Manuel Mendez Liciaga High School

San Sebastian, Puerto Rico

Department of Education

The fertility of Regolith with compost in the Germination and growth of *Lactuca sativa*

MML Team

Team Number: 12697

Challenge Category: High School

I. Background of the investigation:

Compost is produced from the same waste that people generate. By preparing compost we reduce the amount of waste generated by people and preserve the environment. The compost produced is rich in nutrients, when using it as soil it would not be necessary to add synthetic fertilizers. this means the fewer materials are required to take to the moon in addition to producing an organic and healthy product.

On the other hand, we select to plant lettuce because this is a product that grows fast and the plants used almost completely, only the root is removed and everything else is edible. This root can be used to produce compost so it can be recycled, and nothing is going to be wasted. Lettuce is low in calories, has antioxidants, fiber, vitamins, and minerals, making it a good food selection.

II. Experimental Parameter Description

- **Experimental Variable**: Regolith with compost as fertile soil
- **Independent Variable**: compost made from vegetable and fruits
- **Dependent Variable**: germination and growth of the *Lactuca sativa*
- **Controls**: two pots just with regolith
- **Materials**: 12 pots, regolith, compost, water, growth chamber, *Lactuca sativa* seeds, 12 labels, 1 sharpie, 1 grow light, 1 laboratory notebook, 2 thermometers, 2 rulers, 1 graduated cylinder, 1 pH meter, 1 scale

III. Hypothesis:

The compost will enhance the fertility of the regolith.

Because the properties of the compost, the mixture of compost and regolith can be more fertile than the regolith alone. The compost is made of vegetable and fruits and usually is rich in nutrients, therefore we think that this will increase the nutrient present for the plant to growth. Also because of these nutrients we will not use synthetized fertilizers will made the product healthier.

IV. Experimental Contingency Plan:

- If an emergency happens and the class get suspended, the teacher will be responsible for completing the experiment. If possible, the students will observe the experiment using TEAMS platform.
- The teacher responsible contact information is:

Mrs. Brenda Rodriguez

email: brenda_rodz@hotmail.com

Phone number:(787)201-5227

V. Procedure:

1. In five containers prepare 5 concentrations of regolith and compost with the following proportions:

Container # 1	Container # 2	Container # 3	Container # 4	Container # 5
10 %compost 90 % regolith	20 % compost 80% regolith	30% compost 70 % regolith	40% compost 60% regolith	50%compost 50% regolith

2. Label 12 pots: 2 with 100% regolith, 2 with 10% compost: 90% Regolith, 2 with 20% compost:80% regolith, 2 with 30 % compost: 70 % regolith, 2 con 40% compost:60 % regolith y 2 con 50 % compost: 50%regolith. (See the table)

Pots Preparation Table

Control	Experiment A	Experiment B	Experiment C	Experiment D	Experiment E
Pot 1 100 % regolith	Pot 3 90% regolith 10 % compost	Pot 5 80 % regolith 20% compost	Pot 7 70 % regolith 30 % compost	Pot 9 60 % regolith 40 % compost	Pot 11 50 % regolith 50 % compost
Pot 2 100 % regolith	Pot 4 90 % regolith 10 % compost	Pot 6 80% regolith 20% compost	Pot 8 70 % regolith 30 % compost	Pot 10 60 % regolith 40 % compost	Pot 12 50% regolith 50% compost

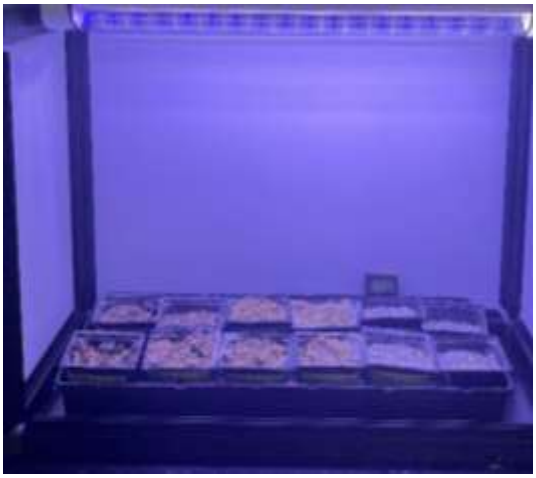
3. Add the corresponding volumes of regolith and compost to their properly labeled pots. Do not compress the material in the pot. On the label also write down the date it is sown and the name of the seed that you are planting.
4. Plant two seeds near the center, one centimeter apart. The depth should be approximately ½ cm. Cover the seeds with a little soil material from the pot.
5. Place the pots in the growth chamber. Set the timer for a light period of 12 hours of lighting in a 24-hour period. From the week 0 to week 2 use white and blue light, from the week 3 to week 4 use only white light and from the week 5 to week 8 use light white and red.

6. Every day proceed to make observations (example: germination date, plant health, etc.) and write it down in the laboratory notebook. If the plant need water, measure the amount added and write it down in the laboratory notebook. See the daily observation data sheet).
7. Every week measure the size of the plant, determine the average temperature and humidity of the room and the grow chamber, measure the soil pH, soil moisture, light received and count the leaves of the plants. Also take pictures of the plants. (See the weekly observations data sheet)
8. After 8 weeks proceed to finish the experiment, remove the plant from the pots and weight the plant. After measure the plants cut the roots and measure the edible part of each plant. Record all observations. Analyze the data, draw the conclusion, and prepare a report.

VI. Results

Weekly growth of the Plants

Initial Set up



Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Eight Week Mass

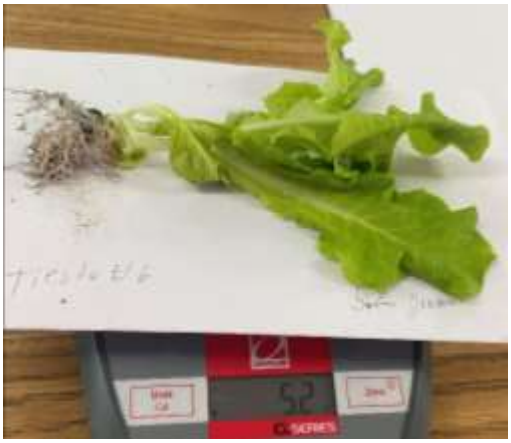
Pot 1

Pot 2

Pot 3

Pot 4

Pot 5



Pot 6

Pot 7

Pot 8

Pot 9

Pot 10

Pot 11

Pot 12

Growth of the plants in 48 days Measured in Mass

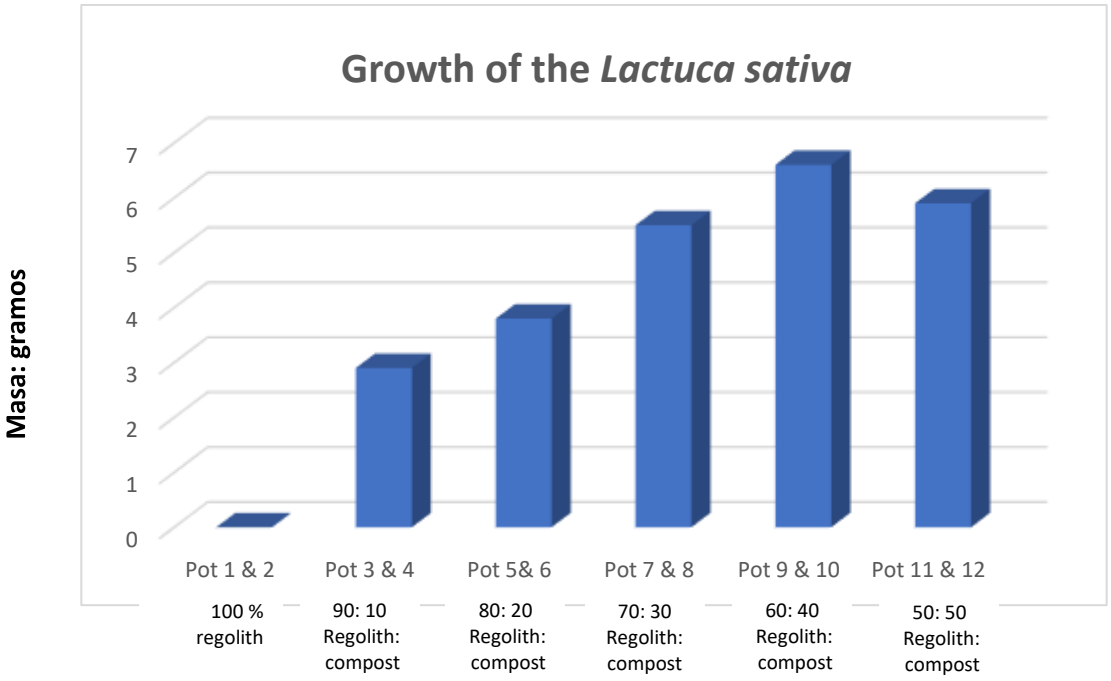
Pot	Concentration	Total Mass (g)	Mass edible	Mass edibles mean
1 Control	100 % regolith	0.1	0.0 g	**0.0 g**
2 Control	100 % regolith	0.1	0.0 g	
3	90% regolith:10 % compost	3.4	3.0 g	**2.9 g**
4	90% regolith:10 % compost	4.7	2.7 g	
5	80% regolith:20 % compost	6.9	3.9 g	**3.8 g**
6	80% regolith:20 % compost	5.2	3.7 g	
7	70% regolith:30 % compost	7.8	6.5 g	**5.5 g**
8	70% regolith:30 % compost	7.5	4.4 g	
9	60% regolith:40 % compost	10.1	6.7 g	**6.6 g**
10	60% regolith:40 % compost	8.7	6.4 g	
11	50% regolith:50 % compost	3.8	3.7 g	**5.9 g**
12	50% regolith:50 % compost	13.0	8.0 g	

Temperature and Humidity

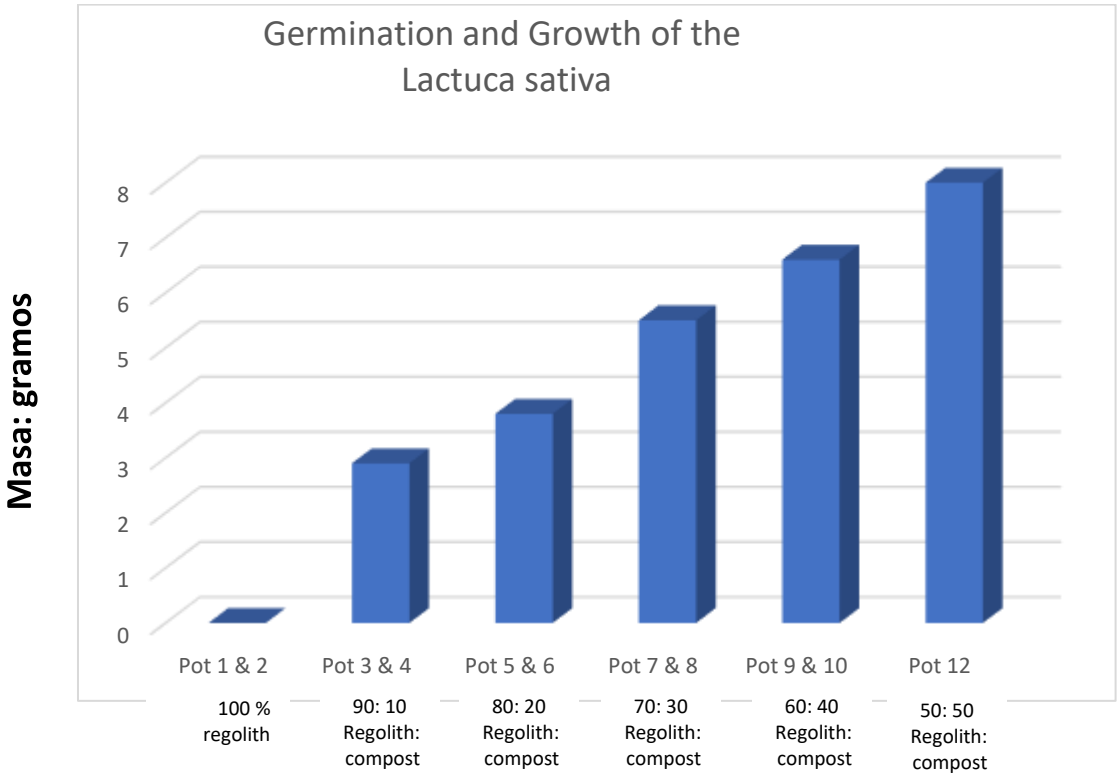
Time	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Weekly mean room temp.	**25.8°**	**25.1°**	**26.8°**	**27.2°**	**27.9°**	**28.5°**	**28.4°**	**27.3°**
Weekly growth chamber temp.	**26.4°**	**25.6°**	**27.1°**	**28.2°**	**27.8°**	**28.9°**	**27.8°**	**27.1°**
Weekly room humidity	**64 %**	**61%**	**56%**	**54%**	**58%**	**62%**	**61%**	**61%**
Weekly growth chamber humidity	**62%**	**61%**	**56%**	**54%**	**58%**	**62%**	**61%**	**65%**

VII. Analysis

- **Growth Chamber Temperature Range was 25.6°-28.5°.**
- **Growth Chamber Humidity Range was 54 %- 65%.**
- **Soil pH range was 7.5-8.0**
- **Soil humidity was very different, from 1 to 8.**
- **Light range received was from 200 to 400.**
- **The weekly amount of water was mainly 60 mL.**



- **Pot 11 grew much less than pot 12, when uprooting the plant, we can see that the root hardly developed compared to all the other plants. If we do noy use the data from eleventh pot, the graph would have a perfect upward trend.**



VIII. Conclusion

After analyzing all the results, we can conclude that the compost increased the fertility of the regolith, therefore our hypothesis is true. In the pot with 100 % regolith, the lettuce seeds germinated and remained alive for 8 weeks, but it barely grew and nothing edible could be obtained. While all the samples that have compost germinated and grew, producing edible material. It was also observed that the higher the compost concentration, the greater the edible mass produced. Pot 11 was the only one that showed less growth than pot 12, both had the same concentration, but when uprooting the plant from pot 11, it can be seen that it developed fewer roots, perhaps it could be a defective seed.

The pH of the soil was maintained in a range of 7.5 to 8.0, the temperature range was warm and an average of 60 mL of water per week was added to each plant, all these parameters are easy to achieve, which also favors this type of harvest.

Using compost is very beneficial, since less garbage is generated, fewer materials need to be taken to the moon, so it yields more resources. Verifying that also increases the fertility of regolith is great news, therefore in the future, this research can be carried out with other products such as peppers, radish, and spinach, since these foods are a short harvest time, tasty and high nutritional value.

IX. References:

Cómo hacer compost con lombrices? (2023, February 1). Retrieved February 17, 2023, from https://infoagro.com.ar/como-hacer-compost-con-lombrices/

Lechuga. (n.d.). Retrieved February 17, 2023, from https://www.cuerpomente.com/guia-alimentos/lechuga

Lunar regolith - NASA. (n.d.). Retrieved April 19, 2023, from https://curator.jsc.nasa.gov/lunar/letss/regolith.pdf

Appendix

Weekly data of the pots

Planting day: February 13, 2023

Pot # 1

TIME:	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Water added	80 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	70 mL
Soil pH	7.5	7.8	7.8	7.8	7.8	7.8	7.8	7.8
Soil humidity	2	2	2	2	2	2	2	2
Light received	200	300	200	200	200	200	200	200

Weekly Growth of Pot # 1

Date of germination: Feb 16, 2023

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Pot # 2

TIME:	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Water added	80 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	70 mL
Soil pH	7.8	7.8	7.5	7.5	7.5	7.5	7.5	7.5
Soil humidity	2	2	2	2	2	2	2	2
Light received	200	300	300	200	200	200	200	200

Weekly Growth of Pot # 2

Date of germination: Feb 16, 2023

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

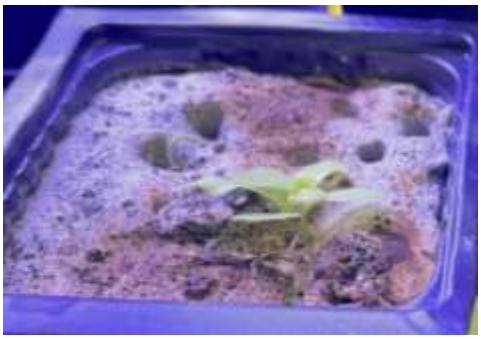
Pot # 3

TIME:	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Water added	80 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	70 mL
Soil pH	7.5	7.8	7.5	7.5	7.5	7.5	7.5	7.5
Soil humidity	2	1	1.5	2	2	2	2	2
Light received	200	300	200	200	200	200	200	200

Weekly Growth of Pot # 3

Date of germination: Feb 16, 2023

Week 1



Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Pot # 4

TIME:	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Water added	80 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	70 mL
Soil pH	7.8	7.8	7.5	7.5	7.5	7.5	7.5	7.5
Soil humidity	2	2	1.5	2	2	2	2	2
Light received	300	300	300	200	200	200	200	200

Weekly Growth of Pot # 4

Date of germination: Feb 19, 2023

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Pot # 5

TIME:	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Water added	80 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	70 mL
Soil pH	7.8	7.8	7.5	7.5	7.5	7.5	7.5	7.5
Soil humidity	4	3	2	6	7	7	7	7
Light received	300	400	300	200	200	200	200	200

Weekly Growth of Pot # 5

Date of germination: Feb 16, 2023

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Pot # 6

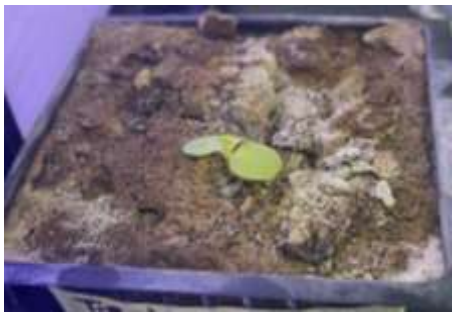
TIME:	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Water added	80 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	70 mL
Soil pH	7.5	7.8	7.5	7.5	7.5	7.5	7.5	7.5
Soil humidity	4	3	2	6	6	6	6	5
Light received	300	400	350	200	300	300	200	200

Weekly Growth of Pot # 6

Date of germination: Feb 16, 2023

Week 1

Week 2



Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Pot # 7

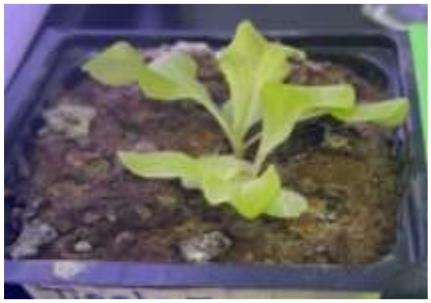
TIME:	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Water added	80 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	70 mL
Soil pH	8	7.8	7.5	7.5	7.5	7.5	7.5	7.5
Soil humidity	6	7	5	5	5	5	5	5
Light received	300	400	300	300	300	300	300	300

Weekly Growth of Pot # 7

Date of germination: Feb 19, 2023

Week 1

Week 2



Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Pot # 8

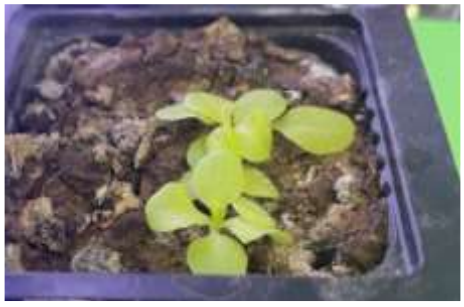
TIME:	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Water added	80 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	70 mL
Soil pH	8.0	7.8	7.5	7.5	7.5	7.5	7.5	7.5
Soil humidity	6	7	6	5	5	5	5	5
Light received	300	400	300	300	300	300	300	300

Weekly Growth of Pot # 8

Date of germination: Feb 17, 2023

Week 1

Week 2



Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Pot # 9

TIME:	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Water added	80 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	70 mL
Soil pH	7.8	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Soil humidity	7	5	4	7	7	6	6	6
Light received	300	300	200	200	200	200	200	200

Weekly Growth of Pot # 9

Date of germination: Feb 16, 2023

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Pot # 10

TIME:	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Water added	80 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	70 mL
Soil pH	7.8	7.8	7.5	7.5	7.5	7.5	7.5	7.5
Soil humidity	7	5	3	7	7	7	7	7
Light received	300	300	300	200	200	200	200	200

Weekly Growth of Pot # 10

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Pot # 11

TIME:	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Water added	80 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	70 mL
Soil pH	7.8	8.0	7.5	7.5	7.5	7.5	7.5	7.5
Soil humidity	7	8	5	7	7	7	7	7
Light received	300	200	200	200	200	200	200	200

Weekly Growth of Pot # 11

Date of germination: Feb 16, 2023

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Pot #12

TIME:	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Water added	80 mL	60 mL	60 mL	60 mL	60 mL	60 mL	60 mL	70 mL
Soil pH	7.8	8.0	7.5	7.5	7.5	7.5	7.5	7.5
Soil humidity	7	6	5	7	7	7	7	7
Light received	300	400	300	200	200	200	200	200

Weekly Growth of Pot # 12

Date of germination: Feb 17, 2023

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

Week 7

Week 8

Teams Members

1) Brenda Rodríguez Cruz (teacher)

2) Vélez Montalvo, Joseph

3) Camacho Avilés, Jahmil Alejandro

4) Soto Rodriguez, Yesliany

5) Torres Rodriguez, Eric Y.

6) Amador Acevedo, Jadiel Gabriel

7) Méndez Hernández, Fabiola

8) Pérez Rodriguez, Alejandro Miguel

9) Sánchez Lisboa, Sheimary

10) Cruz Núñez, Jean

11) González Figueroa, Yeiran Mitchell

12) Ramírez Caban, Yabrielis Enid

13) Ramos Vélez, Naoniel