Comparison of the Influence of Organic and Conventional Cultivation on Yield and Inner Quality in Spinach (*Spinacia Oleracea* L.)

Jinhua Bao[1a*], Cheng Wang[2b*], Xiangjun Shen[3c], Defeng Zhuang[1d], Eriko Sasakid[4e]

[1]College of Agriculture, Inner Mongolia University for Nationalities, Tongliao 028000, China
[2]College of Life Science and Food Engineering, Inner Mongolia University for Nationalities, Tongliao 028000, China
[3]Agro-Technical Extension and Service Center of Horchin District of Tongliao City, Tongliao 028000, China
[4] Department of Agriculture, Rakuno Gakuen University, Ebetsu 0698501, Japan

Abstract: This essay establishes three factors, i.e. organic fertilizer, chemical fertilizer and organic fertilizer with cow carbide. The purpose of the present study was to elucidate influence of organic fertilizer and chemical fertilizer on yield and inner quality in spinach with fifteen treatments at five levels. The results showed that the contents of reducing sugar and nitrate nitrogen of spinach in organic fertilizer handling area was less than those in chemical fertilizer. No significant difference was found among the fresh weight, total sugar content and vitamin C content by utilization of organic fertilizer or chemical fertilizer.

1 INTRODUCTION

Spinach (*Spinacia oleracea* L.) is a green leafy vegetable belonging to *Chenopodiaceae* family. It can be planted throughout the year with strong adaptability, because of its highly nutritious with a large amount of nutrition components such as vitamins in the products. It plays a very important role in vegetable production and market supply (Liu, 2018). In order to increase yield of spinach, excess chemical fertilizer applications will cause nitrate nitrogen accumulation and decline of the nutrient content, such as sugar and vitamins. The application of organic fertilizers instead of chemical fertilizers not only increases the quality of product and improve the performance but also causes a permanent production (Shiva, 2015). The nitrate nitrogen intake providing people is mainly from vegetables, especially the leafy vegetables. Excessive accumulation of nitrate nitrogen in vegetables will potentially endanger our health (Meguro, 1991). In the present study, spinach will be cultivated by organic fertilizer and chemical fertilizer, respectively. Mixed application of organic manure and inorganic fertilizer in production must select suitable proportion, which could reduce nitrate content in fruit and make vegetable quality and yield be greatly improved. The influence of fertilizer on yield and inner quality will be studied, and it maybe provide foundation for high quality production of spinach.

Based on the relation between the amount of fertilizer and fresh weight, phosphate fertilizer was shown that it can affect growth of spinach greatly. Therefore, to eliminate influence of the phosphate fertilizer on the growth, compound fertilizer "organic fertilizer with cow carbide" was employed in our studies.

2 MATERIALS AND METHODS

2.1.Testing Material

The variety (ribiera) was supplied by Sapporo Kawata Chamber of Commerce, the tested soil was the topsoil of gray upland soils collecting from Sapporo city of Hokkaido, Japan.

2.2.Testing Conditions and Design

The experiment was made in a glass greenhouse of Rakuno Gakuen University Junior College in Hokkaidou, Japan. Plastic culture slots (pot, 0.02 m^2) were adopted in the experiment and each one was filled with 2.74 kg soil. We set three factors: Organic fertilizer, chemical fertilizer, organic fertilizer plus cow-carbide and five levels: N 0g/pot, N 0.5 g/pot, 1N g/pot, 2N g/pot, 4N g/pot, respectively. In this experiment, the P content in cow-carbide was applied by the same amount of conversion with that of N 0.5 g/pot used in organic fertilizer.

2.3.Test Methods

2.3.1.Sampling Method

Spinach should be harvest at the forty-first day. The aerial parts of different kinds of treatments were

[a*]jinhuabao@hotmail.com, [b*]wangcheng@imun.edu.cn,
[c] shenxiangjun-cool@126.com, [d] defengzhxinxiang@126.com,
[e] sasakieriko@hotmail.com

collected at the same time. Then, the average value of fresh weight was used to calculate yield with three times repeat. The materials should be stored in the refrigerator at -20℃.

2.3.2.Quality Determination Method

Four steps of quality determination were included as follows: (1) Grind fresh samples into homogenate, extract the homogenate by active ion water, then use high-speed liquid ion machine to measure nitrate content. (2) Extract fresh samples by 5% metaphosphoric acid solution and use the DNP method (2,4-dinitrophenylhydrazine colorimetry) to measure vitamin C content. (3) Put those fresh samples into alcohol (70%), and extract them in boiling water for 40 min, then measure the sugar content by anthracenone colorimetry. (4) Measure the reducing sugar content by high-speed liquid anion switch method.

2.3.3.Data Statistics and Analysis

The Excel 2010 software was adopted for statistics and data analysis.

3 RESULTS

3.1. Influence of Organic and Chemical Fertilizer on the Fresh Weight of Spinach

The results indicated that the fresh weight in the processing area of organic fertilizer was significant higher than that of chemical fertilizer. The relationship between the content of total nitrogen absorbed by spinach, and the fresh weight was investigated, it was shown that there was no relevant with the kinds of fertilizers (Fig. 1), and the fresh weight had a certain increase along with the increase of N content absorption.

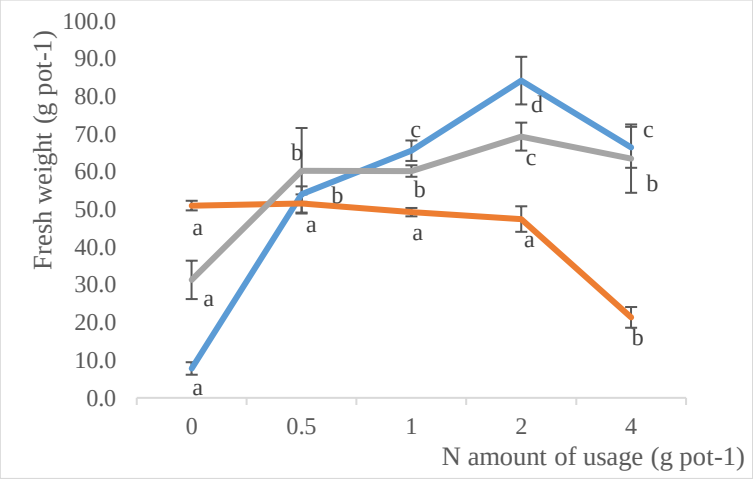

Fig.1 The relations of fresh weight and N usage in spinach

3.2. Influence of Organic and Chemical Fertilizer on the Content of Total Sugar in Spinach

Total sugar content in the processing area of chemical fertilizer had no significant difference compared with that of organic fertilizer. The results of statistical analysis indicated that total sugar content had no correlation to N absorptive amount of spinach, and the correlation coefficient R^2 was only 0.1664. However, there was no obvious differences in total sugar content along with the N absorptive amount changed, in spite of different fertilizers applied (Fig. 2).

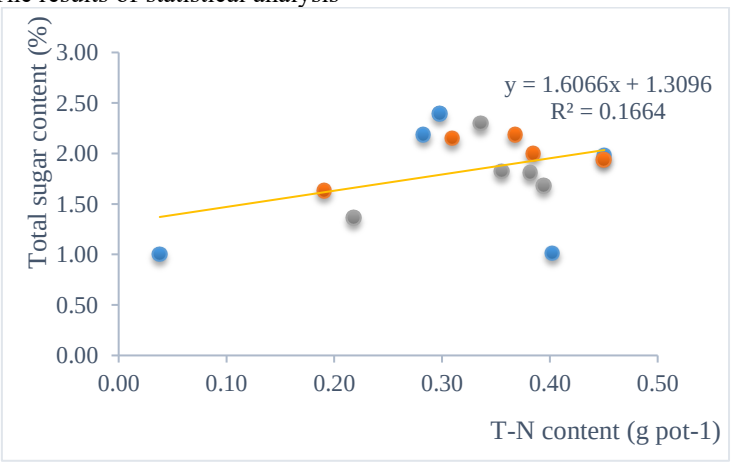

Fig.2 The relations of total sugar content and T-N content in spinach

3.3. Influence of Organic and Chemical Fertilizer on Reducing Sugar Content of Spinach

In the process of reducing sugar content and application of N fertilizer, there was no interaction effect between the application of different fertilizers and application of N fertilizer. While compared with N absorptive amount and reducing sugar content, reducing sugar content in the treatment area of chemical fertilizer was significantly higher than that of the organic fertilizer.

3.4. Influence of Organic and Chemical Fertilizer on The Content of Vitamin C in Spinach

Due to the application of different fertilizers, the content of vitamin C varied with the change of N fertilizer reached a very significant level. But, there was no significant correlation in N absorption and the content of vitamin C, which the correlation coefficient R^2 was only 0.215 (Fig. 3). That is, relative to a certain amount of N absorption, the content of vitamin C had no significant difference whether chemical fertilizer or organic fertilizer was applied.

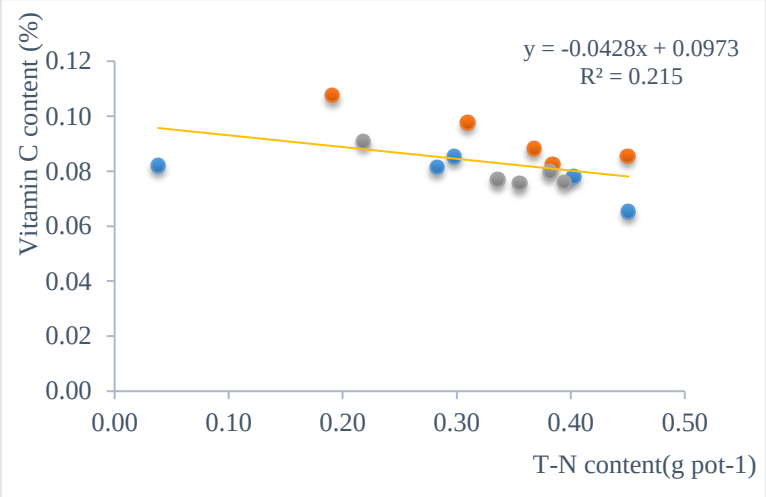

Fig.3 The relations of Vitamin C content and T-N content in spinach

3.5. Influence of Organic and Chemical Fertilizer on the Content of Nitrate Nitrogen in Spinach

The results showed that the content of nitrate nitrogen was not correlated with the N absorption, but nitrate nitrogen was easily accumulated in the processing area of chemical fertilizer while it was difficult to accumulate in the processing area of organic fertilizer. In other words, the content of nitrate nitrogen will be dramatic changes based on the difference in the application of chemical fertilizer or organic fertilizer.

4 DISCUSSION

In this study, whatever organic fertilizer or chemical fertilizer was applied, the fresh weight of spinach had a positive correlation with nitrogen absorption, fresh weight increased along with the increase of employing nitrogen amount of spinach. In addition, there was no significant difference in fresh weight with the increasing of chemical fertilizer application amount. But different results were appeared on the organic processing area. One of the reasons for the phenomenon occurred might be appropriate concentration of electro conductidity (EC) value had reached a harmful status in the processing area of applying chemical fertilizers, which affected the nitrogen absorption and the increasing of fresh weight. While in organic fertilizer processing area, EC value was far less than chemical fertilizer processing area, which resulted in the process of plant itself absorbing N became slow. Because of the excess absorption, N fertilizer excess hazard appeared only in the treatment area (N 4.0 g/pot). At present, there were some reports that it can be directly absorbed phosphate buffer extractable organic nitrogen (PEON) in spinach (Matsumoto, 2000; Miyazawa, 2008), and it will make fresh weight increase in the organic fertilizer processing area, the other reason was may be the influence of variation in different spinach. Otherwise, molasses+organic fertilizer had highly significant result in soil organic carbon content (SOC), nitrogen, potassium, soil pH and yield of spinach (Anish, 2019). Fish manure application with ammonium nitrate treatment provided maximum spinach yield (Ekinci, 2019). In our studies, total sugar content and vitamin C content were not relevant with N absorption amount. There were no significant differences in vitamin C content between chemical fertilizer processing area and organic fertilizer processing area.

Spinach was considered as one of the most important leafy vegetables with nitrate accumulation, a report found low content of the nitric acid via organic cultivation (Koh, 2012). The reason may be considered as the process of organic fertilizer decomposed into soluble nitrogen was carried out before harvest, and the nitric acid content was absorbed at that time. In this study, the nitric acid content in chemical fertilizer processing area was significantly higher than in organic fertilizer processing area. This may be the efficiency of organic fertilizer was slow-release which can not completely play a role in a short time. And organic fertilizer must be decomposed into available nutrients via

micro-organisms gradually, then to be absorbed and applied by spinach.

Reducing sugar content in fertilizer processing area is significantly higher than in organic fertilizer processing area, different fertilizer processing approach will influence the component of spinach. Our studies were carried out in summer and autumn, therefore, it was essential to analyze whether the same results can be clarified by using the different varieties or different periods of one year in future.

5 CONCLUSION

In summary, it was shown that fresh weight of spinach was higher in organic cultivation than in conventional cultivation. There was no significant difference in the content of total sugar and vitamin C. Meanwhile, the contents of reducing sugar and nitric acid generated in conventional cultivation were significantly higher than those in organic cultivation. Our studies were carried out in summer and autumn, therefore, it was essential to analyze whether the same results can be clarified by using the different varieties or different periods of one year in future.

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