Effect of Chemical Fertilizer Reduction on Wax Gourd *(Benincasa hispida)* Growth and Soil Properties in Sunlight Greenhouse

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Abstract: In order to explore the effects of chemical fertilizer reduction on the growth of wax gourd and soil properties, this experiment used five chemical fertilizer reduction treatments in greenhouses of ShuiGaozhuang village to study the Changes in growth of wax gourd and oil properties. The results showed that on the basis of adding organic fertilizer, the difference' plant height of wax gourd between the reduction of chemical fertilizer to 35% and 100% application of chemical fertilizer was not significant. The reduction of chemical fertilizer had little effect on the chlorophyll and nitrogen content of wax gourd leaves. The reduction or non-application of chemical fertilizer had no effect on the contents of total nitrogen, total phosphorus, total potassium and organic matter, and reduced the contents of nitrate nitrogen and available phosphorus, available potassium in soil. Soil bulk density and pH were not significantly different between chemical fertilizer reduction and non-reduction treatment. The soil EC of 100% chemical fertilizer treatment was significantly higher than that without chemical fertilizer treatment.

1. Introduction

Agricultural non-point source pollution has become one of the most important pollution types in China. Agricultural non-point source pollution affects the construction of beautiful China and the sustainable development of agriculture. The use of fertilizer in China ranks first in the world. According to the results of the first national survey of pollution sources, the loss of nitrogen and phosphorus from agricultural non-point sources accounted for 1/3 of the total pollution. With the rapid development of protected vegetables in China, the use of a large number of chemical fertilizers has become the main measure to increase the yield of vegetables. At the same time, unscientific fertilization methods have resulted in waste of fertilizers, pollution of the environment and imbalance of soil nutrients[1-3]. Many studies have shown that the mineral nitrogen and dissolved organic nitrogen in the protected soil are significantly higher than those in the open-air soil, and there is more accumulation in the lower soil, so it was easy to cause leaching loss[4-6]. Each year, nitrogen enters the Yangtze River, Yellow River, and Taihu Lake by fertilization is 92%, 88%, and 70%, respectively. The country has taken many measures to reduce fertilizer application. In February 2015, the Ministry of Agriculture formulated the "Zero Growth Action Plan for Quantitative Use of Fertilizers by 2020", striving to achieve zero growth in the use of fertilizers for major crops by 2020. wax gourd has rich nutritional value, and also has medicinal value such as diuretic and thirst-reducing, liver and kidney protection. It is an important gourd vegetable on the table of the common people[7]. Farmers' traditional habits of growing wax gourd are not only wasteful of resources, but also leads to low utilization of fertilizer. The quality of wax gourd decreased and the soil quality deteriorated, which had an adverse effect on the ecological

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environment. Therefore, it is of great significance to carry out the research on reducing the amount of fertilizer in greenhouse wax gourd, to improve the utilization rate of fertilizer in the growing period of wax gourd, to help farmers save the cost and increase income, and to protect the ecological environment.

2. Materials and Methods

2.1 Research Location.

The experiment was carried out in the sunlight greenhouse of ShuiGaozhuang Village, Xin Kou Town, Xi Qing District, Tianjin.

2.2 Experimental Materials.

The experimental soil was fluvo-aquic soil, the experimental field in 0-30 cm has organic matter 31.11 g/kg, total nitrogen 1.74 g/kg, nitrate nitrogen 10.98 mg/kg, total phosphorus (P) 3.26 g/kg, available phosphorus (P) 245.95 mg/kg, total potassium(K) 1.10 g/kg, available potassium (K) 255.79 mg/kg, pH (H_2O) 7.8, EC 162.75μm/cm. Experimental vegetables was wax gourd (Nongle).Organic fertilizer (N 1.52%, P_2O_5 0.97%, K_2O 2.84%) produced by Heng Run (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.

2.3 Experimental Design.

The experimental greenhouse area was 930 m^2, and was carried out the plot experiments, the area of each plot was 62 m^2, and under the condition of 174 kg of organic fertilizer applied to each plot, there were 4 kinds of base chemical fertilizers, which were CK (100% chemical fertilizer), DH (10% chemical fertilizer less than CK), ZH (25% chemical fertilizer less than CK), GH (35% chemical fertilizer less than CK). And WH (100% chemical fertilizer less than CK), For each treatment repeated 3 times, and the chemical fertilization amount in the plot was shown in table 1.The base fertilizer was applied once before the soil plowed. In addition to the WH treatment, the top dressing was applied to the soil in 5 times during the growth of the wax gourd, and the amount per plot was 1.28 kg. Seedlings began in December 15, 2017 and were transplanted on January 1, 2018. The cultivation method was the traditional alfalfa planting method, with a row spacing of 70 cm and a plant spacing of 40 cm.

Table 1 Different treatment of base chemical fertilizer in each plot [kg]

Treatment	CK	DH	ZH	GH	WH
Chemical fertilizer	5.1	4.6	3.8	3.3	0

2.4 Sampling and Determination Methods.

During the growth of wax gourd, chlorophyll and nitrogen content of wax gourd' leaves were determined by TYS-3N plant nutrition analyzer on April 9 and May 7, and the height of the wax gourd plants was measured with a tape measure on April 9. The soil' physical and chemical properties of 0-30 cm in each plot were measured before the application of the base fertilizer and the wax gourd harvested (Table 2).

Table 2 Method for determining soil physical and chemical properties

Soil properties	Test methods
Organic matter	Chulin method
Total nitrogen	Concentrated sulfuric acid, Semi-micro-Kelvin method
Total phosphorus	Sodium hydroxide melting, Molybdenum antimony, Spectrophotometer
Total potassium	Nitric acid and perchloric acid digestion, Flame photometer or atomic absorption spectrometry
Alkaline nitrogen	Alkaline solution diffusion method
Available phosphorus	Sodium carbonate extraction, Molybdenum antimony, Spectrophotometer
Available potassium	Sodium acetate extraction，Flame photometer
Bulk weight	Ring knife method

pH	Water extraction, Acidity meter
EC	Water extraction, Conductivity meter

2.5 Statistical Analysis.

Use Microsoft Excel (Office 2003) to make charts and use DPS software to process data.

3. Results and Analysis

3.1 Effect of Chemical Fertilizer Reduction on Physiology and Growth of Wax Gourd. Effect of Chemical Fertilizer Reduction on Plant Height of Wax Gourd.

It could be seen from table 3, that the plant height of wax gourd varies from 13.44 cm to 15.89 cm between different fertilization treatments, and the order between different treatments is CK>ZH>GH>DH>WH, and the CK was significant higher than WH, the difference between the others treatments were not significant. It indicated that large quantitative chemical fertilizer application could promote the growth of wax gourd.

Table 3 Plant' height of wax gourd with different fertilization

Treatment	Plant' height (cm)	5% significant level	1% significant level
CK	15.88	a	A
ZH	14.89	ab	A
GH	14.77	ab	A
DH	14.56	ab	A
WH	13.44	b	A

3.2 Effect of Chemical Fertilizer Reduction on Physiology Index of Wax Gourd.

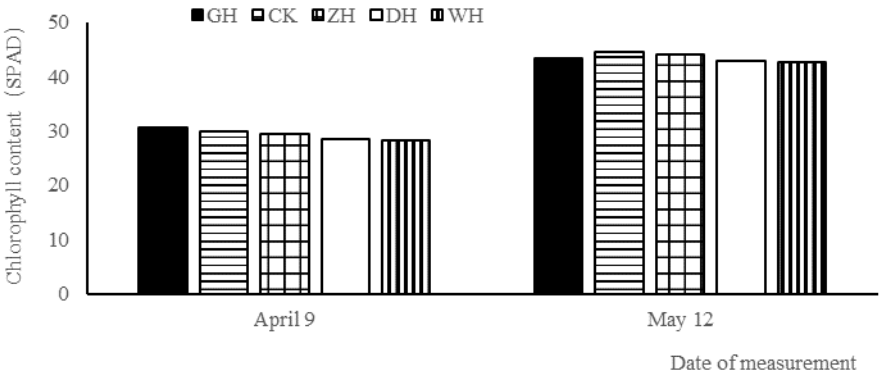

Fig.1 Chlorophyll content of wax gourd leaves treated with different fertilization

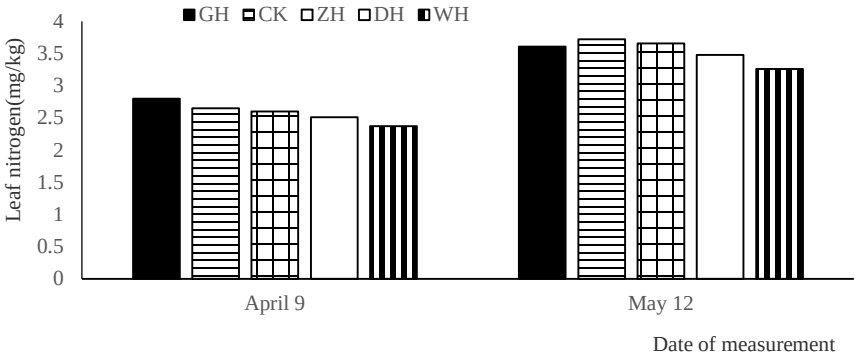

Fig.2 Nitrogen content of wax gourd leaves treated with different fertilization

From figure 1 and 2, we could find that the chlorophyll and nitrogen contents of the wax gourd' leaves were determined on the April 9 in the different fertilization treatments, ranging from 27.07 SPAD to 30.74 SPAD and 2.36 mg/kg to 2.80 mg/kg, and from high to low were

GH>CK>ZH>DH>WH, respectively. The chlorophyll content GH of wax gourd' leaves was significantly higher than WH, and the difference between CK, ZH and DH was not significant. The leaves' nitrogen content of GH was significantly higher than WH. With the growth of wax gourd, the chlorophyll and nitrogen content of leaves increased, and the variation range between different fertilization treatments on May 12 was 41.53 SPAD~44.42 SPAD and 3.36 mg/kg~3.48 mg/kg, respectively, the order of the two indicators was the same, and all were CK> ZH> GH>DH>WH, The different of chlorophyll content of leaves was not significantly between different fertilization treatments, and CK and ZH treatment was significantly higher than WH treatment in the leaves' nitrogen content.

3.3 Effect of Chemical Fertilizer Reduction on Soil' Nutrients. Effect of Chemical Fertilizer Reduction on soil' Total Nutrients.

From table 4, it could be obtained that after the harvest of wax gourd, the soil' total nitrogen and total phosphorus of GH were the highest, which was significantly higher than that of CK and DH. The total potassium content in soil was not significant between different fertilization treatments, and the content of DH was the highest, and the content of WH was the lowest. The organic matter content was the highest in ZH, significantly higher than that in DH and GH, and there was no difference between CK and WH. It showed that the accumulation of total nutrients mainly comes from the input of organic fertilizer and long-term chemical fertilizer. The reduction of chemical fertilizer has little effect on the total nutrient. In addition, one-year data results were not enough.

Table 4 Differences of total nutrient contents in different fertilization treatments' soils[g/kg]

Treatment	Total N	Total P	Total K	OM
CK	2.14bA	3.35bc	0.97aA	39.57abA
DH	2.13bA	3.52bBC	0.98aA	37.55bA
GH	2.52aA	4.01aA	0.97aA	37.72bA
ZH	2.19bA	4.11aA	0.96aA	43.71aA
WH	2.27abA	3.85aAB	0.93aA	40.31abA

3.4 Effect of Chemical Fertilizer Reduction on Soil' Available Nutrients.

From table 4, it could be obtained that after the harvest of wax gourd, the application of chemical fertilizer has a great influence on nitrate nitrogen, and the treatment of CK and DH was significantly higher than that of GH, ZH and WH, and as the amount of chemical fertilizer increases, the soil nitrate nitrogen content increases. The available phosphorus and potassium contents in the soil were at very high levels. The reduction of chemical fertilizer had little effect on available phosphorus and available potassium. The difference of available phosphorus treatment was not significant. The available potassium of the DH treatment was significantly higher than other treatments.The available potassium was the lowest without chemical fertilizer treatment, but it was also at a very high level.

Table 5 Differences of available nutrient contents under different fertilization treatments' soil [mg/kg]

Treatment	Nitrate N	Available P	Available K
CK	31.94 aA	234.23 aA	405.43 bB
DH	31.38 aA	203.41 aA	492.72 aA
GH	17.99 bB	237.13 aA	397.12 bB
ZH	20.18 bB	236.69 aA	378.00 bB
WH	13.86 bB	221.95 aA	372.17 bB

3.5 Effect of Chemical Fertilizer Reduction on Soil' Bulk Density, Etc.

It could be seen from Table 16 that after the harvest of wax gourd, the application of different chemical fertilizers has little effect on the soil bulk density, and the difference between the fertilization treatments was not significant. The soil' pH of CK was the lowest, which was significantly lower than other chemical fertilizer reductions or no chemical fertilizer treatment. The

difference between the other fertilization treatments was not significant. The soil's EC value was also the highest in the CK treatment, and the lowest in the WH treatment without chemical fertilizer. The difference between the CK and WH was significant. The difference in EC value of soil between the other chemical fertilizer reductions treatments was not significant. It showed that long-term application of chemical fertilizers would cause accumulation of soil salinity.

Table 6 Soil sulk density, pH and EC between different fertilization treatments

Treatment	Bulk weight(g/cm)	pH	EC(μs/cm)
CK	1.25 aA	7.68bB	213.93 aA
DH	1.23 aA	7.74aA	204.35 abA
GH	1.21 aA	7.73 aA	170.35 abA
ZH	1.21 aA	7.74 aA	211.55 aA
WH	1.22 aA	7.75 aA	162.08 bA

4. Conclusion

The content of total phosphorus, available phosphorus and available potassium in greenhouse soil was very rich, especially available phosphorus, which was 245.95 mg/kg. On the basis of applying organic fertilizer 28064 kg/hm^2, fertilizer reduced 35%, and had no effect on plant height of wax gourd, and the reduction of chemical fertilizer had little effect on the chlorophyll and nitrogen content of wax gourd leaves. The reduction or non-application of chemical fertilizer had no effect on the contents of total nitrogen, total phosphorus, total potassium and organic matter, and reduced the contents of nitrate nitrogen and available phosphorus, available potassium in soil. Soil bulk density and pH were not significantly different between chemical fertilizer reduction and non-reduction treatment. The soil EC of 100% chemical fertilizer treatment was significantly higher than that without chemical fertilizer treatment. It was suggested that under the condition of greenhouse fertility, urea application should be increased, chemical potassium fertilizer should be reduced, and chemical phosphate fertilizer Could not be applied.

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