



Alternative Agriculture

Question

What are the most effective methods of agriculture?

Hypothesis

If testing the effectiveness of hydroponic, vermiponic, and traditional systems, then the vermiponic system will produce the tallest and biggest plants

Independent Variable

Method of agriculture (hydroponic, vermiponic, or traditional)

Dependent Variables

Height of plants in centimeters and mass of plants in grams

Control Group

Traditional system because soil growth is the widely used method of agriculture and plant growth

Controlled Variables

Amount of light, humidity, temperature, and pH of water

Types of Agriculture



Vermiponics

Plant growth suspended over nutrient filled water in an inert growth medium

Nutrients in vermiponics are supplied by utilizing worm castings



Hydroponics

Plant growth suspended over nutrient filled water in an inert growth medium

Nutrients in hydroponics are supplied by a chemical nutrient solution



Traditional

Plant growth in soil, relying on the nutrients that already exist within the soil

Materials



- **3 plastic containers**

38.8L, 86cm x 38cm x 13cm

- **20 rockwool cubes**

3.8cm x 3.8cm

- **20 net pots**

7.6 cm in diameter

- **15 kg potting soil**

- **1 kg clay pebbles**

- **Lettuce seeds**

Lactuca sativa, 1 pack

- **4 Styrofoam sheets**

40cm x 38 cm x 2cm

- **1.8 kg organic worm castings**

- **2 air pumps**

with air stones and tubing

- **4 T8 grow lights**

1.2m

- **Dyna-Gro liquid plant food**

- **pH control kit**

from General Hydroponics

- **distilled water**

- **Electric timer**

Procedure

1 Set up lights and reservoirs

1. Arrange reservoirs so that the long sides of the containers are touching
2. Hang lights above the containers to give off equal amount of light
3. fill one reservoir with potting soil

2 Start plants

1. Germinate 50 *Lactuca sativa* seeds in pH controlled water and 10 seeds in the soil 1 cm deep
2. After 1 week, transplant 20 seedlings in the cup to the rockwool cubes
3. After 2 weeks, transfer rockwool cubes into the systems

3 Mix solutions

1. worm tea: steep 450g of worm castings in 18L of water for 24 hours
2. nutrient solution: chemical nutrient to water ratio is 15ml: 4L
3. make enough of each solution to fill reservoirs

4 Set-up

1. Place air pumps into the reservoirs
2. Cut holes into styrofoam sheets and place the, over the reservoirs
3. Fill net pots with clay pebbles and a rockwool cube with a 2 week old plant inside
4. Place net pots into the holes in the styrofoam

Maintenance

- **Hydroponic and Vermiponic systems**

maintain the same amount of worm tea and nutrient solution in each reservoir and test the pH of the solutions each week and adjust if needed

- **Traditional System**

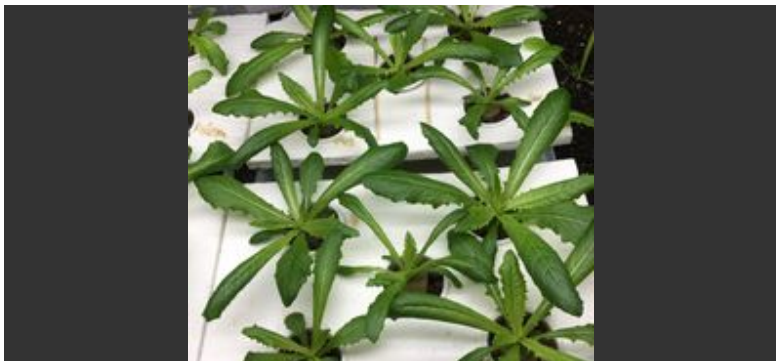
water each soil plant with approx. 80ml of water the first week and 25ml more every week

- **Lights**

Set up an electric timer and set the light to be on for 10 hours a day and adjust the lights so that they remain 60cm above the tallest plant

- **Record**

record the heights of the plants each week



Vermiponic

Hydroponic

Traditional

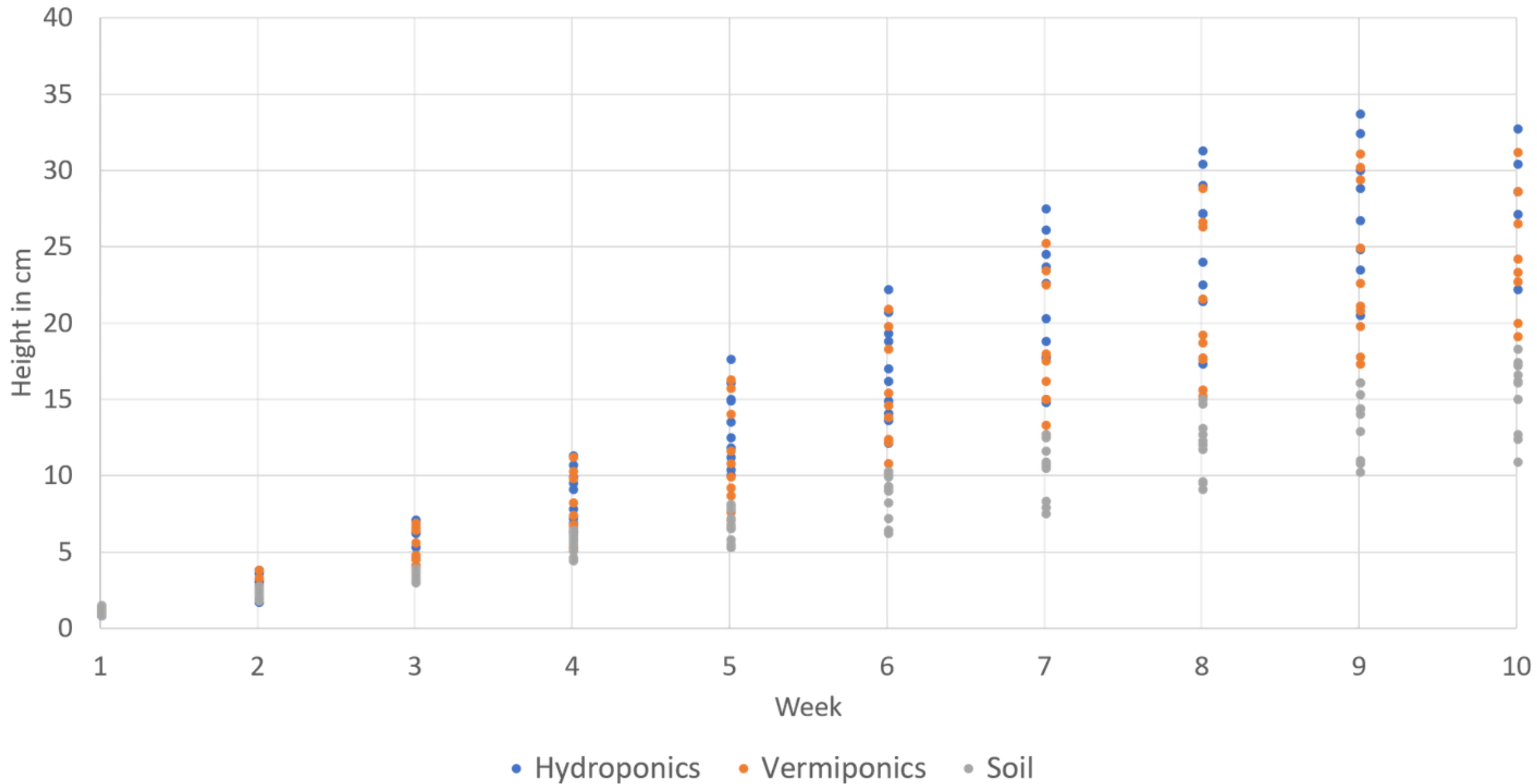


Heights of Lettuce Heads (cm)											
		Week #									
Trial type/#		1	2	3	4	5	6	7	8	9	10
Hydroponic	1	1.1	2.4	4.8	7.9	12.6	16.3	20.4	24.1	28.9	32.8
	2	1.2	3.2	6.3	10.0	15.1	19.4	24.6	29.1	33.8	X
	3	1.4	3.7	6.5	10.8	16.2	20.8	26.2	30.5	X	X
	4	0.9	1.8	3.9	6.4	10.1	12.2	14.9	17.4	20.6	22.3
	5	1.3	2.2	4.2	6.9	11.3	14.2	17.8	21.5	24.9	28.7
	6	1.0	2.5	4.6	7.3	11.9	15.0	18.9	22.6	26.8	30.5
	7	1.0	2.8	5.4	9.2	13.6	17.1	22.7	27.3	30.1	X
	8	1.1	2.2	4.0	7.0	10.5	13.7	17.8	21.5	23.6	27.2
	9	1.5	3.9	7.2	11.4	17.7	22.3	27.6	31.4	X	X
	10	1.4	3.2	6.6	9.6	15.0	18.9	23.8	27.3	32.5	X
average		1.2	2.8	5.4	8.7	13.4	17.0	21.5	25.4	27.5	28.3
Vermiponic	1	1.4	2.8	4.6	6.2	9.3	12.5	15.1	17.8	20.9	23.4
	2	1.1	2.5	4.1	5.4	7.7	10.9	12.8	15.3	17.9	20.1
	3	1.4	2.6	6.5	10.4	15.8	19.9	23.5	26.7	29.5	31.3
	4	1.5	3.9	7.0	11.3	16.4	21.0	25.3	28.9	31.2	X
	5	1.2	2.4	5.7	8.3	11.7	15.5	18.1	21.7	25.0	28.7
	6	1.0	2.2	4.9	7.5	10.9	14.7	17.6	19.3	22.7	26.6
	7	1.3	2.6	4.2	6.9	10.0	13.9	16.3	18.8	21.2	24.3
	8	1.2	2.3	3.9	5.2	7.2	10.3	13.4	15.7	17.4	19.2
	9	1.4	2.9	4.2	6.6	8.8	12.3	15.1	17.7	19.9	22.8
	10	1.3	3.4	6.8	9.9	14.1	18.4	22.6	26.4	30.3	X
Average		1.3	2.8	5.2	7.8	11.2	14.9	18.0	20.8	23.6	25.7
Soil	1	1.1	2.4	3.2	5.2	6.6	8.3	10.7	11.8	13.0	15.1
	2	1.5	2.2	4.0	6.5	8.2	10.3	12.6	14.8	16.2	18.4
	3	1.3	2.6	3.8	5.8	6.9	9.4	11.0	12.8	14.1	16.7
	4	1.0	2.1	3.4	4.6	5.4	6.3	8.0	9.7	11.1	12.5
	5	1.2	2.5	3.8	6.0	8.1	10.4	12.8	15.1	16.2	17.3
	6	0.9	1.9	3.7	5.6	6.7	9.1	10.6	12.1	14.5	16.2
	7	1.1	2.4	3.1	4.7	5.9	7.3	8.4	9.6	10.3	11.0
	8	1.4	2.2	3.4	4.5	5.6	6.5	7.6	9.2	10.9	12.8
	9	1.0	2.8	3.9	6.2	7.9	10.0	11.7	13.2	15.4	17.5
	10	1.6	2.6	3.7	5.9	7.3	9.2	10.9	12.4	14.5	16.3
average		1.2	2.4	3.6	5.5	6.9	8.7	10.4	12.1	13.6	15.4

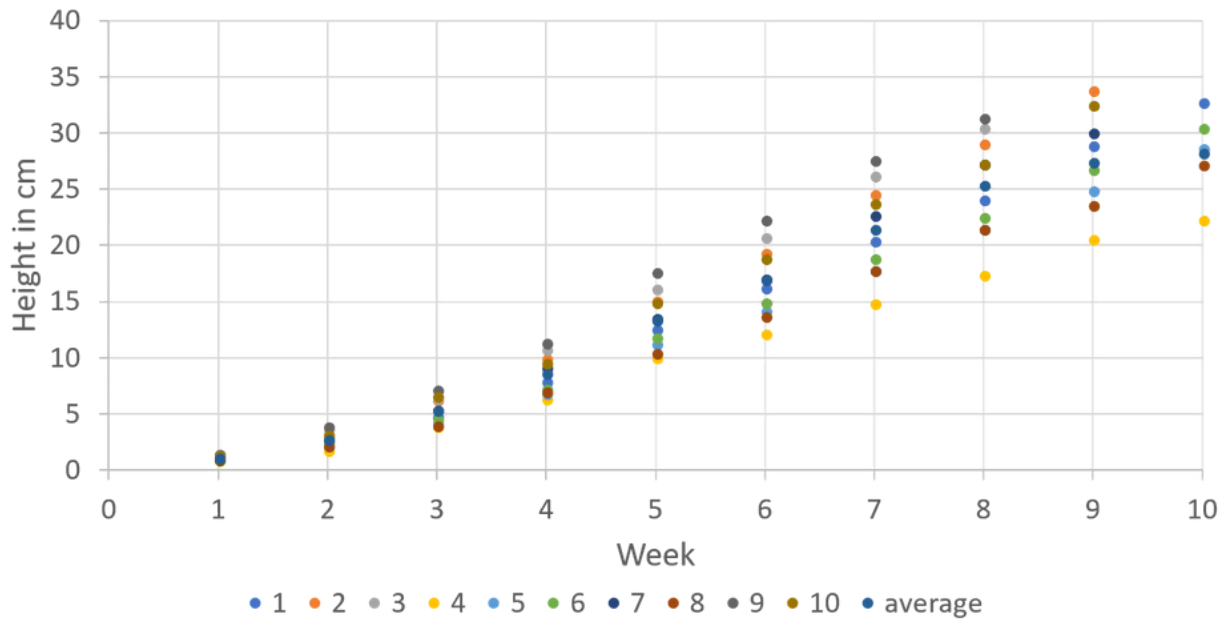
Average Heights of Lettuce in cm												
		Week #										
		1	2	3	4	5	6	7	8	9	10	
Hydroponic		1.2	2.8	5.4	8.7	13.4	17.0	21.5	25.4	27.5	28.3	
Vermiponic		1.3	2.8	5.2	7.8	11.2	14.9	18.0	20.8	23.6	25.7	
Soil		1.2	2.4	3.6	5.5	6.9	8.7	10.4	12.1	13.6	15.4	
Mass of Lettuce Heads in grams												
trial		1	2	3	4	5	6	7	8	9	10	average
Hydroponic		436	450	406	297	382	406	400	362	418	432	399
Vermiponic		311	267	416	415	382	354	323	255	303	403	343
Soil		196	239	217	163	225	211	143	166	228	212	200

Data Tables

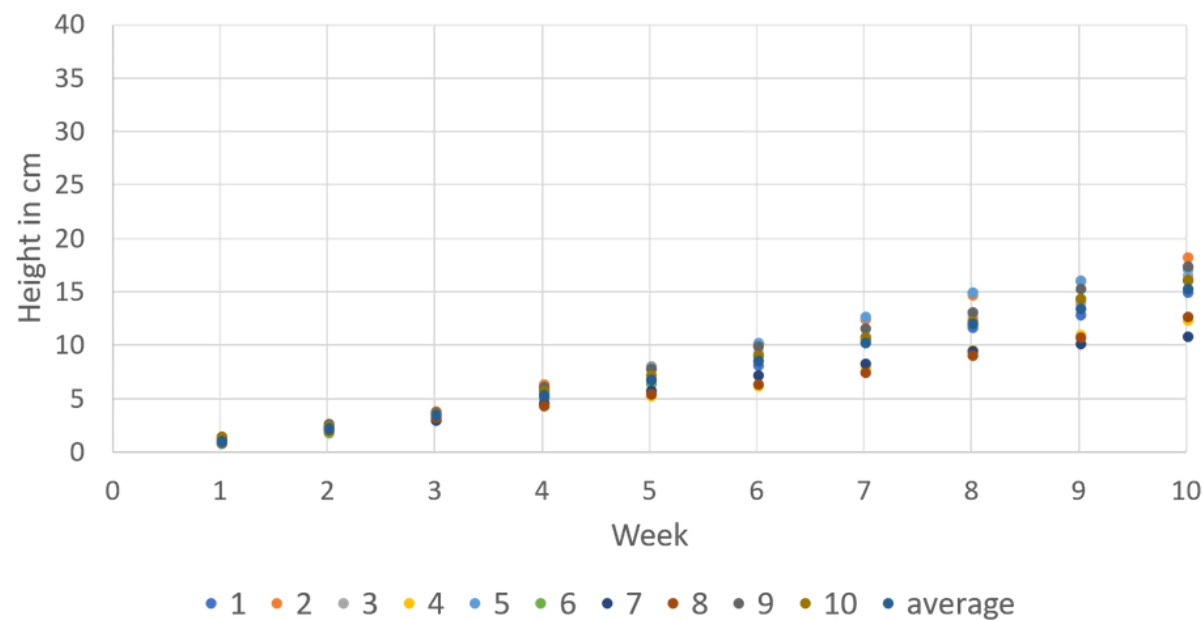
Heights of Lettuce Plants



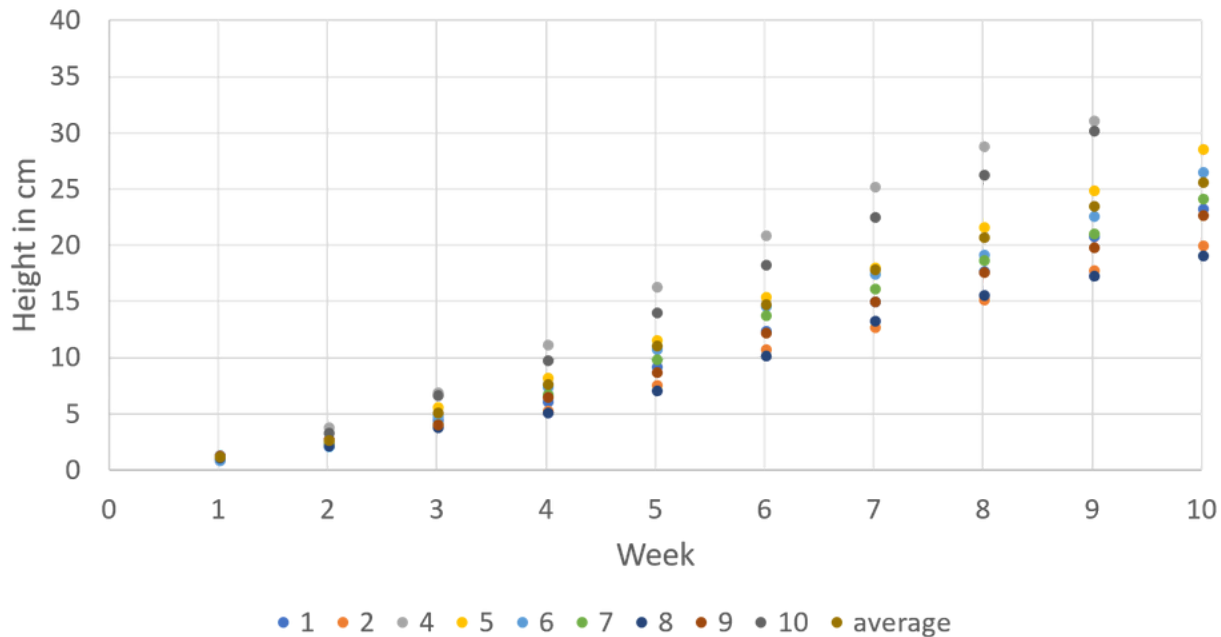
Heights of Hydroponic Lettuce Heads



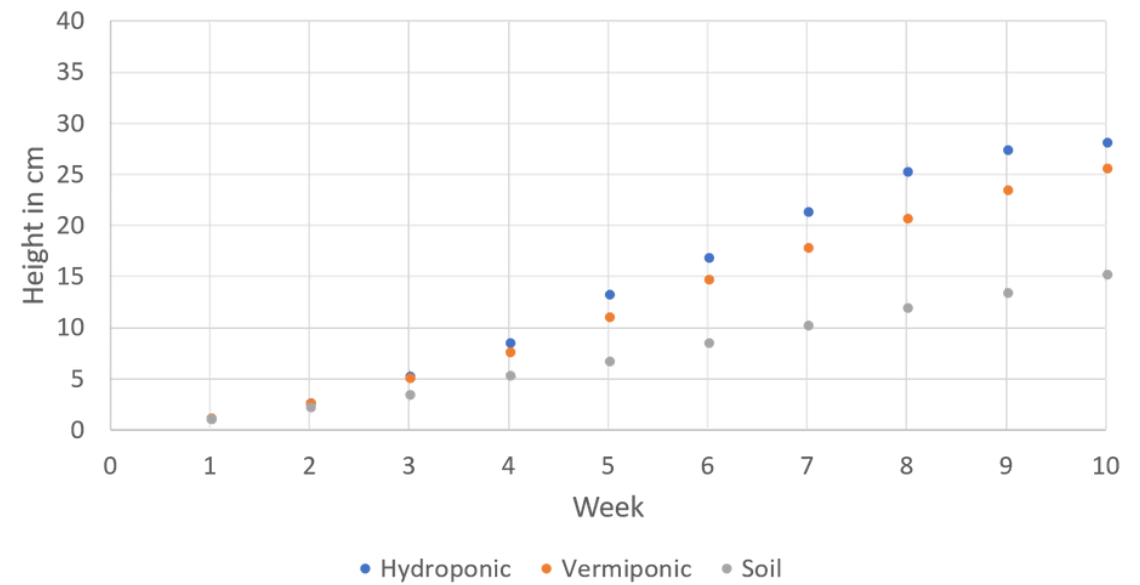
Heights of Soil Lettuce Heads



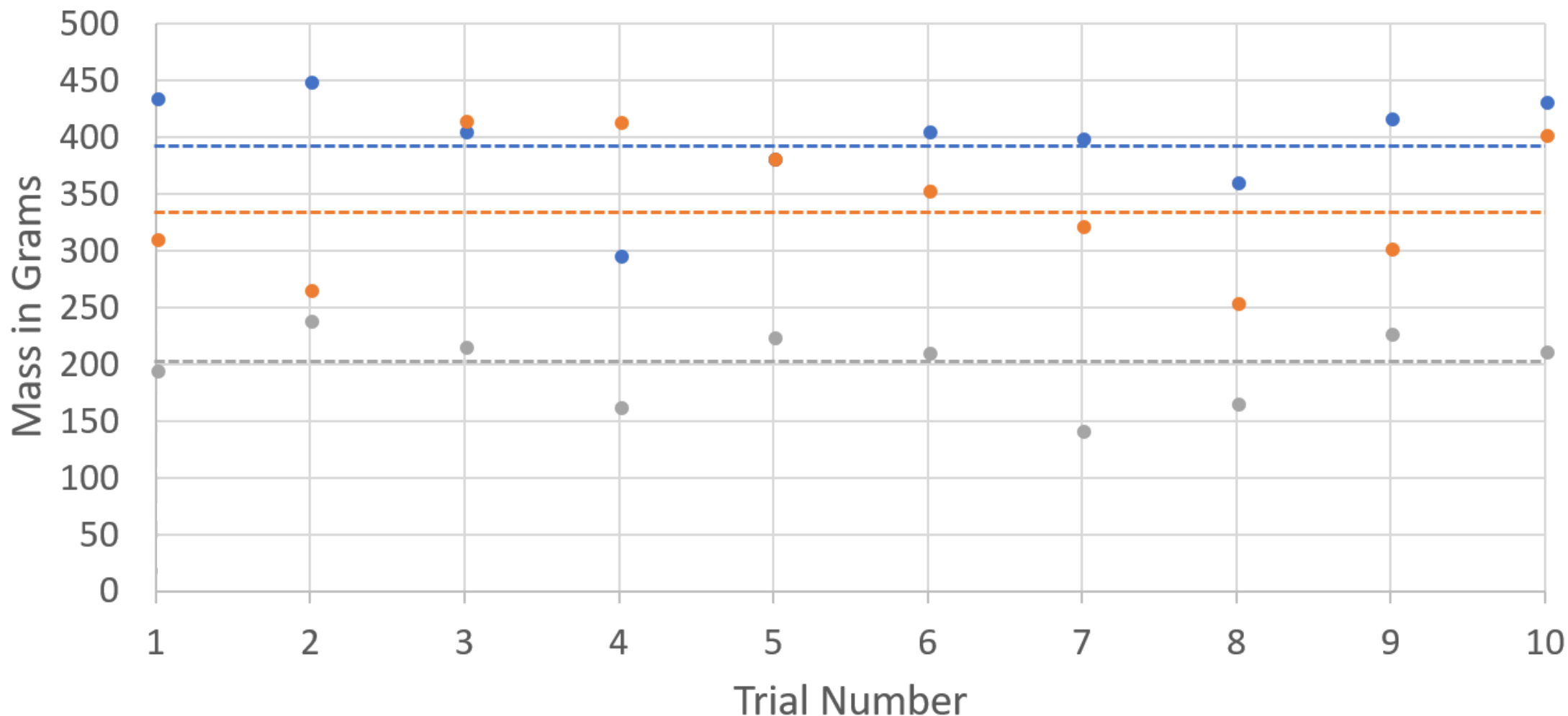
Heights of Vermiponic Lettuce Heads



Average Height of Lettuce Heads



Mass of Lettuce Heads



● Hydroponic ● Vermiponic ● Soil
dotted lines are averages

Statistical Analysis

Hydroponics

Mean: 398.9

Standard Deviation: 44.19766

Variance: 1953.433

n- value: 10

Traditional

Mean: 200

Standard Deviation: 32.10054

Variance: 1030.444

n-value: 10

Vermiaponics

Mean: 342.9

Standard Deviation: 59.90632

Variance: 3588.767

n-value: 10

Student T-Test (1 tail, unpaired)

Hydroponics and Traditional;

T-value = 11.51448; P= 0.000000001389

Vermiaponics and Traditional;

T-value=6.64887; P= 0.00000595636

Alternative Agriculture

The data is statistically significant

The probability that the data occurred by chance for either set of data is less than 5%, so the null hypothesis can be rejected

Both methods of alternative agriculture produce bigger plants

The average masses of the hydroponic and vermiponic plants are significantly higher than the traditional plants

The hypothesis was disproven

Although both methods of alternative agriculture produced plants that were significantly larger than the soil plants, the hydroponic system was more effective than the vermiponic system

Benefits of alternative agriculture

saves water, space, time, and the environment by preventing chemical runoff

Ideal in many conditions

places with a lack of water, space, or fertile soil can benefit such as large cities, Arctic exploration, Mars, or long-term space expeditions