Yuetian soil conditioner can enhance the output, decrease the concentration of heavy metals of areca taro and reduce soil acidity

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Abstract. The influences of using several dosages of Yuetian soil conditioner on the output, heavy metal concentration of areca taro and soil basic fertility characteristics were studied by field plot experiment. Outcomes indicated that the output of areca taro enhanced by 6.2%~12.8%, As concentration decreased by 28.9%~40.0%, Hg concentration decreased by 28.6%~50.0%, soil pH value enhanced by 4.0%~34.9%, exchangeable acid decreased by 10.5%~95.2%, available phosphorus decreased by 36.4%~54.6%, and the concentration of organic matter, hydrolytic nitrogen and available K was different, but the concentration of Pb, Cd and Cr enhanced, and the concentration of Hg and As was different.

1. Introduction

Under the influences of high-temperature and rainy natural conditions and human factors of high-intensity development and utilization of farmland, especially driven by excessive application of chemical fertilizer by farmers in pursuit of high-output in recent years, the problem of acidification of cultivated soil is becoming increasingly serious [1,2]. Because the soil acidification in the cultivation layer causes the decrease of bioavailability of nitrogen, phosphorus and other nutrient elements, soil hardening, and the enhance of concentration of aluminum, iron, manganese and some toxic and harmful heavy metals in the soil [3,4].

Yuetian soil conditioner is a kind of natural mineral raw material rich in calcium, magnesium, silicon, molybdenum and other mineral elements. After industrial activation treatment, it is grinded and processed into micron level powder. Because of its huge contact surface area of soil, it can be fully mixed with the soil evenly, so that the influence nutrient utilization rate can reach the maximum, and timely supplement the medium and small amount of soil which is easy to be lacked elements (such as calcium, magnesium, silicon, molybdenum, etc.). There are a few reports on the experiment of Yuetian soil conditioner in acidified farmland. For example, Ye Yuzhen's research Outcomes indicated that the use of Yuetian brand product 1200 kg/ha on acid soil could influencevily improve the emergence rate of Chinese yam, promote vine growth, enhance its commerciality, and enhance its output and nutritional quality[5]; For another, Wu Lingyun's research Outcomes indicated that, the application of Yuetian brand product 2250 kg/ha could enhance the pH
value of the cultivated soil by 18.4%, significantly improve the agronomic characteristics of cauliflower, and significantly decrease the incidence of cauliflower root swelling, which also had a certain promoting influence on the output of cauliflower\cite{5}. It can be seen that the use of Yuetian brand product in acid farmland has shown a good influence of increasing production and improving soil. However, there are few reports about the application influence of Yuetian brand soil conditioner products on other crops, so it is necessary to further study the application influence on other crops.

Areca taro is the main crop for farmers to enhance their income in Changting county Nanping city, Fujian province. It has an annual planting area of 3300 ha and an annual output value of more than 300 million RMB yuan. It is the third largest planting crop after rice and tobacco and it is also a major industry for Changting county to get rid of poverty and become a well-off society. However, in recent years, due to soil acidification, the output of areca taro has been significantly decreased, soil hardening, nutrient imbalance and soil borne diseases have become increasingly serious. The enhance of soil acidity has led to the enhance of the activity of major toxic and harmful heavy metals in the soil, which has seriously affected the edible and hygienic quality of areca taro products, and has seriously hindered the sustainable and healthy development of areca taro industry in Changting county.

In this paper, areca taro was used as a test crop. The output, heavy metal concentration of areca taro and basic soil properties were studied by using several dosages of soil conditioner products of Yuetian brand.

2. Materials and methods

The field trial was planed in the betel nut and taro planting base of Songlin village, Hetian Town, Changting County, Fujian Province. Six treatments with several doses of Yuetian Brand product were designed: T1, Control; T2, 750 kg/ha; T3, 1125 kg/ha; T4, 1500 kg/ha; T5, 1875 kg/ha; T6, 2250 kg/ha. Different dosage levels of Yuetian brand products were used in each treatment. Each treatment was repeated 3 times, with an area of 20m$^2$ in each experimental plot.

The tested soil conditioner products of Yuetian brand (main technical indexes were CaO $\geq$ 20%, MgO $\geq$ 10%, SiO$_2$ $\geq$ 12%, pH 10~12) were produced and provided by Guangdong Wanshan Soil Remediation Technology Co., Ltd. The Yuetian products used in each treatment were combined with soil preparation and mixed with base fertilizer for uniform application. The tested crop was areca taro, and the main cultivar was Changting areca taro. On March 4, 2019, soil conditioner was applied in combination with land preparation. After the soil conditioner being fully mixed with the arable soil, the border would be prepared and the areca taro seed stem would be planted. On October 30, the soil samples of 0-20cm superficial layer were collected, and then the output was measured. Sampling method: 5 areca taro plants were randomly collected in each experimental plot, and 1kg of them were taken as plant samples to be detected.

3. Outcomes and analysis

3.1. Influence of different amount of Yuetian soil conditioner on output of areca taro

ROutcomes (Table 1) indicated that: compared with the T1, the use of several doses of Yuetian brand soil conditioner could enhance the output of areca taro to a certain extent (underground tuber, the same below), the increasing value was 1083~2233 kg/ha, and the increasing rate was 6.2%~12.8%. The linear regression equation between the amount of soil conditioner (x) of Yuetian brand and the output of areca taro was fitted. It was concluded that the equation $y=-0.0013x^2+3.3933x+17533$ ($R^2 = 0.9666**$) could fit well (Figure 1). According to the regression equation, when the amount of soil conditioner is 1305 kg/ha, the highest output of areca taro is 19747 kg/ha.

| Treatment | Output of plot (kg/20m$^2$) | Output Increasing rate (%) | Equivalent output (kg/hm$^2$) |
|-----------|-----------------------------|----------------------------|-------------------------------|
| T 1       | 34.95                       |                            | 17475                         |
| T 2       | 39.05                       | 11.7                       | 19525                         |
| T 3       | 39.08                       | 11.8                       | 19542                         |
| T 4       | 39.42                       | 12.8                       | 19708                         |
| T 5       | 38.03                       | 8.8                        | 19017                         |
| T 6       | 37.12                       | 6.2                        | 18558                         |
Fig. 1 Linear regression relationship between the amount of Yuetian Brand product and the output of areca taro

### 3.2 Influence of several doses of Yuetian Brand product on heavy metal concentration of areca taro

Outcomes (Table 2) indicated that the As concentration of areca taro could be decreased to a certain extent by using several dosages of Yuetian product, with a decreasing range of 28.9%~40.0%; the Hg concentration of areca taro could also be decreased in general (except for treatment 5), with a reduction range of 28.6%~50.0%; while the influences on Cd, Pb and Cr concentration of areca taro were different, except for treatment 6 and treatment 3 could decrease the Cd concentration of areca taro by 20.9% and 14.5% respectively, treatment 4 could decrease the Pb concentration of areca by 62.9%, treatment 2 and treatment 3 could decrease the Cr concentration of areca by 29.7% and 18.9% respectively, while other treatments indicated an increasing trend.

| Treatment | Cd (mg/kg) | Increasing rate (%) | Pb (mg/kg) | Increasing rate (%) | Hg (mg/kg) | Increasing rate (%) | Cr (mg/kg) | Increasing rate (%) | As (mg/kg) | Increasing rate (%) |
|-----------|------------|---------------------|------------|---------------------|------------|---------------------|------------|---------------------|------------|---------------------|
| T1        | 0.110      | \                  | 1.78       | \                  | 0.014      | \                  | 0.74       | \                  | 0.45       | \                  |
| T2        | 0.170      | 54.5                | 2.18       | 22.5               | 0.010      | -28.6              | 0.52       | -29.7              | 0.31       | -31.1              |
| T3        | 0.094      | -4.5                | 3.37       | 89.3               | 0.007      | -50.0              | 0.60       | -18.9              | 0.27       | -40.0              |
| T4        | 0.210      | 90.9                | 0.66       | -62.9              | 0.009      | -35.7              | 0.90       | -21.6              | 0.28       | -37.8              |
| T5        | 0.170      | 54.5                | 2.44       | 37.1               | 0.017      | 21.4               | 0.88       | 18.9               | 0.27       | -37.8              |
| T6        | 0.087      | -20.9               | 3.09       | 73.6               | 0.010      | -28.6              | 1.28       | 73.0               | 0.32       | -28.9              |

Note 1: The heavy metal concentration of areca taro in the table was calculated on the basis of drying.

Note 2: The moisture concentration of fresh areca taro was 67%.

### 3.3. Influence of different amount of soil conditioner of Yuetian brand on the basic properties of soil after harvest of areca taro

#### 3.3.1 Influence of different amount of Yuetian Brand product on soil pH value and exchangeable acid concentration

Outcomes (Table 3) indicated that the use of several doses of Yuetian brand product could enhance the soil pH value to some certain extent, with an enhance range of 4.0%~34.9%; and could decrease the exchangeable acid of the soil after harvest to a certain extent, with a decrease range of 10.5%~95.2%. Among them, treatment 6 had a relatively good influence on improving soil pH value and reducing soil exchangeable acid concentration.
### Table 3: Influence of different amount of Yuetian product on soil pH value and exchangeable acid concentration

| Treatment | pH Value | pH Increasing rate (%) | Exchangeable acid | Exchangeable acid Increasing rate (%) |
|-----------|----------|------------------------|-------------------|---------------------------------------|
| T1        | 4.5      | \                       | 32.3              | \                                     |
| T2        | 4.7      | 4.0                    | 28.9              | -10.5                                 |
| T3        | 5.6      | 22.5                   | 11.6              | -64.1                                 |
| T4        | 5.3      | 17.9                   | 12.8              | -60.4                                 |
| T5        | 6.0      | 31.8                   | 4.18              | -87.0                                 |
| T6        | 6.1      | 34.9                   | 1.54              | -95.2                                 |

### 3.3.2 Influence of different amount of Yuetian product on the concentration of soil basic nutrients after harvest of areca taro

Outcomes of the experiment (Table 4) indicated that the concentration of available phosphorus in the soil after harvest of areca taro indicated a decreasing trend (except for treatment 2) to some extent by applying different amount of soil conditioner of Yuetian brand, and the decreasing rate ranged from 36.4% to 54.6% respectively, while the concentration of soil organic matter, soil hydrolytic nitrogen and available potassium varied. Among which, the concentration of soil organic matter of treatment 2 and treatment 4 decreased by 3.4% and 9.5%, respectively. But the concentration of soil organic matter of other treatments enhanced by 1.4%~7.2%; for the concentration of soil hydrolytic nitrogen, treatment 3 and 4 decreased by 5.2% and 6.5%, respectively, while that of other treatments enhanced by 6.9%~23.8%; for the concentration of soil available potassium, treatment 4 and treatment 5 decreased by 38.0% and 54.0%, respectively, while that of other treatments enhanced by 14.8%~46.7%.

### Table 4: Influence of several amount of Yuetian product on the concentration of soil basic nutrients

| Treatment | Organic matter (g/kg) Increasing rate (%) | Hydrolytic nitrogen (mg/kg) Increasing rate (%) | Available phosphorus (mg/kg) Increasing rate (%) | Available potassium (mg/kg) Increasing rate (%) |
|-----------|------------------------------------------|-----------------------------------------------|-----------------------------------------------|-------------------------------------------------|
| T1        | 63.6                                     | \                                           | 89.4                                         | \                                               |
| T2        | 61.5                                     | -3.4                                         | 233                                          | 23.8                                            |
| T3        | 64.5                                     | 1.4                                          | 179                                          | -5.2                                            |
| T4        | 57.6                                     | -9.5                                         | 176                                          | -6.5                                            |
| T5        | 66.2                                     | 4.1                                          | 220                                          | 16.8                                            |
| T6        | 68.2                                     | 7.2                                          | 202                                          | 6.9                                             |

### 3.3.3 Influence of different amount of Yuetian soil conditioner on the concentration of available heavy metals in the soil after harvest of areca taro

Table 5: Influence of different amount of Yuetian soil conditioner on the concentration of available heavy metals in the soil after harvest of areca taro

| Treatment | Available Hg (mg/kg) Enhance rate (%) | Available As (mg/kg) Enhance rate (%) | Available Pb (mg/kg) Enhance rate (%) | Available Cd (mg/kg) Enhance rate (%) | Available Cr (mg/kg) Enhance rate (%) |
|-----------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
| T1        | 0.017                                 | 1.276                                | 5.04                                 | 0.040                                | 0.10                                 |
| T2        | 0.018                                 | 0.989                                | -22.5                                | 11.5                                 | 0.047                                |
| T3        | 0.014                                 | 1.537                                | 20.4                                 | 9.82                                 | 94.7                                 |
| T4        | 0.017                                 | 1.207                                | -5.4                                 | 11.4                                 | 126.2                                |
| T5        | 0.024                                 | 1.423                                | 11.5                                 | 13.3                                 | 163.7                                |
| T6        | 0.016                                 | 1.502                                | 17.7                                 | 13.1                                 | 158.9                                |

Outcomes (Table 5) indicated that: compared with T1, (1) the concentration of Pb, Cd and Cr in the soil after harvest of areca taro enhanced by 94.7%~163.7%, 17.1%~65.5% and 5.8%~33.6%, respectively, with the use of different Yuetian brand product. (2) The influence of treatment 3 and treatment 6 on the concentration of available Hg was different, and the decrease rate was 14.1% and 6.3% respectively, while the other treatments indicated a slight enhance trend, the enhance range was 4.3%~45.8%. (3) The influences of different treatments on the As concentration of soil were also different. Treatment 2 and 4 indicated a decreasing trend, with the decreasing rates of 22.5% and 5.4% respectively, while other treatments indicated an increasing trend, with the increasing rates of 11.5%~20.4%.
4. Conclusion

Outcomes indicated that: compared with the CK (treatment 1), the use of several doses of Yuetian brand product could enhance the output of areca taro by 6.2% ~ 12.8%, decrease the As concentration of areca taro by 28.9%~40.0%, Hg concentration by 28.6%~ 50.0%, enhance the soil pH value by 4.0%~34.9%, decrease the exchangeable acid by 10.5% ~ 95.2%, and decrease the available phosphorus by 36.4% ~ 54.6%. However, the concentrations of soil organic matter, soil hydrolytic nitrogen and available potassium were different, while the concentrations of Pb, Cd and Cr were increasing, and the concentrations of Hg and As were different.

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