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Study on interaction effect between root and soil of apple tree

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ABSTRACT

As an important organ for plant absorption, channelling, synthesis, storage, secretion, regulation, fixation and support, root system plays an important role in plant growth and development. The root system is particularly important for perennial tree trees, it is the base and center of the overall development of the tree. Although people are well aware of the interrelationship between above and below ground growth, especially under adverse soil conditions, they encounter various problems involving water, nutrients and ecology, which affect the development state of apple tree roots, and thus restrict the effectiveness of apple tree production. However, under the conditions of field production, the root system of apple trees is affected by soil physicochemical properties, biological ecological factors and their trees The combined influence of the other parts of the body shows the extreme complexity of the biological space-time effect, and The root system is distributed underground, perennial, with complex structure and huge system, which makes the observation and research more difficult It is difficult, so people's research on it is far less in-depth, systematic and comprehensive than that on the ground.

Soil management measures in agricultural production work through the root system, which directly determines the development state and production level of apple trees. Therefore, this paper provides theoretical basis and technical support for the healthy and sustainable development of apple industry and fundamental guarantee for the healthy and sustainable development of apple by summarizing the research progress of the root-soil effect of apple trees.

Apple trees are an important part of agriculture. With the adjustment of rural industrial structure and the opening of agricultural products market, planting apple trees according to local conditions has brought considerable economic benefits to farmers. Apple trees have strong adaptability, not only can be planted in plain areas, but also can grow in hills, deserts and other areas. Apple trees can not only increase income, but also prevent soil erosion, increase green space coverage, and regulate microclimate. In addition, the apple contains a variety of essential nutrients for human growth and development, and the apple itself and its seeds also have medicinal effects. With the development of social economy and the improvement of people's living standards, the demand for apple is increasing, and the quality of apple is also put forward higher requirements. Nutrients, water and temperature are the main factors affecting apple quality, but soil management, pruning and ecological factors also directly or indirectly affect apple quality. Among them, roots are the only bridge between apple trees and the interaction of water, fertilizer, gas and heat in the soil. The water and nutrients required for the growth and development of apple trees and various physiological active substances synthesized are completed by roots. The distribution form of roots can reflect the

utilization and productivity of substances and energy in the soil by apple trees, and the root system also has the potential to improve apple quality.

KEYWORDS

The Root-soil effect; Apple tree; Roots

1. INTRODUCTION

Apple (Malus pumila Mill.) is an apple plant in the rose family, because of its strong adaptability, sweet and crisp taste, rich in a variety of nutrients, easy storage and transportation of fruits and other advantages, by the vast number of people love, in the world's large-scale cultivation and production. China's apple cultivation area and output are ranked first in the world, is one of the world's important apple exporters. In 2020, China's apple cultivation area will reach 2.088 million hectares, and the output will be 44.0661 million tons. The development of the apple industry has become an important part of China's rural revitalization and successful poverty alleviation [1-2].

Shaanxi is located in the western inland of China, with high terrain in the north and south and low terrain in the middle. Due to its superior natural conditions such as warm climate, moderate rainfall and sufficient sunlight, Shaanxi is extremely suitable for apple cultivation, and has been recognized by FAO as the best apple growth area in the world [3]. The planting area and output of Shaanxi apple producing areas rank first among the five major producing areas, with 621,100 hectares of apple cultivation area and 12.424,600 tons of output in 2021. Because of its unique advantages, Shaanxi Apple has become a well-known brand in the world and belongs to one of China's landmark products. After the "14th Five-Year Plan" national planting industry development Plan was put forward, the development of China's apple industry entered a new period. The plan clearly requires that food security continue to be the core, the implementation of the strategy of storing grain in the land, firmly grasp the cultivated land area, resolutely not touch the red line of 1.8 billion mu of cultivated land, and put an end to the "non-agricultural" and "non-grain" of cultivated land. If the apple industry wants to continue its advantageous regional development, diversified development and high-quality development without competing with grain land, it can take the direction of "planting apples on the mountain to ensure ecology" [4]. Therefore, increasing efforts to develop mountain apple is an important measure for the development of China's apple industry.

2. ORGANIZATION OF THE TEXT

2.1. Research on root morphological characteristics

Root diameter, specific root length and surface area are important indexes of root morphology, which are mainly affected by plant heritage transfer factor control and influence of external environmental factors. Root morphology is an important measure of plant productivity factors [5], which play an important role in maintaining the physiological function of roots. Root morphology not only determines nutrition the fractional absorption rate can be used to evaluate the nutrient absorption capacity of the root system, and due to its ability to Plasticity, greatly affected by external environmental factors [6-7], in the case of low nutrient availability, It can also be used to evaluate the nutrient absorption capacity of roots. Heterogeneity of root morphology in woody plants In particular, the mean diameter and root length of fine roots in the root system vary with the root order The specific root length and average surface area decreased with the increase of root order Among the 5 root orders, the average diameter of the first root is the smallest, the root length is the shortest, and the specific root length is the highest The opposite is true of roots [8-14].

2.2. Research on root distribution characteristics

Plant growth and development can not be separated from the root system, which can supply crops by absorbing water and nutrients. Many researchers at home and abroad have studied the distribution of root length density in the range of root distribution. Abdullah et al. [15] studied the root distribution of the two dwarfing apple varieties under different irrigation methods, and the results showed that the rootstock had shallow roots, and the roots were distributed near the center of the trunk at a depth of 50 cm horizontally and 40 cm vertically. The effective root depth began to increase with the increase of tree age. Sokalska et al. [16] studied the spatial root distribution of mature apple trees and showed that the use of drip irrigation could change the underground morphological characteristics of roots, and the root distribution in the soil under drip irrigation was relatively shallow. In some areas, drip irrigation encourages root concentrations in wet areas.

In temperate climates, irrigation also promotes root growth, which may be accentuated if water and fertilizer are used together with drip irrigation [17].

Different kinds of fruit trees have different root distribution because of their own physiological function and structure. However, from the perspective of horizontal direction and different soil depth, plant roots mostly clustered in a certain range, and the overall density gradually decreased with the increase of horizontal or vertical distance. Hao Zhongyong et al. [18] found that the root system of 7-year old Fuji apple gradually decreased with the increase of depth and distance from the trunk. Fan Chonghui et al. [19] studied the underground growth of seven-year-old kiwifruit by trench method, and the results showed that the number of whiskle-roots of kiwifruit was large and dense, and the roots concentrated in a small horizontal range. Liu Hongzhang et al. [20] found that the main roots of sea-buckthorn were concentrated in shallow soil ranging from 0 to 60 cm. Zhang Jinsong et al. [21] investigated the radial and vertical distribution of pomegranate roots, and found that in both vertical and horizontal directions, the root length density gradually decreased with the increase of distance. In the horizontal direction, the roots were concentrated in the 0-100 cm soil of the fruit tree. Li Nan et al. [22] found that the root length density, biomass and surface area of Korla fragrant pear all decreased with the increase of radial distance, and the vertical distribution was stratified.

2.3. Research on root biomass

Root biomass is affected by tree species composition, age and many environmental factors (soil nutrients, water, temperature and soil animals, etc.) [23]. The amount of root biomass directly reflects the amount of nutrients absorbed by roots from the soil bank. The results showed that temperate coniferous forests had the deepest root distribution.

The root biomass within 30cm accounted for about 50% of the total biomass, while the root distribution of the boreal forest was the shallowest, and the root biomass within 30cm accounted for about 80%-90% of the total biomass [24]. The root distribution of temperate deciduous broadleaved forest is also shallow, with more than 80% of the root biomass distributed in the soil layer less than 20cm, while less than 20% of the root biomass distributed in the deep soil [25]. The vertical distribution of tree roots is mainly due to the higher temperature of the upper soil and the higher content of available nutrients in the soil, which is conducive to the growth and absorption of fine roots. On the other hand, the lower soil temperature and poor soil texture are not conducive to the growth of fine roots [26]. Therefore, increasing soil temperature and nutrient availability can promote the distribution of fine roots to deeper soil.

The distribution of roots in the horizontal direction is highly differentiated, and the law is not obvious. However, after a certain distance from the tree base, the distribution of roots becomes more and more sparse, and the decrease trend is obvious. The distribution of root biomass is inversely proportional to the distance from trees, and more than 80% of the root biomass of trees is concentrated within 2m around the trunk [27]. In the roots of Larix larix and Birch forests, the maximum value of fine root

biomass appeared at the midpoint of the projection edge of the trunk and crown, and the minimum value appeared near the trunk

The biomass of fine roots at the edge of the canopy projection was in the middle [28]. However, Yang Xiuyun et al. [29] fell on North China

The study results of fine root biomass of each diameter class in the root of pine leaf showed that the fine root biomass was in the distance from the trunk

At different horizontal distances (0.2m, 0.5m, 1.0m from the tree base, respectively), the differences did not reach significant level. The study of Gan Zhuoting et al. [30] also showed that the sampling was carried out in circular arcs with different radii from apple trees there was no obvious directional difference in the spatial distribution of fine roots.

2.4. Root-Soil interaction effect

The growth and development of roots depend on the suitable soil environment and the supply of nutrients, and the relationship between roots and soil is bound to be "mutually beneficial". The root system is an important organ of the plant, which performs functions such as fixation, transport, storage, absorption, synthesis and distribution. The growth of the above-ground part of the plant depends on the water, mineral nutrients and growth active substances of the root system, and the photosynthetic products of the above-ground part are transported to the root system. The occurrence and formation of root system depends on the carbohydrate supplied by the root system, and the carbon assimilation and growth of the root system depend on the mineral nutrients, water and hormones supplied by the root system. At the same time, plant roots often make physiological responses to the environment to adapt to changing environmental conditions, activate and absorb mineral elements in the soil through root secretion, and change the intensity of water metabolism in the body through osmosis and elastic regulation. The sustainable production of plants must be built on the basis of good roots and strong plants. As an important substrate for plant growth, soil not only provides essential mineral nutrients, water, air and microorganisms for plant growth, but also serves as an important place for material and energy exchange in the ecosystem [31]. Soil texture affects the growth and development of plant roots by influencing the movement and content of heat, air, water and nutrients in soil. The root system has the function of absorbing water and nutrients, and plays an important role in regulating the growth and development of crops. Crop yield is closely related to root growth, and larger biomass can obtain higher biological yield. The root system ADAPTS to the environment by adjusting its diameter. Therefore, root morphological characteristics (including root length density, root diameter, root tip number, etc.) play an important role in determining nutrient and water absorption efficiency.

The relationship between apple root and soil environment interaction and the key factors affecting root vitality were clarified to provide theoretical basis and technical support for the healthy and sustainable development of apple industry, and provide fundamental guarantee for the healthy and sustainable development of apple.

Therefore, it is very important and necessary to strengthen the research of fruit tree root biology and formulate reasonable cultivation measures on this basis to create good soil nutrient space for roots.

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