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Abstract. In order to rationally apply organic fertilizer from black soldier fly (BSF) feces, the effects of different amounts (0, 2%, 4%, 6%, 8%) of BSF feces on rice growth were studied through rice pot experiments. The results showed that the dry matter mass and the yield of rice treated with 4% BSF feces were the highest, compared with the control, which were increased by 40.20% and 49.59%, respectively. While the application of 8% BSF feces inhibited the rice plant height, above-ground dry matter mass and rice yield, which were reduced by 9.98%, 22.59% and 22.66%, respectively. The 4% BSF feces promoted the growth of rice and increased yield, which is an reasonable amount of fertilizer.

Key words: rice; BSF feces; yield.

1. Introduction

Rice is China's largest food crop, Its planting area about 30.176 million hectares in 2017, the yield of rice accounts for about 30% of the grain volume. The total output has been stable for more than 200 million tons for seven consecutive years [1]. The use of chemical fertilizers is a main way to improve the yield of plant in agriculture [2]. With the background of China's 328.5 kg/hm^2 crop fertilizer application rate is higher than the world average [3], agricultural production has deteriorated soil properties, and soil fertility has declined, which will affect the quality and output of grain. Reasonable application of organic fertilizers and appropriate reduction of chemical fertilizer application can effectively improve the physical and chemical properties of soil, improve soil nutrients, and increase soil biological activity [4].

BSF feces organic fertilizer is a new type of bio-organic fertilizer produced by environmental insects to transform livestock and poultry manure. The feces organic fertilizer is rich in organic matter, which is beneficial to microbial populations, and its effect higher than that of poultry and animal manure [5]. Li WJ et al. [6] studies found that BSF transform pig dung into feces, which meet the standard of organic fertilizer, and using BSF feces can improve the growth quality of cabbage; Wu X et al. [7] found that the application of BSF feces could increase the yield of tomato. However, the application of BSF feces has not been reported on rice. The study of the effects on rice growth and soil properties provides a theoretical basis for the application of BSF feces organic fertilizer on rice.

2. Materials and Methods

2.1. Test materials

Variety rice: E28. Soil: taken from a rice field in Hubei, pH 6.24, EC 405 μs/cm, ammonium nitrogen 70.12 mg/kg, available phosphorus 12.23 mg/kg, available potassium 157.68 mg/kg, organic matter 6.52%. BSF feces (feces after BSF transforms chicken manure), its component content is as follows: pH value 8.3, organic matter content 64.00%, total nitrogen content 2.66%, total phosphorus (P_2O_5) Content is 5.03%, total potassium (K_2O) content is 3.80%.

The recovered rice soil was air-dried, ground, sieved through a 1cm sieve, and mixed for future use. The BSF transformed chicken dung into the feces, then made it air-dried, picked out impurities, and set aside.

2.2. Experimental design

This experiment was completed in Tianjin Agricultural University from April to November 2018. The experiment was set up with 5 different feces treatments, CK (0), 2%, 4%, 6%, 8%, each treatment 3 times repeatedly. First, we took a clean plastic bucket (35 * 27 cm) in and filled it with 10 kg of soil. Then, we added feces and stirred well. And then, it placed in a cool place to rot for one month. On May 2018, the paddies with consistent growth rice was selected to move into the plastic bucket, there had 4 seedlings per barrel. Plastic barrels were randomly arranged in the net chamber. During the entire planting period, the soil surface maintained a water layer of 3-5 cm for routine management.

2.3. Test method

The height and chlorophyll (SPAD) value of rice plant were measured at three times on July, August, and September. The rice plant height was measured using a tape measure, and the SPAD was measured using a pad-520 instrument. October, Rice was harvested, dried, and the dry matter quality and rice yield were measured.

2.4. Data analysis

The calculation and mapping of experimental data were completed using Excel software, and the significant difference analysis was performed using SPSS 17.0 ($p<0.05$).

3. Results and Analysis

3.1. Effects of different amounts of BSF feces on rice plant height.

It can be seen from Figure 1 that the rice plant heights of each treatment on August 15 were significantly higher than that of July 15, and the rice plant height on September 15 only the application of 6% BSF feces was higher than that of August 15, which increased 6.07%, and the other treatments had no significant changes compared to the previous month. On July 15, the rice plant heights with 2% and 4% feces were not significantly different from the control a. Compared with the control, the rice plant height of 6% and 8% feces significantly decreased by 10.77% and 24.15%. On August 15, the plant height of 6% and 8% feces decreased by 9.06% and 20.75% compared with the control. On September 15, there was no significant difference at the plant height of rice between the application of 2%, 4%, and 6% feces and the control, and the application of 8% feces rice plant height significantly reduced by 9.98%.

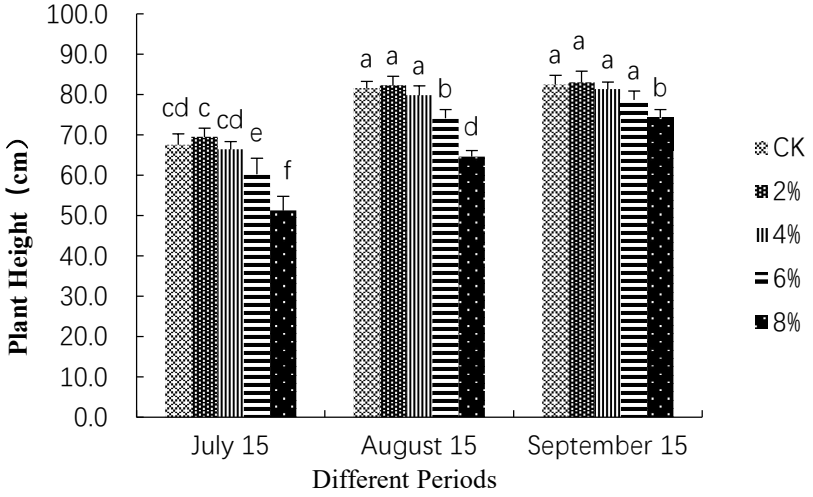

Figure 1. Effects of different amounts of BSF feces on rice plant height.

3.2. Effects of different amounts of BSF feces on rice SPAD value.

It can be seen from Figure 2 that with the increase of the application amount of BSF feces, the SPAD value of rice leaves also increased. On July 15, compared with the control, the application was 2%, 4%, 6% and 8% feces of rice, the SPAD value significantly increased by 5.54%, 5.70%, 7.99%, and 11.29%. On August 15, compared with the control, the SPAD value of rice with 2% feces showed no significant difference, but the SPAD value of rice with 4%, 6% and 8% feces significantly increased, which were increasing by 12.35%, 11.17%, and 12.16%, respectively. On September 15, compared with the control, the SPAD values of rice with 2% feces did not differ significantly. The SPAD value of rice with 4%, 6%, and 8% feces significantly increased, which were increasing by 11.89%, 11.66%, and 13.67%, respectively. As time goes on, the treated SPAD on August 15 were higher than those of on July 15. There is no significant difference between the processed SPAD value on September 15 and those of on August 15.

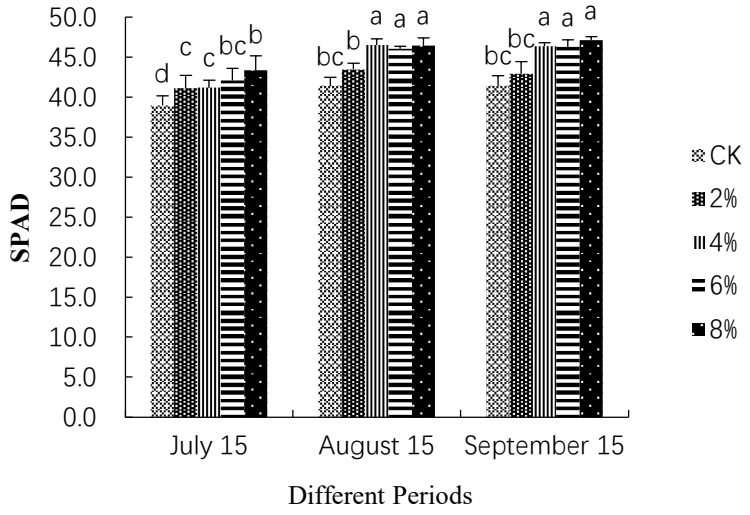

Figure 2. Effects of different amounts of BSF feces on the SPAD value of rice.

3.3. Effects of different amounts of BSF feces on aboveground dry matter quality of rice.
It can be seen from Figure 3 that the aboveground dry matter mass of rice with 4% feces was the highest, which was increased by 40.20% compared with the control. And with 2% and 6% feces of treatments improved by 17.96% and 15.08%, respectively. But there was no significant difference between the two. However, the 8% feces of treatment reduced by 22.59%, the result indicate that 8% feces of treatment inhibited the rice growth.

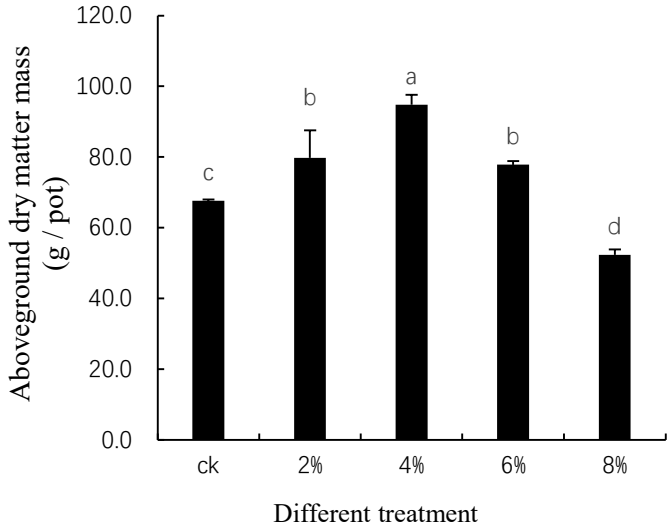

Figure 3. Effects of different amounts of BSF feces on aboveground dry matter quality of rice.

3.4. Effect of different amount of BSF feces on rice yield.
As Figure 4 showed that the order of rice yield between different treatments is: 4%> 2% = 6%> ck> 8%. Compared with the control, the rice yield with 4% feces of treatment was highest, which were increasing by 49.59%. The application of 2% and 6% feces of rice yield significantly increased by 31.79% and 22.59%, respectively. But there was no significant difference between the two. The yield with 8% feces of rice decreased by 22.66%.

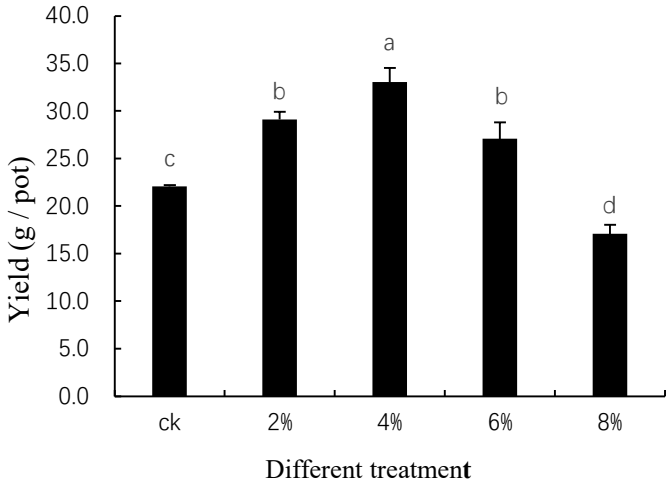

Figure. 4. Effects of different amounts of BSF feces on rice yield.

4. Discussion

Applying an appropriate amount of BSF feces organic fertilizer can significantly improve the chlorophyll content, above-ground dry matter and yield of rice plants. This may be due to the large amount of organic matter contained in BSF feces, which can activate the nutrients in the soil, improve the availability and utilization of fertilizers [8]. In addition, the intestinal tract of the insects contains a large number of microorganisms, which can produce a large number of beneficial active substances in feces through transformation, so that it can promote plant growth and development [9], thereby promote the growth of rice plants and increase rice yield. This result is consistent with Wu's [7] discovery that the application of BSF feces in soil can significantly increase tomato yield; Li [6] found the BSF feces transformed kitchen waste into insect dung significantly increased the width and length of rapeseed leaves compared to the control. In this experiment, the yield of rice with 4% BSF feces significantly increased, but the growth of rice plants with 8% feces significantly affected inhibition. The indexes of plant height, aboveground dry matter quality and yield were significantly lower than those of the control, and obvious greed appeared at the time of harvest. This may be due to the large amount of organic fertilizer applied and the soil itself higher organic matter content leads to imbalanced elements in rice plants, reduces rice resistance [10], and inhibits growth. Moreover, excessive application of feces organic fertilizer will release a lot of nutrients during mineralization, leading to the phenomenon of greed appeared, which cause the transfer of nutrients from greedy green rice to the ears was not smooth, make a large number of photosynthetic products remained in the vegetative organs and a large number of empty grains appeared [11], which eventually caused the harvest to reduce yield.

5. Conclusion

Compared with the control, the application of 4% BSF feces had the greatest effect on improving the SPAD values, aboveground dry matter and yield of rice, increasing 11.89%, 40.20%, and 49.59%, respectively. Application of 8% BSF feces inhibited the indexes of rice growth, above ground dry matter quality and rice yield, which were decreased by 9.98%, 22.59% and 22.66%, respectively. Therefore, the application of 4% BSF feces was the best.

Acknowledgments

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References

[1] Xu CC, Ji L, Chen ZD, et al. Analysis of china's Rice Industry in 2017 and the outlook for 2018, J. China Rice, 2018, 24(02): 1-3. (in Chinese)
[2] Zhang LC, Hu DY, Xiao WH, et al. Effects of oxygen aeration and organic fertilizers on the efficiency of soil fertilizer and rice growth, J. Journal of Hunan Agricultural University(Natural Sciences), 2018, 44(1): 12-16. (in Chinese)
[3] Fu XM, Mao JM, Shen ZS, et al. Development status and trend of bio-organic fertilizer in china, J. Hubei Agricultural Sciences, 2017, 56(03): 401-404. (in Chinese)
[4] Ren FL, Zhang XB, Sun N, et al. A meta-analysis of manure application impact on soil microbial biomass across china's croplands, J. Scientia Agricultura Sinica, 2018, 51(1): 119-128. (in Chinese)
[5] Wu S, Su YH, Ma YL, et al. Study on the fertilizer efficiency of tenebrio molitor L. frass with potted marigold, J. Journal of Shanxi Agricultural Sciences, 2017, 45(12): 1985-1988. (in Chinese)
[6] Li WJ, Zhou WJ, Yang SY, et al. Effects of hermetia illucens sandworm on the growth Performance of cabbage, J. Journal of Anhui Agricultural Sciences, 2016, 44(10): 111-112+115. (in Chinese)
[7] Wu X, Hu CY, Cai RJ, et al. Influence of frass organic manure on tomato growth and quality, J.

Northern Horticulture, 2019, (03): 60-64. (in Chinese)
[8] Huang XY, Shao JS, Ma YT. Effects of the application of pig manure organic fertilizers on soil environment quality, J. Journal of Henan Agricultural Sciences, 2017, 46(11): 60-68. (in Chinese)
[9] Niu CY, He GB, Zhou L, et al. Isolation and identification of bacteria producing enzymes from gut and skin of black soldier fly (Hermetia illulens) larvae, J. Chinese Journal of Applied Entomology, 2010, 47(05): 889-894. (in Chinese)
[10] Zhao Q. Research progress on improving the utilization efficiency of nitrogen fertilizer in rice, J. China Rice, 2016, 22(06): 15-19. (in Chinese)
[11] Yang W, Wang JH. Causes and control measures of rice corruption, J. Agriculture of Jilin, 2012, (01): 86. (in Chinese)