Effects of Functional Organic Materials on Fresh Weight, Quality, Single-melon Weight and SPAD Value of Watermelon

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Abstract [**Objectives**] This study was conducted to explore a functional organic material formula suitable for watermelon cultivation with high quality, high yield and high efficiency. [**Methods**] Four treatments were set in the experiment, namely four functional organic materials, garlic straw treatment (T_1), onion straw treatment (T_2), garlic straw + sheep manure treatment (T_3) and onion straw + chicken manure treatment (T_4), to investigate the effects of different functional organic materials on fresh weight, quality, single-melon weight and SPAD value of watermelon. [**Results**] The effects of different functional organic materials on fresh weight, quality, single-melon weight and SPAD value of watermelon were quite different. The fresh weight, quality, single-melon weight and SPAD value of watermelon were higher in treatment T_3 applying garlic straw and sheep manure and treatment T_4 applying onion straw and chicken manure than in treatment T_1 applying garlic straw and treatment T_2 applying onion straw. Specifically, the fresh weight of whole plant was the highest in treatment T_3, followed by treatment T_4, and the values of the two treatments increased by 12.83% and 5.94% respectively compared with treatment T_1; the weight of single melon was the highest in treatment T_3, followed by treatment T_4, and the values of the two treatments increased by 42.45% and 31.77% respectively compared with treatment T_2; and the SPAD values of treatments T_3 and T_4 were significantly higher than those of treatments T_1 and T_2, and the value of treatment T_3 was the largest. [**Conclusions**] This study provides theoretical support for the popularization and application of fertilization techniques combining organic fertilizers and reduced chemical fertilizers for watermelon.

Key words Watermelon; Organic materials; Fresh weight; Quality; Single-melon weight; SPAD value
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Watermelon in protected areas in early spring has the advantages of early marketing, high price and good benefit, and thus great development potential[1], but it is a crop with high fertilizer demand, and excessive application of fertilizers makes salt accumulate in the soil, which further aggravates the salinization of facility soil[2-3]. In addition, although chemical fertilizers are an important means to increase agricultural production, long-term application of chemical fertilizers will reduce crop quality and damage soil microenvironment[4-5]. Organic fertilizers have the advantages of comprehensive and balanced nutrition and lasting fertilizer effect, and they can improve soil fertility and soil physical and chemical properties, reduce secondary salinization, and thus improve crop yield and quality[6-7]. Functional organic materials refer to functional materials prepared by composed of organic wastes with certain functions of sterilization, disinfection or nutrient supplement, which can be used for crop seedling raising and cultivation. Therefore, this study aimed at reducing fertilizers, applying organic fertilizers to watermelon, and achieving high quality and high yield. Through organic manure materials such as chicken manure and sheep manure and organic waste materials such as garlic straw and onion straw with insect-proof and sterilization functions, the effects of different kinds of organic materials on the fresh weight, quality, single-melon weight and leaf SPAD value of watermelon plants in protected areas were investigated, and the functional organic material formula suitable for high quality, high yield and high efficiency cultivation of watermelon was explored, providing theoretical support for the popularization and application of fertilization techniques combining organic fertilizers and reduced chemical fertilizers for watermelon.

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Materials and Methods

Experimental materials

The experiment was conducted in Bazhuang Experimental Station of Shangqiu Academy of Agriculture and Forestry Sciences from March 25 to July 15, 2024. Watermelon was a hybrid material "M22 × P18" provided by Vegetable Research Institute of Shangqiu Academy of Agriculture and Forestry Sciences. Tested compound fertilizer of nitrogen, phosphorus and potassium ($N : P_2O_5 : K_2O = 15 : 15 : 15$) and tested sheep manure and chicken manure were obtained from local farms, and tested garlic straw and onion straw were obtained from growers.

Experimental design

There were four treatments in the experiment, namely four functional organic materials, garlic straw treatment (T_1), onion straw treatment (T_2), garlic straw + sheep manure treatment (T_3) and onion straw + chicken manure treatment (T_4). Among them,

the application rate of garlic straw in treatment T_1 was 4 500 kg/hm^2; the application rate of onion straw in treatment T_2 was 4 500 kg/hm^2; the application rate of garlic straw in treatment T_3 was 4 500 kg/hm^2, and that of sheep manure was 7 500 kg/hm^2; and the application rate of onion straw in treatment T_4 was 4 500 kg/hm^2, and that of chicken manure was 7 500 kg/hm^2. The application rate of NPK ternary compound fertilizer was the same for various treatments, at 900 kg/hm^2, and other management was the same as that of field cultivation. Each treatment was repeated 3 times, totaling 12 plots, and each plot was fertilized at one time according to the experimental design. Each plot had an area of 28 m^2(4 m×7 m), and the row spacing of watermelon plants was 0.4 m×2 m. The seedlings were transplanted when they had 3 leaves and 1 heart.

Determination indexes and methods

Peel thickness was measured with a ruler, and flesh hardness was measured with a GY-3 pointer type fruit hardness tester. Fresh weight of aboveground part, fresh weight of underground part, fresh weight of whole plant and single-melon weight were weighed by an electronic balance.

Data processing and analysis

Excel 2007 software was used for data processing and drawing. DPS software was used for variance analysis.

Results and Analysis

Effects of functional organic materials on morphogenesis of watermelon

Table 1 shows that different functional organic materials had different effects on the fresh weight of watermelon. The fresh weight of aboveground part was the largest in treatment T_3, followed by treatment T_4, the third in treatment T_2, and the smallest in treatment T_1. The values of treatments T_3 and T_4 increased by 11.54% and 6.06%, respectively, compared with treatment T_1, showing significantly differences from treatment T_1. The fresh weight of underground part was the highest in treatment T_3, which increased by 6.07% compared with treatment T_1 applying garlic straw only, and the difference was significant. The fresh weight of underground part in treatment T_4 increased by 4.19% compared with that in treatment T_2 applying onion straw only, but there was no significant difference between them. The fresh weight of whole plant was the highest in treatment T_3, followed by treatment T_4, and they increased by 12.83% and 5.94% respectively compared with treatment T_1, and were significantly different from treatment T_1.

Effects of functional organic materials on quality and single-melon weight

It could be concluded from Table 2 that different functional organic materials had different effects on watermelon quality and single-melon weight. Watermelon peel thickness was the smallest in treatment T_3 composed of garlic straw and sheep manure, followed by treatment T_4 composed of onion straw and sheep manure, and the difference between them was not significant. However, the values of treatments T_3 and T_4 were 17.65% and 12.50% lower than that of treatment T_2, and the differences were significant. The peel hardness of treatment T_1 was the highest, followed by treatment T_2, and the values of the two treatments increased by 16.25% and 9.20% respectively compared with treatment T_3 and 18.37% and 11.49% respectively compared with treatment T_4. That is to say, they were significantly higher than treatments T_3 and T_4. The weight of single melon was the highest in treatment T_3, followed by treatment T_4, and their values increased by 42.45% and 31.77% respectively compared with treatment T_2.

Table 1 Effects of functional organic materials on fresh weight of watermelon plants

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Treatment	Fresh weight of aboveground part	Fresh weight of underground part	Fresh weight of whole plant
T_1	326.21 c	10.21 b	336.43 c
T_2	330.22 bc	10.03 b	340.25 c
T_3	368.77 a	10.83 a	379.60 a
T_4	345.97 b	10.45 ab	356.42 b

Table 2 Effects of functional organic materials on quality and single-melon weight

treatment	peel thickness cm	peel hardness kg/cm^2	Single-melon weight//kg
T_1	1.32 a	2.83 a	4.01 c
T_2	1.36 a	2.61 b	3.84 c
T_3	1.12 b	2.37 c	5.47 a
T_4	1.19 b	2.31 c	5.06 b

Effects of functional organic materials on SPAD value of watermelon leaves

As shown in Fig. 1, the effects of different functional organic materials on SPAD value of watermelon leaves were different. There were no significant difference in SPAD value of watermelon leaves between treatments T_1 and T_2, but the SPAD value in treatment T_1 was higher than that in treatment T_2; and there was no significant difference between treatments T_3 and T_4, but the SPAD value in treatment T_3 was higher than that in treatment T_4. In addition, the SPAD values in treatments T_3 and T_4 were significantly higher than those in treatments T_1 and T_2, which indicated that the functional organic materials in treatments T_3 and T_4 were more beneficial to improve the SPAD value of watermelon than those in treatments T_1 and T_2, and treatment T_3 was relatively better.

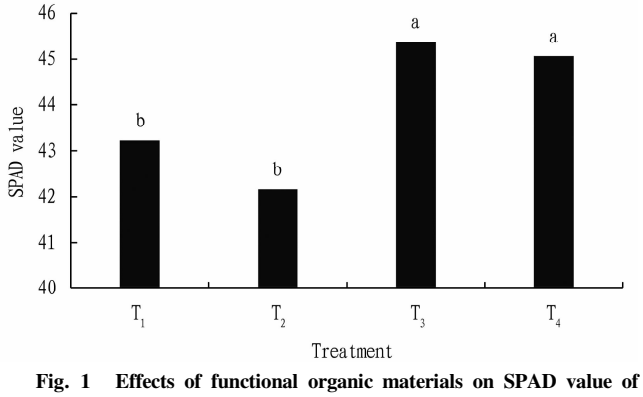

Fig. 1 Effects of functional organic materials on SPAD value of watermelon leaves

Discussion and Conclusions

The fresh weights of aboveground part, underground part and whole plant and SPAD are important reference indexes for measuring the growth strength and biomass accumulation of watermelon. The results of this study showed that the functional organic material composed of garlic straw and chicken manure and the functional organic material composed of onion straw and sheep manure could significantly increase the fresh weights of aboveground part, underground part and whole plant and the SPAD value of watermelon leaves compared with simple application of garlic straw or onion straw, and the functional organic materials composed of garlic straw and chicken manure had the greatest promotion effect on the fresh weight of watermelon. It might be because the application of sheep manure on the basis of garlic straw and chicken manure on the basis of onion straw increased the mineral nutrients such as nitrogen, phosphorus and potassium and organic matter such as humic acid in the soil, which provided more abundant mineral elements for watermelon plant growth, chlorophyll synthesis and plant fresh weight.

The nutritional quality of watermelons determines the commercial value of watermelons. Appropriate peel thickness and peel hardness directly affect the taste for consumers, and higher single-melon weight directly affects the final economic benefits. Therefore, peel thickness, peel hardness and single-melon weight are important reference factors for evaluating the quality and yield of watermelons. The results of this study showed that compared with the application of garlic straw or onion straw, the combination of garlic straw and chicken manure and the combination of onion straw and sheep manure could significantly reduce the thickness and hardness of watermelon peel, increase the edible part and reduce the increase of peel hardness caused by peel thickening, which indicated that the compounded functional organic materials were more conducive to the improvement of watermelon fruit quality. In addition, the combination of garlic straw and chicken manure and the combination of onion straw and sheep manure could significantly increase the weight of single watermelon. It might be because chicken manure could reduce soil bulk density, increase organic matter content, and improve soil enzyme activity[8], thereby promoting watermelon plant growth and improving the weight of single watermelon; and sheep manure increased the contents of available potassium, available phosphorus, hydrolyzable nitrogen and organic matter in soil, and improved the secondary salinization of soil[9], creating a suitable environment for the growth of watermelon and thus improving the weight of single watermelon.

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