ISSN: 2710-0588

Effects of Nitrogen Reduction Combined with Organic Fertilizer on Crops

Hua Zhuang[1,2,*], Ying Wang[1,2]

[1] Shaanxi Provincial Land Engineering Construction Group Co., Ltd., China

[2] Institute of Land Engineering and Technology, Shaanxi Provincial Land Engineering Construction Group Co., Ltd., China

*46504782@qq.com

Abstract

By summarizing the methods of nitrogen fertilizer reduction combined with organic fertilizer, this paper discussed and analyzed the effects of nitrogen fertilizer reduction combined with organic fertilizer on soil carbon and nitrogen content and biological activity of crops, mastered the soil carbon and nitrogen retention capacity of orchards, clarified the relationship between fruit trees and soil environment, and established the optimal effect equation between fertilizer application and yield. It is of great scientific significance to provide theoretical basis and technical support for optimizing fertilizer application in orchards and realizing "zero growth" and "double reduction" of nitrogen fertilizer.

Keywords

Nitrogen Fertilizer; Organic Fertilizer; Soil Carbon.

1. Introduction

Nitrogen is the mineral element with the largest nutrient requirement in plants, which plays an important role in plant organ construction, material metabolism, yield formation and quality. Therefore, many farmers hold the idea of "high input, high yield and high benefit", blindly applying excessive nitrogen fertilizer in order to obtain higher yield.

However, the more nitrogen application is not the better. Excessive nitrogen application is not only likely to cause excessive vegetative growth, delayed flower bud differentiation, reduced number, resulting in tree canopy closure and reduced yield, but also lead to a series of problems such as decreased nitrogen utilization rate, soil ecology and nutrient imbalance, and environmental pollution, resulting in a large amount of resource waste and increased production costs. To this end, China put forward the "zero growth of fertilizer use by 2020 action Plan" in 2015, as far as nitrogen fertilizer is concerned, the use of organic fertilizer to replace nitrogen fertilizer and effectively improve nitrogen utilization rate is the key to achieve "zero growth of fertilizer" and environmental "double reduction" (reduce emissions and reduce pollution). Soil carbon and nitrogen cycles are the most basic ecological processes in farmland ecosystems, and they are interrelated and influence each other. 95% of nitrogen in soil exists in organic form, and the content level of soil carbon often determines the content level of soil nitrogen.

However, in the process of planting management, there exists the phenomenon of excessive application of nitrogen fertilizer in order to obtain high yield, but with the continuous increase of nitrogen fertilizer dosage, there appears the phenomenon of diminishing returns of nitrogen fertilizer effect, and the yield increase effect of nitrogen fertilizer gradually declines, and the utilization rate of fertilizer decreases. Although it is possible to improve the utilization rate of

ISSN: 2710-0588

nitrogen fertilizer by applying less nitrogen fertilizer, it is not the best economic benefit. Therefore, it is essential to take into account the high yield, stable yield, high quality and environmental friendliness of the orchard, achieve green production, and improve soil quality and nutrient utilization efficiency through various measures.

2. Organization of the Text

2.1. Effects of Application of Organic Fertilizer on Soil Organic Carbon Components

Soil organic carbon can be divided into many components according to different grouping methods. The more common and important component for the evaluation of soil quality and management measures is soil active carbon, which has an important impact on the circulation of soil organic matter and the release of soil nutrients. It mainly includes microbial biomass carbon (MBC), water-soluble organic carbon (WSOC), hot water-soluble organic carbon (HWC), easily oxidized organic carbon (ROC) and granular organic carbon (POC). Although soil MBC only accounts for 0.5% to 4.6% of the total soil organic carbon, it is the most active and changeable part of soil organic carbon, and can be used as the driving force for the decomposition and circulation of soil organic matter [1]. Long-term application of chemical fertilizer in farmland will gradually degrade soil quality and reduce soil organic carbon content. However, the application of organic fertilizer can promote the growth of soil organic carbon and stimulate the activity of soil microorganisms, thus greatly affecting the changes of each component of soil organic carbon [2]. Xu et al. [3] showed that the application of organic materials could improve the activity of soil microorganisms and increase the content of MBC, and the effect was positively correlated with the amount of organic materials, and the effect of manure was greater than that of crop straw. Liang Yao et al. [4] applied different organic materials to fertilizing black soil in Northeast China for 6 years and found that combined application of organic fertilizer with chemical fertilizer significantly increased TOC, MBC, WSOC and light organic carbon contents in soil, among which combined application of corn straw with chemical fertilizer increased TOC and light organic carbon by 26% and 136% respectively. Combined application of pig manure with fertilizer increased MBC and WSOC by 52% and 85%, respectively. Liang et al. [5] found that compared with no fertilization and single fertilizer application, the application of farm manure could significantly increase TOC content in 0-30 cm soil layer and WSOC, MBC, HWC, ROC and POC in 0-20 cm soil layer, in which the contents of POC and HWC had the strongest response to the application of farm manure.

2.2. Effects of Organic Fertilizer Application on Soil Nitrogen Components

The variation of soil TN is small, which is usually used to measure the basic fertility of soil nitrogen. Soil nitrogen supply capacity can be achieved by measuring soil available nitrogen (NO_3^--N, NH_4^+-N and hydrolyzed nitrogen). Soil NO_3^--N and NH_4^+-N can be directly absorbed and utilized by plants as inorganic nitrogen. Hydrolyzed nitrogen is the sum of NO_3^--N, NH_4^+-N, amino acids, amides and easily hydrolyzed protein nitrogen, which can reflect the supply of soil nitrogen in the near future. Soil microbial biomass nitrogen (MBN) is the nitrogen fixed by microbial bodies in soil. Different from NO_3^--N and NH_4^+-N, MBN exists in soil as a reserve nitrogen. It is the most active and significant evaluation index reflecting organic nitrogen, and plays an important regulatory role in nitrogen cycling and transformation in soil. The effect of fertilizer application on increasing soil TN content is weak, because the utilization rate of inorganic nitrogen fertilizer in soil is low, nitrogen is mostly lost through leaching, volatilization and other ways, and the application of fertilizer can only increase its effectiveness on crops in the season. The application of organic fertilizer can significantly increase the content of soil TN and its components [6]. In contrast to inorganic nitrogen fertilizer, although the nitrogen applied by organic fertilizer is less effective for crops in the current season, it will

ISSN: 2710-0588

increase the residual nitrogen in the soil. Zhang Yuling et al. [7] found through 16 years of long-term positioning experiment that single application of chemical fertilizer reduced soil TN content, but combined application of chemical fertilizer and organic fertilizer increased soil TN and MBN content significantly. Witter et al. [8] also proved that long-term application of organic materials, such as crop straw, green manure and farm manure, would significantly increase soil MBN content through long-term positioning tests of up to 30 years. In addition, Wu Guanyun et al. [9] believed that long-term application of organic fertilizer would reduce the relative content of hydrolyzed nitrogen in soil, but Han Xiaori[10]found that the application of organic fertilizer would significantly increase the content of ammonia nitrogen and amino sugar nitrogen in soil, and the mineralization effect of soil organic nitrogen would also be correspondingly enhanced.

2.3. Effects of Organic Fertilizer Application on Soil Biological Properties

The excessive application of chemical fertilizer leads to the decrease of fertilizer utilization rate, nutrient imbalance and soil fertility, which affects the sustainable development of agriculture [11]. Organic fertilizer is rich in nutrients and organic matter, which can enhance soil biological activity, improve soil physical and chemical properties [12-14], improve soil quality and improve crop quality [15-16]. Reasonable combination of organic and inorganic application can take into account the advantages of quick effectiveness of inorganic fertilizer and nutrient persistence of organic fertilizer, and improve the balance of soil nutrients [17-19]. Yang et al. [20] found that the application of organic fertilizer significantly increased the number and activity of soil microorganisms. Ellert et al. [21] found that the application of organic fertilizer changed the community structure and activity of soil microorganisms, and significantly increased the number of soil fungi, bacteria and actinomycetes. In addition, the application of organic fertilizer can also promote soil microorganisms to participate in the decomposition and transformation of organic matter, nutrient circulation, energy flow, and almost all soil life processes that affect biodiversity and ecosystem functions, ultimately affecting soil fertility and soil productivity [22].

Application of organic materials can also affect soil enzyme activity by changing soil water, heat and microbial system. Deng and Tabatabai [23] found that returning wheat and corn stalks to the field could increase the activities of acid and alkaline phosphatase, phosphomonesterase, pyrophosphatase and glucanase in soil. Mandal et al. [24] pointed out that the phosphatase activity in soil treated with long-term fertilizer combined with farm manure and straw was higher than that treated with single fertilizer. Sun Ruilian et al. [25] found that organic fertilizer combined with chemical fertilizer could significantly improve the activities of soil invertase, urease and phosphatase. Corn straw can improve the activity of soil invertase. The study of Wang Mei et al. [26] also showed that the application of organic fertilizer could significantly increase the activities of soil urease, sucrase and phosphatase. It can be seen that the application of organic fertilizer is of great significance to the mineralization and decomposition of soil organic matter and to the promotion of nutrient cycling and bioavailability.

2.4. Effects of Fertilization on Root System

As a dynamic interface between above-ground parts of plants and soil, forest root is an important hub connecting trees and the external environment. Its spatial structure and distribution characteristics are closely related to the availability of soil resources [27-28]. Root growth is water-oriented and fertilizing-oriented. Within a certain range, with the increase of soil moisture content and nutrient content, roots will grow in places with water and fertilizer, and their distribution will also increase. If the water level is lower or higher than a certain level, root growth will be unfavorable and even root growth will be stagnant. Soil nutrient availability is closely related to the morphological characteristics of fine roots. Nitrogen and phosphorus in soil are important nutrients affecting the morphology of fine roots, so a lot of researches have been carried out at home and abroad.

ISSN: 2710-0588

The results of the study showed that increasing the availability of nutrients, the fine roots in the root system could grow rapidly and produce no The same branching structure to adapt to environmental changes caused by increased availability of soil resources, in particular.

Under the condition of insufficient soil nutrient availability, the plasticity of fine roots is more significant [29] The increase of soil nitrogen availability can promote the growth of fine roots and change the morphology of fine roots Diameter thickens and specific root length decreases [30]. Cheng Yunhuan et al. [31] showed that with the increase of nitrogen content, Fine roots (< 2mm) root length density, increased than root length. Mei Li et al. [32] discovered Manchus aspergillus.

The fine root biomass and root length density of Larch and Larch were positively correlated with nitrogen, and the nitrate nitrogen was paired 2 The effects of fine root biomass and root length density on tree species were greater than that of ammonium nitrogen, and greater than that of root length and rapid efficiency There was no significant correlation with nitrogen. Most plant roots contribute to the spatial heterogeneity of soil nutrients The different plasticity of the response, thus gaining a greater competitive advantage, while some plant roots can The plastic response is weak, so soil resources should be increased in woodland ecosystems with different site conditions Root systems of forest trees may respond differently to source availability [33-34]. Therefore, if you want to study fertilization If the root distribution of forest trees is affected, it is necessary to know whether the local soil resources can be full The growth of foot trees.

Acknowledgments

This paper was supported by the Open Project Program of State Key Laboratory of Crop Stress Biology for Arid Areas (CSBAA202301), Agricultural and tourism resource integration and its spatial effect under the construction of unmanned farm(DJNY-2024-40).

References

[1] Wang Cuiping. Study on the relationship between soil microbial biomass carbon and organic carbon mineralization [J]. Guangdong Agricultural Sciences Journal of Science, 2013,40(11): 52-54.

[2] Bhattacharya, S. S., Kim, K. H., Das, S., et al. A review on the role of organic inputs in maintaining the soil carbon pool of the terrestrial ecosystem [J]. Journal of Environmental Management, 2016, 167:214-227.

[3] Xu, Y.. , Liu, H., Wang, X., et al. Changes in organic carbon index of grey desert soil in northwest china after long term fertilization [J]. Journal of Integrative Agriculture, 2014,13:554-561.

[4] Liang Yao, Han Xiaozeng, Song Chun, et al. Effect of different organic materials returning to field on active organic carbon of black soil in Northeast China [J] Chinese Journal of Agricultural Sciences, 2011,44(17):3565-3574.

[5] Liang, Q., Chen, H., Gong, Y., et al. Effects of 15 years of manure and inorganic fertilizers on soil organic carbon fractions in a wheat-maize system in the North China Plain [J]. Nutrient Cycling in Agroecosystems, 2011, 92:21-33.

[6] Zhao Dandan. Effects of long-term crop rotation and fertilization on changes of soil carbon and nitrogen pool in dry farmland [D]. Northwest University,Xi 'an, 2017.

[7] Zhang Yuling, Zhang Yulong, Yu Na, et al. Relationship between mineralized nitrogen and microbial biomass nitrogen in paddy soil under different fertilization measures Journal of Soil and Water Conservation, 2007,21(4) :117-121. (in Chinese).

[8] Witter, E., Martensson, A. M., Garcia, F. V. Size of the soil microbial biomass in a long-term field experiment as affected by different N-fertilizers and organic manures [J]. Soil Biology and Biochemistry, 1993,25:659-669.

[9] Wu Guanyun. Morphology, distribution and decomposition ability of soil organic nitrogen [J]. Chinese Journal of Soil Science, 1986,30(02) : 59-60.90-95.

[10] HAN Xiaori, Chen Enfeng, Guo Pengcheng, et al. Effects of long-term fertilization on crop yield and soil nitrogen fertility [J]. Soil Bulletin, 1995,39(06) : 244-246+252.

[11] ZHOU J, GUAN D, ZHOU B, et al. Influence of 34-years of fertilization on bacterial communities in an intensively cultivated black soil in northeast China [J].Soil Biology and Biochemistry, 2015, 90:42-51.

[12] CHEN D, YUAN L, LIU Y, et al. Long-term application of manures plus Chemical fertilizers sustained high rice yield and improved soil chemical and bacterial properties [J]. European Journal of Agronomy, 2017, 90: 34–42.

[13] Wei Wenliang, Liu Lu, Qiu Henghao. Combined application of organic and inorganic fertilizers on yield and nitrogen utilization of main grain crops in China Journal of Plant Nutrition and Fertilizer, 20,26(8):1384-1394. (in Chinese).

[14] ZHAO J, NI T, LI J, et al. Effects of organic –inorganic compound fertilizer with reduced chemical fertilizer application on crop yields, soil biological activity and bacterial community structure in arice-wheat cropping system [J]. Applied Soil Ecology, 2016, 99: 1-12.

[15] SHI Y, LIU X, ZHANG Q, et al. Biochar and organic fertilizer changed the ammonia-oxidizing bacteria and archaea community structure of saline-alkali soil in the North China Plain [J]. Journal of Soils and Sediments, 2020,(20): 12-23.

[16] Tang Hong, Zeng Zhiyuan, Zhang Yangzhu, et al. Effects of chemical nitrogen fertilizer combined with organic fertilizer on tobacco quality, nitrogen uptake and utilization [J]. Journal of North China Agricultural Sciences, 2019,34(4):183-191.

[17] LV Fenglian, Hou Miaomiao, Zhang Hongtao, et al. Organic fertilizer substitution in soil wheat - summer maize rotation system Journal of Plant Nutrition and Fertilizer, 2018,24(1):22-32. (in Chinese).

[18] LUAN H, GAO W, HUANG S, et al. Partial substitution of chemical fertilizer with organic amendments affects soil organic carbon composition and stability in a greenhouse vegetable production system [J]. Soil and Tillage Research, 2019, 191:185-196.

[19] JI L, NI K, WU Z, et al. Effect of organic substitution rates on soil quality and fungal community composition in a tea plantation with long-term fertilization [J].Biology and Fertility of Soils, 2020, 56:633−646.

[20] Yang, X., Meng, J., Lan, Y., et al.Effects of maize stover and its biochar on soil CO2 emissions and labile organic carbon fractions in Northeast China [J]. Agriculture,Ecosystems & Environment, 2017,240:24-31.

[21] Ellert, B. F. H., Clapperton, M. F. J., Anderson, D. F. W. An ecosystem perspective of soil quality [J]. Developments in Soil Science, 1997,25:115-142.

[22] Pang Xin, Zhang Fusuo, Wang Jingguo. Effects of different nitrogen supply levels on rhizosphere microbial biomass nitrogen and microbial activity [J]. Plant Nutrition and Fertilizer Journal, 2000,6(4) :476-480. (in Chinese).

[23] Deng, S. P., Tabatabai, M. A. Effect of tillage and residue management on enzyme activities in soils .1. Amidohydrolases [J]. Biology and Fertility of Soils,1996, 22:202-207.

[24] Mandal, A., Patra, A. K., Singh, D., et al. Effect of long-term application of manure and fertilizer on biological and biochemical activities in soil during crop development stages [J]. Bioresource technology, 2007,98:3585-3592.

[25] Sun Ruilian, Zhao Bingqiang, Zhu Lusheng, et al. Effects of long-term location fertilization on soil enzyme activity and its regulation in soil Plant Nutrition and Fertilizer Journal, 2003,9(4):406-410. (in Chinese).

[26] Wang Mei, Xu Shaozhuo, Liu Yusong, et al. Biochar combined with organic fertilizer can improve soil environment and reduce apple continuous cropping Journal of Plant Nutrition and Fertilizer, 2018,24(1):220-227. (in Chinese).

ISSN: 2710-0588

[27] Zhao Jingwen, Zhang Naiwen, Wang Hong, et al. Effects of different soil surface management measures on root distribution characteristics of pear trees [J].Plant Nutrition and Fertilizer Journal, 2014, 20(1): 164-171.

[28] Hu Tingzhang, He Shuai, Huang Xiaoyun, et al. The transport and signaling function of nitrate transporters in plants [J]Chinese Journal of Biological Physiology, 2009, 45(11): 1131-1136.

[29] Crawford N M, Glass A D M. Molecular and physio logical aspects of nitrate up take in plants [J]. Trends in Plant Science,1998, 3: 389-395.

[30] Dai Tingbo, Cao Weixing, Sun Chuanfan, et al. Effects of increased ammonium nutrition on photosynthesis, nitrate reductase and glutamyl in wheat Effects of amine synthase [J]. Chinese Journal of Applied Ecology, 2003, 14(9): 1529-1532. (in Chinese).

[31] Kang Xiaoyu, Sun Xieping, Chang Cong, et al. Effects of nitrogen forms on seedling growth of different apple rootstocks [J]. Northwest Agriculture Journal of Forest University of Science and Technology: Natural Science Edition, 2013, 41(6): 133-138.

[32] WANG Qing-cheng. Spatial distribution of fine roots of larch and ash in the mixed plantation stand [J]. Journal of Forestry Research, 2002,13(4): 265-268. (in Chinese).

[33] Guo DL., Robert J. Mitchell, Joseph J. Hendricks. Fine root branch orders respond differently to carbon [J]. Oecologia, 2004,140:450457.

[34] Ding Guoquan, Yu Lizhong, Wang Zhiquan. Effect of fertilization on fine root morphology of Japanese Larch [J]. Northeast Forestry University Journal of Science,2010,38(5):16-19.