Effects of Chemical Fertilizer Reduction on Growth and Quality of Tomato

Miaomiao Yuan[a], Xiuping Tian[1,b,*], Jiaxi Dong[1,c], Yingai Tan[1,d], Lu Yue[1,e], Enhan Fang[1,f], and Qiu Zhao[2,g]

[1]College of Agronomy and Resources and Environment, Tianjin Agricultural University, Tianjin 300384, China.

[2]Tianjin Institute of Agricultural Resources and Environment, Tianjin 300192, China,

[a]1447459778@qq.com; [*b]tian5918@sohu.com;
[c]15142505355@163.com; [d]2283296469@qq.com; [e]894177990 @qq.com; [f]shuaibeyong@qq.com;[g]qiuzhao2008@163. Com

[*] Corresponding Author

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Abstract: In order to investigate the effects of chemical fertilizer reduction on the growth and quality of tomato, the application of 100% chemical fertilizer, 10% chemical fertilizer reduction, 25% chemical fertilizer reduction and 35% chemical fertilizer reduction treatment were studied on the basis of organic fertilizer application. Changes in growth physiology quality and yield of tomato were studied. The results showed that, in the case of applying organic fertilizer, compared with traditional fertilization, the reduction of chemical fertilizer to 35% had no effect on the plant height, leaves' nitrogen and chlorophyll contents. The contents of Vc and acidity of tomato were the highest when chemical fertilizer were reduced by 25% and 35%,the reduction of chemical fertilizer to 25% and 35% were significantly lower than that of chemical fertilizer of 100% and reduction of chemical fertilizer to 10% treatment on the content of Vc, and different chemical fertilizer application were not significantly on the acidity content. The nitrate content of tomato decreased with the cut down of fertilizer amount, and the chemical fertilizer reduction of 25% and 35% were significantly lower than that of chemical fertilizer reduction of 10% and chemical fertilizer application 100%.Tomato yield was increased by 0.77% and 1.42% compared with the control group by 10% and 25% reduction of chemical fertilizer, and tomato yield was reduced by 1.28% compared with the control group by 35% reduction of chemical fertilizer. The yield was no significant difference among different fertilization treatments.

1. Introduction

As an important component of agricultural resources, chemical fertilizer plays an irreplaceable role in the development of agriculture. The data shows that the amount of chemical fertilizer used in China is about 58 million tons per year, accounting for 1/3 of the world's fertilizer use[1].Blind application of chemical fertilizers is widespread, which leads to serious nitrogen, phosphorus and heavy metal pollution in farmland[2-4],and excessive application of chemical fertilizers also leads to soil acidification, salinization and other major problems[5].In March 2015, the National Ministry of Agriculture proposed to strive to achieve zero growth in the use of chemical fertilizer and pesticide for major crops by 2020, and it is required by improve fertilization methods, increase the utilization of fertilizer and reduce unreasonable use of inputs[6].To achieve the aim of chemical fertilizer zero growth, one is to subtract the excessive fertilization caused by unreasonable fertilization to improve the utilization rate of fertilizer, Second, in order to improve the utilization of fertilizer, reduce production costs, reduce environmental pollution, promote the green development of planting industry, and provide technical support for sustainable production of high-quality agricultural products without pollution[7-8], and it is necessary to promote the combination of organic and inorganic[7].Tomato*(Solanum lycopersicum*) is the main vegetable of cultivate in our country, At present, the research on fertilization of tomato is concentrated on formula

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fertilization[9], and there is relatively little research on the growth of tomato in greenhouse with reduction. The results showed that the physics and chemistry characteristics of soil and soil enzyme activities were decreased due to long-term unbalanced fertilization, which is lead to a decline in yield and quality of tomato in cultivated with tomato[10].Thus, this experiment explored the effect of fertilizer reduction on growth quality and yield of tomato, provided theoretical support for zero growth action of chemical fertilizer, and provided reference for reasonable fertilization of tomato.

2. Materials and Methods

2.1 Materials.

The experiment was set up in Xinkou town Xiao Shawo Village sunlight greenhouse, Xiqing District, Tianjin Province, China. The soil was fluvo-aquic soil, the experimental field in 0-30 cm organic matter 20.22 g/kg, the total nitrogen 1.55 g/kg, the nitrate nitrogen 48.94 g/kg, total phosphorus (P) 1.46 g/kg, available phosphorus (P) 113.12 mg/kg, total potassium 0.72 g/kg, available potassium (K) 163.17 mg/kg, pH (H_2O) 7.95, EC 167.70 μm/cm. The experimental vegetable was tomato(Gang-9). The base organic fertilizer (N 1.52%, P_2O_5 0.97%, K_2O 2.84%) produced by Hengrun (Tianjin) Biotechnology Development Co., Ltd., and the experimental base chemical fertilizer was Lide(16-16-16) compound fertilizer, top dressing was Batian(15-10-23) compound fertilizer.

2.2 Experimental Design.

Experimental greenhouse' area was 480 m^2, and we used plot experiment, which every experimental plot' area was 40 m^2, under the condition of a certain amount of organic fertilizer, four basic chemical fertilizer treatments were set up, compared with CK treatment (100% chemical fertilizer), followed by DT treatment (10% less than CK), DF treatment (25% less than CK) and DM treatment (35% less than CK), repeated 3 times per treatment. Details on the use of chemical fertilizer and organic fertilizer were given in table1.We raised seeding time was 25 January 2018 and prepared land time was 6 February 2018, with applying base fertilizer, then transplantation and planting in 10 February 2018. The cultivation methods were all traditionally planted with a row spacing of 50 cm and a plant spacing of 40 cm. The top dressing was applied to the soil in four times during the growth of the tomato, and the dosage per plot was 0.90 kg.

Table 1 Amount of chemical fertilizer and organic fertilizer [kg/hm^2]

Treatment	CK	DT	DF	DM
Chemical fertilizer	910.00	817.50	682.50	590.00
Organic fertilizer	30000.00	30000.00	30000.00	30000.00

2.3 Sampling and Determination Methods.

The chlorophyll and the nitrogen content of tomato leaves were determined by TYS-3N plant nutrition analyzer, and the plant height of the tomato plants was measured with a tape ruler on March 13 and April 7, during the growth of tomato. When the tomato was ripe for picking, it was produced according to the plot, and the yield was 666.7m^2.Fruit samples were taken during the fruit-bearing period of the tomato to determine NO_3-N content, Vc content, and acidity (see table2).

Table 2 Measured method of quality index of tomato fruit

Measured index	Measured method
NO3-N	Measured by spectrophotometer
Vc	Iodometry
acidity	Use titration

2.4 Data Statistics Method.

Microsoft Excel 2007 was used to statistics and map the original data, and the difference was

analyzed by DPS software.

3. Results and Analysis

3.1 Effect of Chemical Fertilizer Reduction on Plant Height of Tomato.

As could be seen from fig.1, the results measured on 13 March and 7 April 2018 were that the treatment with 35 % reduction in chemical fertilizer use had the highest plant height, followed by a 25% reduction in chemical fertilizer use and a 10% reduction in chemical fertilizer use, and the plant height of chemical fertilizer without reduction treatment was the shortest. There were no significant difference in plant height between 35% and 25% under chemical fertilizer reduction treatment, but they were significantly higher than that of 10% chemical fertilizer reduction and no chemical fertilizer reduction treatment. That means traditional high concentration fertilization did not increase the plant height of the tomato.

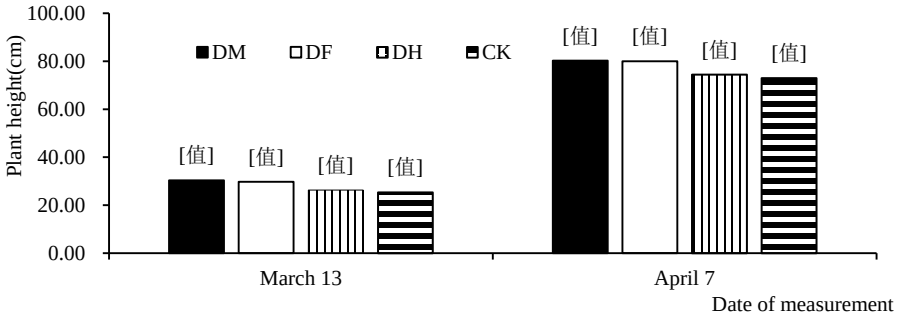

Fig. 1 Plant height of Tomato treated with different fertilization

Note: Different small letters indicate significant difference at 0.05 level. The same as follows.

3.2 Effect of Chemical Fertilizer Reduction on Physiology Index of Tomato.

From fig.2and fig. 3, it was found that on March 13, the nitrogen and chlorophyll content of tomato leaves were in the order of different fertilization treatments from high to low was DM>DT>DF=CK, there was no significant difference among different fertilization treatments, but when the tomato grew to April 7, the treatment with 25 % reduction in chemical fertilizer use had the highest nitrogen content and chlorophyll content of the leaf, followed by the 35% reduction in chemical fertilizer use and the 10% reduction in chemical fertilizer use, and the chemical fertilizer without reduction treatment was the lowest. There was no significant difference in chlorophyll content, and nitrogen content between 35% and 25% reduction of chemical fertilizer were significantly higher than that of chemical fertilizer reduction of 10% and no reduction, and the nitrogen content of 10% reduction chemical fertilizer treatment was significantly higher than that of non-reduction treatment. The results indicated that the traditional fertilizer with high nitrogen and phosphorus were not beneficial to nitrogen accumulation and chlorophyll formation in tomato leaves.

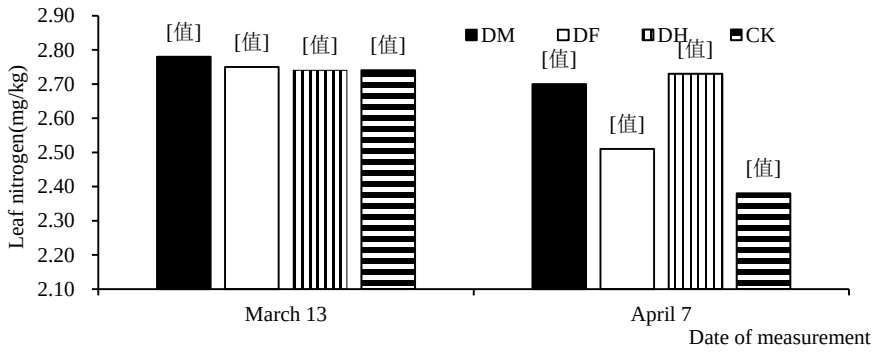

Fig. 2 Chlorophyll content of tomato leaves treated with different fertilization

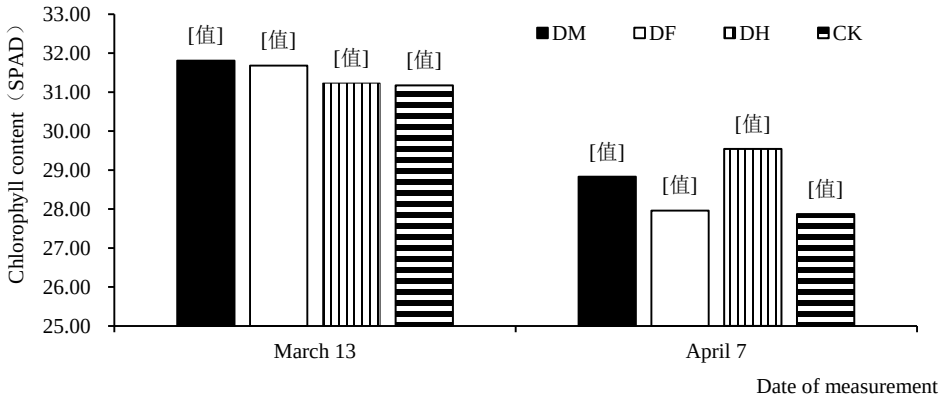

Fig. 3 Nitrogen content of tomato leaves treated with different fertilization

3.3 Effect of Chemical Fertilizer Reduction on Quality of Tomato.

Table3 showed that with the decrease of chemical fertilizer application, the Vc and acidity content of tomato fruit did not decrease. The Vc content of tomato fruit in chemical fertilizer decreased by 25% treatment was the highest, and it increased 4.79% to control treatment. The Vc content of tomato fruit in 25% and 35% chemical fertilizer reduction treatments, which were significantly higher than that of chemical fertilizer reduction of 10% and no reduction treatments. The difference between chemical fertilizer reduction of 25% and chemical fertilizer reduction of 35% were not significant. The acidity content of tomato fruit was different, and the difference between fertilization treatment was not significant. The NO_3-N content of tomato fruit decreased with the decrease of chemical fertilizer application. The treatment of chemical fertilizer reduction of 35% and 25% were significantly lower than that of chemical fertilizer reduction of 10%. There was no significant difference between the treatment of fertilizer reduction of 35% and 25%, and the reduction of fertilizer by 10% and the treatment without reduction.

Table. 3 Differences in quality of Tomato treated with different fertilization treatments

Treatment	Vc[mg/kg]	NO_3-N[mg/kg]	Organic acid[%]
CK	128.30cC	61.71aA	0.40aA
DT	129.87cBC	60.30aA	0.40aA
DF	134.44aA	52.47bB	0.41aA
DM	132.48aA	49.21bB	0.42aA

Note: Small letters indicate significant difference at 0.05 level and capital letters indicate significant difference at 0.01 level, The same as follows.

3.4 Effect of Chemical Fertilizer Reduction on Yield of Tomato.

The yield of tomato treated with different fertilization treatments ranged from 63753.65 to 65503.35 kg/hm^2,the yield of tomato was the highest in the treatment of 25% reduction of chemical fertilizer, which was 1.42% higher than that of the control treatment, the chemical fertilizer reduction of 10% was the second, and the yield was 0.77% higher than that of the control treatment, the yield of fertilizer reduced by 35% was the lowest, which was 1.28% lower than that of the control. The yield difference was not significant between the different fertilization treatment. It showed on the basis of applying organic fertilizer, high amount of chemical fertilizer did not bring high yield and chemical fertilizer application reduced 35%, which had little effect on tomato yield.

Table.4 Differences of tomato yield under different fertilization treatments

Treatment	Plot yield[kg/40 m^2]	Converted to hectare[kg/hm^2]	Reduction rate compared with control[%]
CK	258.35aA	64586.55aA	0
DT	260.35aA	65086.75aA	-0.77
DF	262.01aA	65503.35aA	-1.42
DM	255.02aA	63753.65aA	1.28

4. Conclusion

China's cultivated land only accounts for 9% of the world, and it feeds 22% of the world's population. Among them, chemical fertilizer plays an important role. For a long time, the fertilization methods of Chinese farmers have been affected by traditional habits, and they have fallen into the misunderstanding of fertilization that “excessive fertilization will inevitably lead to excessive returns”[11], and excessive and unreasonable application of chemical fertilizer has become one of the most important sources of agricultural non-point source pollution in China. Fertilization will not only affect the yield of vegetables, but also affect the quality of vegetables. The results of this experiment showed that the difference of tomato plant height between chemical fertilizer reduction and non-reduction was not significant, and the application of high concentration chemical fertilizer was not conducive to the accumulation of nitrogen and chlorophyll content in tomato leaves. The reduction of chemical fertilizer could reduce the content of NO_3-N in tomato fruit and increase the content of Vc in tomato fruit, but had little effect on the organic acid content of tomato fruit. On the basis of applying organic fertilizer, high amount of chemical fertilizer did not bring high yield and chemical fertilizer application reduced 35%, which had little effect on tomato yield.

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