Soil Ecological Protection Effects of Earthworm Fertilizer on Pepper Culture and Soil Microorganism

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Abstract. In order to study the application effects of earthworm fertilizer in organic vegetable cultivation, the application field of earthworm fertilizer was expanded. In the study, the earthworm fertilizer suspension of 22 g·L⁻¹, 44 g·L⁻¹, 88 g·L⁻¹ and 440 g·L⁻¹ were applied to study the effects of earthworm fertilizer of different concentrations on pepper culture and soil microenvironment. The results showed that the morphological and physiological indexes of pepper plants were positively correlated with the concentration of earthworm fertilizer during the same growth period. The plant height, stem diameter, dry and fresh weight above and below ground, chlorophyll content, soluble sugar content, soluble protein content and malondialdehyde content of pepper under the treatment of four concentrations all had promoting effects, and the treatment effect was the most significant at the concentration of 440 g·L⁻¹. The treatment effect was not obvious at 22 g·L⁻¹ concentration.

Keywords: Earthworm Fertilizer, Pepper Culture, Soil Microorganism

1. Introduction

Earthworm fertilizer can also be called earthworm dung, earthworm mud. After the earthworm eats food, it is excreted by various digestive enzymes in the earthworm’s digestive tract and various microorganisms in the intestinal tract[1]-[3]. Because earthworm dung has very small pores and large surface area, it contains a lot of microorganisms that are beneficial to plant growth to multiply and gather in it. Compared with other domestic animals such as cow manure, horse manure, chicken manure, pig manure and some different. Among them, soluble salt, humic acid content, cation exchange and other properties showed a significant increase. Moreover, the nutrient elements and trace elements needed by plants not only exist in earthworm feces, but also contain a lot of them, which are easy to be absorbed by plants [4]-[7]. Therefore, earthworm fertilizer can be used as a new biological fertilizer for crop growth and cultivation. After earthworm fertilizer is applied into the soil, the microbial flora rapidly multiplies to inhibit the propagation of harmful plant bacteria, diversify the soil composition, facilitate the growth and absorption of plants, generate and improve soil fertility, improve the resistance and disease prevention ability of crops, and thus reduce the occurrence of soil-borne diseases in the soil [8]-[10]. Make crops less susceptible to disease, thereby protecting soil ecology, improve soil availability.
2. Materials and Methods

2.1. Test Materials
Four seasons pepper, earthworm organic liquid fertilizer

2.2. Test Methods
Five treatments were set in the experiment, which were earthworm fertilizer of 22 g·L⁻¹, 44 g·L⁻¹, 88 g·L⁻¹ and 440 g·L⁻¹ respectively. They were repeated for three times with clean water as CK, and randomly arranged in groups. The same batch of seeds were used for cavitation tray seedling. When 3 true leaves were grown, they were transferred to a 12cm×12cm nutrition bowl. After the seedling was slowed down, fertilization was started, once every 7 days, 30 ml per bowl for each time, applied for three times in a row, and the relevant indexes of pepper plants and soil were determined.

3. Results and Analysis

3.1. Effects of Earthworm Fertilizer with Different Concentrations on the Growth of Pepper

3.1.1. Effects of Earthworm Fertilizer with Different Concentrations on Plant Height of Pepper
As shown in figure 1, with the increase of earthworm fertilizer suspension concentration and treatment days, the plant height of pepper plants increased to a certain extent, and basically showed an increasing trend. However, compared with CK group, the degree of significant difference was different. For the same treatment days, there was no significant difference in plant height of pepper plants treated with low-concentration earthworm fertilizer suspension, but the significant difference was gradually obvious with the increase of concentration. Moreover, when the concentration was 440 g·L⁻¹, the plant height of pepper was the most significant difference compared with CK group.

![Figure 1](image_url)

**Figure 1.** Effects of earthworm fertilizer with different concentrations on plant height of pepper.

Note: the lowercase letter represents the significance of the difference when P≤0.05, the same as below.

3.1.2. Effects of Earthworm Fertilizer with Different Concentrations on the Stem Diameter of Pepper
As shown in figure 2, with the increase of earthworm fertilizer suspension concentration and treatment days, the stem diameter of pepper plants increased to a certain extent. But compared with CK group significant difference degree is different, the same number of days, low concentration of earthworm fertilizer suspension under the process of hot pepper plant stem thick basic there was no significant difference or significant difference is not obvious, with the increase of the concentration difference
gradually obvious, when the concentration of 440 g·L⁻¹ chili plant stem diameter difference with CK group is the largest, the most obvious difference.

Figure 2. Effect of earthworm fertilizer with different concentrations on plant height of pepper.

### 3.1.3. Effects of Earthworm Fertilizer with Different Concentrations on Dry Matter Accumulation of Pepper

As can be seen from Table 1, with the increase of the concentration of earthworm fertilizer suspension, the difference of earthworm fertilizer suspension on the surface fresh weight, underground fresh weight, surface dry weight and underground dry weight of pepper was gradually obvious. Compared with the control group, 22 g·L⁻¹ treatment showed no significant difference, 44 g·L⁻¹, 88 g·L⁻¹, 440 g·L⁻¹ treatment showed significant difference, among which 440 g·L⁻¹ treatment was the most obvious, indicating that the application of earthworm fertilizer turbidity solution could promote the accumulation of pepper biomass to a certain extent.

| treatment | the ground fresh weight/g | underground fresh weight/g | the ground dry weight/g | underground dry weight/g |
|-----------|--------------------------|----------------------------|-------------------------|--------------------------|
| CK        | 12.36b                   | 8.409b                     | 2.018b                  | 0.6537b                  |
| 22g·L⁻¹   | 12.77b                   | 8.712b                     | 2.134a                  | 0.7206b                  |
| 44g·L⁻¹   | 13.34a                   | 9.027a                     | 2.269a                  | 0.7885a                  |
| 88g·L⁻¹   | 13.79a                   | 9.358a                     | 2.397a                  | 0.9568a                  |
| 440g·L⁻¹  | 14.23a                   | 9.695a                     | 2.531a                  | 1.143a                   |

### 3.2. Effects of Earthworm Fertilizer with Different Concentrations on the Quality of Pepper

#### 3.2.1. Effects of Earthworm Fertilizer with Different Concentration on soluble sugar content of pepper

As can be seen from Figure 3, compared with CK group, the soluble sugar content of 22 g·L⁻¹, 44 g·L⁻¹, 88 g·L⁻¹ and 440 g·L⁻¹ treated were all higher than that of the control group, with significant differences, while the difference of 22 g·L⁻¹ treated was not significant. Among them, the difference of soluble sugar content of 440 g·L⁻¹ treated was the largest, with the most significant difference, and the overall trend was increasing. The reason may be that earthworm fertilizer can improve plant's ability to resist diseases and pests and inhibit harmful bacteria and soil-borne diseases. By increasing the
concentration of earthworm fertilizer, soluble sugar content in plants can be increased so as to improve plant's resistance and survival ability.

![Figure 3](image)

**Figure 3.** Effects of earthworm fertilizer with different concentrations on soluble sugar content of pepper

3.2.2. Effects of Earthworm Fertilizer with Different Concentrations on Soluble Protein Content of Pepper

As can be seen from Figure 4, compared with CK group, the soluble protein content of 22 g·L⁻¹, 44 g·L⁻¹, 88 g·L⁻¹ and 440 g·L⁻¹ concentrations were all higher than that of the control group, and the differences were significant. Among them, the difference between the soluble protein content of 440 g·L⁻¹ treatment and that of the control group was the largest, with the most significant difference, and the overall trend of increase. Analysis of the reason may be the earthworm fertilizer contains types between 16 and 18 kinds of amino acids [4], the content of trace elements is much higher than that of control group, with the increase of earthworm fertilizer suspension concentration plants also gradually increased, soluble protein content in liquid plants grow more and more robust, for some economic plants such as pepper, is conducive to high and stable yield.

![Figure 4](image)

**Figure 4.** Effects of earthworm fertilizer with different concentrations on the soluble protein content of pepper
3.2.3. Effects of Earthworm Fertilizer with Different Concentrations on Chlorophyll Content of Pepper

According to Figure 5, pepper culture with earthworm fertilizer suspension containing different concentrations had a certain influence on the chlorophyll content of pepper, which showed an overall rising trend. Compared with the control group, the chlorophyll content of capsaicin treated with 22 g·L⁻¹, 44 g·L⁻¹, 88 g·L⁻¹ and 440 g·L⁻¹ was higher than that of the control group, and the differences were significant. Among them, the soluble sugar content in 440 g·L⁻¹ treatment was the most different from that in the control group, with the most significant difference. It was concluded that the effect of 440 g·L⁻¹ earthworm fertilizer suspension on the chlorophyll content of capsaicin was the best. Earthworm fertilizer is rich in micronutrients needed by many plants. It can improve the photosynthesis, preserve and strengthen plants, and thus increase the chlorophyll content in plants.

![Figure 5: Effects of earthworm fertilizer with different concentrations on the chlorophyll content of pepper](image)

3.3. Effects of Earthworm Fertilizer with Different Concentrations on Soil Microorganisms

Soil samples from the three test sites were collected. Compared with the control group, the pH of the soil in the treatment area tended to be neutral, while the contents of organic matter, hydrolyzed nitrogen, available phosphorus, and available potassium varied, which had no influence on the whole. However, the total number of bacteria in the soil increased to varying degrees, which showed that the total number of bacteria increased while the actinomycetes decreased (see Table 2), indicating that the application of liquid organic fertilizer of earthworm had a certain improvement effect on the soil microbial status.

| Soil microbial index | Total number of bacteria | Actinomycetes |
|----------------------|--------------------------|---------------|
| CK                   | 5.11 bc                  | 4.65 a        |
| 22g·L⁻¹              | 5.15b                    | 4.62 a        |
| 44g·L⁻¹              | 5.22 b                   | 4.61 a        |
| 88g·L⁻¹              | 5.31 b                   | 4.59 a        |
| 440g·L⁻¹             | 5.62 a                   | 4.56          |
4. Conclusion
The results showed that different concentrations of earthworm fertilizer had different effects on the growth and quality of pepper, but they were all better than the control group. In the scope of this study, high concentration can significantly improve plant growth and quality, and because earthworm manure contains a large amount of humus, it can improve the microbial environment of soil and improve soil fertility. So the most suitable concentration is 440g·L⁻¹.

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