Fast Plant test with various substrates and composts.

PROTOCOL

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OUTLINE

1. Introduction

Worldwide peat is decreasing especially in Europe. This made us work on the alternative for this and Compost could be the alternative for this peat growing media therefore Compost is good for Agriculture because of its resource usage efficiency especially in Nutrients and Organic matter. This is an important project because it centers on the possible replacement of peat growing media if we eventually lose our peat especially in Europe. In this our study we compare and test different quality of composts by using fast growing plant tests to find out the difference on compost quality. We try to find out if different quality of compost from different source can cause growth in Plants. And also if the compost quality determines the growth in plant. Below is the distribution of peat in Europe.

PEAT DISTRIBUTION IN EUROPE

This paper derives the distribution of peat land in Europe as the extent of peat and peat-topped soils indicated by soil databases. The data sources were the 1:1,000,000 European Soil Database (v1.0) and a data set of organic carbon content (%) for the top soils of Europe at 1km x 1km resolution that was recently published in map form.

The strong influences of vegetation and land use on soil organic carbon (OC) content were taken into account in computing the 1km (OC) data set, as was the influence of temperature.

The areas of peat and peat-topped soils estimated from the European Soil Database are generally in close agreement with those obtained using the Map of OC in Top soils of Europe. The results reveal a strong northern bias in the distribution of organic soils across Europe. Almost one-third of the peat land resource of Europe is in Finland, and more than a quarter is in Sweden. The remainder is in Poland, the UK, Norway, Germany, Ireland, Estonia, Latvia, The Netherlands and France. Small areas of peat and peat-topped soils also occur in Lithuania, Hungary, Denmark and the Czech Republic. For most European countries, the distribution of peat and peat-topped soils is probably more accurately portrayed by the Map of OC in Top soils of Europe than by the European Soil Map and Database. Such baseline data are important for the conservation of peat and for making much more precise estimates of carbon stocks in topsoil than have been possible hitherto. The results are also relevant to the planning of effective soil protection measures at European level (Montanarella etal., 2006)
https://www.researchgate.net/publication/26841884_The_distribution_of_peatland_in_Europe

2. Material and Methods

Four different compost were used in the project. Composition of these compost you can see in the Tab. 1.

Tabelle 1: Different composition of the compost, year of formation.

Name of Compost	Content	Year	Shortnote
Compost 5	Leaves, grass, branches	2015	Compost was made at EULS, no aeration or mixing
Compost 7	Made of Waste Water sludge, mixed with Peat	2016	Tartu, passed thermophilic phase, mixed during composting process
Compost 9	Waste water sludge, mixed with wood chips	2015	Jõgeva, mixed during composting
Compost 12	Waste from animal slaughter, general biowaste	2014	Väätsa, mixed several times during composting.
Control (Growing media)	Sphagnum peat		Commercially produced, contained mineral fertilizers, limed

Compost were mixed in different ration with the growing media for 4 pots to each mixture of :

- 100 % compost
- 80 % compost and 20 % growing media (GM)
- 50 % compost and 50 % GM
- 10 % compost and 90% GM

Into each pot were added 1 g cress (*Lepidium sativum*). The pots were covered by plastic and put under uniform lamp. The duration last 1 week. After the duration the cress was harvested and weighed.

For the closed chamber test different composts were put into plastic buckets and 1 g of seed was added into each bucket. Buckets were covered. The duration last 1 week.
For the pH measurement were used 10 g compost and 100 ml of 0.01M CaCl2 solution. The solution was mixed for 1 hour in the shaker and then pH was measured by combined electrode.
For the electrical conductivity were used 10 g of compost and 100 ml distilled water. The solution was mixed for 1 hour in the shaker and then electrical conductivity was measured.

For soil moisture content the aluminium container was weighed empty, then with approximately half full of compost. The samples were put into an oven (150 °C) for 24 hours. After that the container were removed and weighed again.

For soil organic matter by loss on ignition tared porcelain crucible was weighed empty, then with approximately half full of compost. The samples were put into an oven (560 °C) for 24 hours. After that the container were removed and weighed again.

3. Results

Cress test – Pot

After the duration of one week, the pots were removed of their artificial environment. All samples showed a sign of overgrowth except compost 12 the 100% samples, which showed an inhibited growth, by developing slower and dark green leaves. The biomass was established by weighed the harvested cress. The results were summarized in figure 1.

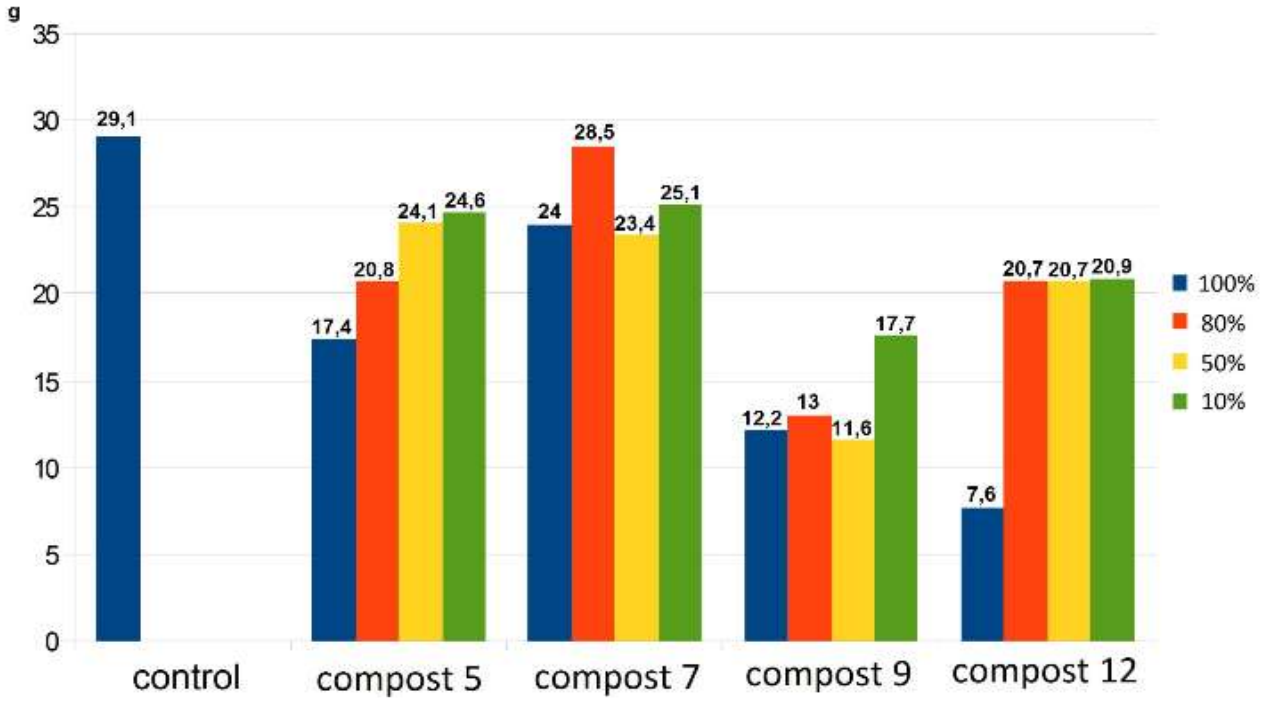

Figure 1: Results of the average biomass, of the different compost mixtures

The results show, that the GM has the highest amount of biomass in comparison to the samples. Compost 9 and 12 yielded the lowest biomass, while compost 7 and 5 were relatively close the control.

Cress test – closed chamber

After the duration of one week, the closed chambers were removed of their condition and observed. All plants of the compost number 5 showed some state of germination, but soon died after that. The same condition were observed for the other three composts. Two samples of compost 7 were showed some state developing with sign of green leaves. Same for one sample of compost 9. For compost 12 showed one sample a typical developing of a plant. After opening the closed chambers a smell of decomposition was experienced.

pH

The results of the pH-Test are summarized in figure 2. The GM had the lowest pH, closely followed my compost 7 with 6.0 and compost 9 with 6.7. The highest pH was observed of compost 5 with 7.6 and compost 12 with 7.3.

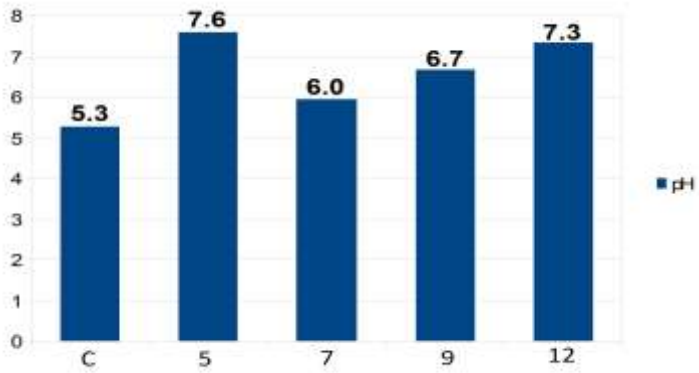

Figure 2: The average pH of the four different composts and control of three samples

Electrical conductivity (EC)

The results of the EC test are summarized in image 3. All compost except compost 12 showed a low conductivity. Compost 12 was nearly three times higher compared to the others with a conductivity of 1.39 mS. The GM was the highest of the four lowest values, with a conductivity of 0.5 mS, followed by compost 7 with 0.38 mS, then compost 9 with 0.32 mS and at last compost 5 with 0.2.

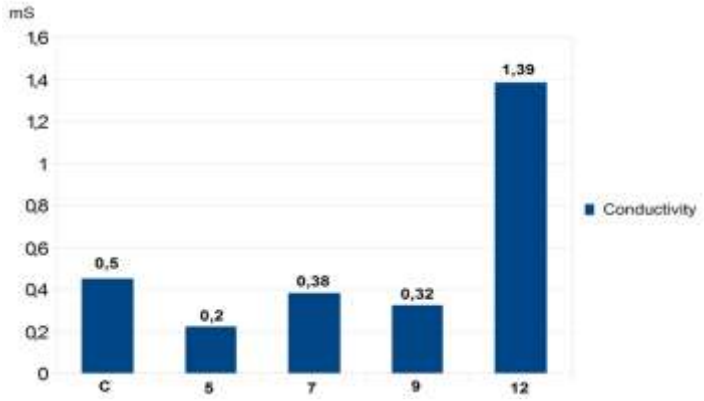

Figure 3: Results of the average EC of the four different composts and growing media using three samples

Soil Moisture Content

The results of the soil moisture content were summarized in figure 4, the formula for the water content in percent was calculated as follows:

$$\%\, water\, content = 100 * \left(\frac{(m1 - m2)}{(m1 - m0)}\right)$$

m0 = weight of empty container

m1 = weight of container with compost befor the heating process

m2 = weight of container with compost after the heating process

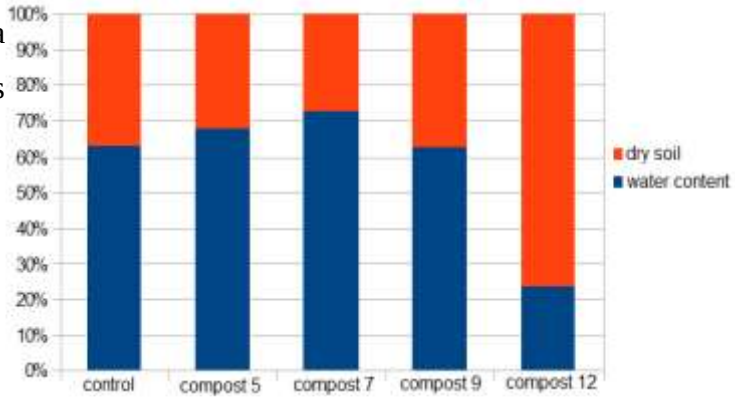

Figure 3: average dry soil and moisture content in percent of the four different composts and growing media measurent by three sample each

After calculating the water content, it is also possible to calculate the dry soil in percent as follows:

$$dry\, soil = 100 - \%\, water\, content$$

Compost 12 showed the higehst amount of dry soil with 76.6% and 23.4 % water conent. The highest amount of water content is visible for compost 7 with 72.6 % water content and 27.4 % dry soil. The soil content for control was 37.1 % and water content 61.9 %. The soil content for compost 5 was 23 % and water content 67 %. Compost 9 had soil content of 37.3 % and water content of 62.7 %.

Loss on ignition

The Results of the loss on ignition test are shown in table 2. Control showed the highest amount of organic matter with 96.1 % followed by compost 7 and compost 5 with 91.9 % and 91.4 %. Compost 9 showed a rather low amount with 82 % and compost 12 the lowest amount of organic matter with 65.5%.

Table 2: Soil organic matter by loss on ignition in percent

Control	Compost 5	Compost 7	Compost 9	Compost 12
96.1 %	91.4 %	91.9 %	82.0 %	65.5 %

C/N ratio

After analyzing the content of the five samples the results regarding the carbon and nitrogen content are listed in table 3. The highest nitrogen content is visible for compost 7 with 2.41 % and 34.42 % carbon resulting to C/N ratio of 14. The second highest nitrogen content was observed for compost 12 with 2.06 % and 24.16 % carbon which resulted into the lowest C/N ratio of 12. Compost 9 got a nitrogen content of 1.61 % in one mg per kg and 26.35 % carbon, resulting into a C/N ration of 16. The second lowest nitrogen content was spotted in compost 5 with 1.36 % and 24.04 % carbon, leading to a C/N ratio of 18. The lowest amount of nitrogen was observed for control with 1.02 % and 47.21 % carbon, resulting into the highest C/N ratio of 46.

Table 3: The content of control and the four compost, listed are the carbon and nitrogen content in percent in one mg per kg and the corresponding C/N ratio

Samples	Control	Compost 5	Compost 7	Compost 9	Compost 12
N%	1.02	1.36	2.41	1.61	2.06
C%	47.21	24.04	34.42	26.35	24.16
C/N ratio	46	18	14	16	12

Macroelements

The results of macroelements content are shown in table 4, the numbers were calculated with the average of three samples of each compost. Showing Compost with highest amount of Calcium 8046.80 mg per kg and highest amount of potassium with 4088.50 mg per kg. The lowest amount of calcium was observed for compost 7 with 2614.03 mg per kg and the lowest potassium content with 499.8 mg per kg. The highest phosphorus content is visible in compost 9 with 880.93 mg per kg and lowest in control with 266.73 mg/kg.

Table 4: Macroelement content for control and the four compost samples, showing the total amount of P, Mg, K and Ca in mg per kg

Sample	Control	Compost 5	Compost 7	Compost 9	Compost 12
P [mg/kg]	266.73	441.30	702.93	880.93	546.87
Mg [mg/kg]	793.53	766.30	1083.50	1014.97	1434.47
K [mg/kg]	786.73	1001.73	499.87	601.87	3110.40
Ca [mg/kg]	4484.03	5074.73	2614.03	4088.50	8046.80

For visualizing and to compare the composts all the numbers in table 4 were added into bar graph figure 5.

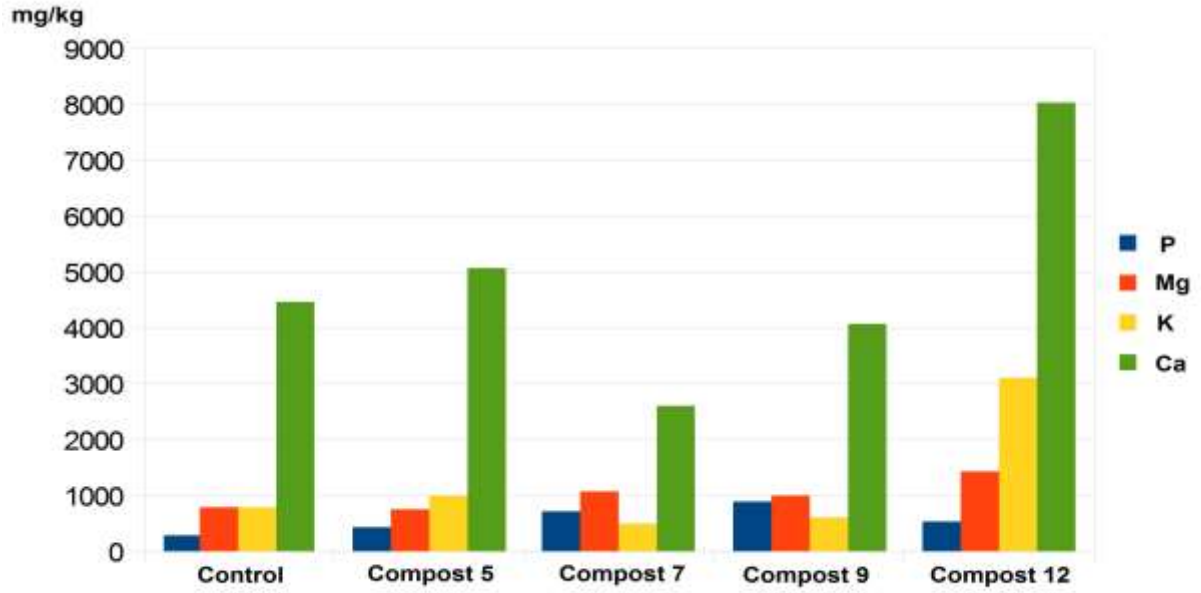

Figure 4: Macroelement content for control and the four compost samples, showing the total amount of P, Mg, K and Ca in mg per kg visualized in bar graph

4. Discussion

The compost experiments showed positive results regarding all composts. However, the cress was overgrown in each sort of compost besides the control that grew on growing media (GM). In comparison to the control (biomass of 29.1 g) composts 5 and 7 had the highest biomass, but still below the control and composts 9 and 12 had the lowest biomass.

The composts 5, 7, 9 and 12 showed an increased growth because of their specific C/N ratio. In composts the optimal ratio of these two elements is normally between 15:1 and 35:1. The ratio of compost 5 and compost 12 is below that optimum and the composts 7 and 9 are within the optimum but nevertheless in a low range compared to the maximum of 35:1. It so can be concluded that the concentration of nitrogen is higher in comparison to the concentration of carbon.

Both elements are essential for the development of plants but a high N content that is primary received in form of nitrate and ammonium, leads to fast formation of amino acids and proteins and due to that to a high growth rate.

The pH of each compost is in an optimal range also in the control. This shows that the formation has finished because at the beginning of composting the pH decreases at first due to the formation of organic acids, CO_2 and nitrification.

The measurements of the electric conductivity (EC) resulted in similar values for composts 5, 7, 9 and the control. Compost 12 was a statistical outlier with an EC of 1.39 mS. The reason for that is the high amount of calcium in compost 12. The calcium reacts with chloride to CaCl and more salts in the media correlate with a higher EC.

The measurements of the elements phosphorus, magnesia, potassium and calcium showed the highest amount of P in compost 7 and 9. These composts consisted partially of waste water sludge. This explains the Pcontent because of the use of phosphoric cleaning agents in the household and phosphoric fertilizer in the agriculture. Compost 12 had the highest potassium values because it consists of organic waste. Furthermore, this compost also has the highest amount of calcium for the same reason.

The closed chamber experiments did not work because all samples died against the expectation. Reasons for that could be too much water that maybe disturbed the aerobic processes. Hence, this experiment is not representative and needs to be repeated.

All in all, the hypothesis of the beginning cannot be confirmed by now because all mixtures of composts led to growth indeed but the complete biomass was below the biomass of the control in each sample. So there need to be more studies and investigations to find alternatives that actually replace peat in future agriculture.

5. Future perspectives

We did those experiments because we tried to find an alternative to the common use of peat as a growing media that will certain come close in future. The ambition was to find a composition of compost that results in the same or better biomass of cress in the cress test than the control.
By now such a composition could not be found and more studies are necessary.

References

Montanarella, L., Jones, R.J.A., Hiederer, R. 2006. The distribution of peatland in Europe. Mires and Peatland, Volume 1 (2005), Article 01, http://www.mires-and-peatland.net. 2005 International Mire Conservation Group and International Peat Society.
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