

Study on the Effect of Compound Microbial Fertilizer on Rice Yield

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Abstract

In order to clarify the application effect of compound microbial fertilizer (slurry granulation), a trial on the application effect of compound microbial fertilizer (slurry granulation) on rice was carried out. The results showed that the application of compound microbial fertilizer (spray slurry granulation) on rice can replace the use of chemical fertilizer in equal amount, and the effect of increasing yield and improving quality is remarkable.

Keywords

Rice; Compound microbial fertilizer (slurry granulation); Traits; Yield.

1. Introduction

In recent years, excessive fertilizer application not only destroys soil structure, is prone to pests and diseases, threatens food safety, but also when the amount of fertilizer applied exceeds the soil's ability to maintain, it flows into the surrounding water, forms agricultural non-point pollution, causes eutrophication of water bodies, leads to algae growth and consequently damages the water environment [1-2]. Composite microbial fertilizer is a kind of "three-in-one" fertilizer which integrates beneficial microorganism, organic fertilizer and inorganic fertilizer [3-4]. Composite microbial fertilizer products on the market have achieved a breakthrough in the technology from powder and disc, roller granulation to grouting, which has laid the foundation for improving the commercialization, validity and area extension of composite microbial fertilizers [5].

Composite microbial fertilizer [6] (spray granulation) means a living microorganism which, by means of a combination of specific microorganisms and nutrients, is capable of providing, maintaining or improving plant nutrition, increasing the yield of agricultural products or enhancing their quality. Studies have shown that the use of complex microbial fertilizers during the growth stage of rice can improve not only yield but also the soil environment in paddy fields [7]. Composite microbial fertilizers have been widely used in agricultural production at present [8]. In this paper, composite microbial fertilizer (spray granulation), conventional fertilization and matrix inactivation treatment of compound microbial fertilizers (slurry granulating) were used in field trials to verify the effects of different fertilization conditions on rice yield and indirectly to reflect the effect on soil fertility.

2. Materials and Methods

2.1. Experimental Site and Soil

The test site was located in Baishangsi Village, Shitan Town, Xiangtan County, Hunan Province, China. The test soil is a red and yellow clay developed in the Quaternary red clay, with a clay loam texture, moderate and uniform fertility, convenient drainage and irrigation, and the

planting level is comparable to the local production level, and no fertilizer test has been done in recent years. The results of soil sample analysis before the test were as follows: soil organic matter content 31.1 g/kg, pH 6.22, 131.0 mg/kg of alkaline nitrogen, 19.3 mg/kg of effective phosphorus, and 49.0 mg/kg of fast-acting potassium. the test plots were flat and convenient for irrigation and drainage. The previous crop was rice.

2.2. Test Materials

The rice variety under test was early rice, "Strain Two Superior 120". The compound microbial fertilizer (pelletized by slurry) was produced by Hunan Yuyuan Biotechnology Co., Ltd. The product was black-brown granules, containing ≥ 0.2 billion live bacteria/g (*Bacillus* jelly-like and *Bacillus subtilis*); total nutrients = 25%; organic matter $\geq 20\%$; the implementation standard NY/T 798-2015.

2.3. Experimental Design

The experiment was set up with 4 treatments and 3 replications, with a total of 12 plots. The plot area was 20 m² (4 m×5 m) plots were arranged in randomized groups. Treatment A (compound microbial fertilizer (spray slurry granulation)): 80 kg/667m² of compound microbial fertilizer (spray slurry granulation) was applied, 1/2 of which, i.e., 40 kg/667m², was applied as base fertilizer at the time of land preparation, and the other 1/2 was applied as re-greening fertilizer on the 5th day after transplanting. Treatment B (conventional fertilization): 24.7 kg/667m² of urea, 42 kg/667m² of calcium superphosphate and 10.4 kg/667m² of potassium chloride were applied. Among them, 17.4 kg of urea, 42 kg of calcium superphosphate and 6.2 kg of potassium chloride were applied as basal fertilizer at the time of land preparation, and 7.3 kg of urea and 4.2 kg of potassium chloride were applied as re-greening fertilizer on the 5th day after transplanting. Treatment C (substrate treatment): 80 kg of compound microbial fertilizer (spray slurry granulation) was inactivated, 1/2 of which, i.e. 40 kg/667m², was applied as basal fertilizer at the time of land preparation, and the other 1/2 was applied as re-greening fertilizer on the 5th day after transplanting. Treatment D (blank control): no fertilizer was applied.

2.4. Trial Implementation

Seeding was used on March 25, 2020, and the land was prepared on March 26, 2020, and the leveled rice fields were divided into 3 zone groups of 12 plots. Ridges were raised at plot intervals and covered with film to isolate the ridges, harrowed manually, and harrowed once more after applying fertilizer to the mud according to the trial requirements. rice seedlings of comparable growth were selected for manual transplanting on April 15, with a transplanting density of 5" × 6". rejuvenation fertilizer was applied on April 20 according to the trial design. yield-related data were measured on July 14.

3. Results and Analysis

3.1. Effect on Biological Traits of Rice

The results of the seed test showed (Table 1) that the economic traits of early rice treated with compound microbial fertilizer (spray slurry granulation), including plant height, effective number of spikes per 667m², number of solid grains per spike, and total number of grains, were improved compared with the conventional fertilizer treatment, the substrate treatment, and the blank control treatment. It indicates that the application of compound microbial fertilizer (spray slurry granulation) to early rice still has some effects on the biological traits of rice.

Table 1. Effect of different treatments on economic characters of early rice

Treatment	Average plant height (cm)	Average effective spike number (million spikes/667m ²)	Average number of solid grains (grains/spike)	Average total number of grains (grains/spike)	Average fruit set rate (%)	Average theoretical yield (kg/667m ²)
A	89.3	28.4	70.3	79.1	88.8	498.6
B	86.2	27.1	67.6	75.4	89.7	448.1
C	85.1	27.0	66.1	75.0	88.1	440.2
D	76.4	23.2	50.8	72.9	69.7	260.9

3.2. Effect of Different Fertilization Treatments on Rice Yield

Table 2. Control of rice yield with different fertilizer treatments (kg/667m²)

Treatment	Repeat 1	Repeat 1	Repeat 1	Mean	Control B	ControlC	ControlD
A	457.5	440.9	468.8	455.7	37.5	43.5	198.8
B	420.1	418.8	415.6	418.2		6.0	161.3
C	410.5	412.6	413.5	412.2			155.3
D	250.1	262.4	258.1	256.9			

Table 3. Analysis of variance of rice yield with different fertilizer treatments

Source of variation	Degree of freedom	Sum of squares	Mean square	F value	F0.05	F0.01
Between Treatments	3	69777.069	23259.023	330.659	4.757	9.780
Between Replications	2	65.232	32.616	0.464	5.143	10.925
Error	6	422.048	70.341	—	—	—
Total variation	11	70264.349	—	—	—	—

Rice yields of different fertilizer application treatments were analyzed by ANOVA and the F value between treatments was greater than 0.01 and the difference reached a highly significant level. The highest yield was achieved in treatment A, which was 37.5 kg/667m² higher than B, with a yield increase of 8.97%, and the difference reached a significant level; compared with C, the yield increased by 43.5 kg/667m², with a yield increase of 10.55%, and the difference reached a significant level; compared with D, the yield increased by 198.8 kg/667m², with a yield increase of 77.38%, and the difference reached a highly significant level.

Table 4. Multiple comparisons of rice yields with different fertilizer treatments

No.	Treatment	Mean value (kg/667m ²)	Significance level	
			5%	1%
1	A	455.7	a	A
2	B	418.2	b	B
3	C	412.2	b	B
4	D	256.9	c	C

3.3. Economic Benefit Analysis of Different Fertilization Treatments

Table 5. Comparison of benefits of different fertilization treatments

Treatment	Fertilizer application amount (kg/667m ²)	Fertilizer price (CNY/ton)	Input fertilizer cost (CNY/667m ²)	Gain(CNY/667m ²)	Control B(CNY/667m ²)	Control C(CNY/667m ²)	Control D(CNY/667m ²)
A	80	1750.00	140.0	1090.39	62.15	109.45	396.76
B	77.1		100.9	969.64	-	47.3	276.01
C	80	1650.00	132.0	980.94	-	-	334.61
D	-	-	0	693.63	-	-	-

Note: Based on the price of rice at RMB 2.7/kg, urea at RMB 1.8/kg, calcium superphosphate at RMB 0.7/kg, and potassium chloride at RMB 2.6/kg.

4. Conclusion

(1) The yield of rice applied with compound microbial fertilizer (spray slurry granulation) increased by 37.5 kg/667m² compared with conventional fertilizer application, with a yield increase of 8.97%, and the difference reached a significant level; compared with the substrate treatment, the yield increased by 43.5 kg/667m², with a yield increase of 10.55%, and the difference reached a significant level.

(2) The treatment of applying compound microbial fertilizer (spray slurry granulation) yielded 62.15 CNY/667m² more than conventional fertilizer application, 109.45 CNY/667m² more than the substrate treatment, and 396.76 CNY/667m² more than the blank control.

(3) The application of compound microbial fertilizer (spray slurry granulation) can get increased yield and income, and it is worth to promote vigorously.

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