

Effect of organic fertilizers used in sandy soil on the growth of tomatoes

Yongxia Hou¹, Xiaojun Hu^{1*}, Wenting Yan², Shuhong Zhang², Libin Niu³

¹Shenyang University, Key Laboratory of Regional Environment and Eco-Remediation, Ministry of Education, Shenyang, China; huyongxia@126.com, *Corresponding Author: hu-xj@mail.tsinghua.edu.cn

²College of Horticulture, Shenyang Agricultural University, Shenyang, China; yanwenting2000@126.com, zhangsh024@163.com

³The Affiliated Hospital of Liaoning University of Traditional Chinese Medicine, Shenyang, China; xiaojun7770@163.com

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ABSTRACT

In order to reveal the regulating capacity of organic fertilizers on sandy soil, pots experiments were carried out. The growth of tomatoes planted on sandy soil amended by organic fertilizers was measured. Organic fertilizers can be helpful to improve the plant height, stem diameter, the aerial parts fresh weight, root fresh weight, leaf photosynthetic rates and photosynthesis, and lay a good foundation for the growth of tomatoes. The effect of organic fertilizer is the most significant. Among all the treatments of adding 2.5%, 5%, 10% organic fertilizers, adding 10% organic fertilizers are the best. It can significantly enhance the growth and photosynthesis of tomatoes, and it is among the best of these three soil treatments for sandy soil.

Keywords: Sandy Soil; Organic Fertilizers; Photosynthetic Rate; Tomato

1. INTRODUCTION

Sandification is an environmental problem for the world. China is one of the countries suffered desertification seriously. In 2011, the State Forestry Administration (SFA) has announced the results of forth national monitoring of desertification and sandification. The results show that, by the end of 2009, the area of national sandy lands, 18.03% of national lands, is 1, 731, 100 hm². In these areas, 310,000 hm² became sandy soil obviously. Some are still expanding. Sandy soil is a poor soil which has low contents of organic matters and nutrition. Owing to the loose texture and the gap between particles, the capacity of saving water and nutrients is poor. Not only was development soil productivity had constrained, but also the environmental deterioration and economic losses were getting worse and worse. Soil amendments have been reported to change sandy soil texture in order to

increase water holding capacity [1]. Adding organic fertilizers in sandy soil, the growth of the plant growth was affected [2,3]. and in some cases neutralize soil acidity [3] and enhance soil catalase activity [4]. Horticultural production has an especially reliant relationship with soil. The overspread of cultivated lands is limited, but the amendable capacity is unlimited [5]. Soil amendments can not only change the characters of sandy soil, but enhance yield, quality [6] and stress resistance [7], promote the growth of horticultural plants. As the foundations of tomato growth, development and yield, photosynthesis is an important indicator in the fields of breeding, cultivation and environmental stress. The experiments reported here evaluated the use of organic fertilizers to improve the plant height, stem diameter, the aerial parts fresh weight, root fresh weight, leaf photosynthetic rates and photosynthesis by two kinds of sandy soil, for revealing the regulating capacity of organic fertilizers on sandy soil.

2. MATERIALS AND METHODS

2.1. Materials and Experimental Design

Experiments were conducted at the greenhouse of Shenyang University. The soil is sandy soil. Strong sandy soil was taken from Dong Liujiazi located in 42° 20' 43N, 122° 43' 19E. Weak sandy soil were taken from Xiu Shuihe in Faku located in 42° 21' 26N, 123° 00' 21E. Organic fertilizer was purchased from flower market. The variety of tomato for experiment is Fuyou Dafen.

These were pots experiments. These soil amendments of organic fertilizers were respectively added to two kinds of sandy soil at the mass ratios of 2.5%, 5% and 10%. There were 20 treatments. Each one had 5 repetitions. The experimental treatments are showed as follows (**Table 1**).

Tomatoes were seeded on February 22, 2012 and planted in pots on March 28. Except the amounts of soil amendments and sandy soil, each one was used by one routine management.

Table 1. Treatments.

Treatments	Organic fertilizer (g·kg ⁻¹)	Strong sandy soil(g·kg ⁻¹)	Weak sandy soil (g·kg ⁻¹)	Mass ratio (%)
CK(A)	0	1000	0	0
A1	25	975	0	2.5
A2	50	950	0	5
A3	100	900	0	10
CK(B)	0	1000	0	0
B1	25	0	975	2.5
B2	50	0	950	5
B3	100	0	900	10

2.2. Experimental Methods

The parameters of plant height, stem diameter, the aerial parts fresh weight, root fresh weight were investigated by conventional techniques. By using Lc Pro+ photosynthesis system, the light responses of photosynthesis in leaves of 60 days after planted tomatoes were studied under 2 different soil water conditions: drought (Relative Soil Water Content (RSWC) is 60%) and saturated-water (RSWC is 100%). The measure time was during 10:00 - 12:00 on sunny days. The third healthy functional leaves were chosen from the top as samples, every treatment took 5 samples. The average values were as the final measured results. Artificial light source were used to control Photosynthetic Photon Flux Density (PPFD). The PPFD were 600, 800, 1000, 1200, 1400, and 1600 $\mu\text{mol}\cdot(\text{m}^2\cdot\text{s})^{-1}$. Determined time was 60 s under each PPFD.

3. RESULTS AND DISCUSSION

3.1. Effect of Adding Organic Fertilizers on the Growth of Tomato

Adding 2.5%, 5%, 10% organic fertilizers in strong sandy soil obviously improved the parameters of the plant height, stem diameter, the aerial parts fresh weight, root fresh weight of tomato leaves (**Table 2**). And it had the same trend in weak sandy soil. The parameters of the plant height, stem diameter, the aerial parts fresh weight, root fresh weight improve with the increasing of organic fertilizers.

3.2. Effect of Adding 2.5% Organic Fertilizers on Photosynthetic Rate of Tomato

Adding 2.5% organic fertilizers in strong sandy soil obviously improved photosynthetic rates of tomato leaves

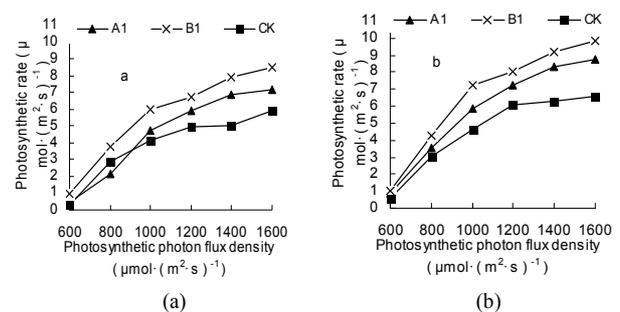
(**Figure 1**). Photosynthetic rates of plants treated by organic fertilizers increased rapidly with the raising of PPFD. With raising trends of the rates got slowly later. The results showed that when the RSWC was 60%, the photosynthetic rate of adding organic fertilizer increased apparently to the max value of $7.13 \mu\text{mol}\cdot(\text{m}^2\cdot\text{s})^{-1}$ under $1600 \mu\text{mol}\cdot(\text{m}^2\cdot\text{s})^{-1}$ PPFD. The increased tendency of tomato photosynthetic rates of every treatments under 100% RSWC was the same as that in drought condition (RSWC is 60%). The max was $8.74 \mu\text{mol}\cdot(\text{m}^2\cdot\text{s})^{-1}$ from organic fertilizer used treatment. By comparing the treatment of A1 and B1, 2.5% soil amendments made a better influence in weak sandy soil than that in strong sandy soil.

3.3. Effect of Adding 2.5% Organic Fertilizers on Photosynthetic Rate of Tomato

According to **Figure 2**, after adding 5% organic fertilizers in strong sandy soil, the photosynthetic rate of tomatoes got an obvious enhancement. With the PPFD

Table 2. The effect of organic fertilizers on the growth of tomato in flowering stage.

Treatments	plant height (mm)	stem diameter (mm)	the aerial parts fresh weight (g)	root fresh weight (g)
CK(A)	201.08	2.84	3.15	0.51
A1	207.45	2.9	3.24	0.58
A2	257.3	3.0	3.35	0.75
A3	286.54	3.1	4.11	0.85
CK(B)	204.92	2.85	3.54	0.65
B1	214.38	2.96	4.03	0.69
B2	223.19	3.14	5.09	0.71
B3	294.9	3.38	5.53	0.82

**Figure 1.** Photosynthetic rate-light response curves of tomato under adding 2.5% soil amendments in strong sandy soil and weak sandy soil: (a) Drought condition (RSWC is 60%); (b) Saturated-water condition (RSWC is 100%).

raising, the photosynthetic rates of the treatments increased rapidly. It was an evident improvement of tomato photosynthetic rate on sandy soil amended by organic fertilizers under 60% RSWC, while the PPFD was 1600 $\mu\text{mol} \cdot (\text{m}^2 \cdot \text{s})^{-1}$, to the max 7.69 $\mu\text{mol} \cdot (\text{m}^2 \cdot \text{s})^{-1}$. After rewatering, the tomato photosynthetic rates tendency of every treatments was similar to that in drought condition (RSWC is 60%). The max was 9.62 $\mu\text{mol} \cdot (\text{m}^2 \cdot \text{s})^{-1}$ from organic fertilizers used treatment. After applying 5% soil amendments on weak sandy soil, it showed that the tomato photosynthetic rate of each treatment in drought condition was higher than that in saturated-water condition by analyzing the effects of different relative soil water contents. The amending effect of adding 5% amendments on weak sandy soil was better than that on the strong one.

3.4. Effect of Adding 10% Soil Amendments on Photosynthetic Rate of Tomato

The tomato photosynthetic rate under 10% organic fertilizers used was increasing with photosynthetic photon flux density (Figure 3). All got the top value when the PPFD was 1600 $\mu\text{mol} \cdot (\text{m}^2 \cdot \text{s})^{-1}$. The effect of the treatment of adding 10% organic fertilizers was better than that of ck in drought condition, the max 7.41 $\mu\text{mol} \cdot (\text{m}^2 \cdot \text{s})^{-1}$. When RSWC was 100%, the max values of organic fertilizers was 9.21 $\mu\text{mol} \cdot (\text{m}^2 \cdot \text{s})^{-1}$. 10% organic fertilizers

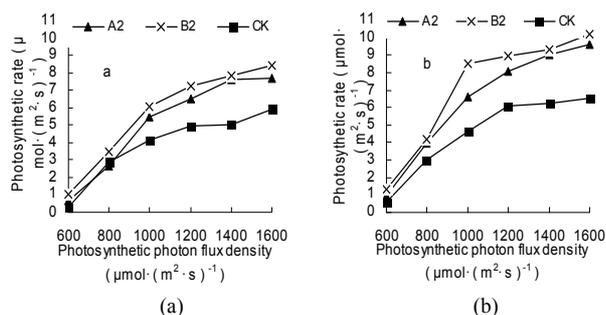


Figure 2. Photosynthetic rate-light response curves of tomato under adding 5% soil amendments in strong sandy soil and weak sandy soil.

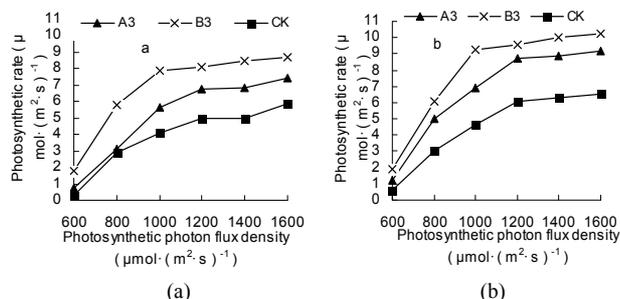


Figure 3. Photosynthetic rate-light response curves of tomato under adding 10% soil amendments in strong sandy soil and weak sandy soil: (a) Drought condition (RSWC is 60%); (b) Saturated-water condition (RSWC is 100%).

made a better influence in weak sandy soil than that in strong sandy soil. The effects of all the treatments on enhancing tomato photosynthetic rate were better than that of control sample.

4. Conclusions

This study showed that after adding two kinds of sandy soil by adding 2.5%, 5% and 10% organic fertilizers under different relative soil water contents, the growth of the plant height, stem diameter, the aerial parts fresh weight, root fresh weight and the photosynthetic rates of tomato affected by organic fertilizer were all enhanced. The effect of using organic fertilizers was obvious. It showed that organic fertilizers could enhance crop physiological activity effectively, improve photosynthesis, and promote the growth of tomato. In addition, they could also enhance the accumulation of photosynthetic production, and establish the foundation of yield and quality. It is probably that organic fertilizers have multi-nutrients for the crop growth, and the ability of improving soil texture and nutritional status. Under the same organic fertilizers used, the effect in saturated-water condition was better than that in drought condition. It showed that the photosynthesis of tomato rebounded after rewatering. The reason is probable that organic fertilizers could enhance the soil water-nutrition holding capacity, and amend the weakness of sandy soil. By comparing the effects on different sandy soil, the photosynthetic rates on weak soil all higher than that on strong soil. The general analysis showed that adding 10% organic fertilizers was the best way to improve photosynthetic rate and growth of tomato.

5. ACKNOWLEDGEMENTS

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