SASTA OLIPHANT SCIENCE AWARDS

SOUTH AUSTRALIAN SCIENCE TEACHERS ASSOCIATION

Prize Winner

Scientific Inquiry

Year 3-4

Amir Chaloob

St Peter's Woodlands Grammar School

MAKING MANURE

Oliphant Science Awards 2024

AMIR CHALOOB
ID: 0683-005
SCIENTIFIC INQUIRY REPORT
SPW YEAR 3
OLIPHANT SCIENCE AWARDS

:

Amir Chaloob
ID 0683-005
Category Scientific Report
Year 3 St Peter's Woodlands Grammar School

Making Manure

Background

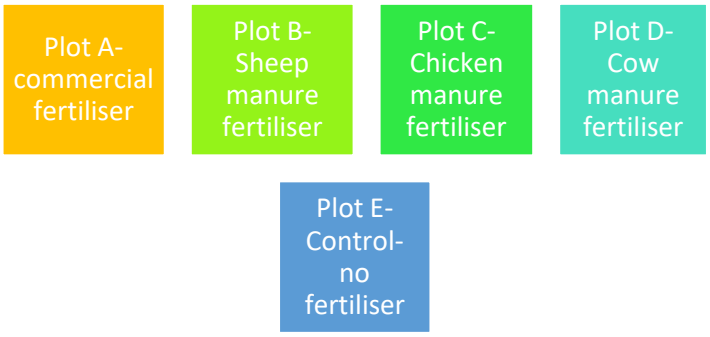
Responsible farming needs a focus on environmental sustainability and agricultural practices. Improving the pastures improves the quality and amount of food available. One way to improve growth is to use fertiliser. Part of reducing our impact on the environment is to recycle, reuse and repurpose what we already have. Chemical fertiliser can contaminate the water and affect the native plants and animals and are expensive. Another form of fertiliser includes using manure. There is lots of manure on farms which could be repurposed. I need to determine the most effective manure fertiliser for pasture improvement with the least impact on the environment and compare this to commercial fertiliser, applied at a frequency and under conditions to mimic real life; relying on rain water and annual fertilising.

Aim: To determine which fertiliser improves the growth of pasture the most and the effect each fertiliser has on soil pH, potassium, nitrogen and phosphate levels. I will be comparing fertilisers made with (1) cow manure, (2) sheep manure, (3) chicken manure, (4) commercial fertiliser.

Materials

- $5m^2$ pasture
- Spray paint
- Measuring tape
- 500g rye grass seeds
- Rain water
- Shovel
- 250ml cup
- 5x 15L bucket
- Pipette
- 4 test tubes
- Safety glasses
- Gloves
- Hanna HI3895 Agricultural test kit
- Paper
- Pen
- Manures- cow, chicken, sheep, chook
- Commercial fertiliser

Method



1. Measure 5x $1m^2$ plots of pasture with a 30cm gap, label A—E
2. Spread 100g rye seeds/plot
3. Make manure mixes
    a. Combine well 1 cup of commercial fertiliser with 10L of rain water in a 15L bucket
    b. Combine 1kg of sheep manure with 10L of rain water in a 15L bucket- label
    c. Repeat 4b for the other types of manure, labelling each mix
4. Test the fertiliser mixtures using the Hanna HI3895 agriculture test kits
    a. pH- pipette 2.5mL of fertiliser to test tube, add Hanna pH test reagent, swirl for 30 seconds, stand for 5 minutes. Compare the colour to the pH card- Record

   b. Phosphate- pipette 2.5mL of fertiliser to test tube, add Hanna phosphate test reagent, swirl for 30 seconds, stand for 1 minute. Compare colour to phosphate card. Record your results.
   c. Nitrogen- pipette 2.5mL of fertiliser mix to test tube, add Hanna nitrogen test reagent, swirl for 30 seconds, stand for 1 minute. Compare colour to nitrogen card- Record.
   d. Potassium- pipette 0.5mL of fertiliser to test tube, add 2ml of rain water, add Hanna potassium test reagent, swirl for 30 seconds, stand for 1 minute. Compare the colour to the potassium card- Record.
5. Evenly spread each fertiliser mix to the corresponding plots.
6. Every week record results
   a. Observation: grass height, thickness, density, colour
   b. Soil testing/plot
      i. Put 2 cup of soil, 5cm below top from the plot into 15L bucket.
      ii. **pH testing**
         1. add 1 teaspoon of the soil to test tube, pipette rain water up to 2.5mL line, add pH reagent, swirl for 30 seconds, after 5 minutes standing, compare the colour to the pH card- record
      iii. **Micronutrient testing**
         1. Add 8 cups of rain water to each bucket of soil, swirl and leave for 24 hours.
         2. **Nitrogen-** pipette 2.5mL of fluid of top of fertiliser liquid to test tube, add Hanna nitrogen test reagent, swirl for 30 seconds, stand for 1 minute. Compare colour to nitrogen card- Record.
         3. **Phosphate**- pipette 2.5mL of top fluid of fertiliser mix to test tube, add Hanna phosphate test reagent, swirl for 30 seconds, stand for 1 minute. Compare colour to the phosphate card- record.
         4. **Potassium**- pipette 0.5mL of the top fluid of fertiliser mix to test tube, add 2ml of rain water, add Hanna potassium test reagent, swirl for 30 seconds, stand for 1 minute, compare colour to potassium card- Record.
7. Repeat step 7 weekly for 4 weeks

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Results

Pasture testing week 0					
	Soil- no fertiliser	Super phosphate	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
Grass height	No rye grass sprouts yet	No rye grass sprouts yet	No rye grass sprouts yet	No rye grass sprouts yet	No rye grass sprouts yet
Grass density	70% Current pasture	80% Current pasture	80% Current pasture	80% Current pasture	80% Current pasture
Grass thickness	No rye grass sprouts yet	No rye grass sprouts yet	No rye grass sprouts yet	No rye grass sprouts yet	No rye grass sprouts yet
Colour	No spouts yet	No spouts yet	No spouts yet	No spouts yet	No spouts yet

Fertiliser mix testing week 0					
	Control Soil- no fertiliser	Fertiliser	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
pH	6	6	9	9	8
Nitrogen	Low	High	Turbid cant read	Medium	Low
Phosphate	Trace	Low	Turbid cant read	Trace	Trace
Potassium	Trace	High	Turbid cant read	Medium—high	Low

Figure 1Pasture marking week 0

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Pasture testing week 1					
	Soil- no fertiliser	Fertiliser	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
Grass height	1cm	1cm	1cm	1cm	2cm
Grass density/coverage	70%	85%	85%	85%	85%
Rye Grass thickness	1mm	1mm	1mm	1mm	1mm
Colour	Bright green sprouts, lots of other types of grass	Bright green sprouts	Worms in the soil	Worms in the soil	

Soil testing- Week 1					
	Soil- no fertiliser	Chemical fertiliser	Cow manure fertiliser soil	Chicken manure fertiliser soil	Sheep manure fertiliser
pH	6	6	7	8	5
Potassium	Trace	High	High	Low	Low
Nitrogen	Low	Medium	Trace	Medium	Trace
Phosphate	Trace	High	Trace	High	Low

Pasture testing week 2 (Rye Grass)					
	Soil- no fertiliser	Chemical fertiliser	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
Grass height	4cm	5cm	4cm	2cm	6mm
Grass thickness	1-2mm	3mm	2mm	2mm	2mm
Grass density	70%	80%	85%	85%	90%
Colour	Bright green but lots of other grasses	Yellow	Bright green	Bright green	Bright green

Soil testing week 2					
	Soil- no fertiliser	Chemical fertiliser	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
pH	6	7	7	8	7
Potassium	Low	Medium	High	Low	Medium
Nitrogen	Trace	Medium	Low	Low	Low
Phosphate	Trace	High	High	Medium	Medium

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Pasture testing week 3					
	Soil- no fertiliser	Chemical fertiliser	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
Grass height	4cm	8cm	6cm	6cm	9mm
Grass thickness	1-2mm	3mm	2mm	2mm	2mm
Coverage	70%	80%	85%	85%	90%
Colour	Bright green rye grass but lots of other grass types	Bright green	Bright green Worms	Bright green	Bright green

Soil testing week 3					
	Soil- no fertiliser	Chemical Fertiliser	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
pH	6	7	7	8	7
Potassium	Low	Medium	Medium	Low	Medium
Nitrogen	Trace	Medium	Low	Low	Low
Phosphate	Trace	High	High	Trace	High

Figure 2 Week 3 Pasture- Commercial fertiliser, sheep, chicken, cow, control L-R

Figure 3 Soil pH testing soil L-R top commercial fertiliser, sheep, chicken; L-R bottom- cow control

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Pasture testing week 4					
	Soil- no fertiliser	Chemical fertiliser	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
Grass height	4cm	8-10cm	8cm	7-8cm	12mm
Grass thickness	1-2mm	3mm	2mm	2mm	3mm
Grass density	70%	94%	90%	94%	96%
Grass colour	Bright green, less rye grass than other plots	Bright green	Bright green	Bright green and other types of grass	Bright green

Soil testing 4					
	Soil- no fertiliser	Chemical Fertiliser	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
pH	6	7	7	8	7
Potassium	Low	Medium	Medium	Low	Medium
Nitrogen	Trace	Medium	Low	Low	Low
Phosphate	Trace	High	High	Trace	High

Figure 4 Final pasture week 4 L-R top- Commercial, sheep, chicken, cow fertiliser; bottom- control

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Conclusion

The commercial fertiliser maintained the most nutrients in the soil, however both sheep and cow manure fertiliser were similar and all had a pH of 7. Sheep manure increased the coverage of the ground the most and the rye grass grew longer. All manure and commercial fertilisers improved the soil nutrients and growth compared to the unfertilised plot. The sheep fertiliser overall improved the pasture the most.

Discussion

Farms are fertilised annually and rely on rainfall. Finding a fertiliser that increased soil nutrients and maintained a neutral pH for the rye grass was important. Growth in length and density of grass was critical.

Chicken manure micronutrients started high but reduced to trace levels by the third week for phosphate and nitrogen. Nitrogen and phosphate are usually high in animal manure. When the chicken manure fertiliser was applied to the pasture, after one week the soil showed high levels of phosphate and medium levels of nitrogen, however both of these had reduced to trace levels in the soil by the 4th week. The chicken manure may release quickly into the soil, providing nutrients, however is broken down and leaves only traces of micronutrients after a short period of time. You would need to regularly apply chicken manure as a fertiliser which might cost lots and take lots of time.

The sheep manure showed increasing amounts of phosphate, nitrogen and potassium over the 4 weeks. The soil started with trace amounts but increased with time. The sheep manure slowly releases into the soil. The pH was also around 7 which is within an optimal pH range for rye grass. The sheep manure also increased the density of coverage and length of the rye grass the most.

Cow manure improved the soil pH to 7 making it optimal for rye grass. It released high levels of potassium into the soil and released increasing levels of phosphate and nitrogen over the weeks.

Commercial fertiliser had the most amount of nitrogen by the final week. Nitrogen is important for the growth of the grass and photosynthesis. However sheep and cow manure had similar levels of phosphate and potassium and a similar pH. So based on cost and the aim for environmental sustainability, reduced impact on the environment and the purpose of repurposing, the sheep and cow fertiliser from a micronutrient and pH effect on the soil are an ideal option for a fertiliser for my pastures.

I would like to further research the difference between more fresh manure versus dried manure. I need to test how cost effective it would be to spread sheep manure versus commercial fertiliser.

References

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3. Charlton D and Stewart A 2006. Pastures for livestock on small farms, accessed 29/5/2024 <https://farmstyle.com.au/news/patures-livestock-small-farms#:~:test=>

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6. Chem talk. What is pH? The pH formula and equation, Accessed 29/5/2024 <https://chemistrytalk.org/what-is-ph/>
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10. Department of Primary Industries and Regional Development 2017. Manure management on small properties. Accessed 2/6/24 <https://www.agric.wa.gov.au/small-landholders-western-australia/manure-management-small-properties#:~:text=Cattle%20produce%2050%2D130kg%20nitrogen,of%20pasture%20for%20a%20year?

- Fang X 2023. Optimum Nitrogen, Phosphorous, and Potassium Fertilizer Application Increased Chrysanthemum Growth and Quality by Reinforcing the Soil Microbial Community and Nutrient Cycling Function. Accessed 2/6/2024 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10708389/>

Word count: 1057

Acknowledgment

My mum helped with the bibliography. My Ipad also allowed me to speak and it typed parts of my report, but I had to correct anything it wrote wrong.

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Scientific Inquiry- Making Manure

Environmental sustainability, sustainable agriculture

Predicted time for planning, research, preparation, experiment, results, writing: 6 weeks
Predicted time for experiment: 3 weeks

What am I researching and why?

I need to improve the pastures on my farm to grow more nutritious food for my cattle. One the ways to improve growth is to use an artificial fertiliser. Part of reducing our impact on the environment is to recycle, reuse and repurpose what we already have. Artificial fertiliser uses chemicals and is also expensive. I know that people use different types of manure to fertiliser their gardens. I have lots of manure on the farm which could be reused and repurposed. I want to know if I can mix up different manure-based fertilisers and test which one works best to improve the growth of the pasture. I want my experiment to mimic real life because if this works well, I can then use a spreader to make up the best fertiliser and seed on my farm and actually make a difference to the pastures.

I am researching soil and what goes well in terms of fertiliser with soil to grow good nutritious pasture for my livestock.

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Questions I need to explore:

1. How can we improve the pasture?
2. What makes a good fertiliser?
3. How can I test the soil to see what it needs?
4. What seed is best to spread for nutrition?
5. How am I going to make fertiliser?
6. Can I test the fertiliser with pH/nutrients?
7. How am I going to compare the different fertilisers?
8. How often do farmers usually fertilise the paddocks?

Based on my research and wanting to reflect real life, I am only spreading each fertiliser once and relying on rainfall to water my grass plots. This is what happens on most farms when artificial fertilisers and seed are spread each year.

2. What makes a good fertiliser?

13/05/2024

Most fertilisers use three basic plant nutrients; nitrogen, phosphorus and potassium. Other micronutrients includes zinc, sulfur, iron, calcium and magnesium and other metals.

United States Environmental Protection Agency epa.gov. January 25th 2024. Agriculture Nutrient Management and Fertilizer. Online 13/5/2024. https://www.epa.gov/agriculture-nutrient-management-and-fertilizer#~:text

Why do we use fertiliser?

13/05/2024

To improve soil

United States Environmental Protection Agency epa.gov

United States Environmental Protection Agency epa.gov. January 25th 2024. Agriculture Nutrient Management and Fertilizer. Online 13/5/2024. https://www.epa.gov/agriculture-nutrient-management-and-fertilizer#~:text

Why can't we just use chemicals? Is fertiliser bad?

Animal manure is one of the main sources of nitrogen and phosphorus in water on the ground. This sounds excellent as we need phosphorus and nitrogen in our fertiliser. However too much of a good

thing can be bad, and excess fertiliser can drain into the river systems and affect the water quality and river eco systems.

I plan to run an agriculturally sustainable farm to improve the environment and reduce the impact of farming on the land. I am focusing on reusing, recycling and repurposing what ever I can, and one of the ways is to repurpose the manure into a fertiliser to improve the pastures. Improving the pastures will improve the quality of feed for the animals and reduce the erosion of the land by improving the ground coverage with a complex root system.

United States Environmental Protection Agency epa.gov. January 25th 2024. Agriculture Nutrient Management and Fertilizer. Online 13/5/2024. https://www.epa.gov/agriculture-nutrient-management-and-fertilizer#~:text

How can we make fertiliser?

Fertilisers can be made from lots of things in the environment including composited organic matter, our vegetable scraps and waste, raw material including leaves, wood and dirt, as well as biosolids including sewage waste. It is important to balance the pH in the fertiliser as well as the other nutrients.

Biosolids can be transformed to make a nutrient organic fertiliser. It is important to process the fertiliser to reduce the risk of contamination and people and animals becoming unwell. The environmental agencies provide guidance to help develop biofertilisers to ensure they do not exceed unsafe levels of micronutrients including arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, zinc.

United States Environmental Protection Agency epa.gov. January 25th 2024. Agriculture Nutrient Management and Fertilizer. Online 13/5/2024. https://www.epa.gov/agriculture-nutrient-management-and-fertilizer#~:text

20/5/2024

1. **How can we improve pastures?**

It is important to make sure the land remains productive and to improve pastures. This is important to ensure the land is well looked after and productive for generations to come but to also ensure the farming can remain economically viable. It is a balance between looking after the environment and making a viable business on the farm. This can be achieved by

(i) managing the land condition including the soil, nutrients and pastures, ensuring the soil has rainfall and is able to store the water and nutrients, allowing seeds to germinate and supporting pasture growth, and stopping erosion by having a good root system and perennial grasses. It is also important the pasture has adequate sunlight exposure. It is also

important to have trees to assist with breakdown (decompensation) and making more nutrients, photosynthesis and to assist with preventing too much excess water on the pasture

(ii) appropriate use of the land includes knowing what type of farming is best suited for the area you live, and how tolerant the land is to grazing, ensuring not to overgraze the pastures and cause irreversible or very expensive damage to the land.

(iii) improving quality of the land which includes improving the biodiversity of the land, balancing perennial grasses with wooded plants and shrubs and trees, having natural flora and fauna and microbes to assist with land maintenance, appropriate use of the land and improving the quality of the pasture.

It is important to understand the grazing ecosystem which includes 3 main factors; (i) how the land is managed in terms of pasture, rainfall and water usage (ii) how many animals you have and the amount of food that they require and (iii) the nutritious quality of the pastures for the animals to eat.

There are different ways to improve land condition which include: (i) managing stock levels to prevent over grazing, (ii) using fire to clear the land for regeneration however this can be high risk and we need to ensure a bush fire is not started, (iii) ensuring a good tree to grass balance to ensure enough grass grows, (iv) implanting seeding for new pastures and (iv) weed control so that nutritious grasses can grow.

Figure 1. The three inter-dependent components of sustainable land management: economics, ecology and society.

Healthy pastures can be assessed based on the nutrient levels, water availability and use, soil condition, a wide variety of native plants and animals that contribute to the health of the pastures and finally the ability of the pasture to sustain farming productivity.

29/5/2024

Why does it matter what grass seed I plant on the farm?

The grass seeds planted should be suited to the environment and the livestock it will need to provide food for. The amount of rainfall, temperature, soil type and topography of the land should be considered

so as the seeds grow into healthy pastures. Beef cattle need predominantly grass pastures which provide a high fibre diet.

What seed is the best to spread for nutrition?

- Grains: wheat, maize, ragi, bajra and barely.
- Seeds: alfalfa seeds, radish seeds, fenugreek seeds, carrot seeds, coriander seeds, pumpkin seed and muskmelon seeds
- Legumes: Mung, Bengal gram, groundnut and peas

Foutch J. Sprouts for optimum nutrition. 8th October 2018. Available at: https://sproutnet.com/blog/sprouts-for-optimum-nutrition/

Best grass for cattle in Australia?

- Temperate species for Southern Australia: ryegrass, cocksfoot, phalaris, tall fescue and prairie grass
- Tropical grass (Northern Australia- Northern Territory, Queensland, top of Western Australia): Rhodes, digit grass, paspalum, kikuyu and panics

Pastures for livestock on small farms. Accessed 29th May 2024. Online https://farmstyle.com.au/news/patures-livestock-small-farms#:~:test=

- Pereninnial rye grass is a good choice in South Australia as it is well suited to the temperate weather of South Australia. It grows all year round, is easy to establish and grow and provides good nutrition for cattle.

Pasture grasses. Accessed 29th May 2024. Available online http://notmanpasture.com.au/pasture-grasses/

2/05/2024

1. **How can I test the soil to see what it needs?**

A soil testing kit can be used which commonly includes testing the pH, potassium phosphate and nitrogen. The pH is a scale of 1-14 that represents how acidic or alkaline something is with pH 0 being most acidic, pH7 neutral and pH 14 most alkaline. Different plants grow better in different types of soil pH. Knowing the pH of your soil allows you to either choose plants that are nest suited for that pH or

you can add additional nutrients to the soil to change the pH to make the soil more suitable for the plants you want.

Alkaline (basic) soil

- pH above 7
- needs more phosphorus, iron and manganese
- add acidic things- compost, manure, garden mulch, sulfur

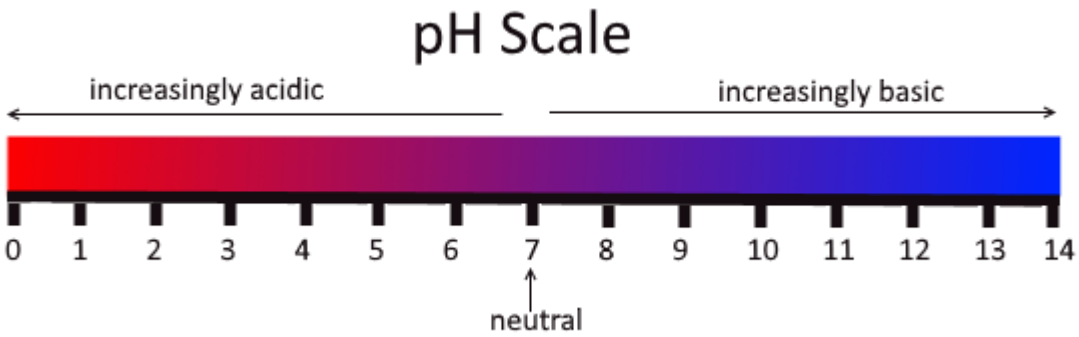
acidic soil

- pH less than 7
- can breakdown soil nutrients more easily which makes them more easily wash away- calcium, magnesium, potassium and copper.
- Add lime, dolomite, poulty manure, mushroom compost

Bunnings. How to test and adjust your soil pH. Available online at: https://www.bunnings.com.au/diy-advice/garden/planting-and-growing/how-to-test -and-adjust0your-soil-ph-level#. Viewed 29/05/2024

2. What is pH

The pH is a measure of how acidic or alkaline (basic) a substance is. The more acidic a substance is, the more Hydrogen ions the substance has. An acidic substance has a pH less than 7. An alkaline substance has a pH more than 7. a pH of 7 is a neutral substance.



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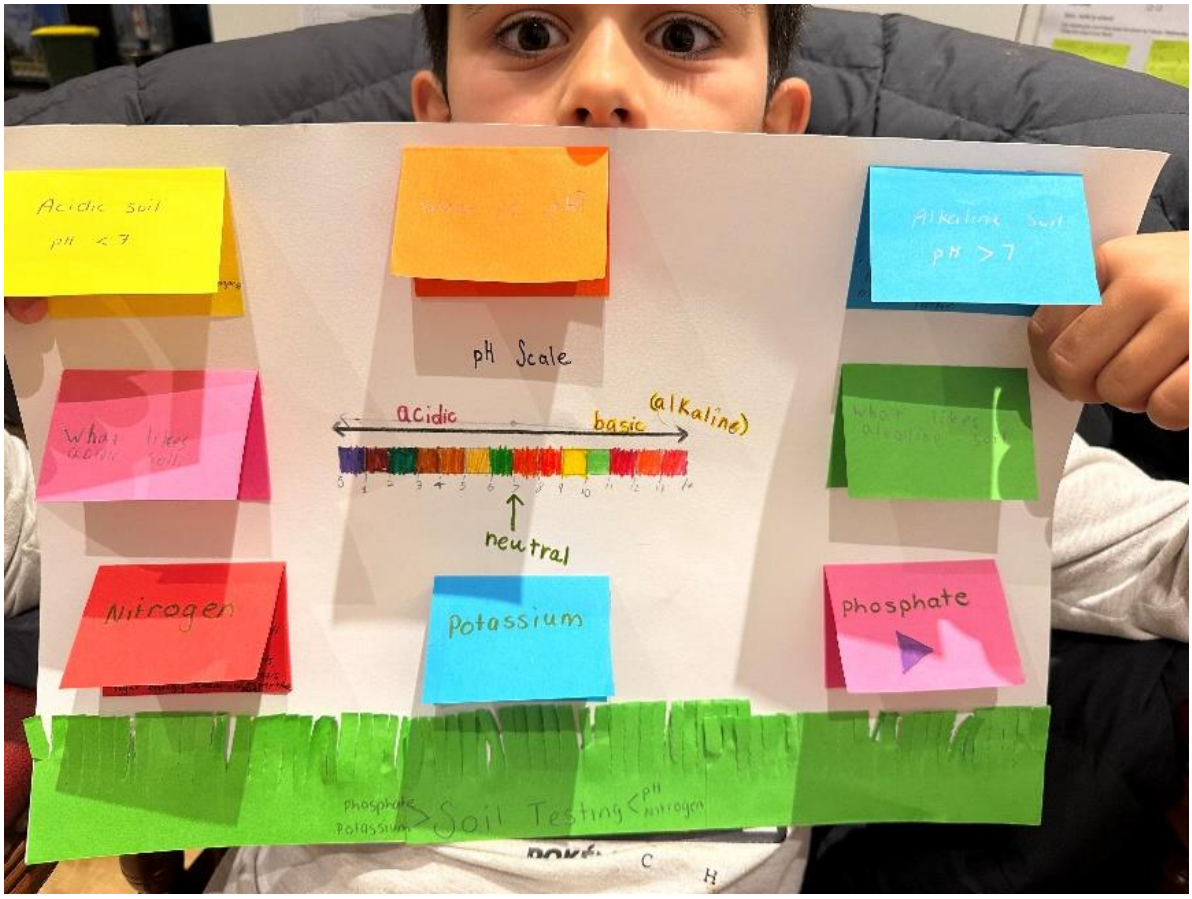

I even made a presentation for my topic talk teaching my class about micronutrient soil testing!

30/5/2024

1. **How often do farmers usually fertilise the paddocks?**

Farmers should apply fertiliser annually to replace the nutrients lost in pastures trough grazing, soil erosion, heavy rains and animal damage to the pasture. Adding nitrogen, phosphorus and sulfur to perennial grass and optimising soil pH to between 6.2-7.2 will improve productivity and multiplication of healthy pastures for livestock.

Boschma SP. Tropical perennial grasses- the role of fertilisers and nitrogen. Prime facts August 2010. Online www.Industry.NSW.gov.au

2/6/2024

What is the best pH for perennial grass seeds?

Perennial rye grass grows best in soil with a pH of 6.-7.2.

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JS Instant lawn blog. Available at: https: https://jbinstantlawn.net/blogs/display/soilphlime#:~:text=When%20it%20comes%20to%20Perennial,acidic%20soil%20in%20many%20areas. Published 06/08/2015. Viewed 02/06/2024.

What is the average pH of cow manure? 6.8-6.9

Pertiwiningrum A et al. Improving nutrients in cattle manure by converting it into biogas sludge and compost. Published D**ecember 2019. IOP Conference Series Earth and Environmental Science 398(1):012003. Online at December 2019. Viewed 2/6/2024. https://www.researchgate.net/publication/337993106_Improving_nutrients_in_cattle_manure_by_converting_it_into_biogas_sludge_and_compost#pf3**

What is the average pH of sheep manure? 6.5-7.5

What is the average pH of chicken manure? 6.5-8

What is the average pH of fertiliser? 7

what is the optimal amount of phosphate potassium and nitrogen in fertiliser?

- Nitrogen is essential for new growth of pastures and is needed for chlorophyll which makes the leaves green and helps plants photosynthesize.
- Phosphorus is important for developing flowers, fruits and the root systems.
- Potassium makes the pastures more tolerant to changing conditions such as drought that put strain on the plants.
- It is important to test the soil first so as you know what nutrients need to be replaced.
- Cattle produce 50-130kg nitrogen, 15-30kg phosphorus and 40-65kg potassium per year. These amounts are sufficient to maintain the fertility of 1-2ha of pasture for a year.
- Sheep manure should have a balanced nutrient content with a nitrogen-phosphorus-potassium ratio of around 3-1-2. Avoid manure that has a very high nitrogen content, as this can burn plants and harm soil microorganisms

Manure management on small properties. 2/11/2017. Online at https://www.agric.wa.gov.au/small-landholders-western-australia/manure-management-small-properties#:~:text=Cattle%20produce%2050%2D130kg%20nitrogen,of%20pasture%20for%20a%20year.. Viewed 2/6/2024

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Now time to prepare and complete my Experiment

Aim: To determine the effect of different fertilisers on the growth of pasture and effect on soil pH, potassium, nitrogen and phosphate levels, comparing fertilisers made with (1) cow manure, (2) sheep manure, (3) chicken manure and (4) commercial fertiliser.

Predicted time for experiment: 3 weeks

Method

1. With spray paint, mark out five 1 metre by 1 metre grass plots
2. Spread an even coverage of seed across all grass plots (100g seeds)
3. Label grass plots A (no fertiliser), B (Chicken manure fertiliser), C (Sheep manure fertiliser), D (cow manure fertiliser), E (control- no fertiliser)
4. Make the manure mixes
    a. Test pH
    b. Phosphate
    c. Nitrogen
    d. Potassium
5. Evenly spread a liquid consistency of fertiliser to the corresponding grass plots
6. Every week record observations

Plot A- Fertiliser	**Plot B- Chicken manure fertiliser**	**Plot C- Sheep manure fertiliser**
Plot D- Cow manure fertiliser	Plot E- control- no fertiliser	

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19/5/2024

Today I completed the first part of my experiment. I tested the manure mixes, it didn't work very well as they are very thick and you need almost clear water to test the pH and nutrients. But I did test the control soil and it worked.

Part A

- Measured and marked out 5 pastures plots- control, fertiliser, cow manure, sheep manure, chicken manure mix
- Made labels for the plots to identify them
- Put on all my protective clothing- mask, goggles and gloves.
- Collected manure from each animal to form the base of my fertilisers (approx. 1kg)
- Collected water from the water tank- I used the water tank rain water as I wanted the experiment to reflect real life, which is the rain falling on the paddocks. The pH testing kit recommends distilled water but this is not what my pastures would normally be water with.

Part B

- Mixed approximately 1kg of manure with 10L of water and mixed to make a slushy mix of each fertiliser.
    - The cow manure was soft and became a thick murky liquid.
    - The chicken manure separated but and became a murky water with chunks.
    - The sheep manure barely separated and the water only became translucent.
    - The fertiliser mix became a white/light brown liquid with lots of little white fertiliser balls in the bottom.

Part C

- I followed the instructions of the soil testing kit
- pH- I collected 2 separate samples of soil from the control plot. I discarded the top 5cm of soil then collected 1 cup (250ml) of soil from the 2 test sites and combined the soil.
- I then put ½ tea spoon of soil in the test tube and filled it with tank water to the 2.5ml line. Then I added the pH reagent, gently swirled the test tube for 30 seconds and waited 5 minutes. After 5 minutes I compared the test tube colour to the pH card.

Part D- Soil testing (control)

- Checking micronutrients- Nitrogen, Phosphate, Potassium
- I added 8 cups of water to the 2 cups of combined soil and mixed this together to make all the soil wet, then I let it sit for 30 minutes, waiting for the soil to settle on the bottom and the liquid to become clear.

- Nitrogen (test tube A)- I added 2.5mL of the soil mix liquid with a pipette to the clean test tube, then added the nitrogen reagent, swirled the tube for 30 seconds, then compared colour of the liquid to the nitrogen colour chart and recorded the results
- Phosphate (test tube B)- I added 2.5mL of the soil mix liquid with a pipette to the clean test tube, then added the phosphate reagent, swirled the tube for 30 seconds, then compared colour of the liquid to the phosphate colour chart and recorded the results
- Potassium K2O (test tube C)- I added 0.5mL of the soil mix liquid with a pipette to the clean test tube, then added 2ml of tank water with a pipette to the same test tube, then added the potassium reagent, swirled the tube for 30 seconds, then compared colour of the liquid to the potassium transparency chart and recorded the results

Part E

- I then repeated individual tests for pH, nitrogen, phosphate and potassium on the 4 different fertiliser types, testing the same way but using the liquid of the manure mixes rather than the soil mix.
- I recorded all the results.
- It was very difficult to interpret the results of the cow manure fertiliser as the liquid was very turbid.

Part F

- I sprinkled 100g of grass seed on each plot.
- I spread the specific manure fertiliser mixes on each plot
- I watered each plot with a hose for 2 minutes to wet the plots

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Figure 1 Collecting Manure

Figure 2Marking out my plots

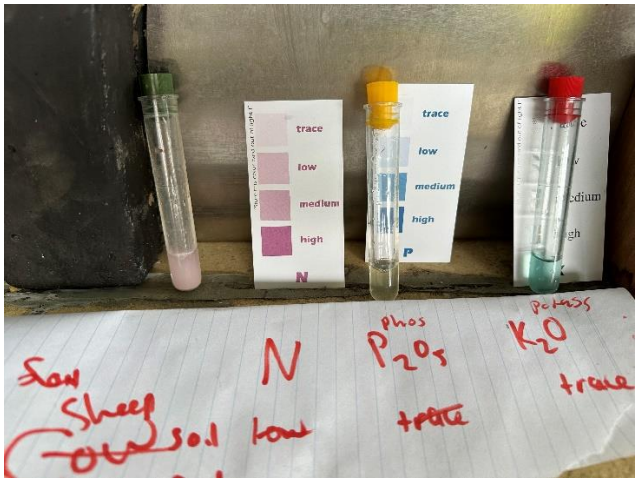

Figure 3 Micronutrient Testing

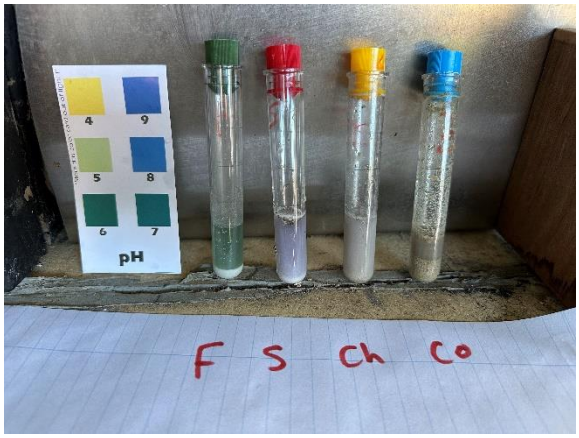

Figure 4 pH testing of fertiliser mixes

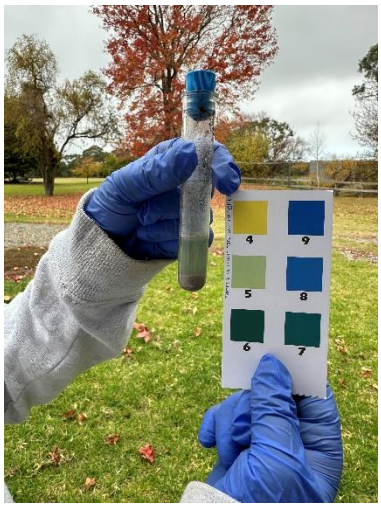

Figure 5 Soil pH testing

Figure 6 Adding the pH reagent

Figure 7 Preparing the soil for pH testing

Figure 8 Pipetting the water

Figure 9 Seed Spreading

Figure 10 Soil sample collection

Figure 11 Preparing the soil for micronutrient testing

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Figure 12 Preparing the spread the fertiliser

26/5/2024- week 1

- I took 1 cup samples of soil, 5cm below the top soil, from each plot.
- I repeated the testing of pH, nitrogen, phosphate and potassium on each individual plot (control, fertiliser, cow, sheep, chicken)
- I compared the thickness of growth of the grass (looking at the strands of grass), the density of coverage of the plot (how much of the seed was growing across the plot) and the length of the grass growth.
- I recorded my results.

2/6/2024- week 2

- I took 1 cup samples of soil, 5cm below the top soil, from each plot.
- I repeated the testing of pH, nitrogen, phosphate and potassium on each individual plot (control, fertiliser, cow, sheep, chicken)
- I compared the thickness of growth of the grass (looking at the strands of grass), the density of coverage of the plot (how much of the seed was growing across the plot) and the length of the grass growth.
- I recorded my results.

9/6/2024- week 3

- I took 1 cup samples of soil, 5cm below the top soil, from each plot.

- I repeated the testing of pH, nitrogen, phosphate and potassium on each individual plot (control, fertiliser, cow, sheep, chicken)
- I compared the thickness of growth of the grass (looking at the strands of grass), the density of coverage of the plot (how much of the seed was growing across the plot) and the length of the grass growth.
- I recorded my results.

16/6/2024- week 4

- I took 2x 1 cup samples of soil, 5cm below the top soil, from each plot.
- I repeated the testing of pH, nitrogen, phosphate and potassium on each individual plot (control, fertiliser, cow, sheep, chicken)
- I compared the thickness of growth of the grass (looking at the strands of grass), the density of coverage of the plot (how much of the seed was growing across the plot) and the length of the grass growth.
- **I let my cows taste test the grass to choose the best one**

Results

- Compare height of grass growth
- Compare thickness of grass
- Compare density of grass
- Compare colour of grass
- Have the cows taste test the grass
- Test the soil at week 0, 1, 2, 3

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Results

19/5/2024

Pasture testing week 0					
	Soil- no fertiliser	Super phosphate	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
Grass height	No rye grass sprouts yet	No rye grass sprouts yet	No rye grass sprouts yet	No rye grass sprouts yet	No rye grass sprouts yet
Grass density	70% Current pasture	80% Current pasture	80% Current pasture	80% Current pasture	80% Current pasture
Grass thickness	No rye grass sprouts yet	No rye grass sprouts yet	No rye grass sprouts yet	No rye grass sprouts yet	No rye grass sprouts yet
Colour	No spouts yet	No spouts yet	No spouts yet	No spouts yet	No spouts yet

Fertiliser mix testing week 0					
	Control Soil- no fertiliser	Fertiliser	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
pH	6	6	9	9	8
Nitrogen	Low	High	Turbid cant read	Medium	Low
Phosphate	Trace	Low	Turbid cant read	Trace	Trace
Potassium	Trace	High	Turbid cant read	Medium—high	Low

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26th May 2024

Pasture testing week 1					
	Soil- no fertiliser	Fertiliser	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
Grass height	1cm	1cm	1cm	1cm	2cm
Grass density/coverage	70%	85%	85%	85%	85%
Rye Grass thickness	1mm	1mm	1mm	1mm	1mm
Colour	Bright green sprouts, lots of other types of grass	Bright green sprouts	Worms in the soil	Worms in the soil	

Soil testing- Week 1					
	Soil- no fertiliser	Chemical fertiliser	Cow manure fertiliser soil	Chicken manure fertiliser soil	Sheep manure fertiliser
pH	6	6	7	8	5
Potassium	Trace	High	High	Low	Low
Nitrogen	Low	Medium	Trace	Medium	Trace
Phosphate	Trace	High	Trace	High	Low

2nd June 2024

Pasture testing week 2 (Rye Grass)					
	Soil- no fertiliser	Chemical fertiliser	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
Grass height	4cm	5cm	4cm	2cm	6mm
Grass thickness	1-2mm	3mm	2mm	2mm	2mm

Grass density	70%	80%	85%	85%	90%
Colour	Bright green but lots of other grasses	Yellow	Bright green	Bright green	Bright green

Soil testing 2 weeks after fertiliser applied					
	Soil- no fertiliser	Chemical fertiliser	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
pH	6	7	7	8	7
Potassium	Low	Medium	High	Low	Medium
Nitrogen	Trace	Medium	Low	Low	Low
Phosphate	Trace	High	High	Medium	Medium

9th June 2024

Pasture testing week 3					
	Soil- no fertiliser	Chemical fertiliser	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
Grass height	4cm	8cm	6cm	6cm	9mm
Grass thickness	1-2mm	3mm	2mm	2mm	2mm
Coverage	70%	80%	85%	85%	90%
Colour	Bright green rye grass but lots of other grass types	Bright green	Bright green Worms	Bright green	Bright green

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Soil testing 3weeks after fertiliser applied					
	Soil- no fertiliser	Chemical Fertiliser	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
pH	6	7	7	8	7
Potassium	Low	Medium	Medium	Low	Medium
Nitrogen	Trace	Medium	Low	Low	Low
Phosphate	Trace	High	High	Trace	High

Examples of the soil testing

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16th June 2024

Pasture testing week 4					
	Soil- no fertiliser	Chemical fertiliser	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
Grass height	4cm	8-10cm	8cm	7-8cm	12mm
Grass thickness	1-2mm	3mm	2mm	2mm	3mm
Grass density	70%	94%	90%	94%	96%
Grass colour	Bright green, less rye grass than other plots	Bright green	Bright green	Bright green and other types of grass	Bright green

Soil testing 4					
	Soil- no fertiliser	Chemical Fertiliser	Cow manure fertiliser	Chicken manure fertiliser	Sheep manure fertiliser
pH	6	7	7	8	7
Potassium	Low	Medium	Medium	Low	Medium
Nitrogen	Trace	Medium	Low	Low	Low
Phosphate	Trace	High	High	Trace	High

Examples of my results recording in the paddock.

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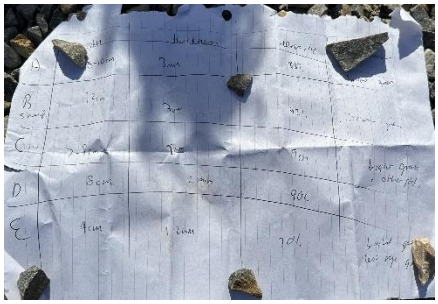

My final pastures





17/6/2024

Observations

- The chicken manure micronutrients started high but by the third week had reduced to trace levels of phosphate and nitrogen. From my research, nitrogen and phosphate levels are usually high in animal manure. When the chicken manure fertiliser was first applied to the pasture, the soil showed high levels of phosphate and medium levels of nitrogen after 1 week, however both

of these had reduced to trace levels in the soil by the 4th week. This may indicate that chicken manure fertiliser releases quickly into the soil, providing nutrients, however is quickly broken down and leaves on traces of micronutrients after a short period of time. Therefore you would likely needed to regularly apply chicken manure fertiliser if this was the option of fertiliser I chose. This may be very costly and time consuming.

- The sheep manure fertiliser showed increasing amounts of phosphate, nitrogen and potassium over the 4 weeks of the study. Initially the soil started with trace amounts but increased with time. This may indicate the sheep manure slowly releases into the soil. This would be beneficial for the slow release of nutrients over time. The pH was also around 7 which is within an optimal pH range for rye grass.
- The cow manure improved the soil pH to 7 making it optimal for rye grass growth. It released high levels of potassium into the soil and released increasing levels of phosphate and nitrogen over the weeks.
- The fertiliser had the most amount of nitrogen by the final week of testing. Nitrogen is important for the growth of the grass and photosynthesis, so this is a great advantage of the chemical fertiliser over the other fertilisers. However the sheep and cow manure has similar levels of phosphate and potassium and a similar pH, within 6-7 compared to the chemical fertiliser. So based on cost alone for the product and the aim for environmental sustainability, reduced impact on the environment and the purpose of reuse recycle and repurpose, the sheep and cow fertiliser from a micronutrient and pH adjustment effect on the soil are an ideal option for a fertiliser for my pastures.
- I would like to further research the difference between more fresh manure versus dried manure.
- The next thing the review and compare was the density, length and animal preference for the different fertilisers on the pastures.

18/6/2024—23/06/2024

I worked on parts of my report every day.

Acknowledgment

My mum helped with the bibliography and proof reading the report. My Ipad also allowed me to speak and it typed parts of my report, but I had to correct anything it wrote wrong.

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OSA RISK ASSESSMENT FORM

for all entries in (✓) ☐ Models & Inventions and ☑ Scientific Inquiry

This must be included with your report, log book or entry. One form per entry.

STUDENT(S) NAME: Amir Chaloob ID: 0683-005

SCHOOL: St Peter's Woodlands Grammar School

Activity: Give a brief outline of what you are planning to do.

I want to improve my farm pasture to improve the food for the cows and sheep and not rely on hay. Farmers use commercial fertilisers but these are expensive. I want to reuse manure to make fertiliser, reusing what we already have which is better for the environment. I just need to test which manure is best and if it works.

Are there possible risks? Consider the following:

- Chemical risks: Are you using chemicals? If so, check with your teacher that any chemicals to be used are on the approved list for schools. Check the safety requirements for their use, such as eye protection and eyewash facilities, availability of running water, use of gloves, a well-ventilated area or fume cupboard.
- Thermal risks: Are you heating things? Could you be burnt?
- Biological risks: Are you working with micro-organisms such as mould and bacteria?
- Sharps risks: Are you cutting things, and is there a risk of injury from sharp objects?
- Electrical risks: Are you using mains (240 volt) electricity? How will you make sure that this is safe? Could you use a battery instead?
- Radiation risks: Does your entry use potentially harmful radiation such as UV or lasers?
- Other hazards.

Also, if you are using other people as subjects in an investigation you must get them to sign a note consenting to be part of your experiment.

Risks	How I will control/manage the risk
Chemical fertiliser Animal manure Chemical reagents	I will be using gloves, protective clothing and protective goggles. I will wash my hands with disinfectant before and after. I will have a parent supervise.

(Attach another sheet if needed.)

Risk Assessment indicates that this activity can be safely carried out

RISK ASSESSMENT COMPLETED BY (student name(s)): Amir Chaloob

SIGNATURE(S): A Chaloob

☐ By ticking this box, I/we state that my/our project adheres to the listed criteria for this Category.

TEACHER'S NAME: Mr Kennedy

SIGNATURE: D Kennedy DATE: 24.6.2024