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Present Situation, Existing Problems and Recommendations for Orchard Fertilization Technology

Shuwei WEI, Shaomin WANG*, Yao TONG, Xiaochang DONG, Ran DONG, Hongwei WANG, Kun RAN, Yong ZHANG

Shandong Institute of Pomology, Tai'an 271000, China

Abstract This paper summarizes the development process and research status of orchard fertilization technology, introduces many kinds of fertilization methods, such as soil testing and fertilizer recommendation method, and nutrition diagnosis method, probes into the main problems existing in orchard fertilization, and puts forward some suggestions for solving them. The development of orchard fertilization technology in China is also projected.

Key words Orchard, Fertilization technology, Recommendations

1 Introduction

China has a long history of fruit tree planting, with planting area and yield at the front ranks of the world fruit planting^[1]. Fertilization is an important job in orchard planting, which not only relates to the yield and quality of fruit, but also plays an important role in maintaining tree health and ensuring high quality and stable yield^[2]. Improper fertilization in fruit tree production will not only lead to low yield and poor quality, affect the economic benefits of fruit farmers, but also lead to the waste of water and fertilizer resources, which is not conducive to the sustainable development of the industry^[3]. However, at present, there are many problems in fruit tree production in China, such as improper fertilization time, unreasonable ratio of fertilizers and application rate of fertilizers, and unscientific fertilization methods. In this paper, the present situation of orchard fertilization technology, the methods of orchard fertilization, the existing problems and suggestions for orchard fertilization are summarized in order to provide reference for production.

2 Development status of orchard fertilization technology

Before the 18th century, fruit farmers usually managed the water and fertilizer for fruit trees according to their own planting experience. The main fertilizer used in this period was organic fertilizer. With the rapid development of chemical industry, crops generally used chemical fertilizer to increase production and income. Most fruit farmers applied chemical fertilizer blindly in pursuit of benefits, resulting in chemical fertilizer and pesticide residues in fruits. At the same time, excessive fertilizer in soil caused serious

soil acidification and salinization^[5]. Since the 1980s, with the rapid development of orchard industry, the blind application of single chemical fertilizer has been unable to meet the requirements of industrial development. After a lot of research and in-depth exploration, there have been many fertilization methods and technical means, including fertilization based on soil testing and fertilizer recommendation method, and fertilization based on nutrition diagnosis method.

2.1 Fertilization based on soil testing and fertilizer recommendation

Fertilization based on soil testing and fertilizer recommendation is to calculate the amount of fertilizer needed according to the difference between the total amount of nitrogen, phosphorus and potassium required by the fruit trees to be planted in the whole orchard and the content of nitrogen, phosphorus and potassium in the orchard soil as well as the amount of nitrogen, phosphorus and potassium contained in fertilizer. Fertilization based on soil testing and fertilizer recommendation is the result of comprehensive application of modern agricultural science and technology, its core is to adjust and solve the contradiction between crop fertilizer demand and soil fertilizer supply, supplement the nutrient elements needed by crops, balance nutrient supply and reduce fertilizer application at the same time, so as to increase crop yield and improve fruit quality^[6]. In many experiments, it is proved that this is a scientific fertilization method, and the effect of fertilization is good. However, in the actual operation process, it is more complex, difficult to grasp, and it does not consider the impact of fertilizer conversion ratio, geographical environmental factors and biological characteristics so as to give full play to the maximum effect of mixed fertilizer.

2.2 Fertilization based on nutrition diagnosis

Plant nutrition diagnosis is a fertilization technique based on plant nutrition chemistry, which can be divided into two kinds; morphological diagnosis and chemical diagnosis^[7]. As the name implies, morphological diagnosis is based on the shape of fruit trees, without any

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* Corresponding author. E-mail: sdipwsm@163.com

equipment, but it also has its limitations. First of all, there are certain requirements for the experience and judgment of orchard managers. Secondly, when changes in the appearance of fruit trees are observed, fruit trees have been victimized, which may lead to problems such as yield reduction or fruit quality decline. Finally, the change of fruit tree appearance may correspond to a variety of fruit tree damage factors, and it is difficult to distinguish^[8]. Chemical diagnosis is to determine the growth status of plants by detecting the content of various elements in soil and plants by chemical analysis, which is convenient and accurate. For example, the nutritional nitrogen content of different plant organs can be measured by means of chemical analysis^[9]. Then, by comparing with the critical value of nitrogen content, it is concluded whether the plant organs are deficient in nitrogen, and then we can make the corresponding fertilization decision according to the result of the judgment. This method is widely used in the United States, Germany, Britain and other developed countries^[10]. In addition, Tong Yueao^[11] believes that the determination and analysis of the content of various elements in soil by means of chemical analysis can reflect the nutrient surplus and loss of trees, which is helpful for us to find out the reasons for the lack of elements. For example, fruit trees are prone to iron deficiency in calcareous soil, but we may also find that the excessive content of CO_3^{2-} in soil may lead to the decrease of iron absorption capacity of roots and lead to the symptoms of iron deficiency.

3 Problems in orchard fertilization

3.1 Too little or improper application of organic fertilizer

Because fruit farmers do not have a scientific understanding of the type and amount of fertilizer needed by fruit trees, they usually only judge according to their own experience, and lack nutritional diagnosis of fruit trees. This may lead to the application of a large amount of N, P, K, urea and other chemical fertilizers to fruit trees^[12]. Excessive application of chemical fertilizer cannot improve the yield and fruit quality of fruit trees, and long-term application of chemical fertilizer will destroy the aggregate structure of soil, which is easy to make the soil compacted and the fertilizer efficiency reduced. In addition, excessive application of chemical fertilizer and neglect of the application of organic fertilizer will make fruit trees more prone to diseases and pests, and thus lead to low fruit yield and poor quality. Nowadays, most of the organic fertilizers used in rural areas come from animal feces rich in organic matter. This kind of farm manure is a slow-acting fertilizer, it needs to be thoroughly decomposed before being absorbed and utilized directly by the roots of plants. If the undecomposed farm manure is applied directly, the heat generated by the decomposing process is easy to burn the roots of fruit trees. In addition, farm manure will absorb a large amount of N in the process of decomposing, resulting in the decrease of soil N efficiency. Moreover, the undecomposed farm manure contains tumblebug, peach fruitborer, Japanese pear lace bug and other pests and some seeds of weeds, which will lead to all kinds of diseases

and pests in fruit trees if it is directly used^[13].

3.2 Unreasonable fertilization ratio and fertilizer application rate

Rational fertilization is one of the important factors to increase fruit yield and improve fruit quality. The application of fertilizer is not the more the better, if the amount of fertilizer application exceeds the amount needed for the growth and development of fruit trees, it will easily lead to the imbalance of nutrition absorption of fruit trees, excessive vegetative growth of fruit trees, lower yield and lower economic income of fruit farmers. For example, in some areas rich in water resources, orchard managers usually use the irrigation and fertilization method of "much fertilizer and much water" to plant and manage fruit trees, resulting in too fast growth of fruit trees, wasting nutrients, affecting their flower bud differentiation, and causing serious water environmental pollution. Moreover, fruit trees need to apply different fertilizers at different growth stages. The fruit farmers often apply fertilizer only when they are idle, resulting in the application of the wrong fertilizer at the wrong time. For example, in the application of undecomposed organic fertilizer in winter, due to the low soil temperature in winter, organic fertilizer needs a long time to be decomposed, and it cannot achieve the purpose of replenishing nutrients for fruit trees in time, easy to cause unnecessary economic losses.

3.3 Unscientific methods of fertilization

At present, most fruit farmers use the method of hole application to fertilize fruit trees, so the depth of fertilization is easily affected by the depth of hole. If the fertilization is in too deep soil, beyond the distribution layer of the root system of fruit trees, it will lead to the waste of fertilizer. If the fertilization is in too shallow soil, because the root system tends to nutrients for growth, it will lead to root floating, thus reducing the ability of drought and waterlogging resistance and lodging resistance of fruit trees. In addition, because fruit trees mainly absorb nutrients through the root cap of the root system, if the distance between fertilizers applied by fruit farmers and fruit trees is too short, it will lead to a large amount of nutrient loss. Moreover, some fruit farmers' fertilization to the fruit tree is too concentrated, and if one-time fertilizer application is too much, it is easy to cause root injury phenomenon, and is not conducive to the healthy growth of fruit trees.

4 Recommendations for orchard fertilization

4.1 Increasing the application rate of organic fertilizer after decomposing

Before applying organic fertilizer, the undecomposed organic fertilizer should be composted first, and the microorganisms should be fully decomposed, and the high temperature of the decomposing process can also kill the parasites, eggs, weed seeds and pathogenic microorganisms hidden in the fertilizer. After decomposing, fruit trees should be fertilized in time to reduce the loss of organic fertilizer efficiency. In addition to applying decomposed compost and manure, fruit farmers can also increase the content of organic matter in fruit tree soil and improve the aggregate structure of soil by means of grass mulc-

hing and straw crushing and deep burying. In addition, the application of organic fertilizer and appropriate amount of biological fertilizer can not only improve the efficiency of fruit trees to absorb nutrients, but also transform the harmful substances in organic fertilizer that may cause damage to the fruit trees.

4.2 Rational fertilization Rational fertilization is the application of corresponding fertilizer in the critical period of fruit trees in order to meet the nutrition needed for the normal growth and development of fruit trees. Fertilization is mainly based on base fertilizer, supplemented by topdressing fertilizer, and chemical fertilizer and organic fertilizer are combined for application, which can ensure the maximization of soil nutrition^[14]. Generally speaking, in September, basic fertilizer should be applied to fruit trees, and topdressing to fruit trees should be emphasized in three stages: flower bud differentiation, flowering, fruit expansion and autumn shoot stop. In the process of fertilization, we should not only pay attention to the application of N, P, K fertilizer, but also pay attention to the application of organic fertilizer and micro-fertilizer. Moreover, the application rate of fertilizer should be comprehensively considered according to the variety, growth stage and soil quality of fruit trees. For example, peach trees need more N and K fertilizer, while the amount of P fertilizer is less, while the application rate of N, P and K in apple is close to 2:1:2. Moreover, the mixed application of some fertilizers can improve the fertilizer absorption efficiency of fruit trees. For example, calcium superphosphate can be mixed with organic fertilizer, but the mixed application of some fertilizers will cause the loss of fertilizer efficiency, such as the mixed application of plant ash and N fertilizer, resulting in the failure of ammonium nitrogen in N fertilizer.

4.3 Scientific fertilization Scientific fertilization is another important factor to improve fruit yield and fruit quality. Traditional fertilization methods include ring fertilization, strip fertilization, and radial fertilization. This not only requires a lot of manpower, but also may hurt fruit trees in digging ditches due to less experience, and fertilizer cannot be effectively transferred to the root cap of fruit trees. It is also possible that due to the high concentration of local chemical fertilizer, it may damage the roots of fruit trees. In this regard, we can use a fertilizer gun to fertilize fruit trees. It can realize accurate fertilization, so it saves fertilizer and has fast fertilization effect, and because of its convenient operation, it greatly reduces the human input and losses to the root of fruit trees. It can be used with pesticides at the same time, to save time and effort, and reduce environmental pollution. In addition, the fertilization for fruit trees can also be managed by fertilization machinery. At present, foreign countries have developed fertilization machinery that can adjust the depth of ditch, such as the automatic regulation system of fertilization depth developed by Saeya *et al.* based on ultrasonic sensor^[15-16]. When fruit trees have the symptoms of lack of a certain nutrient element, underground fertilization cannot timely supplement the missing elements of fruit trees, and we can use

foliar fertilization method. Foliar fertilization has a high utilization rate and rapid effect, especially on the symptoms of iron deficiency, boron deficiency and zinc deficiency^[17].

4.4 Promoting soil testing and fertilizer recommendation technology and precision irrigation and fertilization technology The optimal fertilizer application rate of fruit trees is determined by the growth status of fruit trees, the amount of fertilizer needed and the condition of soil. By using the technology of soil testing and fertilizer recommendation, fruit farmers can apply the most appropriate amount of fertilizer. This not only reduces the cost of fertilizer, but also greatly improves the yield and quality of fruit, thus improving the economic benefits of fruit farmers. At present, many fruit farmers only pay attention to the application of N and P fertilizer, but ignore the supplement of K fertilizer for fruit trees. This will not only reduce the quality of the fruit, but also acidify the soil, which is not conducive to the sustainable planting of fruit trees. The technology of soil testing and fertilizer recommendation is a technology of scientific fertilization for fruit trees according to the expected yield level and growth based on the measured value of soil nutrients. The fruit trees under this kind of fertilization generally have the characteristics of strong stress resistance, high fruit quality and strong economic effect^[18]. Precision irrigation and fertilization is an advanced irrigation and fertilization technology to transport nutrient solution to crops through irrigation system. It is the product of the combination of precision fertilization and precision irrigation^[19-20]. The advanced detection means are mainly used to realize the digital and networked real-time monitoring of each growth stage of crops. At the same time, advanced technologies such as 3S (GPS, GIS, RS) and computer are used to predict crop growth trend, soil moisture, climate factors and so on. According to the monitoring results, combined with the requirements of crop growth and development, accurate automatic technical facilities are used for irrigation and fertilization, and the best water and fertilizer resources are used in exchange for the best and highest yield of crops. At the same time, it is also conducive to maintaining soil fertility and promoting the sustainable development of agriculture^[21].

5 Prospect

Fruit tree industry plays an important role in agricultural production in China. The key to the sustainable development of fruit industry in China is to study how to improve the yield and quality of fruit trees through scientific and reasonable fertilization technology while ensuring the efficient utilization of water and fertilizer resources and the effective solving of environmental pollution. Compared with the developed countries, China still lags behind in the research of scientific fertilization technology. It is necessary to strengthen the research on the fertilization technology of orchard, actively popularize the technology of precision irrigation and fertilization in orchard, improve the economic income of fruit farmers and promote the healthy development of fruit tree industry in China.

the money to the bid-winning enterprise account through the bank in time, and checks and summarizes the *Promotion and Management Account of Insecticide-spreading Instrument Purchase* in each village. After confirming that it is correct, it shall be reported to the Agricultural and Rural Bureau together with the bank bills, the video materials of the pesticide purchase site and the public photos with the official seal. It is strictly forbidden to sell the bid-winning products through the sales outlets of the bid-winning enterprises.

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