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# Tebei calcium oyster powder may enhance rice output, decrease rice heavy metal concentration and reduce soil acidity

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**Abstract.** The influences of several doses of Tebei calcium oyster powder on rice output, heavy metal concentration and basic soil fertility characteristics were studied by field plot experiment. Outcomes indicated that the use of several doses of Tebei calcium oyster powder could raise the dry matter output of rice by 5.24%~20.65%, reduce the Cd and Pb concentration of rice by 7.80%~53.67% and 12.63%~60.10%, raise the pH value of soil by 4.1%~24.5%, decrease the exchangeable acid (potential acid) by 1.0%~53.8%, and decrease the concentration of Influenceive Cd and Pb by 64.22%~77.98% and 4.65%~22.59%, respectively.

## 1. Introduction

Under the double influences of the natural conditions of regional high temperature and rainy weather and the man-made factors of high intensity exploitation and utilization of farmland, in particular, driven by the large amount of chemical fertilizers used by farmers in pursuit of high output and by the increasing damage of acid rain in recent years, the trouble of soil acidification of cultivated land in Red-soil Region of Southern China has become increasingly serious<sup>[1,2]</sup>. Soil acidification caused soil compaction, the decrease of biological availability of nutrient elements such as nitrogen and phosphorus, and the increase of metal ions such as aluminum, iron, manganese and toxic and harmful heavy metal elements in soil<sup>[3]</sup>.

Tebei calcium oyster powder is made of oyster shell with the procession of "protective baking and staged activation" and particle size separation. Using the procession, almost of the organic nutrient elements of oyster shell would be kept<sup>[4,5]</sup>. And trial results has proved that Tebei calcium oyster powder is an good soil conditioner. At present, it has been reported that the use of Tebei calcium oyster powder on the acid farm soil may obviously increase the output of some agriculture products such as vegetable, peanut, Panax notoginseng, and so on<sup>[6-8]</sup>, but it is rarely researched about the using results on other crops.

In order to accelerate the popularization and application of Tebei calcium oyster powder products on crops, rice was selected as the trial crop mater to researched the influences of using several dosages of Tebei calcium product on rice output, heavy metal concentration and basic soil fertility



characteristics. The aim of this paper is to provide Tebei calcium oyster powder products for the treatment of acidified paddy soil.

## 2. Materials and methods

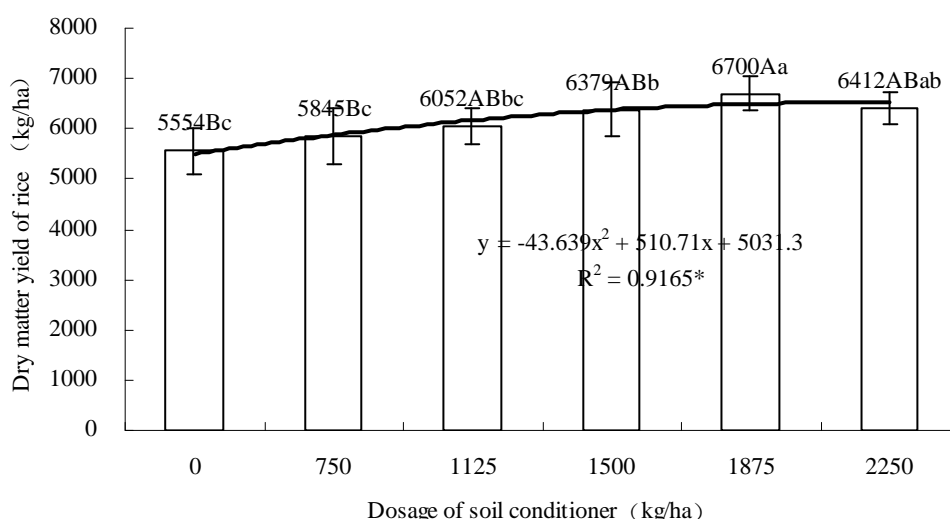
The test was assigned in the betel nut and rice planting base of Xiaosong Town, Jian'ou City, Fujian Province. Six treatments were designed with several dosage of Yuetian brand soil conditioners, for examples: T1, Control; T2, 750 kg/ha; T3, 1125 kg/ha; T4, 1500 kg/ha; T5, 1875 kg/ha; T6, 2250 kg/ha. Each treatment was repeated 3 times, and the area of each trial plot was 20m<sup>2</sup>. Tebei calcium oyster powder products were made and offered by Fujian Mata Agricultural Development Co., Ltd.

Except for the use of several dosages of Tebei calcium oyster powder product, other farming measures of each treatment were exactly the same of the daily field management. Tebei calcium oyster powder products of each treatment were combined with soil preparation and base fertilizer application on June 25, 2019. Rice was selected as the tested crop in this trial. It was sowed on May 25, and transplanted seedlings on June 26. The samples of rice and soil were collected from each plot and the output of rice was measured on September 29.

The soil and plant samples were analyzed and determined with references<sup>[9]</sup>.

## 3. Outcomes and analysis

### 3.1. Influence of several doses of Tebei calcium oyster powder on dry matter output of rice



**Fig. 1** Influence of several doses of Tebei calcium oyster powder on dry matter output of rice

Outcomes (Fig. 1) indicated that the use of several doses of Tebei calcium oyster powder product could raise the dry matter output of rice to some extent. the raise range of dry matter output of rice was 5.24%~20.65%, compared with CK (T1). Among all treatments, T5 (1875 kg/ha) had a better influence on the raise of rice dry matter output .

The linear regression equation between the amount of Tebei calcium oyster powder product (x) and the output of rice dry matter (y) was fitted. It was concluded that the quadratic equation  $y = -43.639x^2 + 510.71x + 5031.3$  ( $R^2 = 0.9165^*$ ) could be used for better fitting (Figure 1).

### 3.2. Influences of several doses of Tebei calcium calcium oyster powder product on heavy metal concentration in Rice

Outcomes (Table 1) indicated that the use of several doses of Tebei calcium oyster powder product could decrease the concentration of Cd and Pb of rice to some extent, with the reduction range of 7.80%~53.67% and 12.63%~60.10% respectively; among them, treatment 5 and treatment 6 had a better influence on the reduction of Cd and Pb concentration of rice.

**Table 1** Influences of several doses of Tebei calcium oyster powder product on heavy metal concentration in rice

Treatment	Cd		Pb	
	Concentration (mg/kg)	Increasing rate (%)	Concentration (mg/kg)	Increasing rate (%)
T1	0.218Aa	\	0.198Aa	\
T2	0.201Aa	-7.80	0.173Aa	-12.63
T3	0.182ABab	-16.51	0.152Aab	-23.23
T4	0.150ABb	-31.19	0.115ABb	-41.92
T5	0.101Bc	-53.67	0.083Bc	-58.08
T6	0.112Bc	-48.62	0.079Bc	-60.10

### 3.3. Influences of several doses of Tebei calcium soil conditioner on soil pH and exchangeable acid concentration after rice harvest

**Table 2** Influences of several doses of Tebei calcium oyster powder product on soil pH and exchangeable acid concentration

Treatment	pH		Exchangeable acid	
	Value	Increasing rate (%)	Concentration (mmol/L)	Increasing rate (%)
T1	4.9Aa	\	3.92Aa	\
T2	5.1Aa	4.1	3.88Aa	-1.0
T3	5.2Aa	6.1	3.53Aa	-9.9
T4	5.4ABa	10.2	2.86Ab	-27.0
T5	5.8ABb	18.4	2.12Bc	-45.9
T6	6.1Bb	24.5	1.81Bc	-53.8

Outcomes (Table 2) indicated that the use of several doses of Tebei calcium oyster powder product could raise soil pH by 4.1% ~ 24.5%; and could reduce the soil exchangeable acid (potential acid) by 1.0% ~ 53.8%. Inside them, T6 had got a better result on increasing soil pH and decreasing exchangeable acid concentration than others.

### 3.4. Influence of several doses of Tebei calcium oyster powder product on the concentration of soil effective heavy metals

Outcomes (Table 3) indicated that the concentration of soil effective Cd and Pb decreased with the use of several doses of Tebei calcium oyster powder product, with the decrease range of 64.22%~77.98% and 4.65%~22.59%, respectively.

**Table 3** Influence of several doses of Tebei calcium oyster powder product on the concentration of effective heavy metals in soil

Treatment	Effective Cd		Effective Pb	
	Concentration (mg/kg)	Increasing rate (%)	Concentration (mg/kg)	Increasing rate (%)
T1	0.087a	\	1.912a	\
T2	0.078b	-64.22	1.823a	-4.65
T3	0.069b	-68.35	1.764a	-7.74
T4	0.061b	-72.02	1.697a	-11.24
T5	0.058b	-73.39	1.587ab	-17.00
T6	0.048b	-77.98	1.480b	-22.59

#### 4. Conclusion

The outcomes indicated that the dry matter output of rice was raised by 5.24%~20.65% when treated with several doses of Tebei calcium oyster powder product compared with CK (T1), in which T5 (1875 kg/ha) had got a better result than others on the rice dry matter output. And it could decrease the rice concentration of Cd and Pb by 7.80~53.67% and 12.63%~60.10%, respectively. Inside them, T5 and T6 had got a better result than other treatments on decreasing the heavy metal concentration of rice. After rice harvest, the pH value of soil was raised by 4.1% ~ 24.5%, the exchangeable acid (potential acid) was decreased by 1.0%~53.8%, and the concentration of soil effective Cd and Pb was decreased by 64.22% ~ 77.98% and 4.65% ~ 22.59%, respectively. In general, under the conditions of this experiment, the influence of using Tebei calcium oyster powder product (1875-2250kg/ha) on rice output, concentrations of heavy metal elements and decreasing of soil acidity is relatively better. It is suggested that Tebei calcium soil conditioner should be widely used in acid rice field in red soil area.

#### 5. Acknowledgments

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