Soil Enzyme Activity and Physicochemical Properties of Tea Garden

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Abstract: Soil enzymes play an important role in material circulation and energy flow in ecosystems. In this study, three tea plantations, without fertilizer, organic fertilizer and chemical fertilizer were carried out to determine the activity of soil hydrogen peroxide enzyme and sucrose enzyme, and the physical and chemical properties of soil (soil weight, soil moisture content, soil pH and soil temperature). The results showed that the soil enzyme activity of fertilizer applied was the highest, and the soil enzyme activity without fertilizer was the lowest. Soil enzyme activity is closely related to soil physical and chemical properties, which is of great significance to improve the yield and quality of tea leaves.

1 INTRODUCTION

Soil microorganisms can have a significant effect on enzyme activity. For example, cellulase, phosphatase and urease are closely related to the content of microorganisms. As the content of microorganisms increases, their activities also increase. Nasegy used root inoculation to change the genetic traits of microorganisms, enhance the activities of phosphatase and phosphonate esterase in soil, and weaken the activities of enzymes such as glycosides (Naseby 1998).

Soil moisture content, temperature (heat) and air have significant effects on soil enzyme activity. Enzyme activity is active in the case of relatively high soil moisture but decreases when the soil is too wet. The amount of pyrethroase in the mucous grain with the temperature are negative correlation when temperature at 25-60 ℃, soil temperature increased to 70 ℃, enzyme activity increased, but the temperature is higher than 70 ℃, the pyrethroase will occur in a short period of time passivation phenomenon. The enzyme becomes inactivated when the temperature rises to 150 ℃ and heats up for a day. Overrein found a correlation between enzyme activity and oxygen elements of pyrethroenes, which are affected by air directness (Min 1978).

Soil pH has a great effect on the rate of enzyme chemical reaction. Urease is most active in the pH range of 6.5 to 7.0. Some enzymes, such as deoxygenase and hydrogen peroxide enzyme, are completely inactivated when the pH is lowered below 5.0. Soil pH also affects urease protein structure and smaller molecules such as amino group, which changes enzyme activity. The lower the acidity, the more enzymes the clay can absorb. Urease can be adsorbed much in weak acid medium than that in weak base medium.

The organic matter in soil can directly affect the physical and chemical properties of soil. The enzymes will be attached to the surface of organic matter, some in humus complex, still active. Urease, invertase and acid phosphatase are directly affected by organic matter, N and P elements (Liu 2003). Fan Jun found that the activities of urease and protease increased with the increment of organic matter content (Fan 2003).

The diameter and stability of soil aggregates were closely related to enzyme activities. The enzyme activity was higher in the smaller aggregate diameter. Urease of umber soil and black soil mostly accumulates in micro-reunion, which are the same size as soil clay (Zhou 1980). In the soil solution, only a small amount of soil enzymes, more soil enzymes gathered on the clay surface. Protease and urease are the same, mostly concentrated in soil clay.

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Sprayed pesticides can enter the soil and affect soil enzyme activity directly. Shen Biao found that chlorobenzene, a substance in pesticides, can stimulate urease activity. Dehydrogenase activity decreased when chlorobenzene concentration was increased (Shen 1997). Organochlorine pesticides, the main component of which is HCH, can inhibit hydrogen peroxide enzyme activity (Pang 2002). He Wenxiang found that Insecticidal Dan inhibited urease, oxidase activity and phosphatase (He 2002).

Different fertilization measures also effect enzyme activity. The enzyme activity was more active in the organic matter. Enzyme activity can be enhanced with barnyard manure, but will be reduced without fertilizer (He 2001). The application of fertilizer can slightly enhance enzyme activity, and the root metabolism accelerates, secretes more substances, increases the growth rate of microorganisms, enhances enzyme activity finally. Soil fertility is a measure of the soil's ability to provide a variety of nutrients needed for crop growth. It is the comprehensive performance of basic properties of soil, for agricultural production. The application of different fertilizers affects the level of soil enzyme activity, which plays a key role in soil fertility and can reflect the soil productivity. Therefore, the study on the soil enzyme activity in tea garden is a basis for high quality and yield of tea production, and provides theoretical guidance for tea planting.

2 MATERIALS AND METHODS

2.1 Soil Samples

In order to take out soil samples randomly, five sampling points were randomly set in the tea garden, and about 10g of soil was taken out at a soil depth of 10cm for reserve. The soil was placed in sterile bottles and marked.

2.2 Hydrogen Peroxide Enzyme

Weigh 5 grams of air-dried soil and put it in a 150 ml triangular flask with 5 ml of 0.3% hydrogen peroxide solution and 40 ml of distilled water. The same reagent was taken without soil sample as the control group. Then the bottle was plugged tightly with a cork and placed on a shaker. The rotation speed was adjusted to 120r/min and the oscillation time was 30min. After 30min, the bottle was taken out. After opening the cork, 5mL of 1.5mol/L sulfuric acid was immediately injected and filtered with dense filter paper.

After filtration, 25mL of filtrate was taken out and titrated with potassium permanganate solution with a concentration of 0.002mol/L to reddish color. The catalase activity was then calculated as 0.002mol/L ml of potassium permanganate solution per gram of soil weight, which was the difference between the control group and the soil-taking group. Its calculation formula is as follows:

Soil hydrogen peroxide enzyme activity (mL $KMnO_4$ / g air-dried soil) =V / DWT

(V: 0.002mol / L $KMnO_4$ solution in mg (mL); DWT: Air dried soil weight (g)

2.3 Sucrose Enzyme

The activity of sucrose enzyme was determined by 3, 5-dinitrosalicylic acid colorimetry. Using sucrose as substrate, glucose is produced under the catalysis of sucrose enzyme. 3, 5-dinitrosalicylic acid reacts with glucose to form 3-amino-5-nitrosalicylic acid, which has the maximum absorption value at 508 nm.

Configuration of glucose standard solution: add an appropriate amount of distilled water to the beaker, slowly add benzoic acid, and stir with a glass rod until benzoic acid dissolves and a small amount of crystals precipitate, to complete the preparation of saturated benzoic acid solution. Then, 500 mg glucose was weighed and dissolved in an appropriate amount of benzoic acid solution, and 100 mL volumetric flask was filled with benzoic acid saturated solution for constant volume (5 mg/mL).

Weigh 0.45 g of air-dried soil into a 10 mL centrifuge tube, add 1 mL phosphoric acid buffer (pH=5.5) and 0.06 mL toluene, then add 3 mL 8% sucrose solution, shake well, cover tightly, and place in an incubator at 37 °C for one day. Then take out the centrifuge tube, shake it well, centrifuge it for 5 min, and set the speed at 4000 r/min. After centrifugation, remove 0.2 mL of the upper liquid and add 20 mL to the glass tube. Injected 3,5-dinitrocylic salicylic acid 0.5 mL in the glass tube, immediately after the glass tube 5 min heated with boiling water, after which the surface of the glass tube with tap water washed 3 min, to achieve cooling purposes. Then distilled water was used to dilute the color liquid to 5 mL, and the spectrophotometer was set at 508 nm for colorimetry, and the light absorption value was recorded.

Sucrose enzyme activity was expressed as mg of glucose per unit of soil after one day

Glucose (mg) =100 × a

(100 is the conversion unit; A: the number of mg of glucose from the standard curve)

2.4 Soil Physical and Chemical Properties

2.4.1 Soil Bulk Density

After measuring the quality of the ring knife, go to the tea garden to take soil samples. Level the area where the soil samples will be taken. After levelling, vertically insert the ring knife into the soil, with one end of the blade downward, until the soil column reaches the upper end of the ring knife. Clean up the soil around the ring knife with a shovel and then remove the ring knife, remove the excess soil with a soil cutting knife, cover the edge of the ring knife with filter paper, and bring the bottom cover back to the laboratory for future use. The soil bulk density calculation formula is as follows:

Soil bulk density (g / cm^3) = dry soil / ring knife volume

Dry soil weight in ring knife (g) =100 wet soil weight in ring knife /100 soil moisture content

2.4.2 Soil Moisture Content

Prepare aluminium boxes, and collect about 10 g of soil samples. Open the lid of the box before putting it into the oven. The oven temperature is set at 105 °C and the drying time is 8 h. Then the aluminium box was taken out and weighed, and then the aluminium box was put into the oven to dry for 3 h until the difference between the two weighing was less than 0.05 g.

$$W\,\% = (g1-g2) / (g2-g) \times 100\%$$

W: water content of soil (%), g: weight of aluminium box (g), g1: weight of humidified soil in aluminium box (g), g2: weight of aluminium box plus dry soil (g)

2.4.3 Soil Ph

Weigh 20g of air-dried soil samples processed by 2mm aperture sieve and put them in a 50ml beaker, add 20ml of distilled water, and stir the soil suspension continuously for 5 minutes with a glass rod. After the soil particles are fully dispersed, stand for 30min for measurement. When measuring, the pH meter is inserted into the beaker of the solution to be measured, and the pH value of the soil sample is recorded when the reading is stable. The pH meter is removed, and the pH meter is washed with distilled water to remove Carbon dioxide. Then, the moisture can be dried with filter paper before the measurement of the next soil sample.

2.4.4 Soil Temperature

Soil temperature was measured with a soil thermometer every 2 h from 6:00 to 18:00, randomly selected three points in the tea garden. Finally, multiple values were analysed to obtain the soil temperature of each tea field.

3 RESULTS AND ANALYSIS

3.1 Enzyme Activity

In Figure 1, hydrogen peroxide enzyme activities of HS, SM and ZB were 1.89± 0.11, 3.27± 0.89 and 5.70± 1.77, respectively. It can be seen that hydrogen peroxide enzyme activity of three types of tea gardens have significant differences. The hydrogen peroxide enzyme activity of the tea garden with fertilizer was the strongest, while the enzyme activity of the tea garden without any fertilizer was the weakest, indicating that both fertilizer and organic fertilizer could increase hydrogen peroxide enzyme activity.

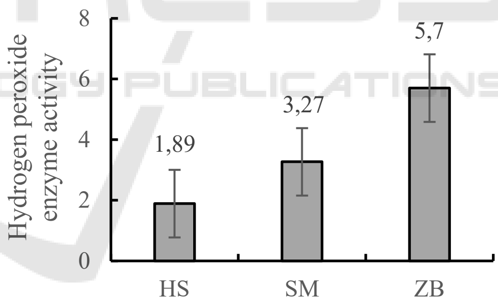

Figure 1: Hydrogen peroxide enzyme activity.

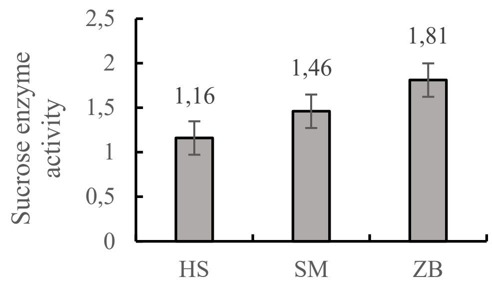

Figure 2: Sucrose enzyme activity.

Note: HS: tea fields treated without any fertilizer, SM: tea fields treated with organic fertilizer, ZB: tea fields treated with chemical fertilizer; Data in the figure were mean ± SD; N= 3; Different lowercase letters indicate significant differences in soil enzyme activity under different fertilizer application conditions. Same as below for icon annotation).

In Figure 2, sucrose enzyme activity data were 0.49± 0.91, 0.75± 0.16 and 1.17± 0.07, respectively. It can be seen both organic fertilizer and chemical fertilizer can promote sucrose enzyme.

3.2 Soil Physicochemical Property

Table 1: Soi physicochemical properties of tea garden.

parameter	HS	SM	ZB
Soil moisture (%)	17.3±3.05	31.3±1.53	26.67±3.22
Volume weight of soil (g/cm^3)	4.66±0.20	3.86±0.16	4.23±0.11
Soil temperature℃ (0-10cm)	16.64±1.90	16.56±3.35	16.62±2.68
Soil temperature℃ (10-20cm)	17.23±2.02	17.07±2.73	16.68±2.38
Soil pH	5.41±0.15	5.74±0.09	5.06±0.18

It can be found that the highest soil water content with organic fertilizer is 31.3 ± 1.53, and the lowest soil water content with no fertilizer is 17.3 ± 3.05. In terms of soil bulk density, the soil bulk density of organic fertilizer treatment was significantly lower than that of the other two treatments, which was 3.86 ± 0.16. In terms of soil temperature, there was no significant difference in soil temperature at the two depths of the three plots, which were 16.64 ± 1.90℃, 16.56 ± 3.35℃ and 16.62 ± 2.68℃ respectively. From the point of view of soil pH value, the weakest acidity of tea field without any fertilizer was 5.74 ± 0.09, and the strongest acidity was 5.06 ± 0.18 when fertilizer was applied.

4 DISCUSSION AND CONCLUSIONS

Long-term application of organic fertilizer can maintain and improve soil voidality, reduce soil bulk density and increase soil surface water content. On the contrary, long-term no fertilizer or only fertilizer will cause poor soil voidality, soil bulk density increases, resulting in soil compaction, reduce soil water storage capacity. Long-term use of fertilizers also acidifies the soil, reducing its pH. The results of this experiment are similar to those of the above studies. The soil bulk density of tea garden with long-term application of organic fertilizer is significantly lower than that of tea garden with long-term application of chemical fertilizer and without fertilizer, while the soil pH and soil water content are significantly higher than those of the latter two treatments.

It can be seen from the experimental data that the activities of catalase and sucrase in the tea garden with low soil bulk density are higher than those in the back mountain without fertilizer. The activities of catalase and sucrase were the strongest in the tea field with chemical fertilizer, because the application of chemical fertilizer had a significant effect on the enzyme activity in the short term, but the long-term application of chemical fertilizer had a negative effect on the soil quality and enzyme activity. In the experimental data, the enzyme activity was the lowest in the plot with the highest temperature, and increased in the plot with the lower temperature.

There were obvious differences in enzyme activities in tea tree soil with different fertilizers, and soil enzymes were closely related to soil fertility. Chemical fertilizer can obtain more nutrients in the short term and increase soil enzyme activity, so the effect of chemical fertilizer treatment is the most significant. However, long-term use of chemical fertilizers is not conducive to the sustainable use of soil.

Through the experimental data, it is concluded that under the conditions of larger soil humidity, moderate temperature, low soil bulk density and low soil pH, it is conducive to the life and reproduction of microorganisms, the increase of microbial number, the increase of soil enzyme activity and the growth of tea trees. The experiment was carried out in the dry season and the plants were in a certain water shortage condition. According to the experimental data, the application of chemical fertilizer or organic fertilizer can promote the physiological activities of microorganisms and increase the soil water content. So, in the dry season, tea plants will not grow poorly because of the lack of water or nutrients in the soil. Sufficient water retention capacity and active microorganism have certain advantages for tea plant growth in dry season, thus improving the yield and quality of tea in spring next year.

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