Study on the effect of adding nutrients on fermentation of compost tea

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Abstract: The study investigated the effects of additives (molasses, seaweed, and fishmeal) on compost tea's nutrient content and fermentation characteristics. Compost tea contains a lot of nutrients and can be used as a supplement for soil nutrients. Molasses, seaweed and fishmeal are common additives in compost tea, and their effects on nutrients in compost tea are the purpose of this study. In this paper, to study the compost tea with added nutrients molasses, seaweed, and fishmeal compost tea, the effects of pH, organic matter, total nitrogen, ammonium nitrogen, nitrate nitrogen and bacteria on the fermentation characteristics of compost tea were investigated with different ratios (1 : 5, 1 : 6, 1 : 7, 1 : 8, 1 : 9) of fertilizer to water. The results showed with the increase of extraction ratio, molasses decreased pH value and ammonium nitrogen content, and seaweed and fishmeal promoted nitrogen mineralization. The optimal fermentation ratio was 1:5 for compost tea.

1. Introduction

The application of chemical products such as fertilizers is a recent development trend. However, long-term application of chemical fertilizer will destroy the dynamic balance of soil ecosystem microorganisms, resulting in environmental pollution. Compost tea refers to the use of decomposed organic fertilizer after different methods of extraction of extract [1], maximize the extraction of microbial communities, functional substances and nutrients in the compost [2]. The beneficial microorganisms in it can multiply in large numbers, and can give full play to the biological control function in addition to nutrition after being applied to the soil. Compost tea is easy to apply topdressing, and can be used for root drip irrigation or leaf spraying through integrated water and fertilizer technology, or as a nutrient solution for soilless cultivation [3-4]. Xu explored the influence of compost tea with different raw materials on tomato growth, and the experiment showed that the application of compost tea could significantly promote the growth of tomato at the seedling stage, and had a significant impact on the content of nutrient elements in the tomato's ground [5].

Compost tea can be divided into aerated compost tea and non-aerated compost tea. In this paper, aerated compost tea was mainly used, which was made by mixing decomposed organic fertilizer with distilled water in a certain proportion and filtering it after several days of leaching under oxygen-permeated biological conditions [6]. In this paper, cattle manure was used as the main raw material of the compost, mixed with distilled water in different proportions, aerated fermentation after compost tea.

2. Experimental materials and methods

2.1. Experimental materials

Ferrous sulfate, phenanthroline, potassium dichromate, sodium hydroxide, potassium nitrate, potassium persulfate, concentrated hydrochloric acid, disodium hydrogen phosphate, sodium hypochlorite, ammonium sulfate, potassium hydroxide, anhydrous ethanol, molasses, fishmeal, seaweed, distilled water, cattle manure.

2.2. Experimental design and preparation of compost tea

The sifted cattle manure and distilled water were mixed at the ratio of 1 : 5, 1 : 6, 1 : 7, 1 : 8, 1 : 9, aerated and fermented for 3 days, filtered with 100 mesh nylon, and the upper liquid was taken as the control. In the experimental group, nutrients such as molasses, fishmeal and seaweed were added in the same proportion of organic fertilizer and distilled water during the fermentation process, and the upper liquid was taken after fermentation and filtration.
2.3. Chemical and physical analysis

The pH of compost tea was directly determined by pH meter. Organic matter (TOC) was determined by potassium dichromate and ferrous sulfate. Total nitrogen (TN) was determined by ultraviolet spectrophotometry with potassium persulfate digestion. Nitrate nitrogen: 2mL sample solution was diluted with hydrochloric acid and ultra-pure water, and determined with UV-1000 ultraviolet spectrophotometer; ammonium nitrogen: moderate ultra-pure water for dilution was added into 50μL sample solution, and then added phenol solution and sodium hypochlorite solution, after color appeared, UV-1000 ultraviolet spectrophotometer was used to determine with. The number of bacteria was determined by CFU.

3. Results & Discussion

3.1. pH

It can be found that there was no significant change in pH value in other treatment groups. As can be seen from Figure 1, the pH of the treated group with molasses added was relatively low, which may be because the microorganisms multiply faster during the fermentation process of the compost tea with molasses added, producing acidic substances such as organic acids, thus reducing the pH value.

![Figure 1. pH of different proportions of compost tea after fermentation.](image)

Note: Different letters indicate significant differences between different groups ($p < 0.05$), the same letter indicated no significant difference between different groups ($p > 0.05$). The error bar represents the standard deviation.

3.2. Organic matter content

Organic matter refers to organic compounds containing carbon in various forms, which can provide nutrients for plants and promote plant growth and development. As can be seen from Figure 2, compared with the control group, the organic matter content of the compost tea with added nutrients increased, and the difference was very significant in the 1:7 ratio of compost tea. In the fishmeal treatment group, 1:5 compost tea had the highest organic content. Except for the molasses treatment group, the organic matter content decreased with the increase of extraction proportion, and the organic matter content in the other treatment groups was the highest at 1:5, and the difference was significant.

![Figure 2. Content of organic matter after fermentation of compost tea of different proportions.](image)

Note: Different letters indicate significant differences between different groups ($p < 0.05$), the same letter indicated no significant difference between different groups ($p > 0.05$). The error bar represents the standard deviation.
3.3. Total nitrogen content

As can be seen from Figure 3, with the increase of mixing ratio, the total nitrogen concentration in the compost tea in the control group decreased; Compared with the control group, the total nitrogen content of experimental group increased, and the total nitrogen content of fishmeal was the highest, and the total nitrogen content was the highest when the mixing ratio was 1:5, and the total nitrogen content decreased with the increase of the proportion. This was because fishmeal has a higher crude protein content. In the molasses and seaweed treatment groups, the total nitrogen content was the highest when the mixing ratio was 1:9, and the difference was significant.

![Figure 3. Total nitrogen content of different proportions of compost tea after fermentation.](image)

Note: Different letters indicate significant differences between different groups ($p < 0.05$), the same letter indicated no significant difference between different groups ($p > 0.05$). The error bar represents the standard deviation.

3.4. Ammonium nitrogen content

The content of ammonium nitrogen can reflect the dynamic change of nitrogen and nitrogen supply capacity. As can be seen from Figure 4, compared with the control group, the fishmeal and seaweed treatment groups decreased with the increase of extraction proportion, and the difference was extremely significant in the proportion of 1:5 compost tea. The content of ammonium nitrogen in the molasses treatment was lower than that in the control group, because the addition of molasses affected nitrogen mineralization and inhibited nitrogen conversion, while the addition of seaweed and fishmeal promoted nitrogen mineralization.

![Figure 4. Content of ammonium nitrogen after fermentation of compost tea with different proportions.](image)

Note: Different letters indicate significant differences between different groups ($p < 0.05$), the same letter indicated no significant difference between different groups ($p > 0.05$). The error bar represents the standard deviation.

3.5. Nitrate nitrogen content

Nitrate nitrogen was the form of nitrogen that can be directly absorbed and utilized by crops. As can be seen from the Figure 5, in the control group, the nitrate nitrogen content of compost tea in the 1 : 5 treatment group was the highest, showing a very significant difference; Compared with the control group, the nitrate nitrogen content in the molasses treatment group increased, and was the highest among the four groups. Among them, the nitrate nitrogen content in the compost tea treated with seaweed and fishmeal decreased compared with the control group.
3.6. The number of bacteria
As can be seen from table 1, the number of bacteria of was more than other proportions when the ratio was 1 : 5. The number of viable bacteria decreased with the increase of extraction ratio. The compost tea at 1 : 5 ratio was more suitable for bacterial growth. This may be due to the 1 : 5 ratio of compost tea contains more mineral nutrients, which made bacterial activity enhanced.

<table>
<thead>
<tr>
<th>Different proportion treatment groups</th>
<th>Number of bacteria (CFU/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 : 5</td>
<td>3.17*10^8</td>
</tr>
<tr>
<td>1 : 6</td>
<td>2.35*10^8</td>
</tr>
<tr>
<td>1 : 7</td>
<td>2.11*10^8</td>
</tr>
<tr>
<td>1 : 8</td>
<td>1.44*10^8</td>
</tr>
<tr>
<td>1 : 9</td>
<td>8.5*10^7</td>
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</tbody>
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4. Conclusions
At present, no relevant literature has systematically summarized the effects of the addition of molasses, fishmeal and other nutrients on the physical and chemical properties of compost tea. In this paper, the addition of molasses, fishmeal, seaweed and other nutrients to explore their effects on the fermentation characteristics of compost tea, and the optimal mixing ratio of added nutrients to fermented compost tea was obtained. The results showed that the optimal ratio of compost tea with added nutrients was 1 : 5. The addition of molasses promoted the formation of organic acids, thus reducing the pH of compost tea and inhibiting the mineralization of nitrogen. Therefore, the addition of molasses can inhibit the formation and conversion of ammonium nitrogen, which was positively correlated with the extraction ratio. The addition of seaweed and fishmeal can promote the mineralization of nitrogen, and there was a negative correlation with the extraction ratio.

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