HSLU Hochschule Luzern

Practical 1:

Composting Parameters and Plant Tolerance Test

Environmental Chemistry and Biology HS2024

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1 Introduction

This experiment focuses on understanding how different types of compost affect plant growth. It aims to explore the chemical and physical interactions between compost and plant systems. Gaining a better understanding of these processes is essential for improving sustainable farming methods, making nutrients more available to plants, and managing resources effectively in agriculture.

2 Materials and methods

For this experiment, six gardening pots, three buckets containing different types of compost, a containment box, and a sieve were provided.

A scale and a measuring cylinder were used to determine the mass of the compost types (fresh, standard, and finished). The initial and final temperatures at the bottom of each pot were measured using a probe thermometer. Subsequently, pH measurements were conducted on each type of compost, with the samples dissolved in distilled water in a small beaker. Next, the composts were placed into different pots and divided into three distinct groups: 50% finished and 25% finished compost, 50% fresh and 25% fresh compost, and standard soil.

Finally, 15 seeds were carefully placed in each pot, and their growth and development were closely monitored.

2.1 Pictures of proceedings

Figure 1: Pot temperature

Figure 2: Compost dissolution

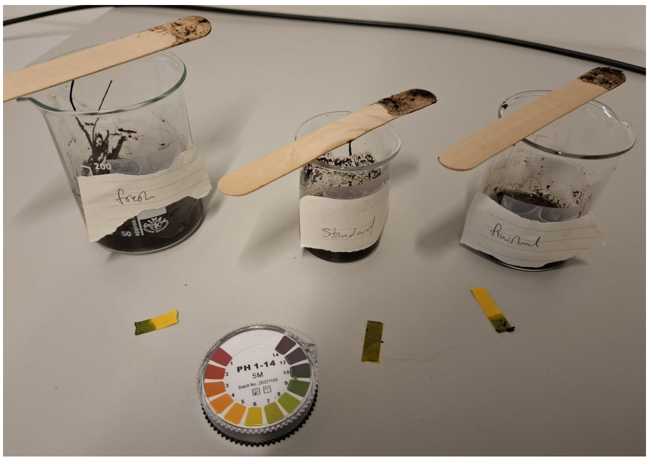

Figure 3: Compost pH results

Figure 4: Triplet of compost inside the pots

3 Results

3.1 Preliminary parameters

We collected three samples: Fresh, Finished, and Standard, and valuated them based on several characteristics, including pH, color, texture, odor, foreign objects, and moisture content. Each sample had distinct features, which helped us assess their condition and quality.

Table 1: Results of preliminary parameters

Sample name	pH	Color	Texture	Odor	Foreign objects	Moisture fist test
Fresh	9	Light brown	Coarse	Smells ammonia	Large roots and plastics	30% humidity
Finished	8	Dark brown	Fine	Smells ammonia	Sticks and plastic particles	20% humidity
Standard	7	Darkest brown	Clumpy	Smells earthy	–	30% humidity

3.2 Fresh, Finished and Standard compost

Three samples were collected, and their raw unit weight was evaluated. The mass of the empty cylinder was measured in grams, with a value of 168.24 g. The mass of the filled cylinder for each sample was then measured, obtaining values in liters. The volume of each sample was also measured in milliliters. Using these measurements, the density results were calculated in both [kg/L] and [kg/m^3] using the formulas:

$$\text{Density}\,[kg/L] = \frac{\text{Mass of filled cylinder } [g] - \text{Mass of empty cylinder } [g]}{\text{Volume of sample } [mL]}$$

$$\text{Density}\left[kg/m^3\right] = \text{Density}\,[kg/L] \cdot 1000\left[L/m^3\right]$$

The average values provided insight into the consistency of the raw unit weight across the different samples.

3.2.1 Fresh compost

Table 2: Results of raw unit weight in three different samples of fresh compost

Sample	1	2	3	Average
Mass of the empty cylinder in [g]	168.24			
Mass of the filled cylinder [g]	120.88	112.20	108.71	113.93
Volume of the sample in [mL]	340	330	390	353.33
Result in [kg/L]	0.356	0.34	0.279	0.325
Result in [kg/m^3]	356	340	279	325

3.2.2 Finished compost

Table 3: Results of raw unit weight in three different samples of finished compost

Sample	1	2	3	Average
Mass of the empty cylinder in [g]	168.24			
Mass of the filled cylinder [g]	214.54	202.91	202.68	206.71
Volume of the sample in [mL]	375	370	380	375
Result in [kg/L]	0.572	0.548	0.533	0.551
Result in [kg/m^3]	572	548	533	551

3.2.3 Standard compost

Table 4: Results of raw unit weight in three different samples of standard compost

Sample	1	2	3	Average
Mass of the empty cylinder in [g]	168.24			
Mass of the filled cylinder [g]	222.95	228.44	212.74	221.38
Volume of the sample in [mL]	355	370	360	361.67
Result in [kg/L]	0.628	0.617	0.591	0.612
Result in [kg/m^3]	628	617	591	612

3.3 Experiment results

Table 5: Experiment results

Group 4	E0	E0	E25	E25	E50	E50
mean compost density (kg/L)	0.325		0.382		0.438	
n° germinated seeds	12	13	11	12	11	10
plants weight (g)	1.672	1.882	0.997	1.294	1.058	1.105

Figure 5: Growth status 2 weeks after insemination

3.3.1 Relative yield

To calculate the relative yield $FM(r)$ at 25% and 50% using the data from the table, we can use this formula:

$$\boxed{FM(r)\% = \frac{FM\%}{E0\%} \times 100}$$

Average FM_{E0}
The average is calculated based on this formula:

$$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

It follows:

$$FM_{E0\%} = \frac{1.672g + 1.882g}{2} = \frac{3.554g}{2} = 1.777g$$

Calculation of the relative yields

1. **E25**:

$$FM(r)\ 25\% = \frac{0.997}{1.777} \times 100 = 56.1\%$$

1: Yield of the first E25% pot

$$FM(r)\ 25\% = \frac{1.294}{1.777} \times 100 = 72.8\%$$

2: Yield of the second E25% pot

2. **E50**:

$$FM_1(r)\ 50\% = \frac{1.058}{1.777} \times 100 = 59.5\%$$

3: Yield of the first E50% pot

$$FM_2(r)\ 50\% = \frac{1.105}{1.777} \times 100 = 62.2\%$$

4: Yield of the second E50% pot

4 Discussion

Interpret the results, discussing and answering the questions.

4.1 Results discussion

4.2 Questions

1. What is the difference between raw unit weight and bulk density? Discuss your results based on the laboratory experiment.

   R:
   Raw unit weight is the density given by the division of the mass of the compost over the volume of the compost. The bulk unit is the density given by the division of the mass of the compost over the volume of the container.

2. How can the pH affect the compost?

   R:
   The more acidic the soil is, the more inactive the bacteria are, and this bring plants to not grow properly. Vice versa for the basicity.
   Compost microorganisms operate best under neutral to acidic conditions, with pH's in the range of 5.5 to 8. During the initial stages of decomposition, organic acids are formed. The acidic conditions are favourable for growth of fungi and breakdown of lignin and cellulose (Cornell University, n.d.).

3. What is the impact of immature compost on plant growth, and how can this be assessed in the lab?

   R:
   Plants will not grow properly if the nitrogen cycle is not working. Indeed, it is generally accepted that compost produced with substrates rich in nitrogen will have a better fertilizing effect, compared to other compost whose substrates are mainly woody. Likewise, immature compost will have a repressive effect on seed germination and plant growth (Tamakloe et al., 2021).
   In the lab, we can do the germination test and for immature compost you have standard growth.

4. How do you calculate the bulk density of compost, and why is this measurement important in the composting process?

   R:
   Divide the mass of the compost by the volume of the container. Bulk density provides an overall indication for the physical and aeration conditions of a composting mass (Paniwnyk, 2014).

5. What would be the environmental impact if fresh compost is added in the plantations/agriculture or when the recommended percentage of compost mixture is not followed?

   R:
   Using fresh or excessive compost can release methane, impair growth through nitrogen depletion, and cause nutrient leaching, leading to water contamination.

4.3 Conclusion

Summarize the key findings and their implications.

References

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Paniwnyk, L. (2014). Application of ultrasound. *Emerging Technologies for Food Processing*, 271–291. https://doi.org/10.1016/B978-0-12-411479-1.00015-2

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Declarations about AI tools

- "*ChatGPT-4 with canvas*" was used as a tool to enhance vocabulary.
  All original sentences come from our individual thoughts and were refined with the support of this tool.
  https://chatgpt.com/
- "DeepL" was used as a translator.
  https://www.deepl.com