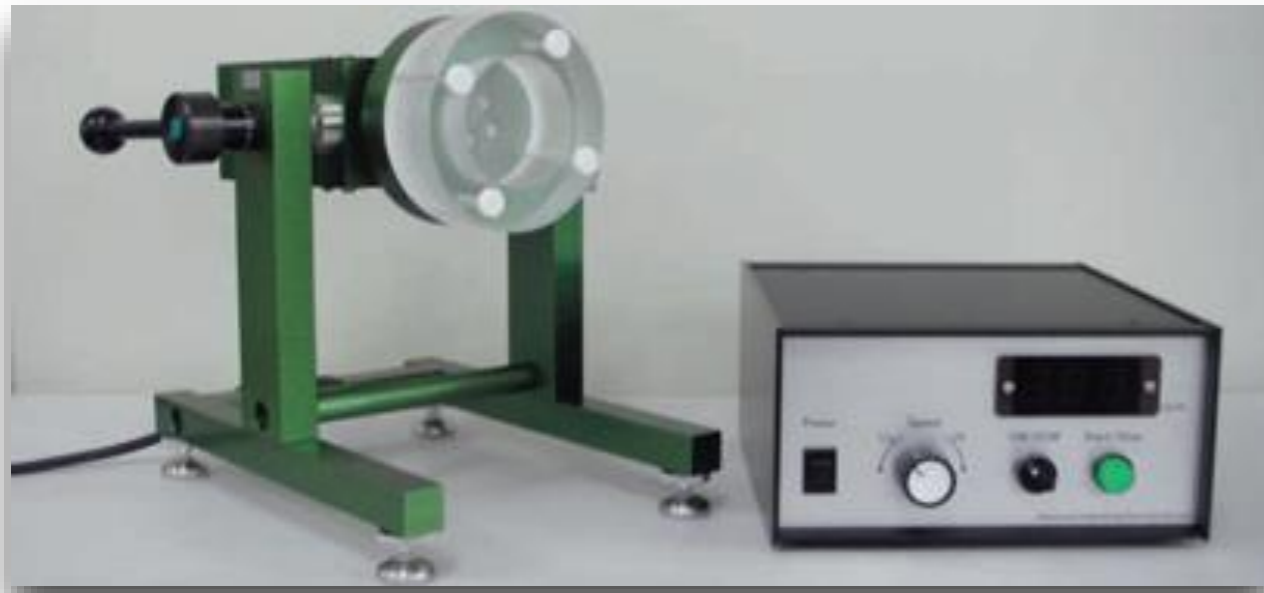


Enhancing Space Education & Research in Microgravity among School Children in Africa: Lessons Learnt and Potential Improvements - ARCSSTE-E UN-ZGIP EXPERIENCE



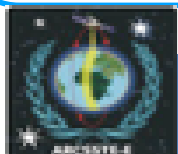
Affiliated to
UNITED NATIONS
Office for Outer Space Affairs

Ganiy I. Agbaje, PhD, fnis, NIGERIA
Executive Director
www.arcsstee.org.ng



United Nations Expert Meeting on Human Space Technology
“Providing Access to Space”

Vienna International Centre, Vienna, Austria
4-6 December 2018



ARCSSTE-E

African Regional Centre for Space Science and Technology Education in English
Obafemi Awolowo University, Ile-Ife, Nigeria

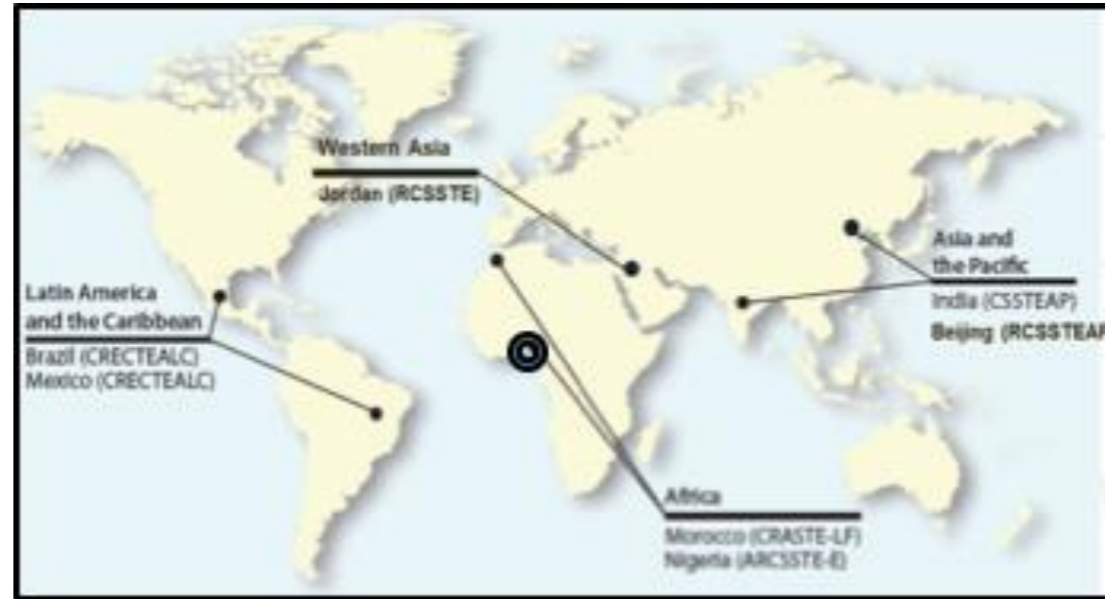
About ARCSSTE-E

African Centres

- ARCSSTE-E (Anglophone – NIGERIA)
- CRASTE-LF (Francophone - MOROCCO)

Other Centres

- India (inaugurated 1995)
- Mexico/Brazil (inaugurated 2003)
- Jordan (inaugurated 2012)
- China (inaugurated 2014)



Mandate: “Develop, through in-depth education, indigenous capability in the core areas of SST



Core Activities

- Education
 - Post Graduate Diploma (PGD) programme
 - MTech programme
- Space Education and Outreach Programme (SEOP)
- Research & Short Term Training in SST

6 thematic areas of Space Science and Technology

- Remote Sensing/Geographic Information Systems (GIS)
- Satellite Communication
- Satellite Meteorology/Global Climate
- Basic Space Science/Atmospheric Physics
- Global Navigation Satellite Systems (GNSS)
- Space Law





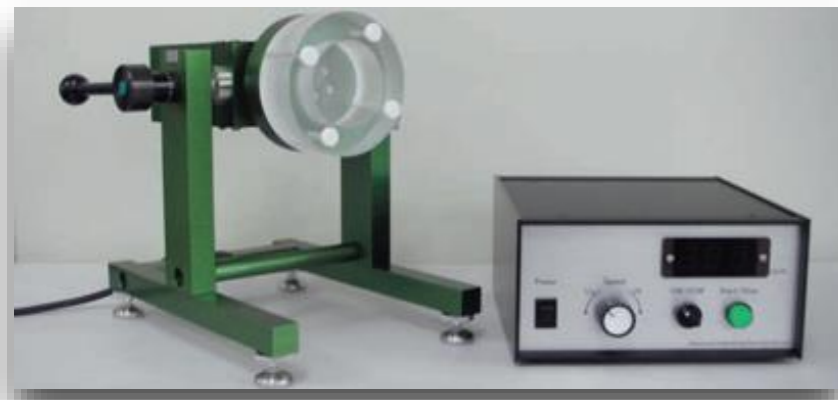
Human Space Technology Initiative [HSTI]

Zero-Gravity Instrument Project (ZGIP)



Aim: Promotes Space Education and Research in Microgravity

Launched: 1st February 2013



1-Axis Clinostat

20 Clinostat distributed on Competitive basis to:

- Schools, Universities, Research Centres & Institutions

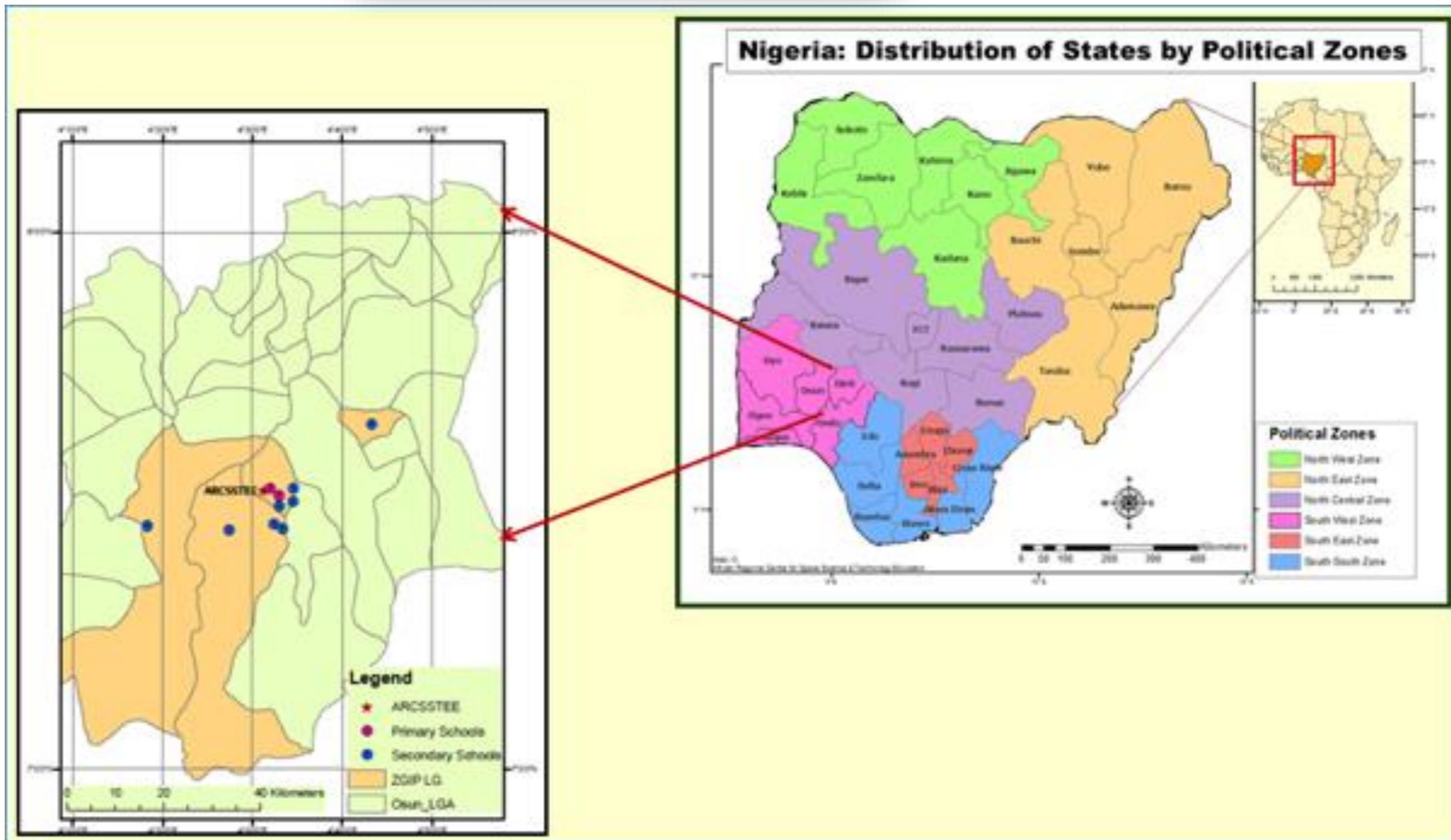
ZGIP Specific Objectives

Teach primary and secondary school students how to:

- Collect scientific data in a laboratory environment
- Analyze the data with specialized software (Image J: <http://rsbweb.nih.gov/ij/download.html>)
- Make Posters and present the result of their study in a Poster Competition



ARCSSTE-E's ZGIP Location



Participants:

- About 100 school children, aged between 7 and 21 years,
- Drawn from ten public and private schools located in Osun State, Nigeria.
- Schools were located within 4 out of the 30 local government areas in Osun State



ZGIP Implementation Stages

Project was implemented in 5 stages:

1. 1-Day Introductory Workshop
2. Laboratory Session
3. Poster Making Session
4. Results Poster Competition
5. Project Evaluation

Introductory Workshop

10 Primary and Secondary schools participated

3 Sessions:

The Theoretical Session

Understanding the Outer Space environment, with special emphasis on the concept of microgravity

The Practical Session:

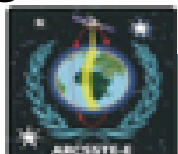
Introduction to the Clinostat

Demonstration on Seed Preparation

Demonstration on how to use the Data Analysis Software: "IMAGE J"

The Quiz Competition to test knowledge in microgravity.

- Instructional Materials were distributed
- Each participating school designed a project that used the Clinostat to examine the growth of indigenous plant seeds, in simulated microgravity conditions in ARCSSTE-E's laboratory



Introductory Workshop

1

Introducing participants to the environment of Outer Space



2

Introducing participants to the Clinostat: simulation of microgravity conditions in the laboratory



3

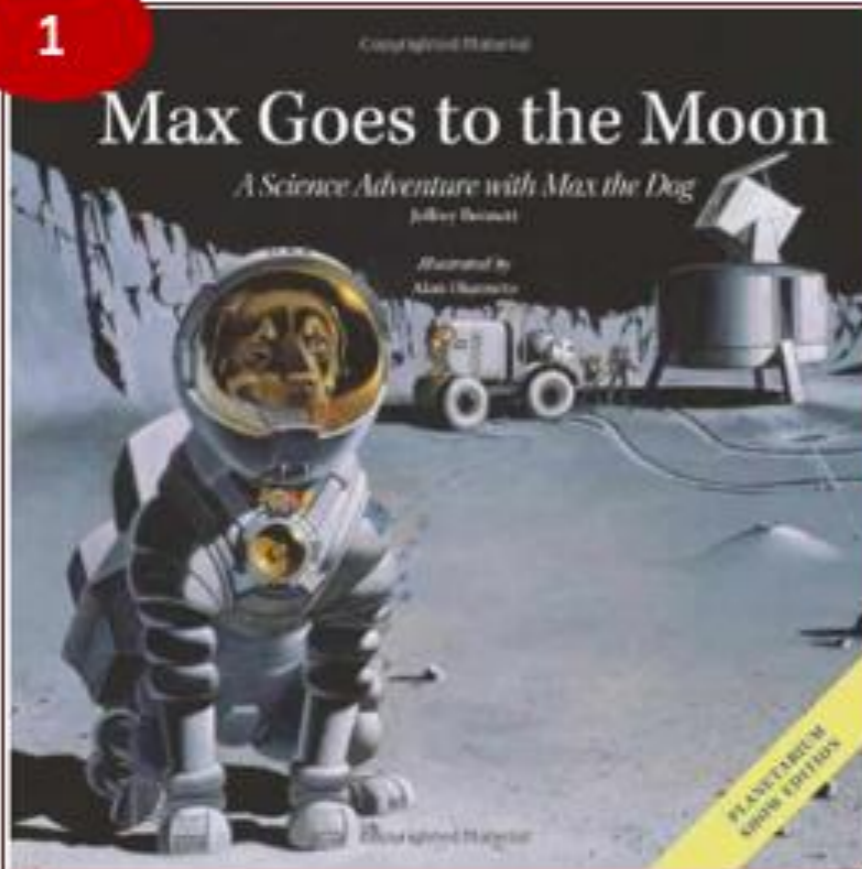
Introducing participants to the ImageJ software for data analysis



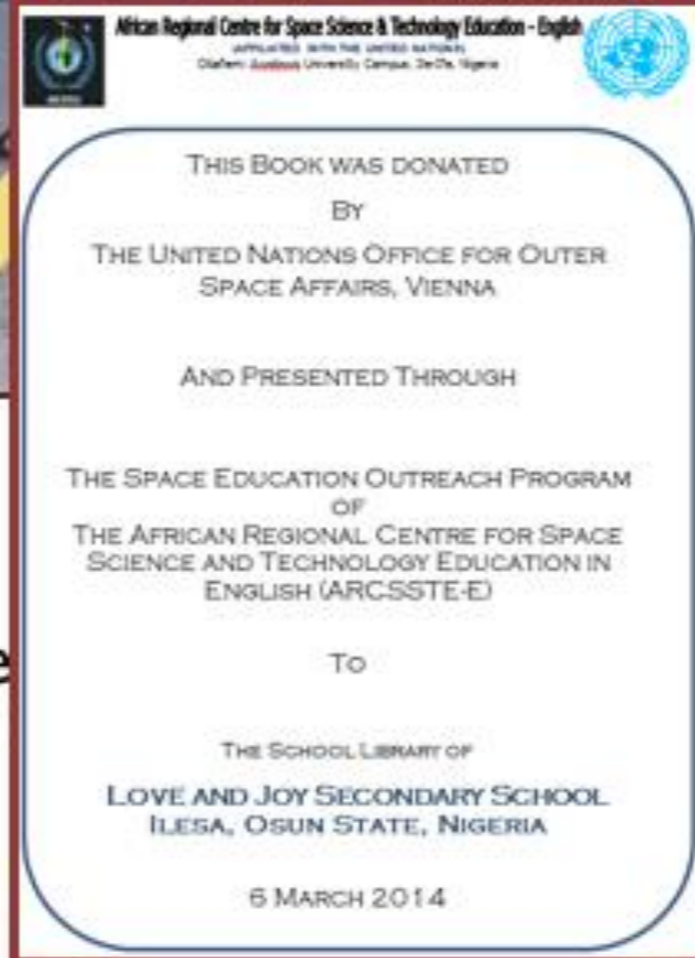
Introductory Workshop:

Distribution of Instructional Materials

1



- Written by astrophysicist Jeffrey Bennett.
- Winner of 2013 Science Communication Award by the American Institute of Physics
- An exciting and informative book for children to learn about outer space.



2



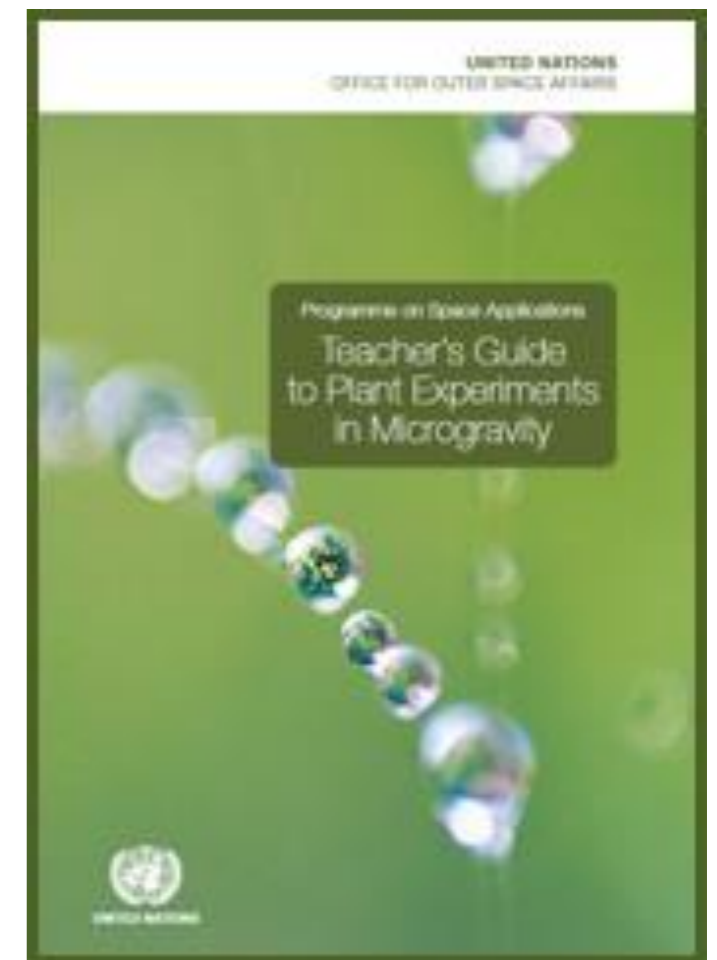
- Power-Point Presentation on the "Zero Gravity" Instrument Project
- UNOOSA Teacher's Guide to Plant Experiment in Microgravity
- ImageJ User's Guide



The Laboratory Session

- To observe the effect of microgravity on the seedlings of some indigenous plants cultivated for food in Nigeria - Black-eyed Pea, Cowpea, Guinea Corn, Maize, Millet, Okra, Rice and Wheat
- Each School had a period of one week, on a planned time-table to work in the ARCSSTE-E's Laboratory to execute their designed project
- "Teacher's Guide to Plant Experiments in Microgravity" published by UNOOSA was used.

Local Seeds Analyzed



The Laboratory Session

Preparing a fertile 'soil' (Agar-agar solution) for planting the seeds



Planting the seeds in the Agar-agar solution

Samples of seeds planted in the Agar-agar solution



Preparing the seeds for fast germination



The Laboratory Session



Mounting the sample on the Clinostat



Adjusting the speed of rotation of the Clinostat



Using a digital camera to collect periodic data from the rotating clinostat



**Germinating seeds:
samples of data collected**



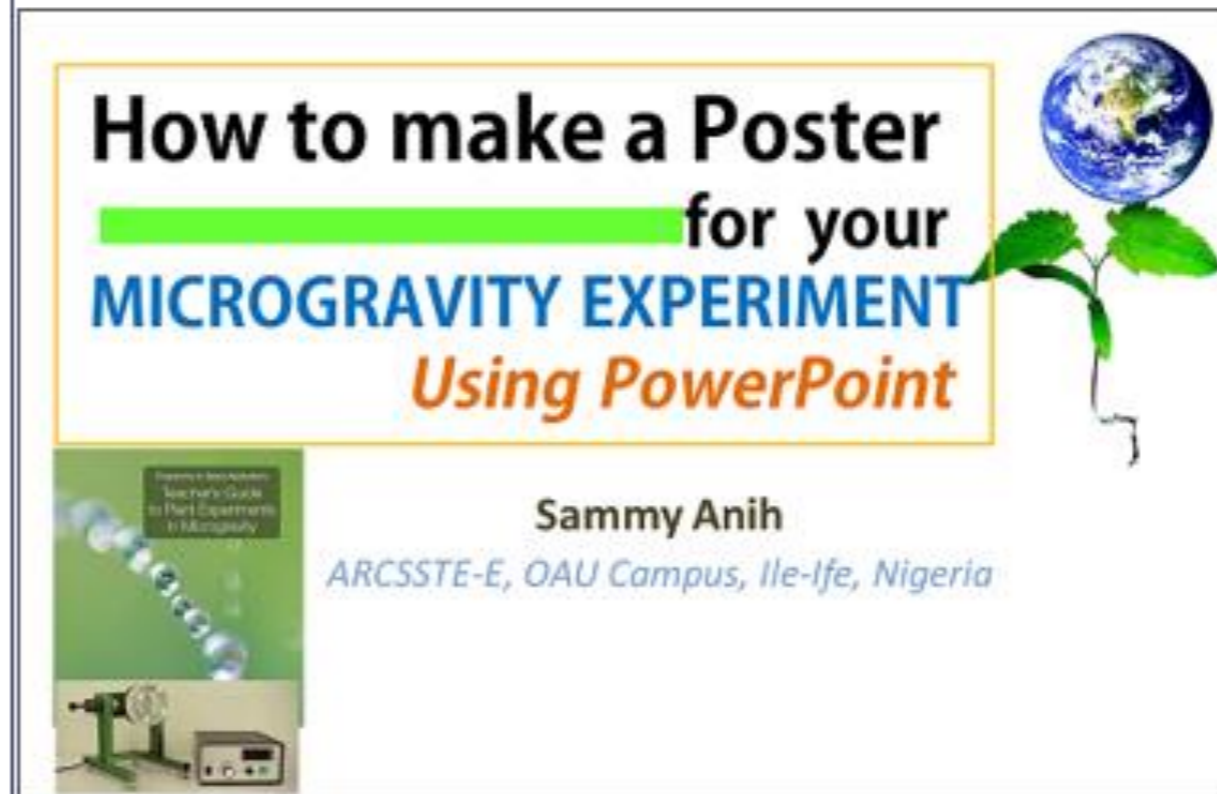
**Data analysis with
ImageJ software**



The Poster Making Session

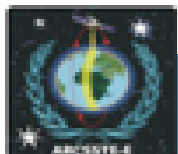

A Poster Making Workshop was organized for the participating schools at the ARCSSTE-E Space Museum where the schools were introduced to the rudiments of poster production and discussed the following topics:

- What is Poster?
- Poster Contents
- Poster Layout
- Design [Techniques and aesthetics behind an effective poster presentation].
- Creating a poster using a PowerPoint.

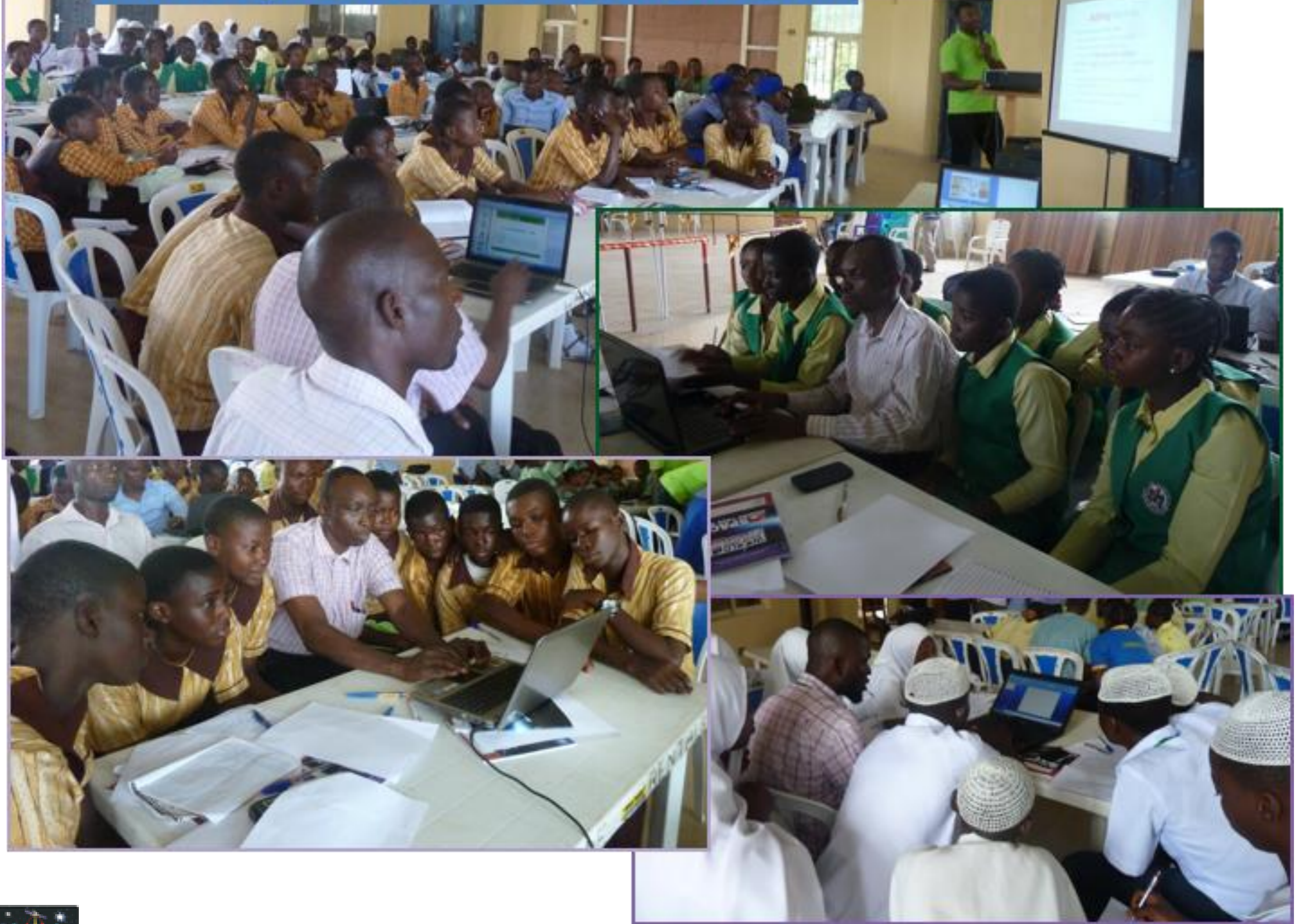


How to make a Poster
for your
MICROGRAVITY EXPERIMENT
Using PowerPoint

Sammy Anih
ARCSSTE-E, OAU Campus, Ile-Ife, Nigeria



Workshop: How to Make Research Poster



ARCSSTE-E

African Regional Centre for Space Science and Technology Education in English
Obafemi Awolowo University, Ile-Ife, Nigeria



EFFECT OF MICRO-GRAVITY ON THE ROOT GROWTH OF MILLET AND OKRA SEEDS



Awwal A., Fatih M., Mubarak J., Mujeeb O., Taofik I., Maryam R., Aisha B., Muminat. H, Mariam A., Sakinah A., Mallam Mutialahi Alade
Islamic College, Osogbo, Nigeria

ABSTRACT

This experiment is to test if plant can grow in a micro-gravity environment. This, also examines whether the space can be commercialized or not in order to reduce the cost at which food items are transported into space. This experiment also demonstrates how plant will grow in a micro-gravity environment. This can be achieved by planting seeds inside the petridish, placing the petridish inside humidifier and placing of the petridishes on the clinostat.

INTRODUCTON

Earlier on, observations made by the World Space Organization shows that there have been wastage of foods and agricultural products due to weightlessness. The Space scientists, therefore, design experiment to stop food wastage. This experiment has been carried out by the NASA to inform young scientists. Therefore, we design our own method of performing this experiment on how to grow plant in space.

MATERIALS

This experiment is to be performed in a controlled environment (i.e. Micro-gravity environment.) The device which produces the effect of microgravity, Agar-agar powder is the substrate used because of its fast rate of germination. Petri dishes are containers where the seeds are grown. Thermometer is used for checking temperature and hygrometer for checking relative humidity. Also, the heating element is used for heating Agar-agar solution.

PROCESS

Firstly, 100ml of tap water is measured, and 1.5g of Agar- agar powder is added to it. The beaker containing the mixture is then placed on a heating device, the mixture is then heated to a range within 70 degree Celsius. The temperature is then checked on the heating device with thermal Crum. A magnetic stirrer is then carefully drop into the mixture, to stir the mixture to prevent lumping of the solution. After heating the mixture to a certain degree, it is then poured into the marked petridishes. Then it is allowed to cool for 20 minutes and the seeds were be planted with the aid of twiser on the marked spot and covered with lid and allowed to solidify for about 20-30 minutes, after which the lid is cleaned with tissue paper and covered back. Then, the petridish is sealed with parafilm and little space is left to allow air penetration.

For fast germination. Thereafter, the petridish is placed in the petridish holder and transferred to the wet chamber to provide moist environment for the seed, then the thermal-hydrograph is placed inside the wet chamber to know the temperature and relative humidity in the cloud, and will be left there for about 20-30 hours. After 20-30 hours, the petridishes will be removed from the cloud. 1G, clinostat, 90 degree and the backup will be sorted out accordingly. The 1G position will not be altered as it is placed in the wet chamber, the 90 degree turn will be turned vertically and the back up will be left unturned in case of error in the preparation of other petridish.

The one to be mounted on the clinostat will be done with the aid of double sided tape which can hold the petridish firmly on the clinostat. Then the revolution per minutes will be set within the range of 10- 20 revolution per minutes. Then, the device (clinostat) will be put on and pictured immediately.

After each 30 minutes, the clinostat will be stopped and the picture of the petridishes mounted on the clinostat is then captured. The camera used to take the picture should be placed 30 cm away from the clinostat and the picture of the 1G, 90 degree turn and backup is also taken every 30 minutes for 4-5 times (2 – 2.5 hours).

RESULTS

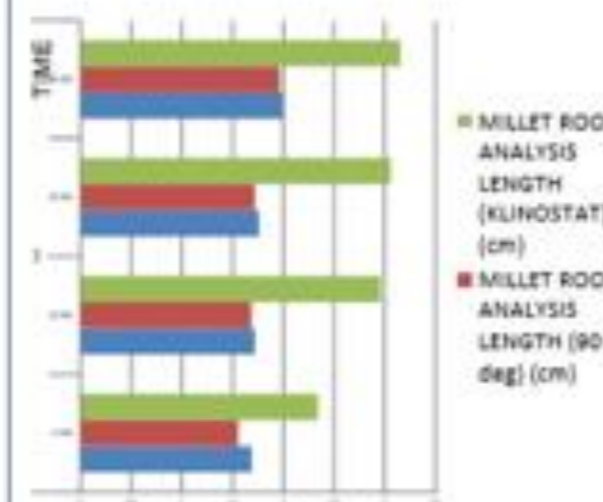
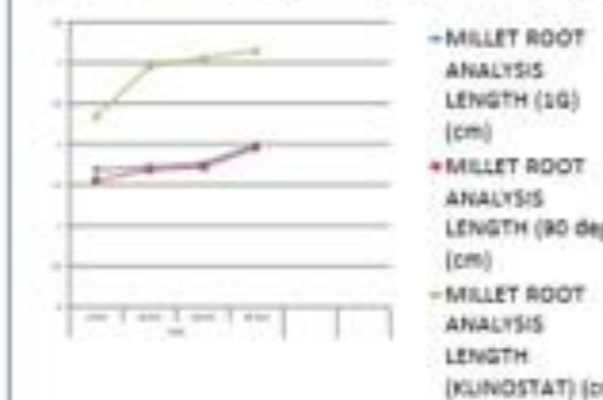
After all these processes, there came in the results of the whole experiment. When weighing the Agar-agar powder, the initial weight of the petridish was 7.2g and the final weight was 8.7g because 1.5g of Agar-agar powder was used for OKRA. The initial temperature before heating the Agar-agar solution on the heating device was 26.2°C and the final temperature was 71.4. When the petridish was in the wet chamber the thermal hydrograph reads the initial temperature to be 27.5°C and the initial humidity was 60%, the final temperature and final relative humidity was 28.2°C and 86% respectively. It was observed that the relative humidity in the wet chamber is within the appropriate range i.e (70%-100%)

When it was exactly 9:36 am the clinostatated petridish has been mounted on the clinostat and the revolutions per minute is set to 15 revolutions per minute and the direction was set to counter clockwise. When it was 9:37 am, the clinostat was powered on. Thereafter, the picture of the root was taken and analysis is done with the aid of IMAGE J

The tables and graphs below illustrate the root growth of Okra and Millet roots

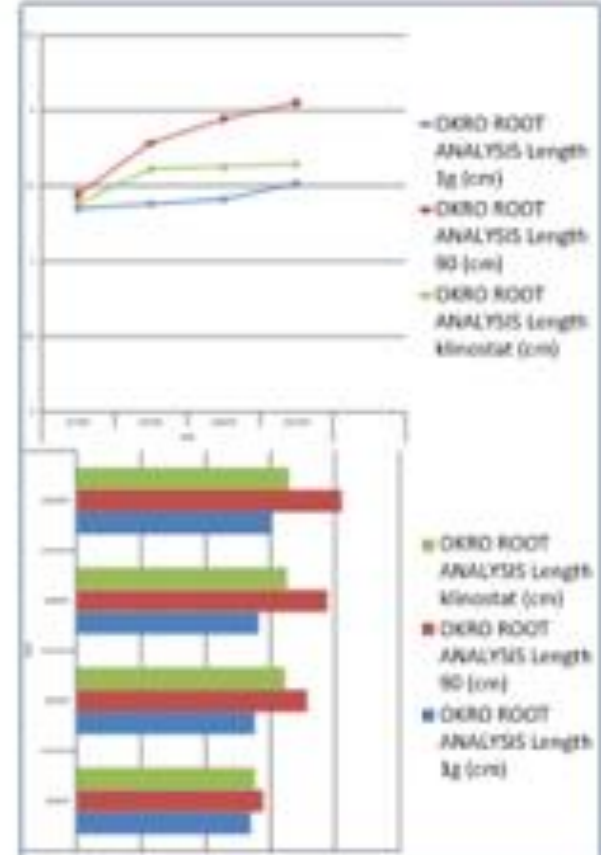
MILLET ROOT ANALYSIS

TIME	AT (1G) LENGHT [CM]	AT (90°) LENGHT [CM]	ON THE (KLINOSTART) LENGHT [CM]
0	1.687	1.554	2.342
30	1.72	1.684	2.950
60	1.76	1.718	3.058
90	1.959	1.963	3.154



OKRA ROOT ANALYSIS

MIN	AT (1G) LENGHT [CM]	AT (90°) LENGHT [CM]	ON THE (KLINOSTART) LENGHT [CM]
30	1.348	1.445	1.383
60	1.38	1.785	1.615
90	1.45	1.944	1.828
120	1.518	2.052	1.846



REFERENCES

- ▶ Teacher's guide of the 2017 practical
- ▶ <http://www.google.com>
- ▶ Image-J software

ACKNOWLEDGEMENT

We like to acknowledge the effort and support of the ANCSSTE-E. Also our profound gratitude goes to our great circle of learning Islamic College Osogbo and the school's management who gave us the opportunity to partake in this programme and to make it come to reality. Lastly, we will like to appreciate the effort of the United Nation (UN).

CONCLUSION

In conclusion, after carrying out the experiment and after analysing our results, we discovered that plants can grow in a micro-gravity environment with absence of gravity or with very low gravity. Also, it was discovered that gravity tends to pull the plant's roots towards the direction of gravity while the shoot tends to move in the opposite direction of gravity. Therefore, "plants' roots are positive to gravity while the shoot is negative to gravity". Furthermore, there was the presence of oxygen and high humidity that aided the plant's growth. In addition to this, we noticed that the plants in micro-gravity environment grow faster than the plants grown in a gravity environment.





EFFECT OF MICRO-GRAVITY ON THE GROWTH RATE AND THE CURVATURE ANGLE OF RICE ROOT



Participants: ABE Favour, OMONITAN Daniel, OMITIRAN Isaac, FAROMO Olalade, OMONITAN Samuel, TAIWO Oluwaseun, ADEBISI Dare, OMITIRAN Adesola, FAFIYEBI Alaba, ADEOBA Phebe, OMONITAN F.A (Mrs.), Love and Joy Secondary School, Ilaje-Ile, Ilesa, Osun State, Nigeria.

Abstract

- Can rice be cultivated in space?
- Does rice roots have effect in a micro-gravity environment?
- What is the effect of micro-gravity on the angle of curvature of rice roots?
- Will micro-gravity affect the growth of rice adversely?

Since the beginning of human space flight, the feeding of astronauts has been a major problem. This is so because astronauts are not able to feed on fresh food in space. That is why it is important to study the behaviors of plant in a micro-gravity environment and know whether plants can be cultivated in space or not.

It is said that the force of gravity determines the movement, growth, and direction of living things especially green plants. And growth and direction of plants affects how a plant will yield product. Therefore, is it possible for plants to survive in space where the effect of gravity is being cancelled out?

So, in order to achieve a micro-gravity environment here on earth, a clinostat was used to simulate a micro-gravity environment for the plants to check the influence of gravity on them. Seeds were planted in agar-agar substrate in a Petri-dish which serve as soil for the seeds to germinate. The seeds were studied for two hours and readings were taken.

Introduction

Rice is a very popular food. It is eaten all over the world. Rice was used for the experiment because:

- It feeds about two billion of the world's population.
 - It serves as raw materials for the production of some other food materials e.g. beer.
 - Rice seeds are not too big neither are they too small to be handled.
 - The germination of rice seeds is within 2-3 days.
- The above reasons are why rice was chosen for the experiment.

So far, micro-gravity researches have been conducted on rice seeds to understand the effect of gravity on it, and to check whether or not it can be cultivated in space.

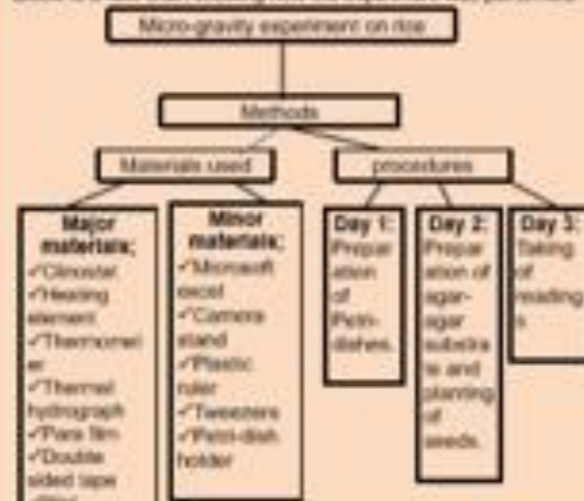
The following micro-gravity researches have been conducted on rice so far:

- Effect of micro-gravity on lactic acid production in rice cell wall.
 - Effect of gravity on the activity of rice shoot cell walls.
 - Effect of gravity on the waving of rice shoot.
 - Effect of gravity on the growth rate of rice shoots.
- It is observed that researchers have not been conducted on the effect of gravity on the growth rate and angle of curvature of rice roots. That is why we have chosen to research on the effect of micro-gravity on the behaviour of rice roots. As students, the clinostat experiment is the best because it is faster, safer, easy to manipulate and can be easily understood.

Methods

We are interested in knowing the effect of micro-gravity on the growth rate and angle of curvature of plant. Rice was chosen for the experiment.

Below is a flow chart showing how the experiment was performed:



Four Petri-dishes were prepared, 1G, clinorotated, 90° turned and backup.
 Readings were taken by taking pictures of seeds at 15mins interval for 2hrs.
 The clinostat was switched off every 30mins and pictures were taken as fast as possible. This is to prevent gravity from acting on the seeds.



Rice seeds on clinostat



Team picture

Results

After the seeds were analyzed, the followings were observed:

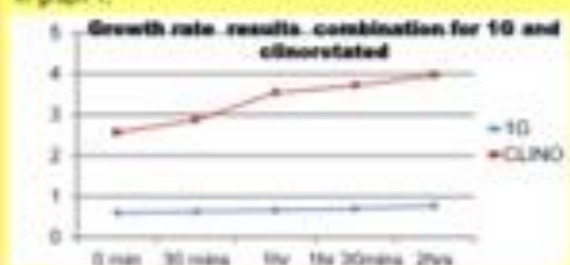
Growth rate

For growth rate, 1G and clinorotated seeds were analyzed. The data obtained are summarized below:

	Time	0min	30mins	1hr	1hr30mins	2hrs
Average length of roots (cm)	1G	0.00	0.03	0.04	0.07	0.07
	clinorotated	0.03	0.07	0.14	0.21	0.27

Table I: the growth rate of 1G and clinorotated seeds.

The growth rate of 1G and clinorotated seeds for rice as shown in graph 1:

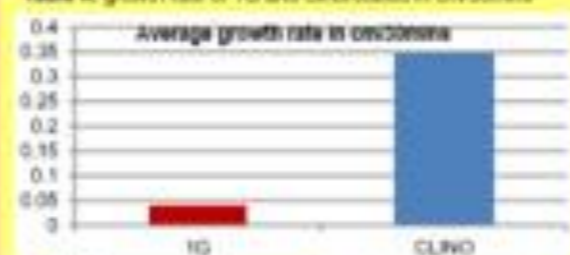


Average growth for both 1G and clinorotated rice seeds as shown in table II:

Graph I: the growth rate of 1G and clinorotated seeds

Time	0min-30mins	30min-1hr	1hr-1hr30mins	1hr30mins-2hrs	Average
1G (cm)	0.02	0.03	0.04	0.07	0.04cm/30mins
clinorotated (cm)	0.03	0.07	0.17	0.21	0.30cm/30mins

Table II: growth rate of 1G and clinorotated in cm/30mins



Graph II: average growth rate of 1G and clinorotated seeds in cm/30mins

Angle of curvature

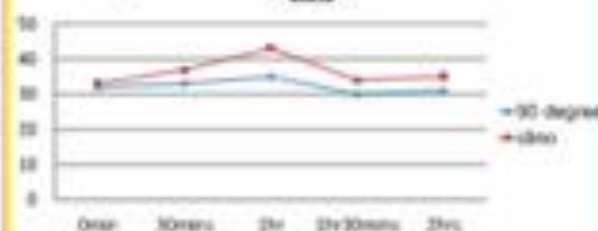
For angle of curvature, clinorotated and 90° turned were analyzed and the following were observed:

Average angle of curvature of clinorotated and 90° as shown in table III:

Average angle of curvature in degree	Time	0min	30mins	1hr	1hr30mins	2hrs
90 degree	clinorotated	32	33	35	36	37
90 degree	90° turned	33	37	43	34	35

Table III: the average angle of curvature rate of clinorotated and 90° seeds.

Graph of result for angle of curvature for 90° and clinorotated



Graph III: the average angle of curvature rate of clinorotated and 90° seeds.

Conclusion

From the experiment so far, it was observed that clinorotated rice roots has a faster growth rate and a higher angle of curvature compared to that of 1G. Therefore, it was concluded that rice can successfully be cultivated in space.

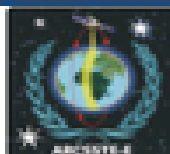
Acknowledgement

For the success of this project, we hereby acknowledge the following bodies who contributed to the success of the research:

- The United Nations
- African Regional Centre for Space Science and Technology Education in English
- Love and Joy Secondary School

References

- Katsuyuki Wakabayashi, 1992, Osaka university, September 2010
- Japan Aerospace explorators: 2007
- Bonnet Coleman & co: 2014



THE GROWTH RATE AND CURVATURE OF BEANS, MAIZE AND WHEAT ROOTS IN A SIMULATED MICROGRAVITY ENVIRONMENT

PROGRESS COMPREHENSIVE HIGH SCHOOL TORO ROAD MODAKEKE – IFE NIGERIA.

ARBOYE IDRIS, OJUNLOLA MARX ODERANTI DORCAS, ODERANTI FAITH, AKINRINADE ABAYOMI, BABATUNDE KEJ, OGUNDELE ABIOJUN, ADENIRI ISAAC, OYAJUMO JESUTOWO, OLUWINDIPO BLESSING, ODERANTI SAMSON, ADEDIRAN ADELINKA



ABSTRACT

The question of how rotation on a horizontal axis (Clinostat removes plants from the influence of the gravitational force) is answered. Wheat, beans and maize were cultivated in microgravity environment. These seeds were selected because of their small sizes and early germination rate. Dry soil, Clinostat and other materials which were jointly provided by ARCSSTE-E and United Nations Office for Outer Space Affairs were used.

This research was able to answer these questions:
 How does gravity change a plant growth?
 How does a plant react to zero gravity?
 Can growing wheat, beans in microgravity condition make its roots grow longer?
 The need of food, fresh oxygen, recycled water and building materials by astronauts and people on earth necessitated this work.
Hypothesis: Growing (plants: beans, maize and wheat) in microgravity environment will make their roots grow longer?
Null Hypothesis: Growing (plants: beans, maize and wheat) in microgravity environment will not make their roots grow longer.
 Seeds of beans, wheat and maize were planted inside petri dishes using Agar – agar as substrate.
 Two things were tested for in our experiment. They were – the growth rate of each seed and their root curvature.
 The growth rate of these seeds were observed, recorded at intervals.

Analysis were done with image j software. The results were represented by graphs and tables.
 Findings from these research shows:
 • Plants can be grown in space.
 • Astronauts can grow their favourite plants using a light version of space garden.
 • Gravity affects the direction of plants.
 • Zero gravity affect plants growth positively and negatively.
 • Wheat grow better in microgravity.

METHODS

- Beans, maize and wheat were cultivated in simulated microgravity.
- Four petri dishes containing Agar – agar substrate accommodated nine seeds each.
- The four petri dishes were labelled as 90° turned, clinostat, 1g turned and backup.

Fig.1. The photographs for 1g, 90° and clinostat are shown below.



Materials used for the experiment:
 Clinostat, Petri dishes (1 pack), Petri dish holder, Five germinating markers, Thermometer, Ingressometer, Heating glass, Small cooking pot/boiler glass, Agar – agar, Double label tape, West chamber, Clinostat chamber, Clinostat balance, Biological medical wastebins, Hand film photo camera, Computer, Image j in the latest version, Magnetic plates.

- 33 seeds were grown in Agar – agar substrate.
- 14 seeds were used for the analysis of growth and root curvature.
- 1g and clinostatized petri dishes were used for growth rate analysis.
- 90° and clinostatized were used for root curvature.
- Data were collected from 14 seeds using the aid of image j software and excel.
- The length of the growth were measured and represented by table.
- The angle of the root curvature were calculated and represented with table.
- Demographic representation were shown below.

RESULTS: DEMOGRAPHICS

Table 1. Growth rate of beans, maize and wheat at 0 min, 30 min, 60 min, 90 min, 120 min intervals.

	beans					maize					wheat				
	0 min	30 min	60 min	90 min	120 min	0 min	30 min	60 min	90 min	120 min	0 min	30 min	60 min	90 min	120 min
1g	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clinostat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Fig.2. beans growth rate



Bar chart showing 1g and Clinostat growth rate of beans.

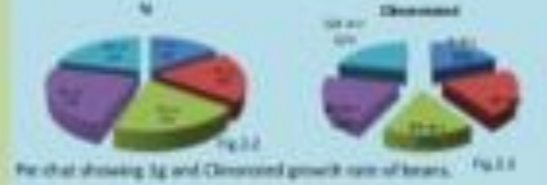


Fig.3. wheat growth rate

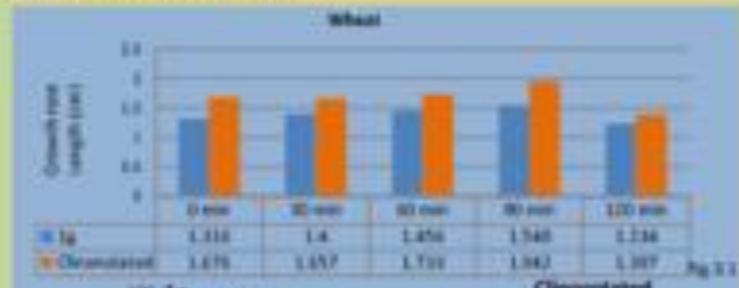


Fig.4. Maize growth rate

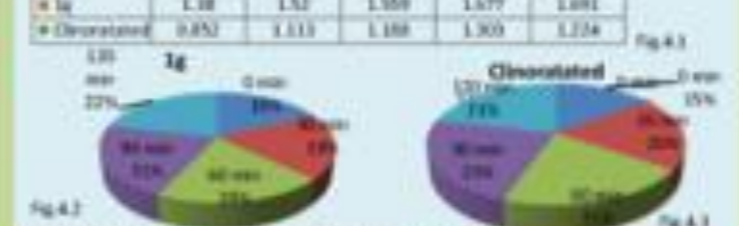


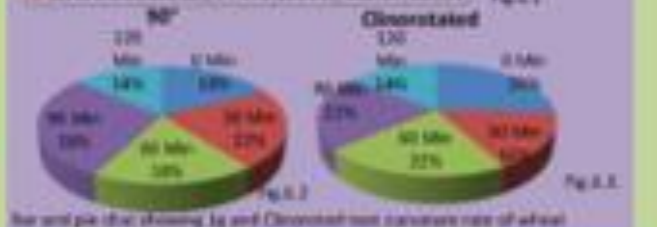
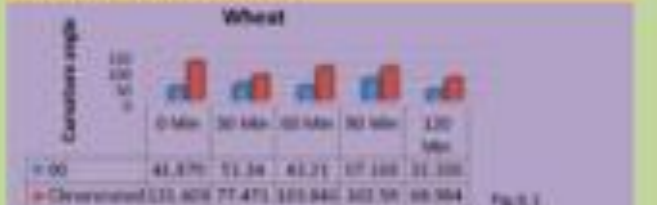
Table 2. Root curvature of beans, maize and wheat at 0 min, 30 min, 60 min, 90 min, 120 min intervals.

	beans					maize					wheat				
	0 min	30 min	60 min	90 min	120 min	0 min	30 min	60 min	90 min	120 min	0 min	30 min	60 min	90 min	120 min
1g	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000
Clinostat	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000	90.000

Fig.5. Maize root curvature

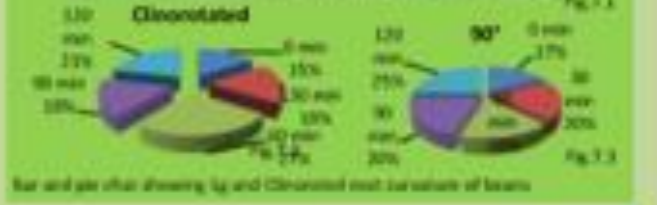


Fig.6. wheat root curvature



Bar and pie chart showing 1g and Clinostat root curvature rate of wheat.

Fig.7. Beans root curvature



Bar and pie chart showing 1g and Clinostat root curvature of beans.

CONCLUSION

- Beans root was positively affected by gravity vector.
- The rate of maize root's growth was increased by gravitational pull.
- Wheat was negatively gravitropic. The Clinostatized grew longer than "1g".
- The angle obtained from the root curvature of Clinostatized were greater than 90° turned.
- The hypothesis was disproved by the growth of both beans and maize while it was approved by wheat growth rate.
- Wheat has the highest growth rate in space.
- There is need for research work on:
 1. Feasibility of plants grown in space and those grown on earth.
 2. Effect of microgravity environment on the quality of plants.

ACKNOWLEDGEMENT

- We will like to acknowledge African Regional Centre for Space Science and Technology Education – English, Obafemi Awolowo University, Ile-Ife, Nigeria.
- United Nations Office for Outer Space Affairs is acknowledged for their contribution.

REFERENCE

- OGDONIS, S.A, 2003. Gravity and plant development.
- Teacher's Guide.





EFFECT OF MICROGRAVITY ON WHEAT AND GUINEA CORN SEEDLING PLANTS

Saliu K., Adeyemi T., Ajayi M., Oladapo M., Bakare R., Akinwumi V., Ijimade B., Adefiwitan F., Olasode O., Oladele O. and M. K. Onabowale
St. David's High School, Ile-Ife, Nigeria



ABSTRACT

Quantitative information on the effect of microgravity on wheat and guinea corn seedling plants were provided. Length and root curvature of the plants were determined using Imager method. The minimum and maximum root lengths of the wheat for clinorotated and non-clinorotated (1g) were 2.63 cm and 4.2 cm; 3.03 cm and 3.23 cm while that of guinea corn are 2.17 cm and 2.58 cm ; 3.03 cm and 3.23 cm respectively. The growth rate of clinorotated wheat is 1.88 times that of guinea corn at 90 minutes while that of 1g was not affected. The higher value of angle indicates a more pronounced curvature of the root, it was observed that clinorotated plants germinated faster than non-clinorotated plants in a micro-gravity environment.

INTRODUCTION

Microgravity is a unique environment in outer space where the effects of gravitational force are minimized. It is also lead to understand how organisms and matter react to gravity, and may also lead to new applications benefiting humankind. Clinostat has been utilized for nearly 100 years to negate gravity and thus provide information on the significance of gravity to the growth of plants, utilized to simulate or duplicate the weightless environment of space flight to provide understanding of possible growth effects upon plants in space stations and provide insights into how plants seed react to an environment with simulated microgravity during germination and early growth.

MATERIALS AND METHODS

The experiment was performed with two seeds-wheat (*Triticum aestivum*) and guinea corn (*Sorghum bicolor*). The size of the seed selected must neither big nor small but MODERATE, for the agar-agar solution-a fertile land to hold for germination. The substrate, agar-agar solution prepared was evenly distributed into the petri dish where nine seeds each of wheat and guinea corn was planted on 5 petri dishes. The seeds were covered for about 20-30 minutes and sealed two-third of the petri dishes with parafilm and leaving the remaining part of the petri dishes for air to the planted seeds inside the wet chamber. The petri dish holder position the seeds in the right position of wheat and guinea corn was placed into the wet chamber, a moist environment for the plants one after the other for about 20 - 30 hours with thermal hygograph measuring both temperature and relative humidity. Data on plants growth were collected from photographs taken during the course of the experiments between 28th July and 1st August 2024 and analyzed using Imager to analyzed the root length and curvature.

RESULTS AND DISCUSSION

Table 1 shows the summary of the descriptive statistics of the growth rates for clinorotated and non-clinorotated (control) wheat (*Triticum aestivum*) and guinea corn (*Sorghum bicolor*). The minimum and maximum root lengths of the wheat for clinorotated and non-clinorotated (1g) were 2.63 cm and 4.2 cm; 3.03 cm and 3.23 cm while that of guinea corn are 2.17 cm and 2.58 cm ; 3.03 cm and 3.23 cm respectively. The overall mean lengths of clinorotated wheat and Guinea-corn in the microgravity environments were 3.05 cm and 2.35 cm respectively. It was observed that the wheat has the longest root of about 4.2 cm at 90 minutes and Guinea corn 2.58 cm at 120 minutes. The mean lengths of 1g for both wheat and guinea corn was 3.14 cm. The average growth rate of wheat and guinea corn for clinorotated root and 1g are 1.53 cm h⁻¹, 1.18 cm h⁻¹ and 1.57 cm h⁻¹ respectively. Also the growth ratio of wheat to guinea corn is 1.3. Figs 1 and 2 show the histogram of the distributions. The charts show that the growth rate of clinorotated wheat is 1.88 times that of guinea corn at 90 minutes while that of 1g remained the same. The speed of clinorotation did not affect growth of clinorotated wheat and guinea corn but growth rate of guinea corn was about 23% lower than wheat.

Table 1: Summary of the results obtained for Clinorotated wheat and Guinea corn and Non-clinorotated (1g control)

Time(min)	WHEAT LENGTH (cm)		GUINEA CORN LENGTH (cm)	
	Clinorotated	Non-clinorotated(1g)	Clinorotated	Non-clinorotated(1g)
0	2.63	3.03	2.17	3.03
30	3.07	3.19	2.41	3.19
60	2.79	3.14	2.36	3.14
90	4.2	3.11	2.25	3.11
120	2.63	3.23	2.23	3.23

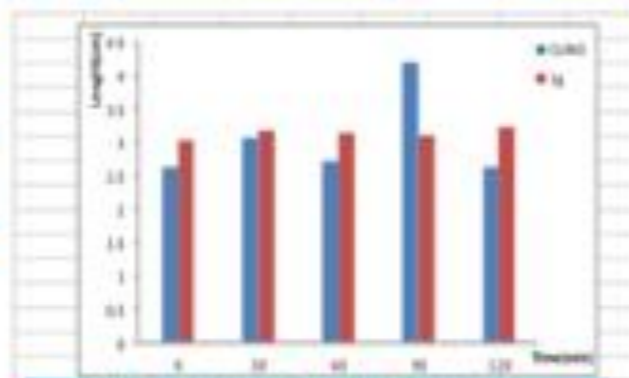


Fig 1: The variation of Clinorotated wheat and Non-clinorotated (1g control)

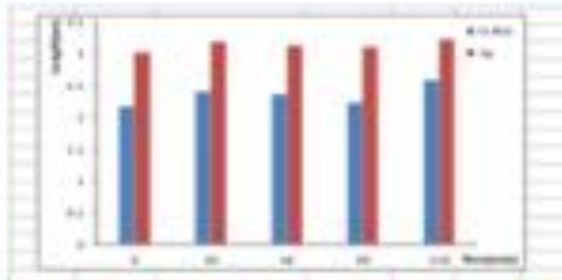


Fig 2: The Variation of Clinorotated Guinea corn and Non-clinorotated (1g control)

Table 2 shows the mean root curvature for both clinorotated wheat and guinea corn. The overall mean for wheat and guinea corn was 108.2° and 65.52° respectively. The least root curvature (44.7°) was observed in guinea corn while the highest 112.94° was observed in wheat in the gravitational response. The line graph of root curvatures for both wheat and guinea corn was showed in figure 3. The higher value of angle indicates a more pronounced curvature of the root therefore, wheat germinated faster than guinea corn in a micro-gravity environments.

Table 2: Summary of the results obtained for Root Curvatures of Wheat and Guinea corn

Time (min)	Wheat α°	G-Corn β°
0	108.33	95.57
30	108.33	50.79
60	105.66	44.7
90	104.41	79.41
120	112.94	83.35

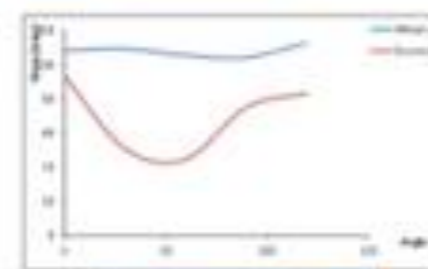


Fig 3: Curvature Chart

CONCLUSION

The results of this study have shown that total mean lengths of clinorotated wheat and Guinea-corn in the microgravity environments were 3.05 cm and 2.35 cm respectively. It was observed that the wheat has the longest root of about 4.2 cm at 90 minutes and Guinea corn 2.58 cm at 120 minutes. The mean lengths of 1g for both wheat and guinea corn was 3.14 cm. The average growth rate of wheat and guinea corn for clinorotated root and 1g are 1.53 cm h⁻¹, 1.18 cm h⁻¹ and 1.57 cm h⁻¹ respectively. Also the growth ratio of wheat to guinea corn is 1.3. The average growth rate of wheat and guinea corn for clinorotated root and 1g are 1.53 cm h⁻¹, 1.18 cm h⁻¹ and 1.57 cm h⁻¹ respectively. The growth rate of clinorotated wheat is 1.88 times that of guinea corn at 90 minutes while that of 1g remained the same. The speed of clinorotation did not affect growth of clinorotated wheat and guinea corn but growth rate of guinea corn was about 23% lower than wheat. The higher value of angle indicates a more pronounced curvature of the root therefore, wheat germinated faster than guinea corn in microgravity environment.

ACKNOWLEDGEMENT

We are extremely grateful to African Regional Center for Space Science and Technology Education in English Obafemi Awolowo University Campus, Ile-Ife, Nigeria (ARCSTE-E). The authors gratefully appreciate ARCSTE-E, USA supply the 1-D-Clinostat and the authority of St. David's High School, Ile-Ife. We are also thankful to Dr. Wumi Alabi, the Head of ARCSTE-E, O. A. U., Ile-Ife Space Education Outreach Program.





EFFECT OF MICROGRAVITY ON THE GROWTH RATE OF OKRA SEEDLING ROOTS

Adefarakan A., Areeson F., Elusiyan J., Mazakanngdim V., Mosobalaje G., Olagoroye F., Olanrewaju O., Olanmi A., Onijogun V., Saibu A., Sanni D.
Sunshine Nursery and Primary School, Road 7, Ile-Ife, Nigeria.



Abstract

The experiment is aimed at investigating the effect of microgravity on the growth rate and curvature of growing okra seedling using a simulated microgravity environment which is a clinostat.

Some attempts have been made by various space scientists and the results showed that some plants could successfully grow in microgravity. However there will be variations: notably, there were reduction in yields and delayed development.

Could this be replicated using a clinostat and will there be a significant effect on the growth of the plants compared to those in 1g?

To find out we used a clinostat to simulate microgravity condition. Okra seeds were used during the investigation and necessary conditions for quick germination of seeds were fulfilled.

The result shows clinostat triggers the same changes that occur when plants are in microgravity of Earth orbit, and would occur during transit to the Moon, Mars and any other first four planets in the Solar System.



Introduction

In the nearest future, space travel would require astronauts to grow their own food due to long time duration of their missions, there will also be the need to supplement food consumed by people on earth due to increase in population. Research in improving plants growth rate and yield as well as their behaviour when under different gravitational conditions will be of great interest to the scientists.

The experiment is aimed at providing space researchers with the opportunity to grow okra in space. The experiment was performed under simulated microgravity conditions. However, similar experiments have been performed in real microgravity in space using various plants: the results came out with variations in the duration of growth and yield. It takes longer time to grow and reduction in yield when one grows in space. This experiment is to provide additional information and a way of discovering improved method in microgravity.

References

1. A key role for curvature compensation ('autotropism') in the local curvature distribution model. *New Phytologist*, 143, 387-390
2. Swarup R et al(2006). Root gravitropism requires lateral root cap and epidermal cells for transport and response to a mobile auxin signal. *Nov. 7(11):1057-65.*

Procedure

The okra seeds were soaked in tap water on the first day and taken out for planting after 24 hours. Four petri dishes were prepared to contain the substrate on which the seeds will be planted. The substrate used is Agar-agar and nine seeds were planted in each petri dish. Each petri dish was closed up to 75% with parafilm to allow air passage. We arranged the petri dishes in the petri dish holder and put them in the wet chamber. The temperature and the relative humidity of the wet chamber were recorded. After 24 hours, we opened the wet chamber, recorded the temperature, the relative humidity and brought out the seeds to carry out the investigation. We took three comparable petri dishes: the first at 1g control, the second at 90 degrees turned and the third mounted on the clinostat with double-sided tape. For each of the samples snapshots were taken at 0 minutes, 30 minutes, 1 hour, 1 hour 30 minutes and 2 hours. Measurement of root lengths and angles were done using Image J while analysis was done with Microsoft Excel.

Results

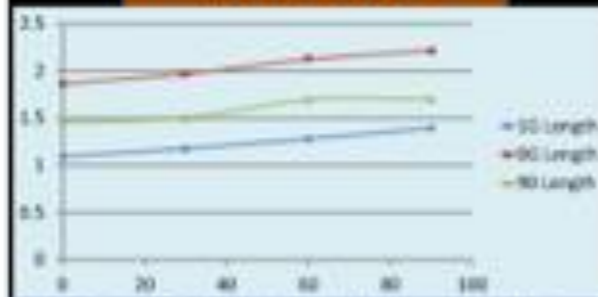


Figure 1: Growth rate okra root at various conditions

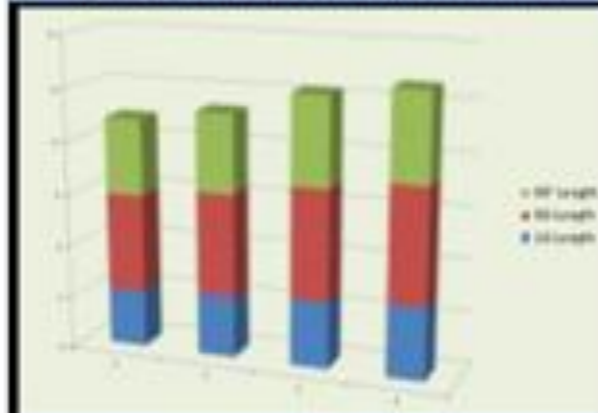


Figure 2: the length of okra root at 30 min interval

Results

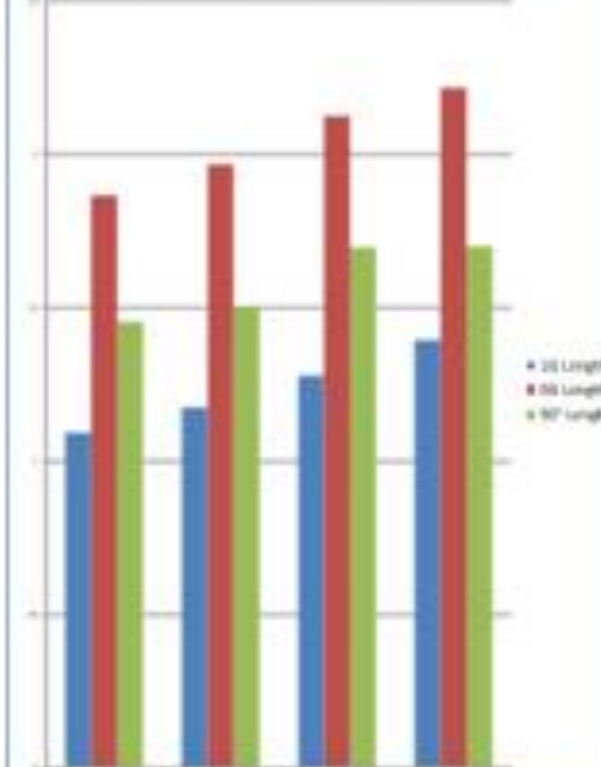


Figure 3: Relative growth rates of Okra roots at different conditions

In Figure 1, the graph shows the growth of the okra roots at various conditions. That is, when the seedling is under gravity, at 90 degrees turn and microgravity. Looking at the 10 and 00 lengths, the lines joining the graph plots are almost linear. This shows increase in the lengths of the roots as the time increases.

In Figure 2, the composite bar chart shows the length of the okra roots at thirty minutes interval for each of the three conditions represented by the three colours. As indicated by the red portions of the bars, there seem to be high rate of growth at micro gravity compared to those of gravity and 90 degrees turn.

In figure 3, the multiple bar chart shows the relative growth rates of okra roots at different conditions as shown by the colours. It can again be seen that the red bars, representing the root lengths at microgravity are the longest, as opposed to those under gravity, which the shortest root lengths.

Conclusion

The growth of okra seed roots were noted at various conditions and their responses were noted. At 10, the okra roots grew on a straight line in the direction of gravity thereby making it positively gravitropic.

At 90 degrees turn, the roots responded to gravity by curving in the direction of gravity and even curved the more as the time increased. Normally, roots grow in the direction of gravity but at microgravity, where the influence of gravity is very low, the roots did not grow in the direction of gravity. Hence, okra seeds can grow in microgravity.

As shown by the results in this experiment, the okra seed roots grew longer at microgravity than those under gravity. This means that there is really no hindrance to growing roots in microgravity.

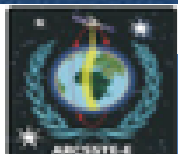
The findings of this experiment further boosts the possibility and chances of cultivating food plants in space and even on other planets like Mars and Venus.

For further research works, the following questions need to be asked:

1. What are the factors that influence the direction of root growth in microgravity?
2. Will the roots later show and curve like those growing under gravity?

Acknowledgement

1. We would like to acknowledge the support from the ARCSSTE-E, OAU Campus, Ile-Ife, Nigeria.
2. In addition, this project would not have been successful without the support from The United Nations Office for Outer Space Affairs.





Effect of Gravity Variation on the Growth of Okra Root

Ojefia D., Adetola E., Abiola E., Elujulo T., Oyerinmade B., Oriyide Z., Olakanmi S., Augustine T., Ajewole P. and Awodoyin K.,
Shepherd Twins Model College, Ile-Ife, Osun State.



ABSTRACT

Space exploration, is man's greatest means to subdue his environment and accelerate development.

Many spinoff of the exploration has brought relief for mankind.

If man is to survive in space, the gravitational effects on the root of indigenous plant became our concern.

The project was carried out at the laboratory of African Regional Center for Space Science and Technology Obafemi Awolowo University, Ile-Ife. The indigenous seed used was okra. Image / application software and Microsoft excel was used for data analysis.

The result shows significant differences in the growth rate. Six readings were taking at 30 minutes interval to determine the growth rate. It was discovered that there are differences in the growth of the root of plant because of gravity influence. The detail of the readings is shown in the result analysis table and graph.



INTRODUCTION

The study of universe and our solar system has shown that the earth is a very special planet: the only one we know to accommodate life. The earth is not only habitat for plants, animals and human beings; it also offers space to many and different culture. The quest for man to fully subdue and expand his environment led him to space exploration which has brought a lot of spin off for mankind.

These spin off has further motivated man to research into the possibilities of surviving in the space as a second home apart from the earth.

If man is then to survive in the outer-space, the gravitational variation on the root of an indigenous plant (okra) became our concern.

MATERIALS AND METHODS

Materials

Materials used for this experiments are; Okra seed, petri dishes, Hygrometer, agar phosphate, water, tweezers, wet chamber (for humidity), digital scale (for measuring), digital camera, heating device, digital thermometer, timing device (stop watch), personal computer, image / application software (for data analysis) and petri-dish holder.

Procedure

The experiment took 4days considering the germination period of the selected seeds which is 3-4 days and carried out in the laboratory with 20°C to 30° and relative humidity of 60% to 100%.

- Day 1: The seeds were soaked overnight to select the healthy ones and facilitate germination.
- Day 2: Petri-dishes were marked as shown for seeds to be planted in them. 1 lg of agar phosphate was made into 100ml of heated water to serve as substrate for the seed. The seed were then planted in the substrate facing same direction inside the petri-dish. petri dishes were cello tape around leaving 2/3 small portion and put inside Petri-dish holder, after planting. The petri-dish holder were then put inside a wet chamber. Hygrometer was placed inside the chamber to measure the humidity.
- Day 3: The four Petri-dishes were marked as (I) Okra seed sample (to test for growth under microgravity) (2) 1 sample was turned at 90° perpendicular to gravity vector (3) Another sample made parallel to gravity vector and the fourth sample turned as back up in the petri-dish holder. Six readings were made at 30 minutes interval. Data were analyzed by statistics. The unit of angle of curvature is in degree and that of length was measured in centimeter. (See the result).
- Day 4: The data were analyzed using Image / Application Software and Excel.



Okra seed sample

The research has shown the possible growth of plant under variation of gravitational force.

There was decrease in value of angle of Curvature comparing its value at each 30 minutes interval for Okra seed sample and 90° turned sample. See fig.1, table.

There are increase in the length per time with 90° turned with the largest value of 0.283cm followed by 1g sample (0.218) and Okra seed representing the least growth of 0.218cm. See fig.2.

This implies that root of okra will grow faster in 90° turned position (while Gravitational force is acting on it) than micro-gravity position (Okra seed sample).

RESULTS

TIME	OKRA SEED SAMPLE	90° TURNED SAMPLE	1G SAMPLE
00:00:00	0.000	0.000	0.000
00:30:00	0.000	0.000	0.000
01:00:00	0.000	0.000	0.000
01:30:00	0.000	0.000	0.000
02:00:00	0.000	0.000	0.000
02:30:00	0.000	0.000	0.000
03:00:00	0.000	0.000	0.000
03:30:00	0.000	0.000	0.000
04:00:00	0.000	0.000	0.000
04:30:00	0.000	0.000	0.000
05:00:00	0.000	0.000	0.000
05:30:00	0.000	0.000	0.000
06:00:00	0.000	0.000	0.000
06:30:00	0.000	0.000	0.000
07:00:00	0.000	0.000	0.000
07:30:00	0.000	0.000	0.000
08:00:00	0.000	0.000	0.000
08:30:00	0.000	0.000	0.000
09:00:00	0.000	0.000	0.000
09:30:00	0.000	0.000	0.000
10:00:00	0.000	0.000	0.000
10:30:00	0.000	0.000	0.000
11:00:00	0.000	0.000	0.000
11:30:00	0.000	0.000	0.000
12:00:00	0.000	0.000	0.000

Table 1 showing the data collected while experimenting with okra seed

TIME	OKRA SEED SAMPLE	90° TURNED SAMPLE	1G SAMPLE
00:00:00	0.000	0.000	0.000
00:30:00	0.000	0.000	0.000
01:00:00	0.000	0.000	0.000
01:30:00	0.000	0.000	0.000
02:00:00	0.000	0.000	0.000
02:30:00	0.000	0.000	0.000
03:00:00	0.000	0.000	0.000
03:30:00	0.000	0.000	0.000
04:00:00	0.000	0.000	0.000
04:30:00	0.000	0.000	0.000
05:00:00	0.000	0.000	0.000
05:30:00	0.000	0.000	0.000
06:00:00	0.000	0.000	0.000
06:30:00	0.000	0.000	0.000
07:00:00	0.000	0.000	0.000
07:30:00	0.000	0.000	0.000
08:00:00	0.000	0.000	0.000
08:30:00	0.000	0.000	0.000
09:00:00	0.000	0.000	0.000
09:30:00	0.000	0.000	0.000
10:00:00	0.000	0.000	0.000
10:30:00	0.000	0.000	0.000
11:00:00	0.000	0.000	0.000
11:30:00	0.000	0.000	0.000
12:00:00	0.000	0.000	0.000

Table 2 showing the value of length of the okra root

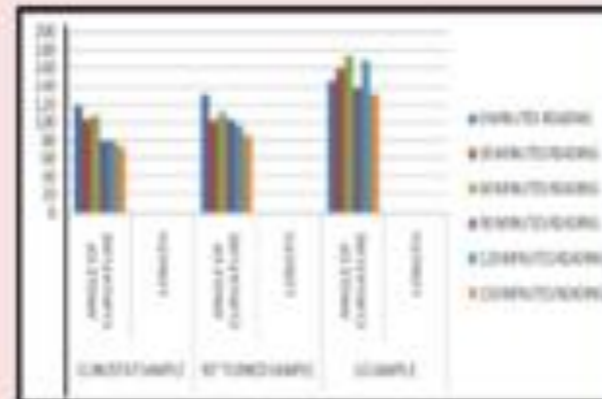


Fig. 1 shows the graph of angle of curvature and length of okra root against time interval

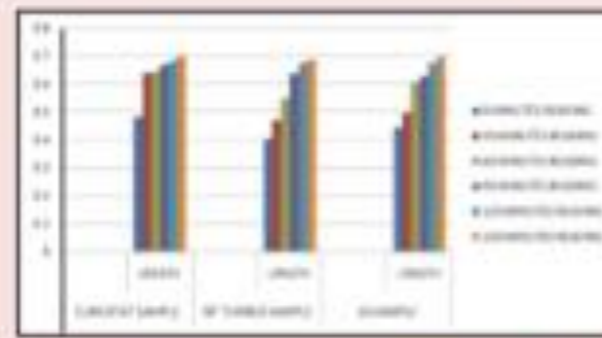


Fig. 2 The graph of length of root with time against its sample

OBSERVATION AND CONCLUSION

It has been established that, the gravitational variation influences the growth of the root of plant.

Plant under weak gravitational force (microgravity) has stunted growth in comparison with others under full gravitational force (earth).

If more conducive environment is assured, it can grow beyond the limited space provided in the petri-dish.

This research has added to the general knowledge of wide range of biological process but, will the weak gravitational force encourage plant to grow into maturation for man consumption in the outer space? And the validity of the extent of the growth could have been determined if the experiment is carried out in the outer space. Maturation of plants in space should be established before man eventually settled in outer space, because "plants and animals" including man, are inseparable, if survival is our prime concern.

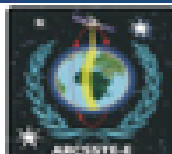
ACKNOWLEDGEMENT

Thanks to Arcsste-e Obafemi Awolowo University-Campus Ile-Ife for its laboratory assistance and United Nation for the provision of Okra seed for the experiment.

Shepherd School Space Club Contact Teacher, Adetola Samidele is hereby acknowledged for motivation, supervision, supply of seeds and food for this project.

REFERENCES

- Cecilia, S. and Natalie T., (2012) *Discovery in the New Aristotle Book*. (Ed) (2012) Germany/House of Astronomy. (Ed) Arnold (UNAAW/Leiden University).
- Togo, T., (2012) Wayne Richard, 3d. 4th. Revised edition.
- Jeffrey, R., (2014) *Man Goes to the Moon. A science Album with Man the Org.* Harcourt Brace Jovanovich, No. 17.





THE EFFECT OF MICRO GRAVITY ON THE GERMINATION OF MILLET SEED

OLAIDE E.A, ADEDIWURA H.A, ADEYENI T.I, OMIDIRE V.S, GODWIN J.O, OLATUNDE F.P, ABIODUN A.A, AKINSOLE S.A, FATAI D.O, ADEBOWALE P.A.
UNIQUE MINDS INTERNATIONAL COLLEGE, OPA, ILE-IFE.



ABSTRACT

Zero gravity instrument project is to promote space education and research in microgravity. It helps students especially geographers in studying the world beyond outer space.

The question that first came to mind in the course of the project is that "can microgravity be simulated in the laboratory on earth?" Other question that follows include: can researchers solve the problem of feeding for the Astronauts and other inhabitants of the outer space? The project helps to gather and solve the presumption hypothesis stated above.

The image / was used for the analysis of the growth rate and root curvature of the millet seeds. Bar chart was used to interpret the result. From the chart, the clinorotated was increasing as the 90° turned sample was decreasing for the growth rate while both clinorotated and 1g control sample were increasing for root curvature.

The project recommends that plant should be grown in space to provide food for the inhabitants of the space.

INTRODUCTION

This project gives insight to what people thought will never happen in years to come, things like: how can microgravity be simulated on earth, how can the problem of feeding be solved for those living in space, can plants be grown in space? These things have never been thought possible.

Clinostat is a device used to simulate microgravity on earth and can be used to grow plant/ crop under microgravity in the laboratory by following some basic principles and protocols. The clinostat cancel out the effect of gravity in all direction. The plant under normal condition will respond to light, temperature, gravity, pressure and water.

PROCEDURE

The apparatus or instruments used during the experiment includes, Clinostat, petri dishes, Parafilm tape, double-sided sticky tape, beaker, weighing balance, hygrometer, wet chamber, agar-agar substrate, heating source, magnetic stirrer. The reference line was drawn on the petri dish which indicates the gravity-vector line, the petri dish mass was measured, then it was used to measure 1.5g of Agar-Agar substrate and was poured into 100ml of water, the solution was heated on the heating source. A magnetic stirrer was dropped into the solution to avoid lumps, after which the solution was poured equally into the petri dishes and was allowed to cool for sometime.

The millet seeds were then planted with their micropyle facing one direction, after the vapour had been tapped out, petri dishes were covered and sealed with parafilm tape.

Note: The seed must not be too big or too small. The petri dishes were arranged in the petri dish holder and were placed into the wet chamber with an hygrometer and left for 30 – 40hours. The petri dish holders were removed from the chamber. The petri dish for the clinorotated sample was mounted on the clinostat. The speed was set into 50rpm. Pictures were taken at interval of 30 minutes.

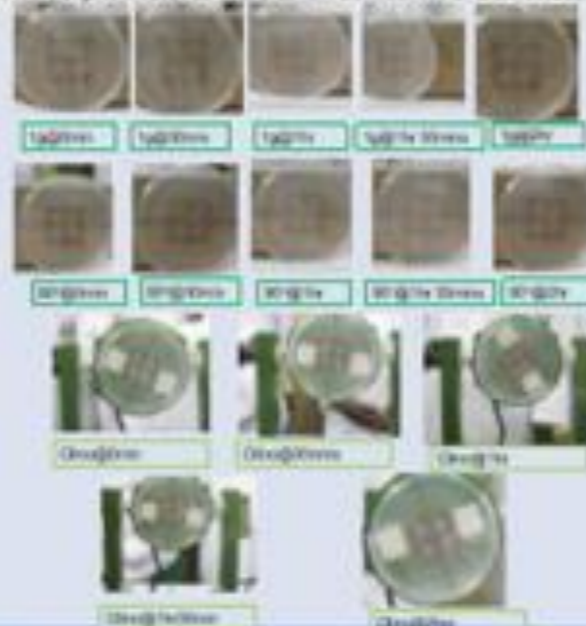


Fig 1.0 IMAGES OF THE OBSERVATIONS OF 1G AND 90° TURNED SAMPLES

Table 1: Root Growth Observation

Rotation	Time	Root Curvature	Growth Rate
Clinorotated	0min	104.800	1.580
	30 min	100.480	1.900
	1 hour	100.310	2.190
	1hr 30 min	100.440	2.304
	2hrs	100.470	2.270
90° turned	0min	104.800	1.580
	30 min	104.800	1.580
	1 hour	103.790	1.664
	1 hr 30 min	101.970	1.708
	2hrs	104.307	1.718

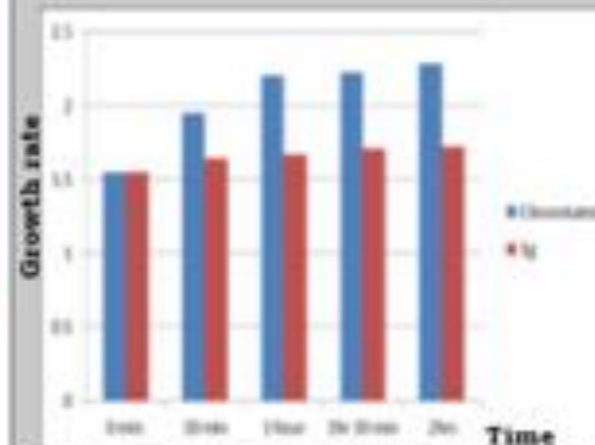


Fig 1.1 The Bar chart Showing Growth Rate against Time

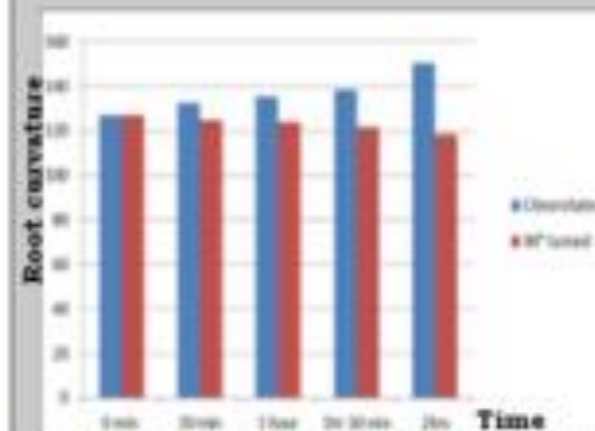


Fig 1.2 Bar Chart Showing Root Curvature Against Time

OBSERVATION

In fig 1.2, it was observed that angle of curvature formed in 90° turned samples decreased with time while angle of curvature formed in the clinorotated sample increased with change in time. For the growth rate, fig 1.1 showed that 1g and clinorotated samples increased with change in time.

RECOMMENDATION

Since the result was positive i.e plants grow in microgravity simulating environment, it can be recommended that plants/crops should be grown in the space.

ACKNOWLEDGEMENT

We thank God Almighty for making it possible for the completion of this project.

We appreciate the principal of our school for granting us the opportunity to partake in this competition.

We also thank our teachers who has participated in one way or the other for the success of this project, The Zero Gravity Instrument Project Management for allowing us to partake in the competition and for the help rendered during the course of the project.

We also extend our profound gratitude to the African Regional Centre for Space Science Technology Education in English (ARCSSTE-E), United Nation and the international cooperation in human space flight.

REFERENCES

- A. Brown, A.O. Dahl and D.K. Chapman (1976) Limitation on the use of the horizontal clinostat as a gravity compensator.
- Leather G R, Forrence L E (1972) increased Ethylene Production during Clinostat Experiments May Cause Leaf Epinasty.
- Raymond M Wheeler, Frank B Salisbury (1981) Gravitropism in Higher Plant Shoots.
- Sammy Anih, (2014) Microgravity Experiment Using PowerPoint ARCSSTE-E, OAU Campus, Ile-Ife, Nigeria.



Poster Competition



- The students presented their study in a Poster Competition in November 2014.
- The poster competition was evaluated by university professors and other eminent scientists. These role models encouraged the young aspiring scientists by their presence as they assessed their work and provided valuable feedbacks to the youngsters during the Poster Competition.
- Winners of the competition were awarded prizes.



Grading of Poster Competition



African Regional Centre for Space Science & Technology Education-English
(AFFILIATED WITH THE UNITED NATIONS)
Obafemi Awolowo University Campus, Ile-Ife, Nigeria



UN- Zero Gravity Instrument Project
Promoting Space Education and Research in Microgravity



Result for the Poster Competition

Instructions: Please rank the schools according to the grading criteria indicated on the following pages and indicate the total scores in the table below. Thank you!

Position	Name of School	Total Score
7th	Islamic College, Osogbo	74.37%
2 nd	Love and Joy Secondary School, Ilesa	77.70%
5 th	Progress Comprehensive High School, Modakeke-Ife	76.06%
4th	Shepherd Twins Model College, Ile-Ife	76.74%
3 rd	St David's High School, Ile-Ife	77.47%
6th	Sunshine Nursery and Primary School, Ile-Ife	75.36%
1 st	Unique Mind International College, Ile-Ife	78.17%



African Regional Centre for Space Science & Technology Education-English
(AFFILIATED WITH THE UNITED NATIONS)
Obafemi Awolowo University Campus, Ile-Ife, Nigeria



UN- Zero Gravity Instrument Project
Promoting Space Education and Research in Microgravity



Award Rubric for Poster Competition

Sunshine Nursery and Primary School, Ile-Ife				
S/N	Grading Criteria	Total Mark Obtainable	Mark Obtained	Total Score
1.	Appearance:			8 1/2
	➤ Station Keeping	5	4	
	➤ Dressing	2	1 1/2	
	➤ Organization	3	3	
2.	Poster Content:			30
	➤ Originality	2	2	
	➤ Title	2	2	
	➤ Abstract	8	6	
	➤ Introduction	3	2	
	➤ Method/Procedure	5	3	
	➤ Result	10	8	
	➤ Discussion	5	4	
	➤ Conclusion	3	2	
	➤ References	2	1	
3.	Presentation			15 1/2
	➤ Knowledge	10	8	
	➤ Logical Flow	4	3	
	➤ Team Work	2	1 1/2	
	➤ Confidence	2	1 1/2	
	➤ Grammar	2	1 1/2	
4.	Poster Design			9
	➤ Layout	2	2	
	➤ Demonstration of Clarity and Organization	2	2	
	➤ Fonts	2	2	
	➤ Color Scheme	2	1 1/2	
	➤ Aesthetics	2	1 1/2	
Total Score				63



ARCSTE-E

African Regional Centre for Space Science and Technology Education in English
Obafemi Awolowo University, Ile-Ife, Nigeria

Analysis of the Results

- The scientific accuracy of the results of the laboratory activities cannot be guaranteed.
- It was observed that 71% of the local seeds analyzed germinated faster under microgravity conditions

➤ Most of the Seeds analyzed germinated faster under microgravity conditions

SN	Local Seed	Normal Gravity Condition Growth Rate (cm/hour)	Micro Gravity Condition Growth Rate (cm/hour)
1	Beans	0.230	0.091
2	Guinea Corn/ Sorghum	0.100	0.530
3	Maize	0.198	0.301
4	Millet	0.201	0.541
5	Okra	0.101 0.111 0.202	0.087 0.175 0.287
6	Rice	0.085	0.700
7	Wheat	0.153	0.172



Winners of the Poster Competition

- 1st Unique Minds International College
- 2nd Love and Joy Secondary School, Ilesa
- 3rd St David's High School, Ile-Ife



Gift item: Each participant received a branded Backpack (School Bag with Inscription)





Contents lists available at

Journal of Environmental Management and Safety

Journal homepage: www.cepa-journal.com



A STUDY OF THE EFFECT OF MICROGRAVITY ON GERMINATION OF MILLET SEED(PENNISETUM GLAUCAM) (Zero Gravity Instrument Project- ZGIP)

¹Morakinyo, O. A. and ²Adebowale, P. A.

¹Space Education Outreach Unit,

African Regional Centre for Space Science and Technology Education in English (ARCSSTE-E)
(Affiliated with the United Nations)

Obafemi Awolowo University Campus, Ile-Ife, Osun State, Nigeria.

Corresponding Author: E-mail: toyin4christ15@yahoo.com, Tel: +234(0)8034665532

²Unique Minds International College, Opa, Ile-Ife, Osun State, Nigeria.

ARTICLE INFO

Article history

Received 30 October 2016

Received in revised form 10 November 2016

Accepted 16 November 2016

Available online 16 November 2016

Keywords:

Germination, Microgravity, Millet seed, Image J software, Zero Gravity Instrument Project- ZGIP

ABSTRACT

This paper focused at studying the world beyond the outer space. Thus, plants grow through light stimulus and effect of gravity had been neutralized by clinostat in order to create microgravity environment. Microgravity environment will make plant respond to light stimulus, through this plant will grow faster. These are the reasons for faster germination in microgravity environment. It is on this note that this study therefore aims to empirically examine, (i.e. main aim) using the clinostat, how plant seeds, small organisms or small samples from material sciences react to simulated microgravity conditions with a view to promote space education and research in microgravity.

copyright© 2016 cepe



ZGIP Project Evaluation

An evaluation of the ZGIP through an oral interview session with the students and teachers was conducted on July 7, 2015

- An evaluation was via oral interview session with the students and teachers
- The project promoted the interest of the participants in the sciences especially in Plant Science, Biology, and Space Science
- This innovative scheme improved their interactive skills and ability to work together as a team
- The interactive mode of instruction employed in the laboratory sessions inspired some teachers to change their method of teaching
- The ZGIP provided a positive educational exposure to a space laboratory environment that many of the students would never have experienced.
- Created the spirit of research in some students, and motivated some to decide to study courses related to space science and exploration



Recommended Potential Improvements in the Implementation of the Project can be Achieved through:

1. Design and Development of Homemade Clinostats for microgravity studies;
2. This would provide opportunities for more students and teachers in Africa to conduct experiments in the different strata of gravity (from low-gravity to microgravity), and in different geographic regions
3. Collaboration between ARCSSTEE and the international community can facilitate the provision of blueprints and built instructions for 'home-made' Clinostats
4. Internet-based user platform where educators can share and discuss operational, educational and engineering/technical information.



Conclusion

- Enthusiasm displayed by the students
 - Favourable responses recorded during oral interview
 - The informal Education & Catch-them-Young approach can be used to:
 - Cultivate Scientific skills among school children
 - Motivate them to develop interest in Space Science & Technology
 - Collaboration to design and develop ‘Home-made’ Clinostats for microgravity studies.
- will lead to increase participation across Africa.



Acknowledgements

- UN-OOSA, for making the Clinostat available for the project
- ZGIP team of ARCSSTEE; students and teachers from all the participating schools; and university professors and other eminent scientists who evaluated the poster presentation.



ZGIP Team of ARCSSTE-E





Thank
you



Ganiy I. Agbaje, PhD, fnis

*gagbaje@arcsstee.org.ng
director@arcsstee.org.ng
www.arcsstee.org.ng*



ARCSSTE-E

African Regional Centre for Space Science and Technology Education in English
Obafemi Awolowo University, Ile-Ife, Nigeria